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Description

This invention relates to rotary tools of the type used in rotating or "wrenching" fasteners such as bolts and screws having polygonal (e.g., square or hexagonal) heads. The invention particularly relates to tools capable of wrenching fastener heads designed, sized or marked in various measuring systems such as the metric system, the English or inch system such as the American fractional system (AF and SAE), and the British systems such as BA, BS and Whitworth (W).

The tools have a uniquely configured opening for receiving a polygonal head of a threaded member.

Many countries have adopted the metric measuring system for the manufacture of bolts, screws, nuts and wrenches. Such countries as France, Germany, Italy, Japan, Czechoslovakia and Russia today almost exclusively utilize the metric system for such manufactures. The United States, Canada, England, Australia, New Zealand and the like, use measuring systems based upon both the English (inch) and metric measuring systems.

National standards or specifications have been adopted by many technically developed countries for sockets and other wrenches. These standards, which differ at least in part from one another, include SAE, ASTM, MIL, GGG-W, BS, FS, DIN, JS, CSN, JUS, and GOST. No uniform international standard has yet been accepted, although more than fifteen years have been devoted to the effort to reach a standard acceptable to all technically developed countries. Great Britain, for example, presently uses up to six different systems for marking spanners, sockets and other wrenches. The United States predominantly uses the English (inch) system (AF, ANSI, MIL and SAE) and, to some extent, the metric system (millimeters). The diversity in such standards has limited the development of new types of bolts, nuts and wrenching tools. Periodic reviews and revisions of such standards have not produced the necessary changes to cover rapid development of a new type of wrenches, and the issuance of new, updated standards often takes over fifteen years. Consequently, a vast number of different wrenching tools of various designs, openings and tolerances are manufactured throughout the world. A user is subjected to a never-ending inventory of wrenching tools to accommodate all of the sizes and measuring systems in existence today. This is costly and inconvenient for individuals and for industry in general.

One attempt to simplify this situation is found in U.S. Patent 4,100,824 which desribes a wrench with a non-uniform interior configuration having one set of grooves sized in the English system and another set of grooves sized in the metric system. This patent does not address the problems created through the use of various additional measuring systems. Care needs to be taken with this system to insert the bolt or nut head in the correct set of grooves, and this wrenching system, moreover, generally is not suitable for use in impact or power sockets or in open end wrenches and British sized spanners and sockets.

U.S.Patent 3 027 790 discloses a wrench having several moving parts as adaptors and does not appear to represent a practical solution to the problem, since professionals and serious amateurs appear to prefer solid one-piece wrenching tools with no extraneous parts.

US-A-3 125 910 (Kavalar) discloses a wrench corresponding to the preamble of the appended claim 1, and having an opening to receive a nut or other polygonal head, the opening consisting of inwardly and outwardly projecting lobes. The wrench, in use, applies pressure against flat faces of the nut by means of the inwardly extending lobes contacting the nut faces at specific locations. Moreover, a variance of more than 5° from that specific contact location has deleterious consequences. Kavalar makes no reference or suggestion that the tool disclosed is of any value in meeting the requirement for a wrench for use with polygonal heads sized according to two or more measuring systems. The present invention now provides a means of satisfying that requirement.

Accordingly, the present invention provides a rotary wrenching tool having an opening for receiving a polygonal head of a threaded member, wherein:

the opening has an axis of rotation and has an inner surface comprising a series of first surfaces concave to said axis of rotation and spaced about the circumference of the opening, and a series of second surfaces convex to said axis of rotation and spaced about the circumference of the opening, successive ones of said first surfaces being disposed between successive ones of said second surfaces around the circumference;

each of the first surfaces is arcuate and is defined as the locus of points falling a given radial distance "r" from a first axis "a" itself spaced a distance "r_1" from, but parallel to, said axis of rotation;

each of the second surfaces is arcuate and is defined as the locus of points falling a radial distance R from a second axis spaced itself a distance "R_1" from, but parallel to, said axis of rotation; and

the dimensions and dispositions of the second surfaces are such that, in use, the contact made by the wrenching tool with the polygonal head is a contact between the arcuate second surfaces and the sides of the polygonal head of the threaded member;

characterised in that:

each surface that forms part of the inner surface of the opening and is contiguous to an arcuate surface merges tangentially into that arcuate surface; and

the angular relationship between r_1 and R_1 is such that if r is equal to R the wrench includes flat surfaces between and tangentially merging with the first and second surfaces.

There have now been devised, according to the present invention, rotary wrenching tools having the ability to tighten or loosen two or more, for example up to six, different sizes of fasteners, without damage to either tool or fastener.

With regard to the dimensions of the wrenching tool, R_1 desirably is larger than r_1, and in the case where each second axis is angularly spaced from at least one next adjacent second axis by 60°, the ratio R_1/r_1 desirablyexceeds 1.5 and preferably exceeds 2.0. In this case also, R is desirably equal to or greater than r, and the ratio R/r preferably exceeds about 5.0. Also in this embodiment in which each second axis is angularly spaced by 60° from at least one next adjacent second axis, the adjacent arcuate surfaces preferably merge tangentially into one another. The terms "arc" and "arcuate" used herein refer to circles.

The second axes of the embodiments described above may, if desired, be spaced from one another by 45° or by 90° to thereby provide an opening accommodating square heads of threaded members. Inwardly convex arcuate surfaces of different sizes may be interspersed with one another.

The rotary wrenching tools of the invention preferably have head-contacting interiors sized to strongly and adequately grip polygonal fastener heads sized in two, preferably three, and up to six different nominal sizes. The ratio (determined as described above) for tools accepting square heads ranges from 1.0001 to about 1.1430 and for tools accepting hexagonal heads ranges from 1.0001 to about 1.0600. Also as the wrench opening sizes are varied (for example Figures 17, 18, 19,), the included angle between any adjacent flats preferably is also varied to better accommodate fastener heads sized in different sizing systems.

In a preferred form the wrenching tools of the invention are simple, single piece rotary wrenching tools having uniform interior configurations and no moving parts and which are specifically sized for turning fasteners (nuts, screws, bolts, etc.) having square, hexagonal or other polygonal heads such that one tool size is capable of strongly and adequately fitting polygonal heads nominally sized in at least two and up to six different nominal sizes and up to seven different system markings. By "rotary tool", "spanner" or "wrench", as used herein, reference is made to tools having openings which completely or partially encircle or encompass the polygonal heads of threaded fasteners such as bolts and screws to rotate the fasteners. Thus, such tools may be of the socket variety in which the rotary tool opening completely encircles the head of the threaded member and is moved into such position axially of the threaded member, or may be of the spanner or open-end wrench variety in which the rotary tool opening only partially encircles the head of the threaded member and may be moved into its wrenching position in a direction generally normal to the axis of the threaded member. Rotary tools include such tools as may commonly be referred to as socket wrenches, box-end spanners, ratcheting box-end, open end, nut drivers, flare-nut, lug-nut, crowfoot and combination wrenches, impact and power socket wrenches, flex-head wrenches, etc.

In a preferred form of the invention wrenching tools are adapted for use with threaded members having square heads and are so sized as to accommodate maximum and minimum sized square-headed members such that the maximum ratio of the nominal distance across opposing flats of such maximum and minimum square-headed members ranges from about 1.0053 to about 1.1430. Similarly, wrenching tools adapted for use with threaded members having hexagonal heads are so sized as to accommodate maximum and minimum sized hexagonal headed members such that the maximum ratio of the nominal distance across opposing flats of such maximum and minimum sized members ranges from about 1.0053 to about 1.0600. Visible indicia are preferably carried adjacent each wrench opening, such indicia comprising at least two and preferably three or more specific but different nominal sizes in at least two different sizing systems.

There are now described, by way of example and with reference to the accompanying drawings, a wrenching tool (also referred to as "wrenching system" or "wrench") according to preferred embodiments (Figures 15 - 21) of the present invention, some of those embodiments being described, for the sake of comparison, with reference to wrenching tools (Figures 1 - 14) of the prior art.

In the drawings:

Figure 1 is a broken-away plan view of a conventional two-contact point drive wrench, the wrench flats making contact with corners of a square or hexagonal bolt head as shown in phantom lines;

Figure 2 is a broken-away plan view of a conventional three-contact point drive wrench similar to that of Figure 1;

Figure 3 is a broken-away plan view of a conventional four-contact point drive wrench similar to that of Figures 1 and 2;

Figure 4 is a broken-away plan view of a conventional wrench similar to that of Figure 1 but having internal wrench flats designed for turning square bolt heads;

Figure 5 is a broken-away plan view of a conventional six-driving point wrench described in British Patent 508,761 for use with hexagonal bolt heads and which avoids contact with corners of a bolt head;

Figure 6 is a broken-away plan view of a conventional twelve-contact point drive wrench for turning hexagonal headed bolts;

Figure 7 is a broken-away plan view of a twelve-contact point wrench designed to contact hexagonal bolt heads without corner contact, of the type described in U.S. Patent 3,125,910 (Kavalar);

Figure 8 is a broken-away plan view of a twelve-point drive wrench which does not contact corners of a hexagonal bolt, one type of which is shown in U.S. Patents 3,272,430 and 3,495,485;

Figure 9 is a broken-away plan view of a twelve-contact point wrenching system of the type shown in U.S. Patent 3,079,819;

Figure 10 is a broken-away plan view of a two-contact point wrench driving square and hexagonal nuts;

Figure 11 is a broken-away plan view of a four-contact point wrench similar to that of Figure 10;

Figure 12 is a broken-away plan view of a three-contact point wrench of the type described in U.S. Patent 3,695,124, used for hexagonal bolt heads and, which does not contact the corners of the heads, in a manner similar to that shown in Figures 10 and 11;

Figure 13 is a broken-away plan view of a six-contact point drive wrench used for hexagonal bolt heads and which does not contact the corners of the heads;

Figure 14 is a broken-away plan view of a twelve-point "spline" drive wrench of the type shown in U.S. Patent 3,675,516, used for turning splined members and also hexagonal bolt heads;

Figure 15 is a broken-away plan view of a novel six-contact point wrenching tool;

Figure 16 is a broken-away plan view of a novel six-contact point wrenching tool;

Figure 17 is a broken-away plan view of a novel four-contact point drive wrench for turning square bolt heads;

Figure 18 is a broken-away plan view of a novel eight-contact point drive wrench for use with square bolt heads;

Figure 19 is a broken-away plan view of a novel six-contact point drive wrenching system;

Figure 20 is a broken-away plan view of a novel eighteen-contact point drive wrenching system for turning hexagonal bolt heads;

Figure 21 is a broken-away plan view of a novel twenty-four-contact point drive wrench;

To aid in understanding the concept of rotary wrenching tools in general, a brief explanation is given below of the contact that occurs between the working surfaces of a rotary wrenching tool and a nut or bolt head. With reference to the conventional wrench of Figure 1, for example, the wrench (10) has wrench flats (11), (12) which are spaced apart a sufficient distance to loosely accommodate the confronting flat surfaces (13), (14) of a hexagonal bolt, shown in phantom lines. If the wrench is turned in the direction of arrow A, it will be understood that the wrench flats bear against the corners of the bolt head, rather than upon the flat surfaces of the bolt head; this is referred to as "corner contact", and use of wrenches of this type can readily score and round the corners of bolt heads, particularly hexagonal bolt heads. With wrenches of the type shown in Figure 7, on the other hand, the interior surface of the wrench opening makes contact not with the corners of the bolt head but rather at points (actually, lines) along the length of the flat bolt head edges. The rounded lobes (15) of the wrench (16) initially make line contact with the bolt head, but as pressure is applied, the bolt head edges are deformed slightly so that contact between the lobes and the bolt head occurs over a broader surface. Although certain wrench configurations, such as that depicted in Figure 8, have been advertised as providing "flat-to-flat" surface contact with hexagonal bolt heads, it will be understood that tolerances in the manufacture of both the wrench and the bolt heads prevent such contact from in fact being along the full surface of the wrench flats, such contact being in fact a line contact until the bolt head is suitably deformed by sharp edges of the wrench. Note that the wrench of Figure 8, in a manner similar to that shown in Figure 5, employs recessed portions to accommodate corners edges of fastener heads to thereby avoid corner contact with the heads.

With reference to the tools exemplified in the drawings, such tools are characterized as having uniform interior configuration. That is, similarly configured interior surface elements (e.g., lobes) are radially spaced the same distance from the axis of the wrenching tool opening. For example, the lobes (15) depicted in Figure 7 are equally radially spaced from the axis X.

The present invention provides rotary wrenching tools which have no moving parts and which are specifically sized for turning fasteners such as nuts, screws and bolts that have square, hexagonal or other polygonal heads. These wrenching tools are characterized by being capable of strongly and adequately fitting polygonal heads nominally sized in at least two different systems such as, for example, the American

Fractional standard ("AF") and the British Standards ("BS", for example), and preferably carrying at least two and preferably three or more suitable size markings in different size systems. That is, the rotary wrenching tools of the invention fit polygonal fastener heads such that scoring or rounding of the heads does not occur even when substantial wrenching torque is applied thereto. Such strong and adequate fitting of the tool to the head of the fastener is such that the application of excessive substantial wrenching torque is more apt to cause physical breakage of the fastener head from the threaded stem of the fastener, or simply cause the deformation ("stripping") of the stem threads. Of particular importance to this embodiment of the invention are those wrenches which have head-confronting surfaces that are contoured to provide recesses opposite corners of the heads to thereby avoid contact with the head corners. Most preferably, the head-confronting surfaces of the rotary tool are provided with inwardly protruding, rounded lobes positioned to encounter the head of a fastening member along flat surfaces of the head, rather than at its corners, the lobe, upon the application of substantial torque, tending to slightly deform the flat surfaces of the head to provide surface-to-surface contact between the wrench and head.

The driving heads of bolts and similar fastening members can be sized in the metric system (e.g., mm) and also in inches using American Fractional ("AF") standards (SAE, MIL, etc.) and British standards such as "BS", "BA" and "W" (Whitworth) measurements. The wrenches preferably are sized so as strongly and adequately accommodate fastener heads of at least two different nominal sizes such that the ratio of the nominal distances across opposing head surfaces falls, in the case of square heads, within the range of about 1.0053 to about 1.1430, and, in the case of hexagonal heads, with the range of about 1.0053 to about 1.0600.

Table I set out below provides a non-inclusive, exemplary list of nominal head openings and size combinations for square and hexagonal head fasteners. Referring, for ease of explanation, to the first entry in the table, this entry describes a wrench which will fully and adequately engage the polygonal head of a threaded fastener that has the nominal dimensions of 1.5mm & 1/16 (AF, U.S. standard) & 16 BA (British standard). As shown in the table, 1/16 inches converts to 1.5875 millimeters. 16 BA, in the British standard, corresponds to 1.4224mm. 1.5mm, in the metric system, is, of course, 1.5mm. The maximum ratio of the maximum nominal distance across flats (1.5875) to the minimum nominal distance across flats (1.4224) is 1.1161, and this is recorded in the final column of the table. As further explanation, the last entry in the table refers to a fastener head having a nominal distance across opposing flats of 220mm. The wrench of the invention, suitably sized, also fully and adequately fits fastener heads sized in the U.S. American Fractional system as 8 5/8" & 8 3/4". The latter nominal values correspond to 219.0731mm and 222.2481mm, respectively. The maximum ratio of the maximum nominal size to the minimum nominal size hence is 222.2481/219.0731, or 1.0145. The ratios thus referred to are calculated according to the following formula:

$$\text{Ratio} = \frac{\text{maximum nominal head size in millimeters}}{\text{minimum nominal head size in millimeters}}$$

TABLE I

WRENCH MARKINGS AND SIZE COMBINATIONS FOR SQUARE AND HEXAGONAL NUTS AND BOLT AND SCREW HEADS

Nominal Head Dimensions and Size Combinations					Nominal Size (in mm.)			RATIO
METRIC (in mm.)	ENGLISH in INCHES							
	US Standard	British Standard			US Standard	British Standard		Maximum
	AF & SAE	BA	W Whit-Worth	BS	AF & SAE	BA	W & BS	
1.5 & -	1/16 & -	16BA	-	-	1.5875	1.4224	-	1.1161
1.5 & -	1/16 -	-	-	-	1.5875	-	-	1.0583
1.5 & -	- -	16BA	-	-	-	1.4224	-	1.0546
- -	1/16 & -	16BA	-	-	1.5875	1.4224	-	1.1161
1.5 & -	1/16 & -	15BA	-	-	1.5875	1.5748	-	1.0583
1.5 & -	- -	15BA	-	-	-	1.5748	-	1.0498
- -	1/16 & -	15BA	-	-	1.5875	1.5748	-	1.0081
- -	1/16 & -	14BA	-	-	1.5875	1.7526	-	1.1040
2 & -	5/64 & -	14BA	-	-	1.9844	1.7526	-	1.1412
2 & -	5/64 & -	-	-	-	1.9844	-	-	1.0079
- -	5/64 & -	14BA	-	-	1.9844	1.7526	-	1.1323
2 & -	- -	14BA	-	-	-	1.7526	-	1.1412
2 & -	5/64 & -	13BA	-	-	1.9844	2.1082	-	1.0624
2 & -	- -	13BA	-	-	- -	2.1082	-	1.0541
- -	5/64 & -	13BA	-	-	1.9844	2.1082	-	1.0624
2 & -	- -	12BA	-	-	-	2.2860	-	1.1430
2.5 & -	3/32 & -	12BA	-	-	2.3812	2.2860	-	1.0936
2.5 & -	3/32 -	-	-	-	2.3812	-	-	1.0499
2.5 & -	- -	12BA	-	-	-	2.2860	-	1.0936
- -	3/32 & -	12BA	-	-	2.3812	2.2860	-	1.0416
2.5 & -	3/32 & -	11BA	-	-	2.3812	2.6162	-	1.0987
2.5 & -	- -	11BA	-	-	-	2.6162	-	1.0465
- -	3/32 & -	11BA	-	-	2.3812	2.6162	-	1.0987
3 & -	7/64 & -	10BA	-	-	2.7781	2.9718	-	1.0799
3 & -	7/64 -	-	-	-	2.7781	-	-	1.0799
3 & -	- -	10BA	-	-	-	2.9718	-	1.0095
- -	7/64 & -	10BA	-	-	2.7781	2.9718	-	1.0691

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TABLE I (Continued)

WRENCH MARKINGS AND SIZE COMBINATIONS FOR SQUARE AND HEXAGONAL NUTS AND BOLTS AND SCREW HEADS

Nominal Head Dimensions and Size Combinations							Nominal Size (in mm.)				RATIO
		ENGLISH in INCHES									
METRIC (in mm.)		US Standard	British Standard				US Standard	British Standard			
		AF & SAE	BA	W Whitworth	BS		AF & SAE	BA	W & BS Standard		maximum
3.2 &	3 &	1/8	-	-	-		3.1750	-	-		1.0667
3.2 &	-	1/8 &	9BA	-	-		3.1750	3.3274	-		1.0480
3.2 &	-	1/8	-	-	-		3.1750	-	-		1.0079
3.2 &	-	-	9BA	-	-		-	3.3274	-		1.0398
-	-	1/8 &	9BA	-	-		3.1750	3.3274	-		1.0480
3.5 &	-	9/64 &	9BA	-	-		3.5718	3.3274	-		1.0735
3.5 &	-	9/64	-	-	-		3.5718	-	-		1.0205
3.5 &	-	-	9BA	-	-		-	3.3274	-		1.0519
-	-	9/64 &	9BA	-	-		3.5718	3.3274	-		1.0735
4 &	-	5/32 &	8BA	-	-		3.9687	3.8608	-		1.0363
4 &	-	5/32	-	-	-		3.9687	-	-		1.0079
4 &	-	-	8BA	-	-		-	3.8608	-		1.0363
-	-	5/32 &	8BA	-	-		3.9687	3.8608	-		1.0282
4.5 &	-	3/16 &	7BA	-	-		4.7625	4.3688	-		1.0898
4.5 &	-	3/16	-	-	-		4.7625	-	-		1.0583
4.5 &	-	-	7BA	-	-		-	4.3688	-		1.0297
-	-	3/16 &	7BA	-	-		4.7625	4.3688	-		1.0898
4.8 &	-	3/16 &	6BA	-	-		4.7625	4.9021	-		1.0290
4.8 &	-	3/16 &	-	-	-		4.7625	-	-		1.0079
4.8 &	-	-	6BA	-	-		-	4.9021	-		1.0213
-	-	3/16 &	6BA	-	-		4.7625	4.9021	-		1.0289
5 &	-	3/16 &	6BA	-	-		4.7625	4.9021	-		1.0499
5 &	-	3/16	-	-	-		4.7625	-	-		1.0499
-	-	3/16 &	6BA	-	-		4.7625	4.9021	-		1.0289
5 &	-	-	6BA	-	-		-	4.9021	-		1.0204
5 &	-	13/64 &	6BA	-	-		5.1593	4.9021	-		1.0529
5 &	-	13/64	-	-	-		5.1593	-	-		1.0319
-	-	13/64 &	6BA	-	-		5.1593	4.9021	-		1.0529

TABLE I (Continued)
WRENCH ~~MARKINGS~~ AND SIZE COMBINATIONS FOR
SQUARE AND HEXAGONAL NUTS AND BOLT AND SCREW HEADS

Nominal Head Dimensions and Size Combinations					Nominal Size (in mm.)			RATIO
METRIC (in mm.)	ENGLISH in INCHES				US Standard	British Standard		
	US Standard	British Standard						
	AF & SAE	BA	W Whitworth	BS	AF & SAE	BA	W & BS	Maximum
5.5 & –	7/32 & –	5BA	–	–	5.5562	5.5888	–	1.0164
5.5 & –	7/32 & –	–	–	–	5.5562	–	–	1.0102
5.5 & –	– –	5BA	–	–	–	5.5888	–	1.0164
– –	7/32 –	5BA	–	–	5.5562	5.5888	–	1.0061
6 & –	1/4 –	–	–	–	6.3499	–	–	1.0583
6 & –	1/4 & –	4BA	–	–	6.3499	6.2991	–	1.0583
7 & –	9/32 –	–	–	–	7.1437	–	–	1.0205
7 & –	9/32 & –	3BA	3/32W &	1/8BS	7.1437	7.1627	7.5437	1.0777
8 & –	5/16 –	–	–	–	7.9374	–	–	1.0079
8 & –	5/16 & –	2BA	–	–	7.9374	8.2295	–	1.0368
9 & –	11/32 –	–	–	–	8.7312	–	–	1.0308
9 & –	– –	–	1/8W &	3/16BS	–	–	8.6359	1.0422
9 & –	3/8 & –	1BA	–	–	9.5249	9.2709	–	1.0583
9 & –	3/8 –	–	–	–	9.5249	–	–	1.0583
10 & –	3/8 & –	–	–	–	9.5249	–	–	1.0499
10 & –	13/32 & –	0BA	–	7/32BS	10.3187	10.4901	10.4901	1.0490
11 & –	7/16 –	–	–	–	11.1124	–	–	1.0102
11 & –	7/16 & –	0BA	–	–	11.1124	10.4901	–	1.0593
11 & –	7/16 & –	–	3/16W &	1/4BS	11.1124	–	11.3029	1.0275
12 & –	15/32 –	–	–	–	11.9061	–	–	1.0079
13 & –	1/2 –	–	–	–	12.6999	–	–	1.0236
13 & –	1/2 & –	–	1/4W &	5/16BS	12.6999	13.3349	13.3349	1.0500
14 & –	9/16 & –	–	1/4W &	5/16BS	14.2874	13.3349	13.3349	1.0714
14 & –	9/16 & –	–	–	–	14.2874	–	–	1.0205
15 & –	19/32 –	–	–	–	15.0811	–	–	1.0054
15 & –	19/32 & –	–	5/16W &	3/8BS	15.0811	–	15.2399	1.0160
16 & 15 & 14 &	9/16 & 5/8 &	–	5/16W &	3/8BS	14.2874 15.8749	–	15.2399	1.1429
16 & –	5/8 & –	–	5/16W &	3/8BS	15.8749	15.2399	15.2399	1.0499

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TABLE I (Continued)
WRENCH MARKINGS AND SIZE COMBINATIONS FOR
SQUARE AND HEXAGONAL NUTS AND BOLT AND SCREW HEADS

Nominal Head Dimensions and Size Combinations								Nominal Size (in mm.)				RATIO
		ENGLISH in INCHES						US Standard	British Standard			
METRIC (in mm.)		US Standard		British Standard								
		AF & SAE		BA	W Whit-worth		BS	AF & SAE	BA	W & BS		Maximum
17 &	-	11/16 &	-	-	-		-	17.4623	-	-		1.0272
17 &	16	-	-	-	-		-	-	-	-		1.0625
18 &	17	-	-	-	-		-	-	-	-		1.0588
18 &	-	23/32 &	-	-	3/8W &		7/16BS	18.2561	-	18.0338		1.0142
19 &	18	-	-	-	-		-	-	-	-		1.0556
19 &	-	3/4 &	-	-	3/8W &		7/16BS	19.0498	-	18.0338		1.0563
20 &	-	25/32 &	-	-	7/16W &		1/2BS	19.8436	=	20.8278		1.0496
20 &	19	-	-	-	-		-	-	-	-		1.0526
20 &	19 &	3/4	-	-	-		-	19.0498	-	-		1.0526
21 &	20	13/16	-	-	-		-	20.6373	-	-		1.0500
21 &	-	13/16 &	-	-	7/16W &		1/2 BS	20.6373	-	20.8278		1.0176
22 &	21	-	-	-	-		-	-	-	-		1.0476
22 &	-	7/8 &	-	-	1/2W &		9/16BS	22.2248	-	23.3678		1.0102
23 &	-	7/8	-	-	-		-	22.2248	-	-		1.0514
23 &	-	7/8	-	-	-		-	22.2248	-	-		1.0349
23 &	22 &	7/8	-	-	-		-	22.2248	-	-		1.0455
24 &	-	15/16	-	-	-		-	23.8123	-	-		1.0079
24 &	-	15/16 &	-	-	1/2W &		9/16BS	23.8123	-	23.3678		1.0271
24 &	23 &	15/16	-	-	1/2W &		9/16BS	23.8123	-	23.3678		1.0435
25 &	-	1	-	-	-		-	25,3998	-	-		1.0160
25 &	-	1	-	-	9/16W &		5/8BS	25.3998	-	25.6538		1.0262
25 &	24 &	15/16 &	1 &	-	9/16W &		5/8BS	23.8123	-	25.6538		1.0773
26 &	25	1 1/32	1	-	9/16W &		5/8BS	26.1935	-	25.6538		1.0477
27 &	-	1 1/16	-	-	5/8W &		11/16BS	26.9873	-	27.9398		1.0353
27 &	26 &	1 1/16 &	1 1/32	-	-		-	26.9873	-	-		1.0385
								26.1935				
27 &	-	1 1/16	-	-	-		-	26.9873	-	-		1.0005
28 &	-	1 1/8	-	-	-		-	28.5748	-	-		1.0205
28 &	27	-	-	-	-		-	-	-	-		1.0370
28 &	27 &	1 1/8 &	1 1/16&	-	5/8W &		11/16BS	28.5748	-	27.9398		1.0588
								26.9873				

TABLE I (Continued)
WRENCH MARKINGS AND SIZE COMBINATIONS FOR
SQUARE AND HEXAGONAL NUTS AND BOLT AND SCREW HEADS

Nominal Head Dimensions and Size Combinations								Nominal Size (in mm.)				RATIO
		ENGLISH in INCHES						US Standard	British	Standard		
METRIC (in mm.)		US Standard		British Standard			US Standard		British	Standard		
		AF & SAE		BA	W Whit-worth	BS	AF & SAE	BA	W & BS		Maximum
29 &	-	1 1/8 &	-	-	5/8W	11/16BS	28.5748	-	27.9398		1.0379
30 &	-	1 3/16 &	-	-	11/16W &	3/4BS	30.1622	-	30.4797		1.0105
30 &	-	1 3/16	-	-	-	-	30.1622	-	-		1.0054
30 &	29 &	1 1/8 &	1 3/16	-	-	-	28.5748	-	-		1.0556
							30.1622				
31 &	-	1 1/4	-	-	-	-	31.7497	-	-		1.0242
31 &	30 &	1 1/4 &	1 3/16&	-	11/16W &	3/4BS	31.7497	-	30.4797		1.0583
31 &	30 &	1 1/4 &	1 3/16	-	-	-	30.1622	-	-		1.0583
32 &	-	1 1/4	-	-	-	-	31.7497	-	-		1.0079
32 &	31 &	1 1/4	-	-	-	-	31.7497	-	-		1.0323
32 &	-	1 1/4 &	-	-	3/4W &	7/8BS	31.7497	-	33.0197		1.0400
33 &	32 &	1 5/16 &	1 1/4&	-	3/4W &	7/8BS	33.3372	-	33.0197		1.0500
							31.7497				
34 &	-	1 3/8 &	-	-	13/16W	15/16BS	34.9247	-	35.3057		1.0384
35 &	34 &	1 3/8 &	1 5/16&	-	13/16W &	15/16BS	34.9247	-	35.3057		1.0591
							33.3372				
36 &	35 &	1 7/16	-	-	13/16W &	15/16BS	35.5122	-	35.3057		1.0286
37 &	-	1 1/2	-	-	-	-	38.0997	-	-		1.0297
38 &	-	1 1/2	-	-	-	-	38.0997	-	-		1.0026
38 &	37 &	1 1/2	-	-	7/8W &	1BS	38.0997	-	37.5917		1.0297
39 &	-	1 9/16	-	-	-	-	39.6872	-	-		1.0176
40 &	-	1 9/16	-	-	-	-	39.6872	-	-		1.0079
41 &	-	1 5/8 &	1 11/16	-	1W &	1 1/8BS	41.2746	-	42.4176		1.0454
							42.8621				
42 &	-	1 11/16	-	-	-	-	42.8621	-	-		1.0205
43 &	-	1 11/16	-	-	-	-	42.8621	-	-		1.0032
44 &	-	1 3/4	-	-	-	-	44.4496	-	-		1.0102
45 &	-	1 3/4	-	-	-	-	44.4496	-	-		1.0124
46 &	-	1 13/16	-	-	-	-	46.0371	-	-		1.0008
46 &	-	1 13/16 &	-	-	1 1/8W &	1 1/4BS	46.0371	-	47.2436		1.0270

TABLE I (Continued)
WRENCH MARKINGS AND SIZE COMBINATIONS FOR
SQUARE AND HEXAGONAL NUTS AND BOLT AND SCREW HEADS

Nominal Head Dimensions and Size Combinations					Nominal Size (in mm.)			RATIO
METRIC (in mm.)	ENGLISH in INCHES				US Standard	British Standard		
	US Standard	British Standard						
	AF & SAE	BA	W Whitworth	BS	AF & SAE	BA	W & BS	Maximum
47 & –	1 7/8 –	–	–	–	47.6246	–	–	1.0133
48 & –	1 7/8 –	–	–	–	47.6246	–	–	1.0079
49 & –	1 15/16 –	–	–	–	49.2121	–	–	1.0043
50 & –	2 –	–	–	–	50.7996	–	–	1.0160
50 & –	1 15/16 –	–	–	–	49.2121	–	–	1.0160
55 & –	2 3/16 & –	–	1 3/8W &	1 1/2BS	55.5620	–	56.3875	1.0252
60 & –	2 3/8 & 2 7/16	–	1 1/2W &	1 5/8BS	60.3245 61.9120	–	61.2135	1.0319
65 & –	2 9/16 & 2 5/8	–	1 5/8W &	1 3/4BS	65.0863 66.6744	–	65.5314	1.0258
70 & –	2 3/4 & –	–	1 3/4W &	2BS	69.8494	–	70.1034	1.0036
75 & –	3 –	–	–	–	76.1993	–	–	1.0160
75 & –	3 & 2 15/16	–	–	–	76.1993 74.6119	–	–	1.0213
80 & –	3 1/8 & –	–	2W &	2 1/4BS	79.3743	–	80.0093	1.0080
85 & –	3 3/8 –	–	–	–	85.7243	–	–	1.0085
90 & –	3 1/2 –	–	2 1/4W &	2 1/2BS	88.8992	–	90.1692	1.0143
95 & –	3 7/8 & 3 3/4 & 3 13/16	–	2 1/2W &	2 3/4BS	98.4241 95.2492 96.8367	–	98.8051	1.0360
100 & –	3 7/8 & –	–	2 1/2W &	2 3/4BS	98.4241	–	98.8051	1.0160
105 & –	4 3/16 & 4 1/8 &	–	2 3/4W &	3BS	106.3616 104.7741	–	106.1711	1.0152
110 & –	4 3/8 –	–	–	–	111.1240	–	–	1.0102
115 & –	4 1/2 & 4 5/8	–	3W &	3 1/4BS	114.2990 117.4740	–	115.0610	1.0278
120 & –	4 3/4 & 4 7/8	–	3 1/4W &	3 1/2BS	120.6489 123.8239	–	123.1889	1.0319
125 & –	4 7/8 –	–	3 1/4W &	3 1/2BS	123.8239	–	123.1889	1.0147
130 & –	5 & 5 1/8 & 5 1/4	–	3 1/2W &	3 3/4BS	126.9989 130.1739 133.3488	–	131.5709	1.0500

TABLE I (Continued)
WRENCH MARKINGS AND SIZE COMBINATIONS FOR
SQUARE AND HEXAGONAL NUTS AND BOLTS AND SCREW HEADS

Nominal Head Dimensions and Size Combinations						Nominal Size (in mm.)			RATIO
	in INCHES								
METRIC (in mm.)	ENGLISH					US Standard	British Standard		Maximum
	US Standard	British Standard							
	AF & SAE	BA	W Whit-worth	BS		AF & SAE	BA	W & BS	
135 & –	5 3/8 & 5 1/4 &	–	3 1/2W &	3 3/4BS		136.5238	–	131.5709	1.0376
						133.3488			
140 & –	5 1/2 & 5 5/8 &	–	3 3/4W &	4BS		139.6988	–	140.9688	1.0227
						142.8738			
145 & –	5 5/8 & 5 3/4	–	–	–		142.8738	–	–	1.0222
						146.0487			
150 & –	5 7/8 –	–	–	–		149.2237	–	–	1.0052
155 & –	6 1/8 –	–	–	–		155.5737	–	–	1.0037
160 & –	6 1/4 –	–	–	–		158.7486	–	–	1.0079
165 & –	6 1/2 & 6 3/8	–	–	–		165.0986	–	–	1.0196
						161.9236			
170 & –	6 5/8 & 6 3/4	–	–	–		168.2735	–	–	1.0189
						171.4485			
175 & –	6 7/8 –	–	–	–		174.6235	–	–	1.0022
180 & –	7 & 7 1/8	–	–	–		177.7985	–	–	1.0178
						180.9734			
185 & –	7 1/4 & 7 3/8	–	–	–		184.1484	–	–	1.0172
						187.3234			
190 & –	7 1/2 & 7 3/8	–	–	–		190.4983	–	–	1.0169
						187.3234			
190 & –	7 5/8 & –	–	–	–		193.6733	–	–	1.0193
195 & –	7 3/4 –	–	–	–		196.8483	–	–	1.0095
200 & –	7 7/8 & 8	–	–	–		208.0233	–	–	1.0160
						203.1983			
210 & –	8 1/4 & 8 3/4	–	–	–		209.5482	–	–	1.0152
						212.7232			
220 & –	8 5/8 & 8 3/4	–	–	–		219.0731	–	–	1.0145
						222.2481			

The rotary wrenching tools of the invention can, for example, bear visually readable markings indicating the at least two and preferably three different head sizes for which they were designed. For example, the first wrench appearing in Table I may be marked "1.5 mm & 1/16in. & 16 BA". The table has been computed using international (ISO) and many national standards and specifications from the United States (SAE, ANSI, MIL, ASTM), British (BS), German (DIN), France (FS), Yogoslavia (JUS), Japan (JS) and

specifications from various manufacturers in the United States, England, France, Germany, Canada, Japan, Italy, Sweden, Spain, Czechoslavakia, Yugoslavia, Taiwan, China, Brazil, etc.

With reference to Figures 3-21, each figure shows positions of a bolt head within the gripping opening of a rotary wrenching tool, the bolt head positions shown in phantom lines referring to the smallest bolt head that can be fully and adequately gripped by the tool. Certain of the Figures also show a wrenching tool in both a socket form (wherein a full circle in either solid or dotted lines appears about the bolt head) or in open-ended wrench form. In Figure 3, for example, a socket is shown in dotted lines as (17), the open-ended wrenching tool version being shown in solid lines as (18). In Figures 4, 5, 7, 9-11, 13-18, 20 and 21, similarly, the socket embodiment is shown in solid lines as (20) and the open-ended embodiment is shown in phantom lines as (22). Further, alternate positions for the ends of the open-ended embodiments may be varied, and several positions are shown, for example, in Figure 14.

The following non-limiting examples will serve to more clearly illustrate various further embodiments of the invention.

Example I

With reference to the embodiment shown in Figure 16, socket and open-end rotary wrenching tools shown generally at (20) and (22) are sized so as to strongly and adequately grip the hexagonal heads of threaded fasteners sized 4 mm a 5/32" & 8 BA, giving a ratio of 1.0363. The wrench of Figure 16, as shown from the drawing, has an axis of rotation X that extends normal to the plane of the paper and has an opening for receiving the polygonal head of a threaded member, in this case, a hexagonal head shown as "H". The opening has an inner, head-confronting surface comprising a series of arcuate first surfaces (24) concave to the axis of the opening and spaced about the circumference of the opening. Each such first surface is defined generally as the locus of points falling a given radial distance r from a first axis "a" that is itself spaced a distance r_1 from, but parallel to, the axis X of the opening. Between the arcuate first surfaces (24) are positioned a series of arcuate second surfaces (26) which are convex to the axis of the opening and are spaced about its circumference, each such second arcuate surface being defined general as the locus of points falling a radial distance R from a second axis A which is itself spaced a distance R_1 from, but parallel to, the axis X of the opening. Each surface that forms the opening and that is contiguous to an arcuate surface tangentially merges into that arcuate surface. R_1 preferably is larger than r_1, and the ratio R_1/r_1 desirably exceeds 1.5 and preferably exceeds 2.0. The arcuate second surfaces (26), it will be noted, form "lobes" having rounded surfaces for making contact with the flats of a hexagonal head of a threaded member. One such member, designated "h," is shown in operative contact with the lobes. Each second axis A is angularly spaced from at least one next adjacent second axis A by 60°.

With further reference to Figure 16, rotary wrenching tools of this general configuration may be manufactured as socket, box-end, open-end, flare nut, nut driver and crowfoot wrenches, sized for receiving hexagonal fastener heads nominally sized as follows:

10 mm & 3/8" (AF) (ratio of 1.0499);

11 mm & 7/16" (AF) & 3/16 W (Whitworth) & 1/4 BS (ratio of 1.0275);

19 mm & 3/4" (AF) & 3/8 W & 7/16 BS (ratio of 1.0563).

Similarly, rotary wrenching tools configured as shown in Figure 16 may be designed as socket, box-end and crowfoot wrenches, sized to accommodate hexagonal fastener heads nominally sized as 28 mm & 27 mm & 1 1/16" (AF) & 1 1/8" (AF) & 5/8 W & 11/16 BS, the wrench having a ratio, as defined above, of 1.0588. Other wrenching tools configured as shown in Figure 16 may be provided as socket and box-end tools sized to receive hexagonal fastener heads nominally sized as 32 mm & 33 mm & 1 5/16" (AF) & 1 1/4" (AF) & 3/4 W & 7/8 BS, the wrench having a ratio of 1.0500. Yet another wrench configured as shown in Figure 16 may be provided as a socket wrench sized to receive hexagonal fastener heads nominally sized as 220 mm & 8 5/8" (AF) & 8 3/4" (AF), the ratio of which is 1.0145.

If the ratio R/r is substantially greater than 1.0, preferably exceeding about 5.0, and if R_1 is substantially larger than r_1, the particularly desirable configuration of the wrench shown in Figure 15 is obtained. This embodiment makes use of large, gently rounded, inwardly projecting lobes (26) separated by rounded recessed arcuate portions (24), the latter providing room to accommodate corners of the head of a threaded member without coming into corner contact therewith. Again, each surface forming the opening that is contiguous to an arcuate surface tangentially merges into that surface.

Example II

Socket and Box-End rotary wrenching tools configured as shown in Figure 15 are sized to receive hexagonal heads of threaded members nominally sized 35 mm & 34 mm & 1 3/8" (AF) & 1 5/16" (AF) & 13/16W & 15/16 BS, the tool having a ratio, as defined above, of 1.0591. Similarly, socket wrenches may be designed in accordance with Figure 15 and sized to receive hexagonal heads of threaded fasteners nominally sized as follows:

a) 105 mm & 4 3/16" (AF) & 4 1/8" (AF) & 2 3/4 W & 3 BS, the ratio being 1.0152;

b) 140 mm & 5 5/8" (AF) & 5 1/2" (AF) & 3 3/4 W & 4 BS, the ratio of which wrench is 1.0227.

c) 200 mm & 7 7/8" (AF) & 8" (AF), with a ratio of 1.0160.

If the wrenching tool shown in Figure 16 in which R is approximately equal to r is modified so that R_1 is approximately equal to r_1, then tools of the general type shown in Figures 18, 20 and 21 are obtained. Referring to Figure 18, eight contact points or lobes (26) are provided. This wrenching tool is particularly adapted for receiving square heads of threaded fasteners. The inner surface of the tool includes portions designated (30) which are generally flat surfaces and that extend between the arcuate first and second surfaces. Such flat surfaces (30) may be oriented so as to come into generally surface-to-surface contact with the flats of a threaded member head, as shown in Figure 18, the angular dimensions appearing in Figure 18 being adapted to promote such surface-to-surface contact. Figure 20 and 21 show tools somewhat similar to that shown in Figure 18, except that the tool of Figure 20 has its lobes angularly spaced 20° apart and the tool of Figure 21 has its lobes spaced angularly 15° apart. Note is made that the spacing between adjacent second axes A of the embodiments of Figures 18, 20 and 21 are generally less than 3R in which R is as described above in connection with Figure 16.

Example III

Socket and box-end rotary wrenching tools may be designed and manufactured in the configuration shown in Figure 18 and specifically sized in accordance with the invention to receive square heads of threaded fasteners nominally sized 13 mm & 1/2" (AF) & 1/4 W & 5/16 BS, and having a ratio of 1.0500. Similarly, socket, box-end and open-end wrenching tools may be designed and manufactured in accordance with the configuration of Figure 18 and sized for receiving square-headed fasteners nominally sized 16 mm & 5/8", and having a ratio of 1.0079. The same socket and box-end tools may be designed and manufactured in accordance with the configurations of Figures 20 and 21 and sized to receive hexagonal fastener heads nominally sized 16 mm & 5/8" (AF), the tools having a ratio of 1.0079.

Using the nomenclature described above in connection with Figure 16, the rotary wrenching tool of Figure 19 is provided with inwardly convex lobes (26) formed generally on radii R swung about axes A, the latter axes being angularly spaced about the axis of rotation X by 60°. Inwardly concave surfaces (24) are formed on radii r swung about axes a and positioned such that two spaced inwardly concave arcuate surfaces are positioned between each of the inwardly convex surfaces (26) forming lobes of the wrench. Generally flat surface portions (30) extend between adjacent inwardly concave and convex surfaces (24) and (26), the inwardly concave surfaces being joined by a surface (32) that is formed on a radius about the axis of rotation X. Again, each surface that forms the wrench opening and that is contiguous to an arcuate surface tangentially merges into that arcuate surface. The wrenching tool of Figure 19 has head-receiving openings configured to provide combinations of line, surface and flat-to-flat contact with differently sized fastener heads.

Example IV

A socket wrenching tool designed and manufactured to have the configuration shown in Figure 19 is specifically sized to receive hexagonal head fasteners nominally sized at 5 mm & 3/16" (AF) & 6 BA, the tool having a ratio of 1.0499. A similar tool is sized to receive hexagonal fastener nuts nominally sized 100 mm & 3 7/8" (AF) & 2 1/2 W & 2 3/4 BS, the tool having a ratio of 1.0160. Similarly, a wrenching tool fabricated in accordance with the configuration of Figure 19 may be specifically sized to receive hexagonal head fasteners nominally sized at 14 mm & 9/16" (AF), the tool having a ratio of 1.0205. Socket and box-end wrenching tools configured as in Figure 19 may be sized to specifically receive hexagonal fastener heads nominally sized 75 mm & 3" (AF) & 2 15/16" (AF), and having a ratio of 1.0213.

An embodiment similar to that described above in connection with Figure 19 is shown in Figure 17, this rotary tool having internally projecting lobes (26) spaced 90° from one another and having a pair of inwardly concave arcuate surfaces (24) formed between each pair of inwardly projecting lobes (26).

Generally flat interior surfaces (30) extend between the arcuate surfaces and merge tangentially into such arcuate surfaces.

Example V

Socket, box-end and open-end wrenching tools may be manufactured in accordance with the configuration shown in Figure 17 and sized to receive square heads of threaded fasteners nominally sized as follows:

a) 11 mm & 7/16" (AF) & 0 BA (ratio of 1.0593)

b) 14 mm & 9/16" (AF) & 1/4 W & 5/16 BS (ratio of 1.0714)

c) 16 mm & 15 mm & 14 mm & 9/16" (AF) & 5/8" (AF) & 5/16 W & 3/8 BS (ratio of 1.1429).

Preferably, the wrenching tools exemplified in Figures 15-21 likewise carry markings adjacent each tool opening identifying at least two and preferably three or more different fastener head sizes that the opening will strongly and adequately engage. Exemplary markings are shown in Figure 16, the markings (4 mm & 5/32 AF & 8 BA) being stamped, in this example, onto or into the handle of the tool. Rotary wrenching tools in the form of sockets would normally have markings on the outer socket surfaces.

While preferred embodiments of the present invention has been described, it should be understood that various changes, adaptations and modifications may be made therein without departing from the invention and the scope of the appended claims.

Claims

1. A rotary wrenching tool having an opening for receiving a polygonal head of a threaded member, wherein:

the opening has an axis of rotation (X) and has an inner surface comprising a series of first surfaces (24) concave to said axis of rotation and spaced about the circumference of the opening, and a series of second surfaces (26) convex to said axis of rotation and spaced about the circumference of the opening, successive ones of said first surfaces (24) being disposed between successive ones of said second surfaces (26) around the circumference;

each of the first surfaces (24) is arcuate and is defined as the locus of points falling a given radial distance "r" from a first axis "a" itself spaced a distance "r_1" from, but parallel to, said axis of rotation (X);

each of the second surfaces (26) is arcuate and is defined as the locus of points falling a radial distance R from a second axis (A) spaced itself a distance "R_1" from, but parallel to, said axis of rotation (X); and

the dimensions and dispositions of the second surfaces (26) are such that, in use, the contact made by the wrenching tool with the polygonal head is a contact between the arcuate second surfaces and the sides of the polygonal head of the threaded member;

characterised in that:

each surface that forms part of the inner surface of the opening and is contiguous to an arcuate surface merges tangentially into that arcuate surface; and

the angular relationship between r_1 and R_1 is such that if r is equal to R the wrench includes flat surfaces between and tangentially merging with the first and second surfaces.

2. A tool according to Claim 1, wherein r and R are unequal and said inner surface includes flat surfaces (30) each disposed between and tangentially merging with one of said first surfaces (24) and one of said second surfaces (26).

3. A tool according to Claim 1 or 2, wherein the first (24) and second (26) surfaces are so disposed relative to said inner surface that, in use, each of the second surfaces contacts the respective adjacent side of the polygonal head substantially midway between the corners of that side.

4. A tool according to Claim 1, 2 or 3, in which each second axis (A) is angularly spaced from at least one next adjacent second axis by 60°.

5. A tool according to Claim 4, wherein R_1 is greater than r_1.

6. A tool according to Claim 5, wherein the ratio R_1/r_1 is greater than 1.5.

7. A tool according to Claim 4, wherein R is equal to or greater than r.

8. A tool according to Claim 7, wherein the ratio R/r is greater than 5.0.

9. A tool according to Claim 1, wherein the series of second arcuate surfaces (26) is configured and arranged to contact the flats of the threaded member head to apply torque thereto, the tool being sized to engage the heads of threaded members that are sized in at least two different nominal sizes such that the ratio of the maximum and minimum of said nominal sizes ranges from about 1.0053 to about 1.1430 for square heads, and from about 1.0053 to about 1.0600 for hexagonal heads.

10. A tool according to Claim 1, wherein said opening is sized to engage the heads of threaded members sized in at least two different nominal sizes such that the ratio of the nominal distance across opposing flats of such at least two differently sized heads ranges from 1.0001 to about 1.1430 for square heads and from 1.0001 to about 1.0600 for hexagonal heads.

11. A tool according to Claim 10, wherein said tool carries, adjacent its opening, visible indicia identifying the at least two different nominal sizes.

12. A tool according to Claim 11, wherein said at least two different nominal sizes are expressed in at least two measurement systems.

13. A tool according to Claim 12, wherein said at least two different nominal sizes are as shown in any of the horizontal entries of the following table:

Nominal Size Combinations in INCHES						Nominal Size (in mm.)				RATIO
METRIC (in mm.)	ENGLISH					US Standard	British Standard			Maximum
	US Standard		British Standard							
	AF & SAE		BA	W Whit-Worth	BS	AF & SAE	BA	W & BS		
1.5 &	–	1/16 &	–	16BA	–	–	1.5875	1.4224	–	1.1161
1.5 &	–	1/16	–	–	–	–	1.5875	–	–	1.0583
1.5 &	–	–	–	16BA	–	–	–	1.4224	–	1.0546
–	–	1/16 &	–	16BA	–	–	1.5875	1.4224	–	1.1161
1.5 &	–	1/16 &	–	15BA	–	–	1.5875	1.5748	–	1.0583
1.5 &	–	–	–	15BA	–	–	–	1.5748	–	1.0498
–	–	1/16 &	–	15BA	–	–	1.5875	1.5748	–	1.0081
–	–	1/16 &	–	14BA	–	–	1.5875	1.7526	–	1.1040
2 &	–	5/64 &	–	14BA	–	–	1.9844	1.7526	–	1.1412
2 &	–	5/64 &	–	–	–	–	1.9844	–	–	1.0079
–	–	5/64 &	–	14BA	–	–	1.9844	1.7526	–	1.1323
2 &	–	–	–	14BA	–	–	–	1.7526	–	1.1412
2 &	–	5/64 &	–	13BA	–	–	1.9844	2.1082	–	1.0624
2 &	–	–	–	13BA	–	–	–	2.1082	–	1.0541
–	–	5/64 &	–	13BA	–	–	1.9844	2.1082	–	1.0624
2 &	–	–	–	12BA	–	–	–	2.2860	–	1.1430
2.5 &	–	3/32 &	–	12BA	–	–	2.3812	2.2860	–	1.0936
2.5 &	–	3/32	–	–	–	–	2.3812	–	–	1.0499
2.5 &	–	–	–	12BA	–	–	–	2.2860	–	1.0936
–	–	3/32 &	–	12BA	–	–	2.3812	2.2860	–	1.0416
2.5 &	–	3/32 &	–	11BA	–	–	2.3812	2.6162	–	1.0987
2.5 &	–	–	–	11BA	–	–	–	2.6162	–	1.0465
–	–	3/32 &	–	11BA	–	–	2.3812	2.6162	–	1.0987
3 &	–	7/64 &	–	10BA	–	–	2.7781	2.9718	–	1.0799
3 &	–	7/64	–	–	–	–	2.7781	–	–	1.0799
3 &	–	–	–	10BA	–	–	–	2.9718	–	1.0095
–	–	7/64 &	–	10BA	–	–	2.7781	2.9718	–	1.0691

Nominal Size Combinations							Nominal Size (in mm.)			RATIO
METRIC (in mm.)	ENGLISH in INCHES						US Standard	British Standard		maximum
	US Standard	British Standard								
	AF & SAE	BA	W Whit-worth	BS			AF & SAE	BA	W & BS	
3.2 &	1/8	-	-	-			3.1750	-	-	1.0667
3.2 &	1/8 &	9BA	-	-			3.1750	3.3274	-	1.0480
3.2 &	1/8	-	-	-			3.1750	-	-	1.0079
3.2 &	-	9BA	-	-			-	3.3274	-	1.0398
-	1/8 &	9BA	-	-			3.1750	3.3274	-	1.0480
3.5 &	9/64 &	9BA	-	-			3.5718	3.3274	-	1.0735
3.5 &	9/64	-	-	-			3.5718	-	-	1.0205
3.5 &	-	9BA	-	-			-	3.3274	-	1.0519
-	9/64 &	9BA	-	-			3.5718	3.3274	-	1.0735
4 &	5/32 &	8BA	-	-			3.9687	3.8608	-	1.0363
4 &	5/32	-	-	-			3.9687	-	-	1.0079
4 &	-	8BA	-	-			-	3.8608	-	1.0363
-	5/32 &	8BA	-	-			3.9687	3.8608	-	1.0282
4.5 &	3/16 &	7BA	-	-			4.7625	4.3688	-	1.0898
4.5 &	3/16	-	-	-			4.7625	-	-	1.0583
4.5 &	-	7BA	-	-			-	4.3688	-	1.0297
- &	3/16 &	7BA	-	-			4.7625	4.3688	-	1.0898
4.8 &	3/16 &	6BA	-	-			4.7625	4.9021	-	1.0290
4.8 &	3/16 &	-	-	-			4.7625	-	-	1.0079
4.8 &	-	6BA	-	-			-	4.9021	-	1.0213
-	3/16 &	6BA	-	-			4.7625	4.9021	-	1.0289
5 &	3/16 &	6BA	-	-			4.7625	4.9021	-	1.0499
5 &	3/16	-	-	-			4.7625	-	-	1.0499
-	3/16 &	6BA	-	-			4.7625	4.9021	-	1.0289
5 &	-	6BA	-	-			-	4.9021	-	1.0204
5 &	13/64 &	6BA	-	-			5.1593	4.9021	-	1.0529
5 &	13/64	-	-	-			5.1593	-	-	1.0319
-	13/64 &	6BA	-	-			5.1593	4.9021	-	1.0529

Nominal		Size Combinations					Nominal Size (in mm.)			RATIO
METRIC (in mm.)		ENGLISH in INCHES								
		US Standard		British Standard			US Standard	British Standard		
		AF & SAE		BA	W Whit-worth	BS	AF & SAE	BA	W & BS	Maximum
5.5 &	-	7/32 &	-	5BA	-	-	5.5562	5.5888	-	1.0164
5.5 &	-	7/32 &	-	-	-	-	5.5562	-	-	1.0102
5.5 &	-	-	-	5BA	-	-	-	5.5888	-	1.0164
-	-	7/32	-	5BA	-	-	5.5562	5.5888	-	1.0061
6 &	-	1/4	-	-	-	-	6.3499	-	-	1.0583
6 &	-	1/4 &	-	4BA	-	-	6.3499	6.2991	-	1.0583
7 &	-	9/32	-	-	-	-	7.1437	-	-	1.0205
7 &	-	9/32 &	-	3BA	3/32W &	1/8BS	7.1437	7.1627	7.5437	1.0777
8 &	-	5/16	-	-	-	-	7.9374	-	-	1.0079
8 &	-	5/16 &	-	2BA	-	-	7.9374	8.2295	-	1.0368
9 &	-	11/32	-	-	-	-	8.7312	-	-	1.0308
9 &	-	-	-	-	1/8W &	3/16BS	-	-	8.6359	1.0422
9 &	-	3/8 &	-	1BA	-	-	9.5249	9.2709	-	1.0583
9 &	-	3/8	-	-	-	-	9.5249	-	-	1.0583
10 &	-	3/8 &	-	-	-	-	9.5249	-	-	1.0499
10 &	-	13/32 &	-	0BA	-	7/32BS	10.3187	10.4901	10.4901	1.0490
11 &	-	7/16	-	-	-	-	11.1124	-	-	1.0102
11 &	-	7/16 &	-	0BA	-	-	11.1124	10.4901	-	1.0593
11 &	-	7/16 &	-	-	3/16W &	1/4BS	11.1124	-	11.3029	1.0275
12 &	-	15/32	-	-	-	-	11.9061	-	-	1.0079
13 &	-	1/2	-	-	-	-	12.6999	-	-	1.0236
13 &	-	1/2 &	-	-	1/4W &	5/16BS	12.6999	13.3349	13.3349	1.0500
14 &	-	9/16 &	-	-	1/4W &	5/16BS	14.2874	13.3349	13.3349	1.0714
14 &	-	9/16 &	-	-	-	-	14.2874	-	-	1.0205
15 &	-	19/32	-	-	-	-	15.0811	-	-	1.0054
15 &	-	19/32 &	-	-	5/16W &	3/8BS	15.0811	-	15.2399	1.0160
16 &	15 & 14 &	9/16 &	5/8 &	-	5/16W &	3/8BS	14.2874 15.8749	-	15.2399	1.1429
16 &	-	5/8 &	-	-	5/16W &	3/8BS	15.8749	15.2399	15.2399	1.0499

Nominal Size Combinations						Nominal Size (in mm.)			RATIO
		ENGLISH in INCHES							
		US Standard	British Standard			US Standard	British	Standard	
METRIC (in mm.)		AF & SAE	BA	W Whit-worth	BS	AF & SAE	BA	W & BS	Maximum
17 &	-	11/16 & -	-	-	-	17.4623	-	-	1.0272
17 &	16	- -	-	-	-	-	-	-	1.0625
18 &	17	- -	-	-	-	-	-	-	1.0588
18 &	-	23/32 & -	-	3/8W &	7/16BS	18.2561	-	18.0338	1.0142
19 &	18	- -	-	-	-	-	-	-	1.0556
19 &	-	3/4 & -	-	3/8W &	7/16BS	19.0498	-	18.0338	1.0563
20 &	-	25/32 & -	-	7/16W &	1/2BS	19.8436	-	20.8278	1.0496
20 &	19	- -	-	-	-	-	-	-	1.0526
20 &	19 &	3/4 -	-	-	-	19.0498	-	-	1.0526
21 &	20	13/16 -	-	-	-	20.6373	-	-	1.0500
21 &	-	13/16 & -	-	7/16W &	1/2 BS	20.6373	-	20.8278	1.0176
22 &	21	- -	-	-	-	-	-	-	1.0476
22 &	-	7/8 & -	-	-	-	22.2248	-	-	1.0102
23 &	-	7/8 -	-	1/2W &	9/16BS	22.2248	-	23.3678	1.0514
23 &	-	7/8 -	-	-	-	22.2248	-	-	1.0349
23 &	22 &	7/8 -	-	-	-	22.2248	-	-	1.0455
24 &	-	15/16 -	-	-	-	23.8123	-	-	1.0079
24 &	-	15/16 & -	-	1/2W &	9/16BS	23.8123	-	23.3678	1.0271
24 &	23 &	15/16 -	-	1/2W &	9/16BS	23.8123	-	23.3678	1.0435
25 &	-	1 -	-	-	-	25,3998	-	-	1.0160
25 &	-	1 -	-	9/16W &	5/8BS	25.3998	-	25.6538	1.0262
25 &	24 &	15/16 & 1 &	-	9/16W &	5/8BS	23.8123	-	25.6538	1.0773
26 &	25	1 1/32 1	-	9/16W &	5/8BS	26.1935	-	25.6538	1.0477
27 &	-	1 1/16 -	-	5/8W &	11/16BS	25.3998 26.9873	-	27.9398	1.0353
27 &	26 &	1 1/16 & 1 1/32	-	-	-	26.9873 26.1935	-	-	1.0385
27 &	-	1 1/16 -	-	-	-	26.9873	-	-	1.0005
28 &	-	1 1/8 -	-	-	-	28.5748	-	-	1.0205
28 &	27	- -	-	-	-	-	-	-	1.0370
28 &	27 &	1 1/8 & 1 1/16 &	-	5/8W &	11/16BS	28.5748 26.9873	-	27.9398	1.0588

Nominal Size Combinations in INCHES							Nominal Size (in mm.)				RATIO
METRIC (in mm.)	ENGLISH						US Standard	British		Standard	
	US Standard		British Standard								
	AF & SAE		BA	W Whit-worth	BS		AF & SAE	BA	W & BS		Maximum
29 &	-	1 1/8 &	-	5/8W	11/16BS		28.5748	-	27.9398		1.0379
30 &	-	1 3/16 &	-	11/16W &	3/4BS		30.1622	-	30.4797		1.0105
30 &	-	1 3/16	-	-	-		30.1622	-	-		1.0054
30 &	29 &	1 1/8 & 1 3/16	-	-	-		28.5748	-	-		1.0556
							30.1622				
31 &	-	1 1/4 -	-	-	-		31.7497	-	-		1.0242
31 &	30 &	1 1/4 & 1 3/16 &	-	11/16W &	3/4BS		31.7497	-	30.4797		1.0583
31 &	30 &	1 1/4 & 1 3/16	-	-	-		30.1622	-	-		1.0583
32 &	-	1 1/4 -	-	-	-		31.7497	-	-		1.0079
32 &	31 &	1 1/4 -	-	-	-		31.7497	-	-		1.0323
32 &	-	1 1/4 & -	-	3/4W &	7/8BS		31.7497	-	33.0197		1.0400
33 &	32 &	1 5/16 & 1 1/4 &	-	3/4W &	7/8BS		33.3372	-	33.0197		1.0500
							31.7497				
34 &	-	1 3/8 & -	-	13/16W	15/16BS		34.9247	-	35.3057		1.0384
35 &	34 &	1 3/8 & 1 5/16 &	-	13/16W &	15/16BS		34.9247	-	35.3057		1.0591
							33.3372				
36 &	35 &	1 7/16 -	-	13/16W &	15/16BS		35.5122	-	35.3057		1.0286
37 &	-	1 1/2 -	-	-	-		38.0997	-	-		1.0297
38 &	-	1 1/2 -	-	-	-		38.0997	-	-		1.0026
38 &	37 &	1 1/2 -	-	7/8W &	1BS		38.0997	-	37.5917		1.0297
39 &	-	1 9/16 -	-	-	-		39.6872	-	-		1.0176
40 &	-	1 9/16 -	-	-	-		39.6872	-	-		1.0079
41 &	-	1 5/8 & 1 11/16	-	1W &	1 1/8BS		41.2746	-	42.4176		1.0454
							42.8621				
42 &	-	1 11/16 -	-	-	-		42.8621	-	-		1.0205
43 &	-	1 11/16 -	-	-	-		42.8621	-	-		1.0032
44 &	-	1 3/4 -	-	-	-		44.4496	-	-		1.0102
45 &	-	1 3/4 -	-	-	-		44.4496	-	-		1.0124
46 &	-	1 13/16 -	-	-	-		46.0371	-	-		1.0008
46 &	-	1 13/16 & -	-	1 1/8W &	1 1/4BS		46.0371	-	47.2436		1.0270

Nominal Size Combinations in METRIC (in mm.)			Nominal Size (in mm.)						RATIO
			ENGLISH			US Standard	British	Standard	
			US Standard	British Standard					
			AF & SAE	BA	W Whit-worth	BS	AF & SAE	BA	W & BS	Maximum
47	&	–	1 7/8	–	–	–	47.6246	–	–	1.0133
48	&	–	1 7/8	–	–	–	47.6246	–	–	1.0079
49	&	–	1 15/16	–	–	–	49.2121	–	–	1.0043
50	&	–	2	–	–	–	50.7996	–	–	1.0160
50	&	–	1 15/16	–	–	–	49.2121	–	–	1.0160
55	&	–	2 3/16 & –	–	1 3/8W &	1 1/2BS	55.5620	–	56.3875	1.0252
60	&	–	2 3/8 & 2 7/16	–	1 1/2W &	1 5/8BS	60.3245	–	61.2135	1.0319
65	&	–	2 9/16 & 2 5/8	–	1 5/8W &	1 3/4BS	65.0863	–	65.5314	1.0258
							66.6744			
70	&	–	2 3/4 & –	–	1 3/4W &	2BS	69.8494	–	70.1034	1.0036
75	&	–	3 –	–	–	–	76.1993	–	–	1.0160
75	&	–	3 & 2 15/16	–	–	–	76.1993	–	–	1.0213
							74.6119			
80	&	–	3 1/8 & –	–	2W &	2 1/4BS	79.3743	–	80.0093	1.0080
85	&	–	3 3/8 –	–	–	–	85.7243	–	–	1.0085
90	&	–	3 1/2 –	–	2 1/4W &	2 1/2BS	88.8992	–	90.1692	1.0143
95	&	–	3 7/8 & 3 3/4 &	–	2 1/2W &	2 3/4BS	98.4241	–	98.8051	1.0360
			3 13/16				95.2492			
							96.8367			
100	&	–	3 7/8 & –	–	2 1/2W &	2 3/4BS	98.4241	–	98.8051	1.0160
105	&	–	4 3/16 & 4 1/8 &	–	2 3/4W &	3BS	106.3616	–	106.1711	1.0152
							104.7741			
110	&	–	4 3/8 –	–	–	–	111.1240	–	–	1.0102
115	&	–	4 1/2 & 4 5/8	–	3W &	3 1/4BS	114.2990	–	115.0610	1.0278
							117.4740			
120	&	–	4 3/4 & 4 7/8	–	3 1/4W &	3 1/2BS	120.6489	–	123.1889	1.0319
							123.8239			
125	&	–	4 7/8 –	–	3 1/4W &	3 1/2BS	123.8239	–	123.1889	1.0147
130	&	–	5 & 5 1/8 &	–	3 1/2W &	3 3/4BS	126.9989	–	131.5709	1.0500
			5 1/4				130.1739			
							133.3488			

Nominal Size Combinations					Nominal Size (in mm.)			RATIO
METRIC (in mm.)	ENGLISH in INCHES				US Standard	British Standard		Maximum
	US Standard	British Standard						
	AF & SAE	BA	W Whitworth	BS	AF & SAE	BA	W & BS	
135 & –	5 3/8 & 5 1/4 &	–	3 1/2W &	3 3/4BS	136.5238	–	131.5709	1.0376
					133.3488			
140 & –	5 1/2 & 5 5/8 &	–	3 3/4W &	4BS	139.6988	–	140.9688	1.0227
					142.8738			
145 & –	5 5/8 & 5 3/4	–	–	–	142.8738	–	–	1.0222
					146.0487			
150 & –	5 7/8 –	–	–	–	149.2237	–	–	1.0052
155 & –	6 1/8 –	–	–	–	155.5737	–	–	1.0037
160 & –	6 1/4 –	–	–	–	158.7486	–	–	1.0079
165 & –	6 1/2 & 6 3/8	–	–	–	165.0986	–	–	1.0196
					161.9236			
170 & –	6 5/8 & 6 3/4	–	–	–	168.2735	–	–	1.0189
					171.4485			
175 & –	6 7/8 –	–	–	–	174.6235	–	–	1.0022
180 & –	7 & 7 1/8	–	–	–	177.7985	–	–	1.0178
					180.9734			
185 & –	7 1/4 & 7 3/8	–	–	–	184.1484	–	–	1.0172
					187.3234			
190 & –	7 1/2 & 7 3/8	–	–	–	190.4983	–	–	1.0169
					187.3234			
190 & –	7 5/8 & –	–	–	–	193.6733	–	–	1.0193
195 & –	7 3/4 –	–	–	–	196.8483	–	–	1.0095
200 & –	7 7/8 & 8	–	–	–	200.0233	–	–	1.0160
					203.1983			
210 & –	8 1/4 & 8 3/4	–	–	–	209.5482	–	–	1.0152
					212.7232			
220 & –	8 5/8 & 8 3/4	–	–	–	219.0731	–	–	1.0145
					222.2481			

Patentansprüche

1. Drehschraubenschlüssel mit einer Öffnung zur Aufnahme eines polygonalen Kopfes eines Gewindeelements, wobei
die Öffnung eine Rotationsachse (X) und eine Innenfläche mit einer Reihe erster Flächen (24), die

konkav zu der Rotationsachse und über dem Umfang der Öffnung verteilt angeordnet sind, und einer Reihe zweiter Flächen (26), die konvex zu der Rotationsachse und über den Umfang der Öffnung verteilt angeordnet sind, aufweist, wobei um den Umfang herum aufeinanderfolgende erste Flächen (24) zwischen aufeinanderfolgenden zweiten Flächen (26) angeordnet sind;
jede der ersten Flächen (24) bogenförmig ist und als der Ort von Punkten definiert ist, die einen gegebenen radialen Abstand "r" von einer ersten Achse "a" aufweisen, welche selbst in einem Abstand "r_1" von, aber parallel zu der Rotationsachse (X) angeordnet ist;
jede der zweiten Flächen (26) bogenförmig ist und als der Ort von Punkten definiert ist, die einen radialen Abstand (R) von einer zweiten Achse (A) aufweisen, welche selbst in einem Abstand "R_1" von, aber parallel zu der Rotationsachse (X) angeordnet ist; und
die Dimensionen und Anordnungen der zweiten Flächen (26) derart sind, daß der beim Gebrauch durch den Schraubenschlüssel mit dem polygonalen Kopf hergestellte Kontakt ein Kontakt zwischen den bogenförmigen zweiten Flächen und den Seiten des polygonalen Kopfes des Gewindeelements ist;
dadurch gekennzeichnet,
daß jede Fläche, die einen Abschnitt der Innenfläche der Öffnung bildet und an eine bogenförmige Fläche angrenzt tangential in diese bogenförmige Fläche übergeht; und
daß die Winkelbeziehung zwischen r_1 und R_1 derart ist, daß, wenn r gleich R ist, der Schraubenschlüssel zwischen der ersten und zweiten Fläche tangential in diese übergehende ebene Flächen aufweist.

2. Werkzeug nach Anspruch 1, wobei r und R ungleich sind und die Innenfläche ebene Flächen (30) aufweist, die jeweils zwischen einer der ersten Flächen (24) und einer der zweiten Flächen (26) angeordnet sind und tangential in diese übergehen.

3. Werkzeug nach Anspruch 1 oder 2, wobei die ersten (24) und zweiten (26) Flächen so relativ zu der Innenfläche angeordnet sind, daß beim Gebrauch jede der zweiten Flächen die entsprechende angrenzende Seite des polygonalen Kopfes im wesentlichen mittig zwischen den Ecken der Seite berührt.

4. Werkzeug nach Anspruch 1, 2 oder 3, wobei jede zweite Achse (A) in einem Winkel von 60° von wenigstens einer nächsten angrenzenden zweiten Achse beabstandet ist.

5. Werkzeug nach Anspruch 4, wobei R_1 größer als r_1 ist.

6. Werkzeug nach Anspruch 5, wobei das Verhältnis R_1/r_1 größer als 1,5 ist.

7. Werkzeug nach Anspruch 4, wobei R gleich oder größer als r ist.

8. Werkzeug nach Anspruch 7, wobei das Verhälnis R/r größer als 5,0 ist.

9. Werkzeug nach Anspruch 1, wobei die Reihen von zweiten bogenförmigen Flächen (26) so ausgebildet und angeordnet sind, daß sie die Flächen des Kopfes des Gewindeelements berühren, um ein Drehmoment darauf zu übertragen, wobei das Werkzeug so dimensioniert ist, daß es an Köpfen von Gewindeelementen angreift, die in wenigstens zwei verschiedenen Nenngrößen so ausgebildet sind, daß das Verhältnis des Maximums und Minimums der Nenngrößen zwischen etwa 1,0053 und etwa 1,1430 für quadratische Köpfe, bzw. etwa 1,0053 und etwa 1,0600 für hexagonale Köpfe liegt.

10. Werkzeug nach Anspruch 1, wobei die Öffnung so dimensioniert ist, daß sie an Köpfen von Gewindeelementen angreift, die in wenigstens zwei verschiedenen Nenngrößen so ausgebildet sind, daß das Verhältnis des nominalen Abstands sich gegenüberliegender Flächen der wenigstens zwei verschieden dimensionierten Köpfen von 1,0001 bis etwa 1,1430 für quadratische Köpfe und von 1,0001 bis etwa 1,0600 für hexagonale Köpfe reicht.

11. Werkzeug nach Anspruch 10, wobei das Werkzeug angrenzend an seine Öffnung sichtbare Anzeigen aufweist, die die zwei unterschiedlichen Nenngrößen identifizieren.

12. Werkzeug nach Anspruch 11, wobei die wenigstens zwei unterschiedlichen Nenngrößen in wenigstens zwei Maßsystemen ausgedrückt sind.

13. Werkzeug nach Anspruch 12, wobei die wenigstens zwei unterschiedlichen Nenngrößen wie in einer der horizontalen Eintragungen der folgenden Tabelle gezeigt sind:

Nenngrössenkombinationen						Nenngrösse (mm)				maximales Verhältnis
metrisch (mm)	englisch (inch)					Standard USA		Standard Grossbritannien		
	Standard USA		Standard Grossbritannien			AF & SAE	BA	W & BS		
	AF & SAE		BA	W Whit-Worth	BS					
1.5 & -	1/16 & -		16BA	-	-	1.5875	1.4224	-		1.1161
1.5 & -	1/16 & -		-	-	-	1.5875	-	-		1.0583
1.5 & -	- & -		16BA	-	-	-	1.4224	-		1.0546
- & -	1/16 & -		16BA	-	-	1.5875	1.4224	-		1.1161
1.5 & -	1/16 & -		15BA	-	-	1.5875	1.5748	-		1.0583
1.5 & -	- & -		15BA	-	-	-	1.5748	-		1.0498
- & -	1/16 & -		15BA	-	-	1.5875	1.5748	-		1.0081
- & -	1/16 & -		14BA	-	-	1.5875	1.7526	-		1.1040
2 & -	5/64 & -		14BA	-	-	1.9844	1.7526	-		1.1412
2 & -	5/64 & -		-	-	-	1.9844	-	-		1.0079
- & -	5/64 & -		14BA	-	-	1.9844	1.7526	-		1.1323
2 & -	- & -		14BA	-	-	-	1.7526	-		1.1412
2 & -	5/64 & -		13BA	-	-	1.9844	2.1082	-		1.0624
2 & -	- & -		13BA	-	-	-	2.1082	-		1.0541
- & -	5/64 & -		13BA	-	-	1.9844	2.1082	-		1.0624
2 & -	- & -		12BA	-	-	-	2.2860	-		1.1430
2.5 & -	3/32 & -		12BA	-	-	2.3812	2.2860	-		1.0936
2.5 & -	3/32 & -		-	-	-	2.3812	-	-		1.0499
2.5 & -	- & -		12BA	-	-	-	2.2860	-		1.0936
- & -	3/32 & -		12BA	-	-	2.3812	2.2860	-		1.0416
2.5 & -	3/32 & -		11BA	-	-	2.3812	2.6162	-		1.0987
2.5 & -	- & -		11BA	-	-	-	2.6162	-		1.0465
- & -	3/32 & -		11BA	-	-	2.3812	2.6162	-		1.0987
3 & -	7/64 & -		10BA	-	-	2.7781	2.9718	-		1.0799
3 & -	7/64 & -		-	-	-	2.7781	-	-		1.0799
3 & -	- & -		10BA	-	-	-	2.9718	-		1.0095
- & -	7/64 & -		10BA	-	-	2.7781	2.9718	-		1.0691

Nenngrössenkombinationen						Nenngrösse (mm)			maximales Verhältnis
metrisch (mm)	englisch (inch)					Standard USA	Standard Grossbritannien		
	Standard USA		Standard Grossbritannien						
	AF & SAE	BA	W Whit-worth	BS		AF & SAE	BA	W & BS	
3.2 &	1/8	-	-	-		3.1750	-	-	1.0667
3.2 &	1/8 &	9BA	-	-		3.1750	3.3274	-	1.0480
3.2 &	1/8	-	-	-		3.1750	-	-	1.0079
3.2 &	-	9BA	-	-		-	3.3274	-	1.0398
-	1/8 &	9BA	-	-		3.1750	3.3274	-	1.0480
3.5 &	9/64 &	9BA	-	-		3.5718	3.3274	-	1.0735
3.5 &	9/64	-	-	-		3.5718	-	-	1.0205
3.5 &	-	9BA	-	-		-	3.3274	-	1.0519
-	9/64 &	9BA	-	-		3.5718	3.3274	-	1.0735
4 &	5/32 &	8BA	-	-		3.9687	3.8608	-	1.0363
4 &	5/32	-	-	-		3.9687	-	-	1.0079
4 &	-	8BA	-	-		-	3.8608	-	1.0363
-	5/32 &	8BA	-	-		3.9687	3.8608	-	1.0282
4.5 &	3/16 &	7BA	-	-		4.7625	4.3688	-	1.0898
4.5 &	3/16	-	-	-		4.7625	-	-	1.0583
4.5 &	-	7BA	-	-		-	4.3688	-	1.0297
-	3/16 &	7BA	-	-		4.7625	4.3688	-	1.0898
4.8 &	3/16 &	6BA	-	-		4.7625	4.9021	-	1.0290
4.8 &	3/16 &	-	-	-		4.7625	-	-	1.0079
4.8 &	-	6BA	-	-		-	4.9021	-	1.0213
-	3/16 &	6BA	-	-		4.7625	4.9021	-	1.0289
5 &	3/16 &	6BA	-	-		4.7625	4.9021	-	1.0499
5 &	3/16	-	-	-		4.7625	-	-	1.0499
-	3/16 &	6BA	-	-		4.7625	4.9021	-	1.0289
5 &	-	6BA	-	-		-	4.9021	-	1.0204
5 &	13/64 &	6BA	-	-		5.1593	4.9021	-	1.0529
5 &	13/64	-	-	-		5.1593	-	-	1.0319
-	13/64 &	6BA	-	-		5.1593	4.9021	-	1.0529

Nenngrössenkombinationen						Nenngrösse (mm)				maximales Verhältnis
metrisch (mm)	englisch (inch)					Standard USA	Standard Grossbritannien			
	Standard USA		Standard Grossbritannien							
	AF & SAE		BA	W Whitworth	BS	AF & SAE	BA	W & BS		
5.5 &	-	7/32 &	-	5BA	-	-	5.5562	5.5888	-	1.0164
5.5 &	-	7/32 &	-	-	-	-	5.5562	-	-	1.0102
5.5 &	-	-	-	5BA	-	-	-	5.5888	-	1.0164
-	-	7/32	-	5BA	-	-	5.5562	5.5888	-	1.0061
-	-	1/4	-	-	-	-	6.3499	-	-	1.0583
6 &	-	1/4 &	-	4BA	-	-	6.3499	6.2991	-	1.0583
6 &	-	9/32	-	-	-	-	7.1437	-	-	1.0205
7 &	-	9/32 &	-	3BA	1/8BS	1/8BS	7.1437	7.1627	7.5437	1.0777
7 &	-	5/16	-	-	-	-	7.9374	-	-	1.0079
8 &	-	5/16 &	-	2BA	-	-	7.9374	8.2295	-	1.0368
8 &	-	11/32	-	-	-	-	8.7312	-	-	1.0308
9 &	-	-	-	-	3/16BS	-	-	-	8.6359	1.0422
9 &	-	3/8 &	-	1BA	-	-	9.5249	9.2709	-	1.0583
9 &	-	3/8	-	-	-	-	9.5249	-	-	1.0583
9 &	-	3/8 &	-	-	-	-	9.5249	-	-	1.0499
10 &	-	13/32 &	-	0BA	7/32BS	7/32BS	10.3187	10.4901	10.4901	1.0490
10 &	-	7/16	-	-	-	-	11.1124	-	-	1.0102
11 &	-	7/16 &	-	0BA	-	-	11.1124	10.4901	-	1.0593
11 &	-	7/16 &	-	-	1/4BS	1/4BS	11.1124	-	11.3029	1.0275
11 &	-	15/32	-	-	-	-	11.9061	-	-	1.0079
12 &	-	1/2	-	-	-	-	12.6999	-	-	1.0236
13 &	-	1/2 &	-	-	5/16BS	5/16BS	12.6999	13.3349	13.3349	1.0500
13 &	-	9/16 &	-	-	5/16BS	5/16BS	14.2874	13.3349	13.3349	1.0714
14 &	-	9/16 &	-	-	-	-	14.2874	-	-	1.0205
14 &	-	19/32	-	-	-	-	15.0811	-	-	1.0054
15 &	-	19/32 &	-	-	3/8BS	3/8BS	15.0811	-	15.2399	1.0160
15 &	-	-	-	-	-	-	-	-	-	-
16 &	15 & 14 &	9/16 &	5/8 &	-	3/8BS	3/8BS	14.2874	-	15.2399	1.1429
							15.8749			
16 &	-	5/8 &	-	-	3/8BS	3/8BS	15.8749	15.2399	15.2399	1.0499

Nenngrossenkombinationen						Nenngrosse (mm)				maximales Verhältnis
metrisch (mm)	englisch (inch)					StandardUSA	Standard	Grossbritannien		
	Standard USA		Standard	Grossbritannien						
	AF & SAE		BA	W Whit-worth	BS	AF & SAE	BA	W & BS		
17 &	-	11/16 &	-	-	-	17.4623	-	-		1.0272
17 &	16	-	-	-	-	-	-	-		1.0625
18 &	17	-	-	-	-	-	-	-		1.0588
18 &	-	23/32 &	-	3/8W &	7/16BS	18.2561	-	18.0338		1.0142
19 &	18	-	-	-	-	-	-	-		1.0556
19 &	-	3/4 &	-	3/8W &	7/16BS	19.0498	-	18.0338		1.0563
20 &	-	25/32 &	-	7/16W &	1/2BS	19.8436	=	20.8278		1.0496
20 &	19	-	-	-	-	-	-	-		1.0526
20 &	19 &	3/4	-	-	-	19.0498	-	-		1.0526
21 &	20	13/16	-	-	-	20.6373	-	-		1.0500
21 &	-	13/16 &	-	7/16W &	1/2 BS	20.6373	-	20.8278		1.0176
22 &	21	-	-	-	-	-	-	-		1.0476
22 &	-	7/8 &	-	-	-	22.2248	-	-		1.0102
23 &	-	7/8	-	1/2W &	9/16BS	22.2248	-	23.3678		1.0514
23 &	-	7/8	-	-	-	22.2248	-	-		1.0349
23 &	22 &	7/8	-	-	-	22.2248	-	-		1.0455
24 &	-	15/16	-	-	-	23.8123	-	-		1.0079
24 &	-	15/16 &	-	1/2W &	9/16BS	23.8123	-	23.3678		1.0271
24 &	23 &	15/16	-	1/2W &	9/16BS	23.8123	-	23.3678		1.0435
25 &	-	1	-	-	-	25,3998	-	-		1.0160
25 &	-	1	-	9/16W &	5/8BS	25.3998	-	25.6538		1.0262
25 &	24 &	15/16 &	1 &	9/16W &	5/8BS	23.8123	-	25.6538		1.0773
26 &	25	1 1/32	1	9/16W &	5/8BS	26.1935	-	25.6538		1.0477
27 &	-	1 1/16	-	5/8W &	11/16BS	25.3998	-	27.9398		1.0353
27 &	26 &	1 1/16 &	1 1/32	-	-	26.9873	-	-		1.0385
27 &	-	1 1/16	-	-	-	26.9873	-	-		1.0005
28 &	-	1 1/8	-	-	-	26.1935	-	-		1.0205
28 &	27	-	-	-	-	28.5748	-	-		1.0370
28 &	27 &	1 1/8 &	1 1/16 &	5/8W &	11/16BS	-	-	-		1.0588
						28.5748	-	27.9398		
						26.9873				

Nenngrössenkombinationen						Nenngrosse (mm)			
metrisch (mm)	englisch (inch)								
	Standard USA		Standard Grossbritannien			Standard USA	Standard Grossbritannien		maximales Verhältnis
	AF & SAE		BA	W Whit-worth	BS	AF & SAE	BA	W & BS	
29 & -	1 1/8 &	-	-	5/8W	11/16BS	28.5748	-	27.9398	1.0379
30 & -	1 3/16 &	-	-	11/16W &	3/4BS	30.1622.	-	30.4797	1.0105
30 & -	1 3/16	-	-	-	-	30.1622	-	-	1.0054
30 & 29 &	1 1/8 &	1 3/16	-	-	-	28.5748 30.1622	-	-	1.0556
31 & -	1 1/4	-	-	-	-	31.7497	-	-	1.0242
31 & 30 &	1 1/4 &	1 3/16&	-	11/16W &	3/4BS	31.7497	-	30.4797	1.0583
31 & 30 &	1 1/4 &	1 3/16	-	-		30.1622	-	-	1.0583
32 & -	1 1/4	-	-	-	-	31.7497	-	-	1.0079
32 & 31 &	1 1/4	-	-	-	-	31.7497	-	-	1.0323
32 & -	1 1/4 &	-	-	3/4W &	7/8BS	31.7497	-	33.0197	1.0400
33 & 32 &	1 5/16 &	1 1/4&	-	3/4W &	7/8BS	33.3372 31.7497	-	33.0197	1.0500
34 & -	1 3/8 &	-	-	13/16W	15/16BS	34.9247	-	35.3057	1.0384
35 & 34 &	1 3/8 &	1 5/16&	-	13/16W &	15/16BS	34.9247 33.3372	-	35.3057	1.0591
36 & 35 &	1 7/16	-	-	13/16W &	15/16S	35.5122	-	35.3057	1.0286
37 & -	1 1/2	-	-	-	-	38.0997	-	-	1.0297
38 & -	1 1/2	-	-	-	-	38.0997	-	-	1.0026
38 & 37 &	1 1/2	-	-	7/8W &	1BS	38.0997	-	37.5917	1.0297
39 & -	1 9/16	-	-	-	-	39.6872	-	-	1.0176
40 & -	1 9/16	-	-	-	-	39.6872	-	-	1.0079
41 & -	1 5/8 &	1 11/16	-	1W &	1 1/8BS	41.2746 42.8621	-	42.4176	1.0454
42 & -	1 11/16	-	-	-	-	42.8621	-	-	1.0205
43 & -	1 11/16	-	-	-	-	42.8621	-	-	1.0032
44 & -	1 3/4	-	-	-	-	44.4496	-	-	1.0102
45 & -	1 3/4	-	-	-	-	44.4496	-	-	1.0124
46 & -	1 13/16	-	-	-	-	46.0371	-	-	1.0008
46 & -	1 13/16 &	-	-	1 1/8W &	1 1/4BS	46.0371	-	47.2436	1.0270

Nenngrossenkombinationen					Nenngrosse (mm)			
metrisch (mm)	englisch (inch)							
	Standard USA	Standard Grossbritannien			Standard USA	Standard Grossbritannien		maximales Verhaltnis
	AF & SAE	BA	W Whit-worth	BS	AF & SAE	BA	W & BS	
47 & -	1 7/8 -	-	-	-	47.6246	-	-	1.0133
48 & -	1 7/8 -	-	-	-	47.6246	-	-	1.0079
49 & -	1 15/16 -	-	-	-	49.2121	-	-	1.0043
50 & -	2 -	-	-	-	50.7996	-	-	1.0160
50 & -	1 15/16 -	-	-	-	49.2121	-	-	1.0160
55 & -	2 3/16 & -	-	1 3/8W &	1 1/2BS	55.5620	-	56.3875	1.0252
60 & -	2 3/8 & 2 7/16	-	1 1/2W &	1 5/8BS	60.3245 61.9120	-	61.2135	1.0319
65 & -	2 9/16 & 2 5/8	-	1 5/8W &	1 3/4BS	65.0863 66.6744	-	65.5314	1.0258
70 & -	2 3/4 & -	-	1 3/4W &	2BS	69.8494	-	70.1034	1.0036
75 & -	3 -	-	-	-	76.1993	-	-	1.0160
75 & -	3 & 2 15/16	-	-	-	76.1993 74.6119	-	-	1.0213
80 & -	3 1/8 & -	-	2W &	2 1/4BS	79.3743	-	80.0093	1.0080
85 & -	3 3/8 -	-	-	-	85.7243	-	-	1.0085
90 & -	3 1/2 -	-	2 1/4W &	2 1/2BS	88.8992	-	90.1692	1.0143
95 & -	3 7/8 & 3 3/4 & 3 13/16	-	2 1/2W &	2 3/4BS	98.4241 95.2492 96.8367	-	98.8051	1.0360
100 & -	3 7/8 & -	-	2 1/2W &	2 3/4BS	98.4241	-	98.8051	1.0160
105 & -	4 3/16 & 4 1/8 &	-	2 3/4W &	3BS	106.3616 104.7741	-	106.1711	1.0152
110 & -	4 3/8 -	-	-	-	111.1240	-	-	1.0102
115 & -	4 1/2 & 4 5/8	-	3W &	3 1/4BS	114.2990 117.4740	-	115.0610	1.0278
120 & -	4 3/4 & 4 7/8	-	3 1/4W &	3 1/2BS	120.6489 123.8239	-	123.1889	1.0319
125 & -	4 7/8 -	-	3 1/4W &	3 1/2BS	123.8239	-	123.1889	1.0147
130 & -	5 & 5 1/8 & 5 1/4	-	3 1/2W &	3 3/4BS	126.9989 130.1739 133.3488	-	131.5709	1.0500

Nenngrossenkombinationen					Nenngrosse (mm)			
metrisch (mm)	englisch (inch)							maximales Verhältnis
	Standard USA	Standard Grossbritannien			Standard USA	Standard Grossbritannien		
	AF & SAE	BA	W Whitworth	BS	AF & SAE	BA	W & BS	
135 & -	5 3/8 & 5 1/4 &	-	3 1/2W &	3 3/4BS	136.5238 133.3488	-	131.5709	1.0376
140 & -	5 1/2 & 5 5/8 &	-	3 3/4W &	4BS	139.6988 142.8738	-	140.9688	1.0227
145 & -	5 5/8 & 5 3/4	-	-	-	142.8738 146.0487	-	-	1.0222
150 & -	5 7/8 -	-	-	-	149.2237	-	-	1.0052
155 & -	6 1/8 -	-	-	-	155.5737	-	-	1.0037
160 & -	6 1/4 -	-	-	-	158.7486	-	-	1.0079
165 & -	6 1/2 & 6 3/8	-	-	-	165.0986 161.9236	-	-	1.0196
170 & -	6 5/8 & 6 3/4	-	-	-	168.2735 171.4485	-	-	1.0189
175 & -	6 7/8 -	-	-	-	174.6235	-	-	1.0022
180 & -	7 & 7 1/8	-	-	-	177.7985 180.9734	-	-	1.0178
185 & -	7 1/4 & 7 3/8	-	-	-	184.1484 187.3234	-	-	1.0172
190 & -	7 1/2 & 7 3/8	-	-	-	190.4983 187.3234	-	-	1.0169
190 & -	7 5/8 & -	-	-	-	193.6733	-	-	1.0193
195 & -	7 3/4 -	-	-	-	196.8483	-	-	1.0095
200 & -	7 7/8 & 8	-	-	-	200.0233 203.1983	-	-	1.0160
210 & -	8 1/4 & 8 3/4	-	-	-	209.5482 212.7232	-	-	1.0152
220 & -	8 5/8 & 8 3/4	-	-	-	219.0731 222.2481	-	-	1.0145

Revendications

1. Outil de torsion tournant, ayant une ouverture pour recevoir une tête polygonale d'un élément fileté, dans lequel :

- l'ouverture a un axe de rotation (X) et a une surface interne comprenant une série de premières surfaces (24), concaves par rapport audit axe de rotation et espacées autour de la périphérie de l'ouverture, et une série de secondes surfaces (26), convexes par rapport audit axe de rotation et espacées autour de la périphérie de l'ouverture, des surfaces successives desdites premières surfaces (21) étant disposées entre des surfaces successives desdites secondes surfaces (26) autour de la périphérie ;
- chacune des premières surfaces (24) est cintrée et est définie comme étant le lieu des points tombant à une distance radiale donnée "r" d'un premier axe "a", lui-même étant espacé d'une distance "r_1" dudit axe de rotation (X), mais parallèle à ce dernier ;
- chacune des secondes surfaces (26) est cintrée et est définie comme étant le lieu des points tombant à une distance radiale R d'un second axe (A), lui-même étant espacé d'une distance "R_1" dudit axe de rotation (X), mais parallèle à ce dernier ; et
- les dimensions et dispositions des secondes surfaces (26) sont telles qu'à l'utilisation, le contact fait par l'outil de torsion avec la tête polygonale est un contact entre les secondes surfaces cintrées et les côtés de la tête polygonale de l'élément fileté ;

caractérisé par le fait que :

- chaque surface qui fait partie de la surface interne de l'ouverture et est contiguë à une surface cintrée se fond tangentiellement dans cette surface cintrée ; et
- la relation angulaire entre r_1 et R_1 est telle que, si r est égal à R, l'outil de torsion comprend des surfaces plates entre les premières et secondes surfaces et se fondant tangentiellement avec ces surfaces.

2. Outil selon la revendication 1, dans lequel r et R sont inégaux et ladite surface interne comprend des surfaces plates (30), chacune disposée entre l'une desdites premières surfaces (24) et l'une desdites secondes surfaces (26) et se fondant tangentiellement avec ces surfaces.

3. Outil selon la revendication 1 ou 2, dans lequel les premières et secondes surfaces (respectivement 24 et 26) sont disposées par rapport à ladite surface interne de telle sorte qu'à l'utilisation, chacune des secondes surfaces entre en contact avec le côté adjacent respectif de la tête polygonale, sensiblement à mi-chemin entre les angles de ce côté.

4. Outil selon la revendication 1, 2 ou 3, dans lequel chaque second axe (A) est espacé angulairement d'au moins un second axe adjacent suivant, de 60°.

5. Outil selon la revendication 4, dans lequel R_1 est plus grand que r_1.

6. Outil selon la revendication 5, dans lequel le rapport R_1/r_1 est supérieur à 1,5.

7. Outil selon la revendication 4, dans lequel R est égal ou supérieur à r.

8. Outil selon la revendication 7, dans lequel le rapport R/r est supérieur à 5,0.

9. Outil selon la revendication 1, dans lequel la série des secondes surfaces cintrées (26) est configurée et disposée pour être en contact avec les plats de la tête de l'élément fileté afin de leur appliquer un couple, l'outil étant dimensionné pour venir en prise avec les têtes des éléments filetés qui sont dimensionnées suivant au moins deux dimensions nominales différentes, telles que le rapport du maximum et du minimum desdites dimensions nominales se situe d'environ 1,0053 à environ 1,1430 pour des têtes carrées, et d'environ 1,0053 à environ 1,0600 pour des têtes hexagonales.

10. Outil selon la revendication 1, dans lequel ladite ouverture est dimensionnée pour venir en prise avec les têtes d'éléments filetés dimensionnées suivant au moins deux dimensions nominales différentes, telles que le rapport de la distance nominale à travers des plats opposés de ces au moins deux têtes dimensionnées différemment se situe dans la plage allant de 1,0001 à environ 1,1430 pour des têtes carrées et de 1,0001 à environ 1,0600 pour des têtes hexagonales.

11. Outil selon la revendication 10, dans lequel ledit outil porte, au voisinage de son ouverture, des index visibles identifiant les au moins deux différentes dimensions nominales.

12. Outil selon la revendication 11, dans lequel lesdites au moins deux dimensions nominales différentes sont exprimées dans au moins deux systèmes de mesure.

13. Outil selon la revendication 12, dans lequel lesdites au moins deux dimensions nominales différentes sont telles que présentées dans l'une quelconque des entrées horizontales du tableau suivant :

Combinaisons de dimensions nominales							Dimension Nominale (en mm)			RAPPORT Maximum
SYSTEME METRIQUE (en mm)	ANGLAIS en POUCES						Norme US	Norme Britannique		
	Norme US		Norme Britannique				AF & SAE	BA	W & BS	
	AF & SAE	BA	W Whit-Worth	BS						
1.5 &	1/16 &	16BA	-	-			1.5875	1.4224	-	1.1161
1.5 &	1/16	-	-	-			1.5875	-	-	1.0583
1.5 &	-	16BA	-	-			-	1.4224	-	1.0546
-	1/16 &	16BA	-	-			1.5875	1.4224	-	1.1161
1.5 &	1/16 &	15BA	-	-			1.5875	1.5748	-	1.0583
1.5 &	-	15BA	-	-			-	1.5748	-	1.0498
-	1/16 &	15BA	-	-			1.5875	1.5748	-	1.0081
-	1/16 &	14BA	-	-			1.5875	1.7526	-	1.1040
2 &	5/64 &	14BA	-	-			1.9844	1.7526	-	1.1412
2 &	5/64 &	-	-	-			1.9844	-	-	1.0079
-	5/64 &	14BA	-	-			1.9844	1.7526	-	1.1323
2 &	-	14BA	-	-			-	1.7526	-	1.1412
2 &	5/64 &	13BA	-	-			1.9844	2.1082	-	1.0624
2 &	-	13BA	-	-			-	2.1082	-	1.0541
-	5/64 &	13BA	-	-			1.9844	2.1082	-	1.0624
2 &	-	12BA	-	-			-	2.2860	-	1.1430
2.5 &	3/32 &	12BA	-	-			2.3812	2.2860	-	1.0936
2.5 &	3/32	-	-	-			2.3812	-	-	1.0499
2.5 &	-	12BA	-	-			-	2.2860	-	1.0936
-	3/32 &	12BA	-	-			2.3812	2.2860	-	1.0416
2.5 &	3/32 &	11BA	-	-			2.3812	2.6162	-	1.0987
2.5 &	-	11BA	-	-			-	2.6162	-	1.0465
-	3/32 &	11BA	-	-			2.3812	2.6162	-	1.0987
3 &	7/64 &	10BA	-	-			2.7781	2.9718	-	1.0799
3 &	7/64	-	-	-			2.7781	-	-	1.0799
3 &	-	10BA	-	-			-	2.9718	-	1.0095
-	7/64 &	10BA	-	-			2.7781	2.9718	-	1.0691

Combinaisons de dimensions nominales						Dimension Nominale (en mm)			RAPPORT Maximum
SYSTEME METRIQUE (en mm)	ANGLAIS en POUCES					Norme US	Norme Britannique		
	Norme US		Norme Britannique						
	AF & SAE		BA	W Whit-worth	BS	AF & SAE	BA	W & BS	
3.2 &	3 &	1/8	-	-	-	3.1750	-	-	1.0667
3.2 &	-	1/8 &	9BA	-	-	3.1750	3.3274	-	1.0480
3.2 &	-	1/8	-	-	-	3.1750	-	-	1.0079
3.2 &	-	-	9BA	-	-	-	3.3274	-	1.0398
-	-	1/8 &	9BA	-	-	3.1750	3.3274	-	1.0480
3.5 &	-	9/64 &	9BA	-	-	3.5718	3.3274	-	1.0735
3.5 &	-	9/64	-	-	-	3.5718	-	-	1.0205
3.5 &	-	-	9BA	-	-	-	3.3274	-	1.0519
-	-	9/64 &	9BA	-	-	3.5718	3.3274	-	1.0735
4 &	-	5/32 &	8BA	-	-	3.9687	3.8608	-	1.0363
4 &	-	5/32	-	-	-	3.9687	-	-	1.0079
4 &	-	-	8BA	-	-	-	3.8608	-	1.0363
-	-	5/32 &	8BA	-	-	3.9687	3.8608	-	1.0282
4.5 &	-	3/16 &	7BA	-	-	4.7625	4.3688	-	1.0898
4.5 &	-	3/16	-	-	-	4.7625	-	-	1.0583
4.5 &	-	-	7BA	-	-	-	4.3688	-	1.0297
-	-	3/16 &	7BA	-	-	4.7625	4.3688	-	1.0898
4.8 &	-	3/16 &	6BA	-	-	4.7625	4.9021	-	1.0290
4.8 &	-	3/16 &	-	-	-	4.7625	-	-	1.0079
4.8 &	-	-	6BA	-	-	-	4.9021	-	1.0213
-	-	3/16 &	6BA	-	-	4.7625	4.9021	-	1.0289
5 &	-	3/16 &	6BA	-	-	4.7625	4.9021	-	1.0499
5 &	-	3/16	-	-	-	4.7625	-	-	1.0499
-	-	3/16 &	6BA	-	-	4.7625	4.9021	-	1.0289
5 &	-	-	6BA	-	-	-	4.9021	-	1.0204
5 &	-	13/64 &	6BA	-	-	5.1593	4.9021	-	1.0529
5 &	-	13/64	-	-	-	5.1593	-	-	1.0319
-	-	13/64 &	6BA	-	-	5.1593	4.9021	-	1.0529

Combinaisons de dimensions nominales ANGLAIS en POUCES						Dimension Nominale (en mm)			RAPPORT Maximum
SYSTEME METRIQUE (en mm)	Norme US	Norme Britannique				Norme US	Norme Britannique		
	AF & SAE	BA	W Whit-worth	BS		AF & SAE	BA	W & BS	
5.5 & -	7/32 & -	5BA	-	-		5.5562	5.5888	-	1.0164
5.5 & -	7/32 & -	-	-	-		5.5562	-	-	1.0102
5.5 & -	-	5BA	-	-		-	5.5888	-	1.0164
- -	7/32 -	5BA	-	-		5.5562	5.5888	-	1.0061
- -	1/4 -	-	-	-		6.3499	-	-	1.0583
6 & -	1/4 & -	4BA	-	-		6.3499	6.2991	-	1.0583
6 & -	9/32 -	-	-	-		7.1437	-	-	1.0205
7 & -	9/32 & -	3BA	3/32W &	1/8BS		7.1437	7.1627	7.5437	1.0777
7 & -	5/16 -	-	-	-		7.9374	-	-	1.0079
8 & -	5/16 & -	2BA	-	-		7.9374	8.2295	-	1.0368
8 & -	11/32 -	-	-	-		8.7312	-	-	1.0308
9 & -	- -	-	1/8W &	3/16BS		-	-	8.6359	1.0422
9 & -	3/8 & -	1BA	-	-		9.5249	9.2709	-	1.0583
9 & -	3/8 -	-	-	-		9.5249	-	-	1.0583
9 & -	3/8 & -	-	-	-		9.5249	-	-	1.0499
10 & -	13/32 & -	0BA	-	7/32BS		10.3187	10.4901	10.4901	1.0490
10 & -	7/16 -	-	-	-		11.1124	-	-	1.0102
11 & -	7/16 & -	0BA	-	-		11.1124	10.4901	-	1.0593
11 & -	7/16 & -	-	3/16W &	1/4BS		11.1124	-	11.3029	1.0275
11 & -	15/32 -	-	-	-		11.9061	-	-	1.0079
12 & -	1/2 -	-	-	-		12.6999	-	-	1.0236
13 & -	1/2 & -	-	1/4W &	5/16BS		12.6999	13.3349	13.3349	1.0500
13 & -	9/16 & -	-	1/4W &	5/16BS		14.2874	13.3349	13.3349	1.0714
14 & -	9/16 & -	-	-	-		14.2874	-	-	1.0205
14 & -	19/32 -	-	-	-		15.0811	-	-	1.0054
15 & -	19/32 & -	-	5/16W &	3/8BS		15.0811	-	15.2399	1.0160
16 & 15 & 14 &	9/16 & 5/8 &	-	5/16W &	3/8BS		14.2874	-	15.2399	1.1429
						15.8749			
16 & -	5/8 & -	-	5/16W &	3/8BS		15.8749	15.2399	15.2399	1.0499

Combinaisons de dimensions nominales ANGLAIS en POUCES						Dimension Nominale (en mm)				RAPPORT Maximum
SYSTEME METRIQUE (en mm)		Norme US	Norme Britannique			Norme US	Norme Britannique			
		AF & SAE	BA	W Whit-worth	BS	AF & SAE	BA	W & BS		
17 &	-	11/16 &	-	-	-	17.4623	-	-		1.0272
17 &	16	-	-	-	-	-	-	-		1.0625
18 &	17	-	-	-	-	-	-	-		1.0588
18 &	-	23/32 &	-	3/8W &	7/16BS	18.2561	-	18.0338		1.0142
19 &	18	-	-	-	-	-	-	-		1.0556
19 &	-	3/4 &	-	3/8W &	7/16BS	19.0498	-	18.0338		1.0563
20 &	-	25/32 &	-	7/16W &	1/2BS	19.8436	=	20.8278		1.0496
20 &	-	-	-	-	-	-	-	-		1.0526
20 &	19	3/4	-	-	-	19.0498	-	-		1.0526
20 &	19 &	-	-	-	-	-	-	-		1.0500
21 &	20	13/16	-	-	-	20.6373	-	-		1.0176
21 &	-	13/16 &	-	7/16W &	1/2 BS	20.6373	-	20.8278		1.0476
22 &	21	-	-	-	-	-	-	-		1.0102
22 &	-	7/8 &	-	-	-	22.2248	-	-		1.0514
23 &	-	7/8	-	1/2W &	9/16BS	22.2248	-	23.3678		1.0349
23 &	-	7/8	-	-	-	22.2248	-	-		1.0455
23 &	22 &	7/8	-	-	-	22.2248	-	-		1.0079
24 &	-	15/16	-	-	-	23.8123	-	-		1.0271
24 &	-	15/16 &	-	1/2W &	9/16BS	23.8123	-	23.3678		1.0435
24 &	23 &	15/16	-	1/2W &	9/16BS	23.8123	-	23.3678		1.0160
25 &	-	1	-	-	-	25,3998	-	-		1.0262
25 &	-	-	-	9/16W &	5/8BS	25.3998	-	25.6538		1.0773
25 &	24 &	15/16 &	1 &	9/16W &	5/8BS	23.8123	-	25.6538		1.0477
26 &	25	1 1/32	1	9/16W &	5/8BS	26.1935	-	25.6538		
27 &	-	1 1/16	-	5/8W &	11/16BS	25.3998	-	27.9398		1.0353
27 &	26 &	1 1/16 &	1 1/32	-	-	26.9873	-	-		1.0385
27 &	-	1 1/16	-	-	-	26.1935	-	-		1.0005
27 &	-	1 1/8	-	-	-	26.9873	-	-		1.0205
28 &	-	-	-	-	-	28.5748	-	-		1.0370
28 &	27	-	-	-	-	-	-	-		1.0588
28 &	27 &	1 1/8 &	1 1/16 &	5/8W &	11/16BS	28.5748	-	27.9398		
						26.9873				

Combinaisons de dimensions nominales							Dimension Nominale (en mm)				RAPPORT Maximum
SYSTEME METRIQUE (en mm)	ANGLAIS en POUCES						Norme US		Norme Britannique		
	Norme US		Norme Britannique				AF & SAE		BA	W & BS	
	AF & SAE		BA	W Whit-worth	BS		AF & SAE		BA	W & BS	
29 &	-	1 1/8 &	-	5/8W	11/16BS		28.5748		-	27.9398	1.0379
30 &	-	1 3/16 &	-	11/16W &	3/4BS		30.1622		-	30.4797	1.0105
30 &	-	1 3/16	-	-	-		30.1622		-	-	1.0054
30 &	29 &	1 1/8 & 1 3/16	-	-	-		28.5748		-	-	1.0556
							3C.1622				
31 &	-	1 1/4	-	-	-		31.7497		-	-	1.0242
31 &	30 &	1 1/4 & 1 3/16 &	-	11/16W &	3/4BS		31.7497		-	30.4797	1.0583
31 &	30 &	1 1/4 & 1 3/16	-	-	-		30.1622		-	-	1.0583
32 &	-	1 1/4	-	-	-		31.7497		-	-	1.0079
32 &	31 &	1 1/4	-	-	-		31.7497		-	-	1.0323
32 &	-	1 1/4 &	-	3/4W &	7/8BS		31.7497		-	33.0197	1.0400
33 &	32 &	1 5/16 & 1 1/4 &	-	3/4W &	7/8BS		33.3372		-	33.0197	1.0500
							31.7497				
34 &	-	1 3/8 &	-	13/16W	15/16BS		34.9247		-	35.3057	1.0384
35 &	34 &	1 3/8 & 1 5/16 &	-	13/16W &	15/16BS		34.9247		-	35.3057	1.0591
							33.3372				
36 &	35 &	1 7/16	-	13/16W &	15/16BS		35.5122		-	35.3057	1.0286
37 &	-	1 1/2	-	-	-		38.0997		-	-	1.0297
38 &	-	1 1/2	-	-	-		38.0997		-	-	1.0026
38 &	37 &	1 1/2	-	7/8W &	1BS		38.0997		-	37.5917	1.0297
39 &	-	1 9/16	-	-	-		39.6872		-	-	1.0176
40 &	-	1 9/16	-	-	-		39.6872		-	-	1.0079
41 &	-	1 5/8 & 1 11/16	-	1W &	1 1/8BS		41.2746		-	42.4176	1.0454
							42.8621				
42 &	-	1 11/16	-	-	-		42.8621		-	-	1.0205
43 &	-	1 11/16	-	-	-		42.8621		-	-	1.0032
44 &	-	1 3/4	-	-	-		44.4496		-	-	1.0102
45 &	-	1 3/4	-	-	-		44.4496		-	-	1.0124
46 &	-	1 13/16	-	-	-		46.0371		-	-	1.0008
46 &	-	1 13/16 &	-	1 1/8W &	1 1/4BS		46.0371		-	47.2436	1.0270

Combinaisons de dimensions nominales ANGLAIS en POUCES						Dimension Nominale (en mm)				RAPPORT Maximum
SYSTEME METRIQUE (en mm)		Norme US		Norme Britannique		Norme US		Norme Britannique		
		AF & SAE	BA	W Whit-worth	BS	AF & SAE	BA	W & BS		
47 &	-	1 7/8	-	-	-	47.6246	-	-		1.0133
48 &	-	1 7/8	-	-	-	47.6246	-	-		1.0079
49 &	-	1 15/16	-	-	-	49.2121	-	-		1.0043
50 &	-	2	-	-	-	50.7996	-	-		1.0160
50 &	-	1 15/16	-	-	-	49.2121	-	-		1.0160
55 &	-	2 3/16 &	-	1 3/8W &	1 1/2BS	55.5620	-	56.3875		1.0252
60 &	-	2 3/8 & 2 7/16	-	1 1/2W &	1 5/8BS	60.3245	-	61.2135		1.0319
65 &	-	2 9/16 & 2 5/8	-	1 5/8W &	1 3/4BS	65.0863 66.6744	-	65.5314		1.0258
70 &	-	2 3/4 &	-	1 3/4W &	2BS	69.8494	-	70.1034		1.0036
75 &	-	3	-	-	-	76.1993	-	-		1.0160
75 &	-	3 & 2 15/16	-	-	-	76.1993 74.6119	-	-		1.0213
80 &	-	3 1/8 &	-	2W &	2 1/4BS	79.3743	-	80.0093		1.0080
85 &	-	3 3/8	-	-	-	85.7243	-	-		1.0085
90 &	-	3 1/2	-	2 1/4W &	2 1/2BS	88.8992	-	90.1692		1.0143
95 &	-	3 7/8 & 3 3/4 & 3 13/16	-	2 1/2W &	2 3/4BS	98.4241 95.2492 96.8367	-	98.8051		1.0360
100 &	-	3 7/8 &	-	2 1/2W &	2 3/4BS	98.4241	-	98.8051		1.0160
105 &	-	4 3/16 & 4 1/8 &	-	2 3/4W &	3BS	106.3616 104.7741	-	106.1711		1.0152
110 &	-	4 3/8	-	-	-	111.1240	-	-		1.0102
115 &	-	4 1/2 & 4 5/8	-	3W &	3 1/4BS	114.2990	-	115.0610		1.0278
120 &	-	4 3/4 & 4 7/8	-	3 1/4W &	3 1/2BS	117.4740 120.6489	-	123.1889		1.0319
125 &	-	4 7/8	-	3 1/4W &	3 1/2BS	123.8239	-	123.1889		1.0147
130 &	-	5 & 5 1/8 & 5 1/4	-	3 1/2W &	3 3/4BS	126.9989 130.1739 133.3488	-	131.5709		1.0500

Combinaisons de dimensions nominales ANGLAIS en POUCES						Dimension Nominale (en mm)			RAPPORT Maximum
SYSTEME METRIQUE (en mm)	Norme US	Norme Britannique			Norme US	Norme Britannique		
	AF & SAE	BA	W Whit-worth	BS	AF & SAE	BA	W & BS	
135 &	–	5 3/8 & 5 1/4 &	–	3 1/2W &	3 3/4BS	136.5238	–	131.5709	1.0376
						133.3488			
140 &	–	5 1/2 & 5 5/8 &	–	3 3/4W &	4BS	139.6988	–	140.9688	1.0227
145 &	–	5 5/8 & 5 3/4	–	–	–	142.8738	–	–	1.0222
						146.0487			
150 &	–	5 7/8 –	–	–	–	149.2237	–	–	1.0052
155 &	–	6 1/8 –	–	–	–	155.5737	–	–	1.0037
160 &	–	6 1/4 –	–	–	–	158.7486	–	–	1.0079
165 &	–	6 1/2 & 6 3/8	–	–	–	165.0986	–	–	1.0196
						161.9236			
170 &	–	6 5/8 & 6 3/4	–	–	–	168.2735	–	–	1.0189
						171.4485			
175 &	–	6 7/8 –	–	–	–	174.6235	–	–	1.0022
180 &	–	7 & 7 1/8	–	–	–	177.7985	–	–	1.0178
						180.9734			
185 &	–	7 1/4 & 7 3/8	–	–	–	184.1484	–	–	1.0172
						187.3234			
190 &	–	7 1/2 & 7 3/8	–	–	–	190.4983	–	–	1.0169
						187.3234			
190 &	–	7 5/8 & –	–	–	–	193.6733	–	–	1.0193
195 &	–	7 3/4 –	–	–	–	196.8483	–	–	1.0095
200 &	–	7 7/8 & 8	–	–	–	200.0233	–	–	1.0160
						203.1983			
210 &	–	8 1/4 & 8 3/4	–	–	–	209.5482	–	–	1.0152
						212.7232			
220 &	–	8 5/8 & 8 3/4	–	–	–	219.0731	–	–	1.0145
						222.2481			

Fig.1

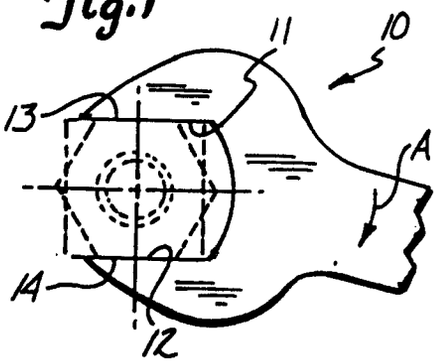


Fig.2

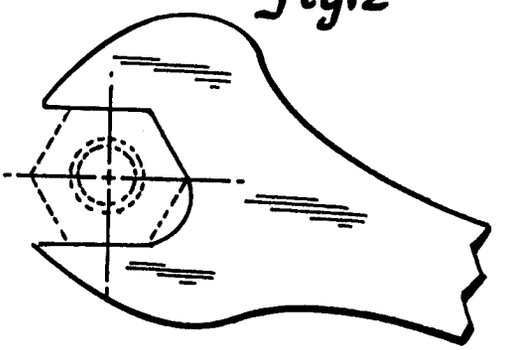


Fig.3

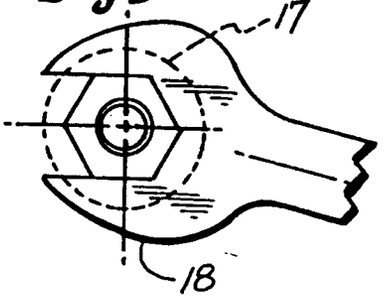


Fig.4

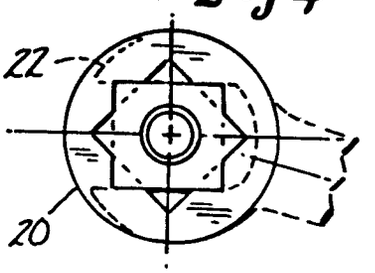


Fig.5

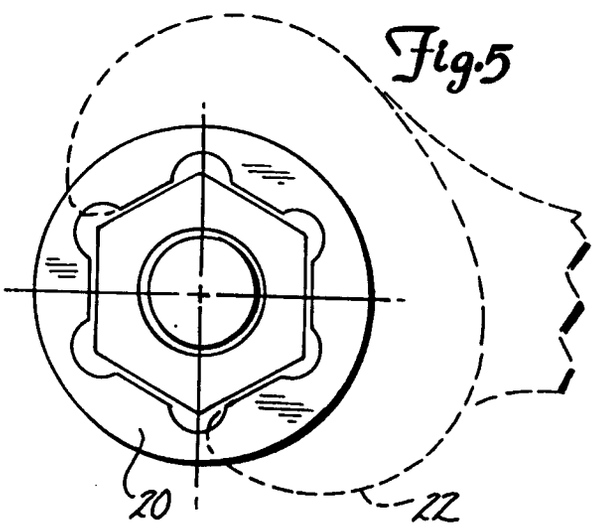


Fig.6

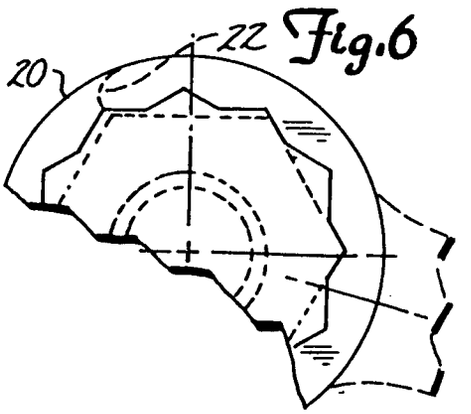


Fig.7

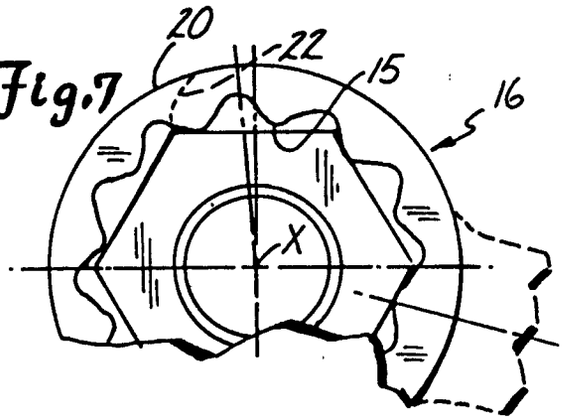


Fig.10

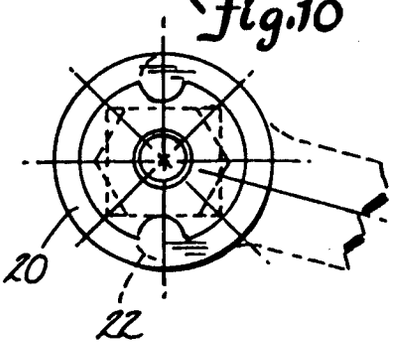


Fig.8

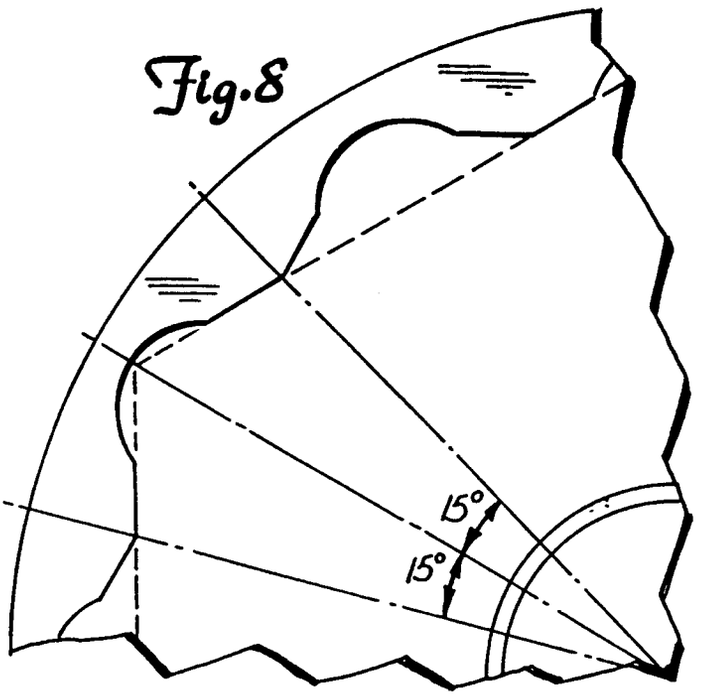


Fig.11

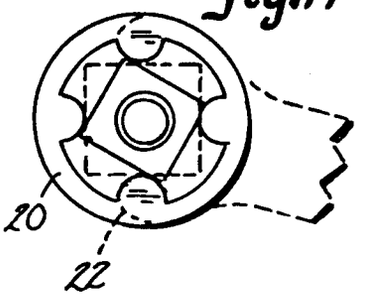


Fig.12

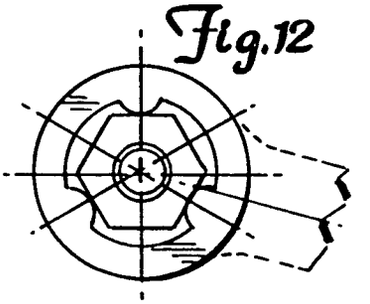


Fig.9

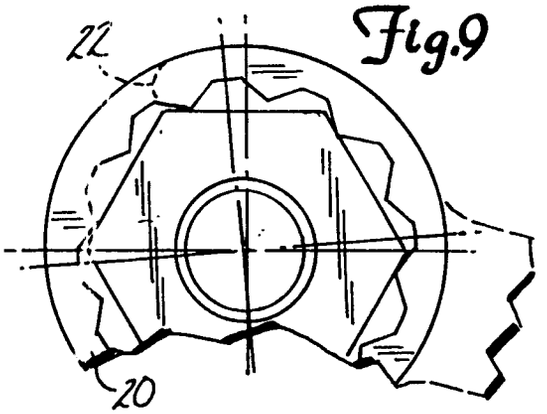


Fig.13

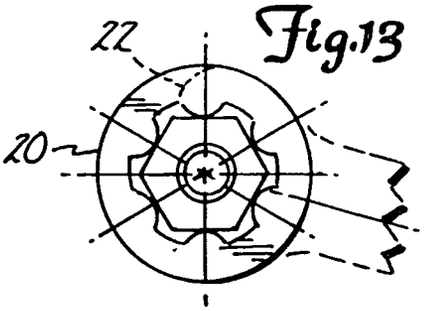


Fig.15

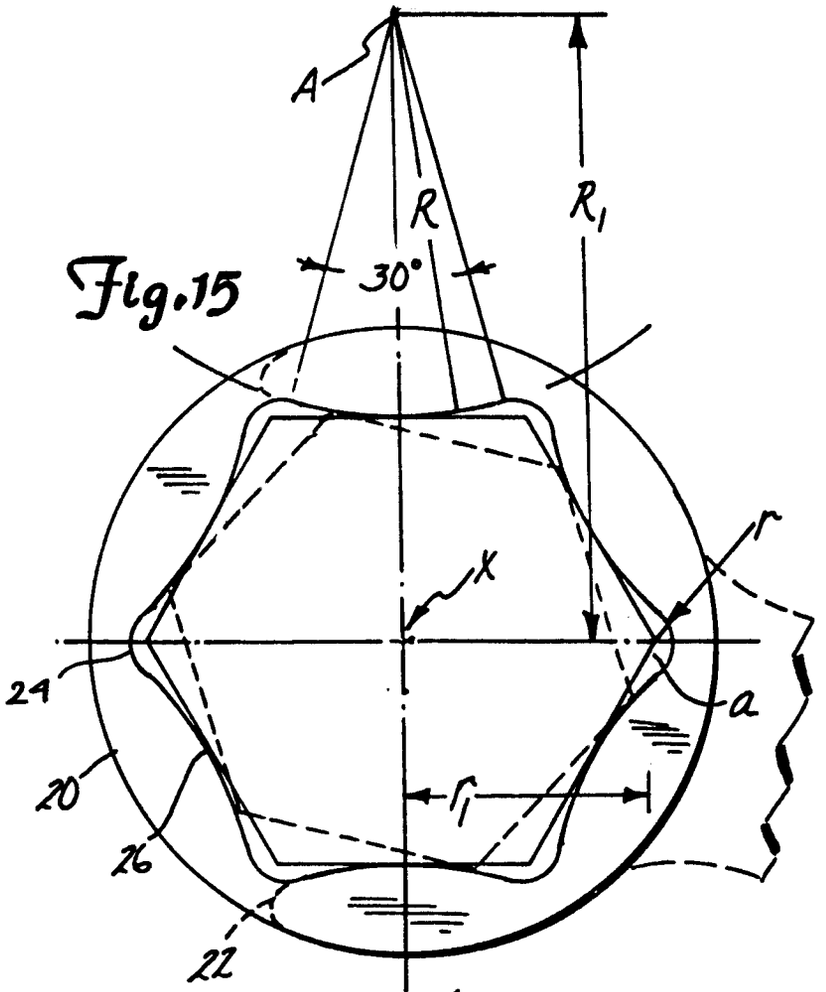

A
R
R1
30°
X
r
24
a
20
r1
26
22

Fig.16

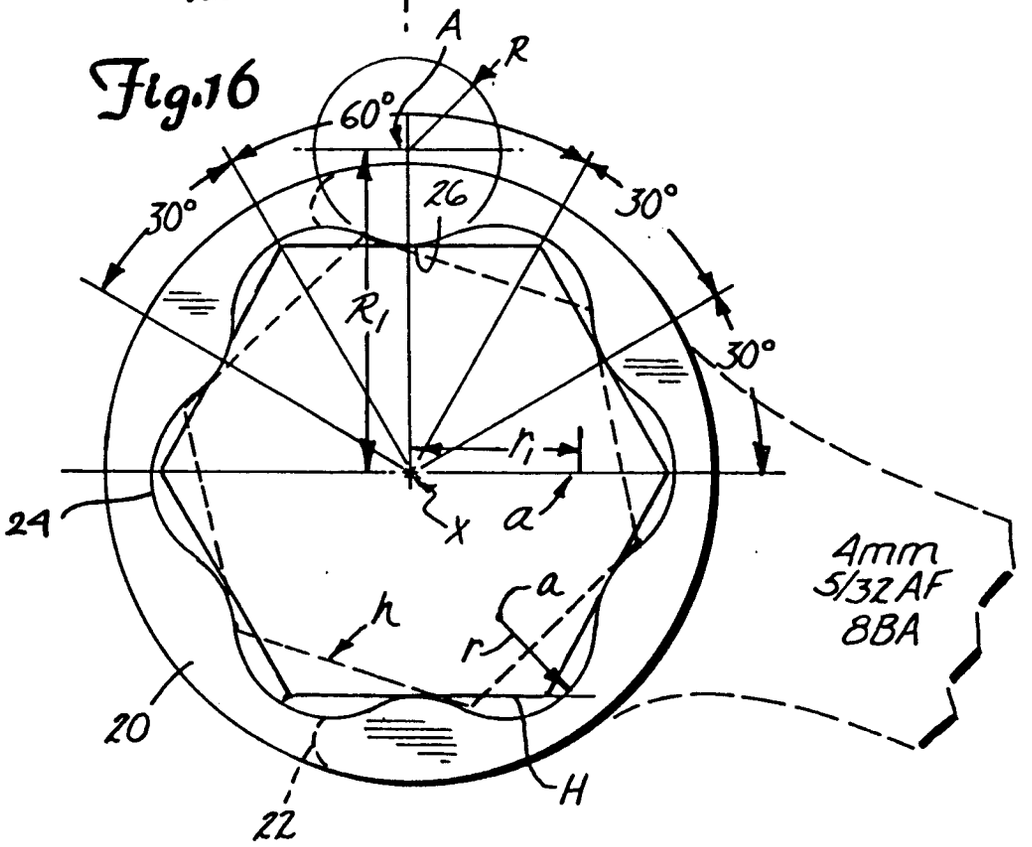

A
R
60°
30°
30°
26
30°
R1
r1
X
a
24
4mm
5/32AF
8BA
a
h
r
20
22
H

Fig.17

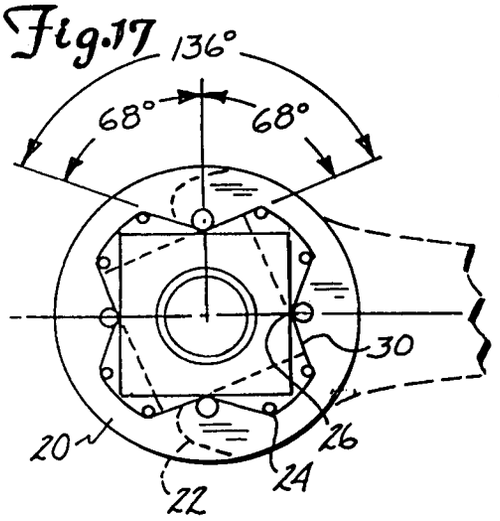


Fig.14

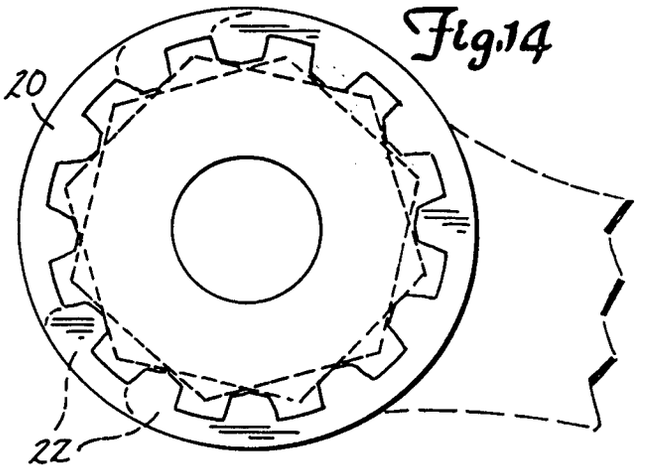


Fig.18

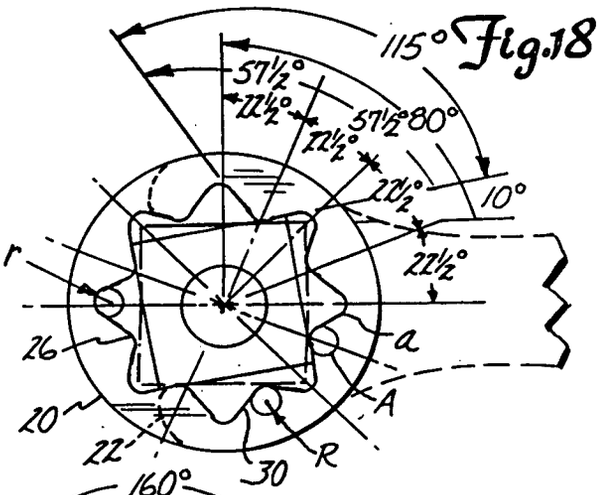
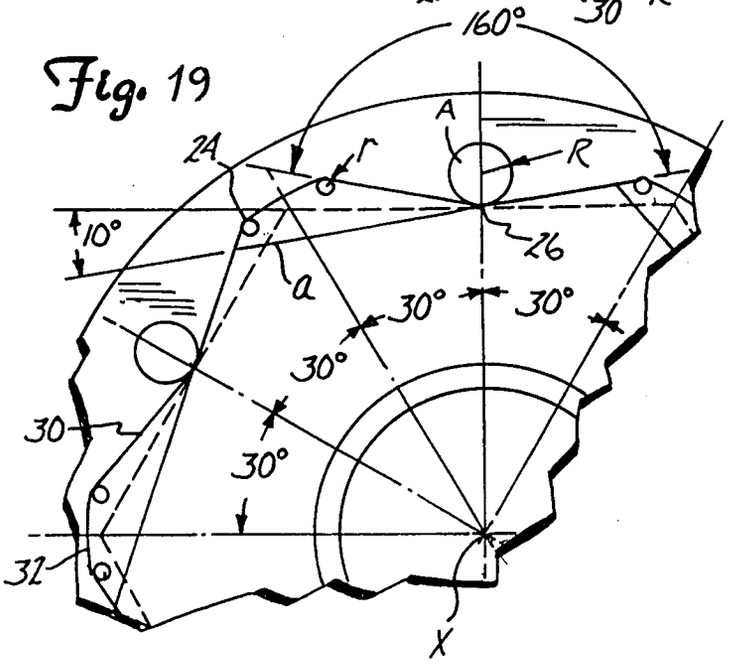


Fig. 19



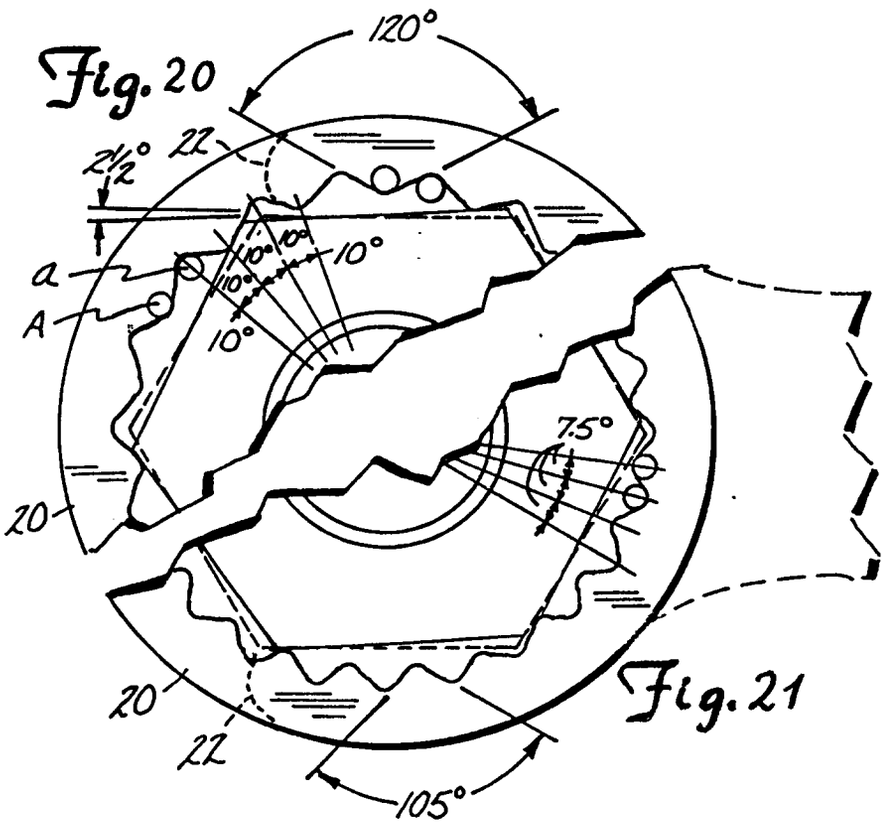


Fig. 20

Fig. 21