

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 describes 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 (Kavalár) 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. Kavalár 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 "r₁" 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 "R₁" 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 desirably exceeds 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 (Kavalor);

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 Maximum
ENGLISH in INCHES								
METRIC. (in mm.)	US Standard		British Standard		US Standard		British Standard	
	AF & SAE	BA	W Whitworth	BS	AF & SAE	BA		
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	

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 maximum
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						
3.2 &	3 &	1/8	-	-	-	3.1750	-	-	1.0667					
3.2 &	-	1/8 &	-	-	-	3.1750	3.3274	-	1.0480					
3.2 &	-	1/8	-	-	-	3.1750	-	-	1.0079					
3.2 &	-	-	-	-	-	-	3.3274	-	1.0398					
-	-	1/8 &	-	-	-	3.1750	3.3274	-	1.0480					
3.5 &	-	9/64 &	-	-	-	3.5718	3.3274	-	1.0735					
3.5 &	-	9/64	-	-	-	3.5718	-	-	1.0205					
3.5 &	-	-	-	-	-	-	3.3274	-	1.0519					
-	-	9/64 &	-	-	-	3.5718	3.3274	-	1.0735					
4 &	-	5/32 &	-	-	-	3.9687	3.8608	-	1.0363					
4 &	-	5/32	-	-	-	3.9687	-	-	1.0079					
4 &	-	-	-	-	-	-	3.8608	-	1.0363					
-	-	5/32 &	-	-	-	3.9687	3.8608	-	1.0282					
4.5 &	-	3/16 &	-	-	-	4.7625	4.3688	-	1.0898					
4.5 &	-	3/16	-	-	-	4.7625	-	-	1.0583					
4.5 &	-	-	-	-	-	-	4.3688	-	1.0297					
-	-	3/16 &	-	-	-	4.7625	4.3688	-	1.0898					
4.8 &	-	3/16 &	-	-	-	4.7625	4.9021	-	1.0290					
4.8 &	-	3/16 &	-	-	-	4.7625	-	-	1.0079					
4.8 &	-	-	-	-	-	-	4.9021	-	1.0213					
-	-	3/16 &	-	-	-	4.7625	4.9021	-	1.0289					
5 &	-	3/16 &	-	-	-	4.7625	4.9021	-	1.0499					
5 &	-	3/16	-	-	-	4.7625	-	-	1.0499					
-	-	3/16 &	-	-	-	4.7625	4.9021	-	1.0289					
5 &	-	-	-	-	-	-	4.9021	-	1.0204					
5 &	-	13/64 &	-	-	-	5.1593	4.9021	-	1.0529					
5 &	-	13/64	-	-	-	5.1593	-	-	1.0319					
-	-	13/64 &	-	-	-	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	Nominal Size (in mm.)			
	US Standard	British Standard		US Standard	British Standard	W & BS	
	AP & SAE	BA	W Whitworth	BS	AP & SAE	BA	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
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	-	-	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	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	-	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	1.0500
14 &	9/16 &	-	1/4W &	5/16BS	14.2874	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 &	-	5/16W &	3/8BS	14.2874	-	1.1429
16 &	5/8 &	-	-	-	15.8749	15.2399	1.0499

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 Maximum
METRIC (in mm.)	ENGLISH		in INCHES		US Standard	British Standard	W & BS	
	US Standard	AF & SAE	BA	W Whitworth				
17 &	11/16 &	-	-	-	-	17.4623	-	1.0272
17 &	-	-	-	-	-	-	-	1.0625
18 &	-	-	-	-	-	-	-	1.0588
18 &	23/32 &	-	-	3/8W &	7/16BS	18.2561	18.0338	1.0142
19 &	-	-	-	-	-	-	-	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 &	3/4	-	-	-	-	19.0498	-	1.0526
20 &	13/16	-	-	-	-	20.6373	-	1.0500
21 &	13/16 &	-	-	7/16W &	1/2BS	20.6373	20.8278	1.0176
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 &	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 &	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 &	15/16 &	1 &	-	9/16W &	5/8BS	23.8123	25.6538	1.0773
26 &	1 1/32	1	-	9/16W &	5/8BS	26.1935	25.6538	1.0477
27 &	1 1/16	-	-	5/8W &	1 1/16BS	25.3998	27.9398	1.0353
27 &	1 1/16 &	1 1/32	-	-	-	26.9873	-	1.0385
27 &	1 1/16	-	-	-	-	26.1935	-	1.0005
28 &	1 1/8	-	-	-	-	26.9873	-	1.0205
28 &	1 1/8	-	-	-	-	28.5748	-	1.0370
28 &	1 1/8 &	1 1/16 &	-	5/8W &	1 1/16BS	28.5748	27.9398	1.0588
28 &	1 1/8 &	1 1/16 &	-	-	-	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
METRIC (in mm.)	ENGLISH in INCHES				US Standard	British Standard	W & BS	
	US Standard	BA	W Whitworth	BS				
29 &	1 1/8 &	-	-	5/8W	11/16BS	28.5748	-	27.9398
30 &	1 3/16 &	-	-	1 1/16W &	3/4BS	30.1622	-	30.4797
30 &	1 3/16	-	-	-	-	30.1622	-	-
30 &	1 1/8 & 1 3/16	-	-	-	-	28.5748	-	-
31 &	1 1/4	-	-	-	-	30.1622	-	-
31 &	1 1/4 & 1 3/16	-	-	1 1/16W &	3/4BS	31.7497	-	30.4797
31 &	1 1/4 & 1 3/16	-	-	-	-	30.1622	-	-
32 &	1 1/4	-	-	-	-	31.7497	-	-
32 &	1 1/4	-	-	-	-	31.7497	-	-
32 &	1 1/4 &	-	-	3/4W &	7/8BS	31.7497	-	33.0197
32 &	1 1/4 &	-	-	3/4W &	7/8BS	33.3372	-	33.0197
33 &	1 5/16 & 1 1/4 &	-	-	-	-	31.7497	-	-
34 &	1 3/8 &	-	-	13/16W	15/16BS	34.9247	-	35.3057
35 &	1 3/8 & 1 5/16 &	-	-	13/16W &	15/16BS	34.9247	-	35.3057
36 &	1 7/16	-	-	13/16W &	15/16BS	35.5122	-	35.3057
37 &	1 1/2	-	-	-	-	38.0997	-	-
38 &	1 1/2	-	-	-	-	38.0997	-	-
38 &	1 1/2	-	-	7/8W &	1BS	38.0997	-	37.5917
39 &	1 9/16	-	-	-	-	39.6872	-	-
40 &	1 9/16	-	-	-	-	39.6872	-	-
41 &	1 5/8 & 1 11/16	-	-	1W &	1 1/8BS	41.2746	-	42.4176
42 &	1 11/16	-	-	-	-	42.8621	-	-
43 &	1 11/16	-	-	-	-	42.8621	-	-
44 &	1 3/4	-	-	-	-	44.4496	-	-
45 &	1 3/4	-	-	-	-	44.4496	-	-
46 &	1 13/16	-	-	-	-	46.0371	-	-
46 &	1 13/16 &	-	-	1 1/8W &	1 1/4BS	46.0371	-	47.2436

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 Maximum
METRIC (in mm.)	ENGLISH		in INCHES		US Standard	British Standard	W & BS	
	US Standard	AF & SAE	BA	W Whitworth				
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	-	1.0252
60 &	-	2 3/8 & 2 7/16	-	1 1/2W & 1 5/8BS	-	60.3245	-	1.0319
65 &	-	2 9/16 & 2 5/8	-	1 5/8W & 1 3/4BS	-	61.9120	-	1.0258
70 &	-	2 3/4 &	-	1 3/4W & 2BS	-	66.6744	-	1.0036
75 &	-	3 &	-	-	-	76.1993	-	1.0160
75 &	-	3 & 2 15/16	-	-	-	76.1993	-	1.0213
80 &	-	3 1/8 &	-	2W &	2 1/4BS	79.3743	-	1.0080
85 &	-	3 3/8 &	-	-	-	85.7243	-	1.0085
90 &	-	3 1/2 &	-	2 1/4W & 2 1/2BS	-	88.8992	-	1.0143
95 &	-	3 7/8 & 3 3/4 & 3 13/16	-	2 1/2W & 2 3/4BS	-	98.4241	-	1.0360
100 &	-	3 7/8 &	-	2 1/2W & 2 3/4BS	-	96.8367	-	1.0160
105 &	-	4 3/16 & 4 1/8 &	-	2 3/4W & 3BS	-	98.4241	-	1.0152
110 &	-	4 3/8 &	-	-	-	106.3616	-	1.0102
115 &	-	4 1/2 & 4 5/8 &	-	3W &	3 1/4BS	104.7741	-	1.0278
120 &	-	4 3/4 & 4 7/8 &	-	3 1/4W & 3 1/2BS	-	111.1240	-	1.0319
125 &	-	4 7/8 &	-	3 1/4W & 3 1/2BS	-	114.2990	-	1.0147
130 &	-	5 & 5 1/8 & 5 1/4	-	3 1/2W & 3 3/4BS	-	117.4740	-	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 Maximum
METRIC (in mm.)	ENGLISH in INCHES				BS	AF & SAE	British Standard	W & BS	
	US Standard	BA	W Whitworth	US Standard					
135 &	5 3/8 & 5 1/4 &	-	3 1/2W & 3 3/4BS	-	136.5238	-	131.5709	1.0376	
140 &	5 1/2 & 5 5/8 &	-	3 3/4W & 4BS	-	133.3488	-	140.9688	1.0227	
145 &	5 5/8 & 5 3/4	-	-	-	139.6988	-	-	1.0222	
150 &	5 7/8	-	-	-	142.8738	-	-	1.0052	
155 &	6 1/8	-	-	-	142.8738	-	-	1.0037	
160 &	6 1/4	-	-	-	146.0487	-	-	1.0079	
165 &	6 1/2 & 6 3/8	-	-	-	149.2237	-	-	1.0196	
170 &	6 5/8 & 6 3/4	-	-	-	155.5737	-	-	1.0189	
175 &	6 7/8	-	-	-	158.7486	-	-	1.0022	
180 &	7 & 7 1/8	-	-	-	161.9236	-	-	1.0178	
185 &	7 1/4 & 7 3/8	-	-	-	165.0986	-	-	1.0172	
190 &	7 1/2 & 7 3/8	-	-	-	168.2735	-	-	1.0169	
190 &	7 5/8 &	-	-	-	171.4485	-	-	1.0193	
195 &	7 3/4	-	-	-	174.6235	-	-	1.0095	
200 &	7 7/8 & 8	-	-	-	177.7985	-	-	1.0160	
210 &	8 1/4 & 8 3/4	-	-	-	180.9734	-	-	1.0152	
220 &	8 5/8 & 8 3/4	-	-	-	184.1484	-	-	1.0145	

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), Yugoslavia (JUS), Japan (JS) and

specifications from various manufacturers in the United States, England, France, Germany, Canada, Japan, Italy, Sweden, Spain, Czechoslovakia, 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.

15 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 & 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 R₁ is approximately equal to r₁, 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 "r₁" 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 "R₁" 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 r₁ and R₁ 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 R₁ is greater than r₁.

6. A tool according to Claim 5, wherein the ratio R₁/r₁ 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.
- 5 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 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.
- 15 11. A tool according to Claim 10, wherein said tool carries, adjacent its opening, visible indicia identifying the at least two different nominal sizes.
- 20 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:

25

30

35

40

45

50

55

5

10

15

20

25

30

35

40

45

50

55

Nominal METRIC. (in mm.)	Size Combinations					Nominal Size (in mm.)				RATIO Maximum
	ENGLISH		in INCHES							
	US Standard	British Standard	BS	W Whit- Worth	US Standard	British	Standard			
	AF & SAE	BA			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	

5

10

15

20

25

30

35

40

45

50

55

Nominal METRIC (in mm.)		Size Combinations in INCHES					Nominal Size (in mm.)			RATIO maximum
		ENGLISH		British Standard			US Standard	British	Standard	
		US Standard	AF & SAE	BA	W Whit- worth	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 &	-	3/16 &	-	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 METRIC (in mm.)	Size Combinations in INCHES					Nominal Size(in mm.)				RATIO Maximum
	ENGLISH		British Standard			US Standard		British		
	US Standard		W Whitworth			AF & SAE		BA		
	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	
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	
9 &	3/8 &	-	-	-	9.5249	-	-	-	1.0499	
10 &	13/32 &	0BA	-	7/32BS	10.3187	10.4901	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 &	-	-	-	11.1124	-	-	-	1.0275	
11 &	15/32	-	3/16W &	1/4BS	11.9061	-	-	11.3029	1.0079	
12 &	1/2	-	-	-	12.6999	-	-	-	1.0236	
13 &	1/2 &	-	1/4W &	5/16BS	12.6999	13.3349	13.3349	13.3349	1.0500	
13 &	9/16 &	-	1/4W &	5/16BS	14.2874	13.3349	13.3349	13.3349	1.0714	
14 &	9/16 &	-	-	-	14.2874	-	-	-	1.0205	
14 &	9/16 &	-	-	-	15.0811	-	-	-	1.0054	
15 &	19/32	-	5/16W &	3/8BS	15.0811	-	-	15.2399	1.0160	
15 &	19/32 &	-	-	-	-	-	-	-	-	
16 &	9/16 &	-	5/16W &	3/8BS	14.2874	-	15.2399	15.2399	1.1429	
16 &	5/8 &	-	5/16W &	3/8BS	15.8749	15.2399	15.2399	15.2399	1.0499	
16 &	5/8 &	-	-	-	15.8749	-	-	-	-	

5

10

15

20

25

30

35

40

45

50

55

Nominal METRIC (in mm.)	Size Combinations					Nominal Size (in mm.)				RATIO Maximum
	ENGLISH		in INCHES			US Standard	British Standard	BA	W & BS	
	AF & SAE	BA	W Whitworth	BS						
17 &	11/16 &	-	-	-	-	17.4623	-	-	-	1.0272
17 &	-	-	-	-	-	-	-	-	-	1.0625
18 &	-	-	-	-	-	-	-	-	-	1.0588
18 &	23/32 &	-	3/8W &	7/16BS	18.2561	-	-	18.0338	-	1.0142
19 &	-	-	-	-	-	-	-	-	-	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 &	3/4	-	-	-	-	19.0498	-	-	-	1.0526
21 &	13/16	-	-	-	-	20.6373	-	-	-	1.0500
21 &	13/16 &	-	7/16W &	1/2BS	20.6373	-	-	20.8278	-	1.0176
22 &	-	-	-	-	-	-	-	-	-	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 &	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 &	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 &	15/16 &	1 &	9/16W &	5/8BS	23.8123	-	-	25.6538	-	1.0773
25 &	1 1/32	1	9/16W &	5/8BS	26.1935	-	-	25.6538	-	1.0477
26 &	-	-	-	-	-	25.3998	-	-	-	-
27 &	1 1/16	-	5/8W &	11/16BS	26.9873	-	-	27.9398	-	1.0353
27 &	1 1/16 &	1 1/32	-	-	26.9873	-	-	-	-	1.0385
27 &	1 1/16	-	-	-	-	26.1935	-	-	-	-
28 &	1 1/8	-	-	-	-	26.9873	-	-	-	1.0005
28 &	1 1/8	-	-	-	-	28.5748	-	-	-	1.0205
28 &	-	-	-	-	-	-	-	-	-	1.0370
28 &	1 1/8 &	1 1/16 &	5/8W &	11/16BS	28.5748	-	-	27.9398	-	1.0588
28 &	-	-	-	-	-	26.9873	-	-	-	-

5

10

15

20

25

30

35

40

45

50

55

Nominal METRIC (in mm.)		Size Combinations				Nominal Size (in mm.)				RATIO Maximum
		ENGLISH		in INCHES		US Standard	British Standard	BA	W Whitworth	
		US Standard	AF & SAE	BA	W Whitworth					
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
31 &	-	1 1/4	-	-	-	-	30.1622	-	-	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
32 &	32 &	1 1/4 &	-	-	3/4W &	7/8BS	33.3372	-	33.0197	1.0500
33 &	32 &	1 5/16 & 1 1/4 &	-	-	-	-	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
36 &	35 &	1 7/16	-	-	13/16W &	15/16BS	33.3372	-	35.3057	1.0286
37 &	-	1 1/2	-	-	-	-	35.5122	-	-	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 &	-	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 1/8BS	46.0371	-	47.2436	1.0270

Nominal		Size Combinations				Nominal Size (in mm.)				RATIO Maximum
METRIC (in mm.)	ENGLISH	in. INCHES		W Whitworth	BS	US Standard		British BA		
		US Standard	AF & SAE			BA	AF & SAE		Standard	
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	-	61.9120	-	-	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	-	-	-	1.0213
80 &	-	3 1/8 &	-	2W & 2 1/4BS	-	74.6119	-	-	80.0093	1.0080
85 &	-	3 3/8	-	-	-	79.3743	-	-	-	1.0085
90 &	-	3 1/2	-	2 1/4W & 2 1/2BS	-	85.7243	-	-	90.1692	1.0143
95 &	-	3 7/8 & 3 3/4 & 3 13/16	-	2 1/2W & 2 3/4BS	-	88.8992	-	-	98.8051	1.0360
100 &	-	3 7/8 &	-	2 1/2W & 2 3/4BS	-	98.4241	-	-	-	1.0160
105 &	-	4 3/16 & 4 1/8 &	-	2 3/4W & 3BS	-	95.2492	-	-	98.8051	1.0152
110 &	-	4 3/8	-	-	-	96.8367	-	-	98.8051	1.0160
115 &	-	4 1/2 & 4 5/8	-	3W & 3 1/4BS	-	98.4241	-	-	106.1711	1.0152
120 &	-	4 3/4 & 4 7/8	-	3 1/4W & 3 1/2BS	-	104.7741	-	-	-	1.0102
125 &	-	4 7/8	-	3 1/4W & 3 1/2BS	-	111.1240	-	-	115.0610	1.0278
130 &	-	5 & 5 1/8 & 5 1/4	-	3 1/2W & 3 3/4BS	-	114.2990	-	-	123.1889	1.0319
						117.4740	-	-	123.1889	1.0319
						120.6489	-	-	123.1889	1.0147
						123.8239	-	-	131.5709	1.0500
						126.9989	-	-		
						130.1739	-	-		
						133.3488	-	-		

5
10
15
20
25
30
35
40
45
50

Nominal METRIC (in mm.)		Size Combinations					Nominal Size (in mm.)				RATIO Maximum				
		ENGLISH		in INCHES			US Standard	British Standard	BA	W Whitworth		BS	AF & SAE	British Standard	W & BS
		US Standard	AF & SAE	BA	British Standard										
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 155.5737	-	-	1.0052					
155 &	-	6 1/8	-	-	-	-	155.5737 158.7486	-	-	1.0037					
160 &	-	6 1/4	-	-	-	-	158.7486 165.0986	-	-	1.0079					
165 &	-	6 1/2 &	6 3/8	-	-	-	165.0986 161.9236	-	-	1.0196					
170 &	-	6 5/8 &	6 3/4	-	-	-	161.9236 168.2735	-	-	1.0189					
175 &	-	6 7/8	-	-	-	-	168.2735 174.6235	-	-	1.0022					
180 &	-	7 &	7 1/8	-	-	-	174.6235 177.7985	-	-	1.0178					
185 &	-	7 1/4 &	7 3/8	-	-	-	177.7985 180.9734	-	-	1.0172					
190 &	-	7 1/2 &	7 3/8	-	-	-	180.9734 184.1484	-	-	1.0169					
190 &	-	7 5/8 &	-	-	-	-	184.1484 187.3234	-	-	1.0193					
195 &	-	7 3/4	-	-	-	-	187.3234 193.6733	-	-	1.0095					
200 &	-	7 7/8 &	8	-	-	-	193.6733 196.8483	-	-	1.0160					
210 &	-	8 1/4 &	8 3/4	-	-	-	196.8483 208.0233	-	-	1.0152					
220 &	-	8 5/8 &	8 3/4	-	-	-	208.0233 203.1983	-	-	1.0145					

Patentansprüche

55

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



5
10
15
20
25
30
35
40
45
50

Nominal METRIC (in mm.)		Size Combinations					Nominal Size (in mm.)				RATIO Maximum
		ENGLISH		in INCHES			US Standard	British Standard	BA	W & BS	
		US Standard	AF & SAE	BA	W Whitworth	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 155.5737	-	-	-	1.0052
155 &	-	6 1/8	-	-	-	-	155.5737 158.7486	-	-	-	1.0037
160 &	-	6 1/4	-	-	-	-	158.7486 165.0986	-	-	-	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 177.7985	-	-	-	1.0022
180 &	-	7 &	7 1/8	-	-	-	177.7985 180.9734	-	-	-	1.0178
185 &	-	7 1/4 &	7 3/8	-	-	-	180.9734 184.1484	-	-	-	1.0172
190 &	-	7 1/2 &	7 3/8	-	-	-	184.1484 187.3234	-	-	-	1.0169
190 &	-	7 5/8 &	-	-	-	-	187.3234 193.6733	-	-	-	1.0193
195 &	-	7 3/4	-	-	-	-	193.6733 196.8483	-	-	-	1.0095
200 &	-	7 7/8 &	8	-	-	-	196.8483 208.0233	-	-	-	1.0160
210 &	-	8 1/4 &	8 3/4	-	-	-	208.0233 203.1983	-	-	-	1.0152
220 &	-	8 5/8 &	8 3/4	-	-	-	203.1983 209.5482	-	-	-	1.0145
							209.5482 212.7232	-	-	-	
							212.7232 219.0731	-	-	-	
							219.0731 222.2481	-	-	-	

Patentansprüche

55

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;
- 5 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 "r₁" 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 "R₁" von,
- 10 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,**
- 15 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 r₁ und R₁ derart ist, daß, wenn r gleich R ist, der Schraubenschlüssel zwischen der ersten und zweiten Fläche tangential in diese übergehende ebene Flächen aufweist.
- 20 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.
- 25 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.
- 30 5. Werkzeug nach Anspruch 4, wobei R₁ größer als r₁ ist.
6. Werkzeug nach Anspruch 5, wobei das Verhältnis R₁/r₁ größer als 1,5 ist.
- 35 7. Werkzeug nach Anspruch 4, wobei R gleich oder größer als r ist.
8. Werkzeug nach Anspruch 7, wobei das Verhältnis R/r größer als 5,0 ist.
- 40 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
- 45 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
- 50 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.
- 55 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)					W Whitworth	BS	AF & SAE		BA	W & BS
		Standard USA	Standard Grossbritannien		Standard USA	Standard Grossbritannien						
			AF & SAE	BA								
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		



5 <
--



metrisch (mm)	Nenngrößenkombinationen					Nenngrösse (mm)					maximales Verhältnis
	englisch (inch)					W Whit- worth	BS	AF & SAE	BA	W & BS	
	Standard USA										
	Standard Grossbritannien										
50	45	40	35	30	25	20	15	10	5		
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 &	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 &	-	-	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 &	-	-	-	11.1124	-	-	1.0275		
11 &	-	15/32	-	-	3/16W &	11.9061	-	11.3029	1.0079		
12 &	-	1/2	-	-	-	12.6999	-	-	1.0236		
13 &	-	1/2 &	-	-	-	12.6999	13.3349	13.3349	1.0500		
13 &	-	9/16 &	-	-	5/16BS	14.2874	13.3349	13.3349	1.0714		
14 &	-	9/16 &	-	-	5/16BS	14.2874	-	-	1.0205		
14 &	-	19/32	-	-	-	15.0811	-	-	1.0054		
15 &	-	19/32 &	-	-	3/8BS	15.0811	-	15.2399	1.0160		
16 &	15 & 14 &	9/16 &	5/8 &	-	3/8BS	14.2874	-	15.2399	1.1429		
16 &	-	5/8 &	-	-	3/8BS	15.8749	15.2399	15.2399	1.0499		



5

10

15

20

25

30

35

40

45

50

55

Nenngrossenkombinationen										Nenngrosse (mm)			maximales Verhältnis
metrisch (mm)		englisch (inch)					Standard USA						
		Standard Grossbritannien					Standard Grossbritannien						
		AF & SAE	BA	W Whitworth	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 &	1/2BS	-	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 &	-	1/2W &	9/16BS	-	23.8123	-	-	-	1.0079		
24 &	-	15/16 &	-	1/2W &	9/16BS	-	23.8123	-	23.3678	-	1.0271		
24 &	23 &	15/16	-	-	-	-	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 &	-	9/16W &	5/8BS	-	23.8123	-	25.6538	-	1.0773		
26 &	25	1 1/32	-	9/16W &	5/8BS	-	26.1935	-	25.6538	-	1.0477		
27 &	-	1 1/16	-	5/8W &	1 1/16BS	-	25.3998	-	27.9398	-	1.0353		
27 &	26 &	1 1/16 &	-	-	-	-	26.9873	-	-	-	1.0385		
27 &	-	1 1/16	-	-	-	-	26.9873	-	-	-	1.0005		
28 &	-	1 1/8	-	-	-	-	26.1935	-	-	-	1.0205		
28 &	27 &	1 1/8	-	-	-	-	26.9873	-	-	-	1.0370		
28 &	27 &	1 1/8 &	-	5/8W &	1 1/16BS	-	28.5748	-	27.9398	-	1.0588		



5

10

15

20

25

30

35

40

45

50

55

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



5

10

15

20

25

30

35

40

45

50

55

Nenngrößenkombinationen		Nenngrösse (mm)				maximales Verhältnis	
metrisch (mm)	englisch (inch)	Standard USA		Standard Grossbritannien		W & BS	BA
		AF & SAE	BA	W Whitworth	BS		
47	1 7/8	-	-	-	-	47.6246	-
48	1 7/8	-	-	-	-	47.6246	-
49	1 15/16	-	-	-	-	49.2121	-
50	2	-	-	-	-	50.7996	-
50	1 15/16	-	-	-	-	49.2121	-
55	2 3/16	-	-	1 3/8W & 1 1/2BS	-	55.5620	56.3875
60	2 3/8	2 7/16	-	1 1/2W & 1 5/8BS	-	60.3245	61.2135
65	2 9/16	2 5/8	-	1 5/8W & 1 3/4BS	-	61.9120	65.5314
70	2 3/4	-	-	1 3/4W & 2BS	-	66.6744	70.1034
75	3	-	-	-	-	69.8494	-
75	3	2 15/16	-	-	-	76.1993	-
80	3 1/8	-	-	2W & 2 1/4BS	-	74.6119	80.0093
85	3 3/8	-	-	-	-	79.3743	-
90	3 1/2	-	-	2 1/4W & 2 1/2BS	-	85.7243	-
95	3 7/8	3 3/4	-	2 1/2W & 2 3/4BS	-	88.8992	90.1692
		3 13/16	-	-	-	98.4241	98.8051
100	3 7/8	-	-	2 1/2W & 2 3/4BS	-	95.2492	-
105	4 3/16	4 1/8	-	2 3/4W & 3BS	-	96.8367	98.8051
110	4 3/8	-	-	-	-	98.4241	106.1711
115	4 1/2	4 5/8	-	3W & 3 1/4BS	-	106.3616	-
120	4 3/4	4 7/8	-	3 1/4W & 3 1/2BS	-	104.7741	123.1889
125	4 7/8	-	-	3 1/4W & 3 1/2BS	-	111.1240	-
130	5	5 1/8	-	3 1/2W & 3 3/4BS	-	114.2990	123.1889
		5 1/4	-	-	-	117.4740	131.5709
			-	-	-	120.6489	-
			-	-	-	123.8239	-
			-	-	-	126.9989	-
			-	-	-	130.1739	-
			-	-	-	133.3488	-



50 45 40 35 30 25 20 15 10 5	Nenngrossenkombinationen					Nenngrosse (mm)			maximales Verhältnis		
	metrisch (mm)	english (inch)				W Whitworth	BS	AF & SAE		BA	W & BS
		Standard USA	Standard Grossbritannien	Standard USA	Standard Grossbritannien						
		AP & SAE	BA								
135 &	-	5 3/8 & 5 1/4 &	-	3 1/2W & 3 3/4BS	-	136.5238	-	131.5709	1.0376		
140 &	-	5 1/2 & 5 5/8 &	-	3 3/4W & 4BS	-	133.3488	-	140.9688	1.0227		
145 &	-	5 5/8 & 5 3/4	-	-	-	139.6988	-	-	1.0222		
150 &	-	5 7/8	-	-	-	142.8738	-	-	1.0052		
155 &	-	6 1/8	-	-	-	146.0487	-	-	1.0037		
160 &	-	6 1/4	-	-	-	149.2237	-	-	1.0079		
165 &	-	6 1/2 & 6 3/8	-	-	-	155.5737	-	-	1.0196		
170 &	-	6 5/8 & 6 3/4	-	-	-	158.7486	-	-	1.0189		
175 &	-	6 7/8	-	-	-	165.0986	-	-	1.0022		
180 &	-	7 & 7 1/8	-	-	-	161.9236	-	-	1.0178		
185 &	-	7 1/4 & 7 3/8	-	-	-	168.2735	-	-	1.0172		
190 &	-	7 1/2 & 7 3/8	-	-	-	171.4485	-	-	1.0169		
190 &	-	7 5/8 &	-	-	-	174.6235	-	-	1.0193		
195 &	-	7 3/4	-	-	-	177.7985	-	-	1.0095		
200 &	-	7 7/8 & 8	-	-	-	180.9734	-	-	1.0160		
210 &	-	8 1/4 & 8 3/4	-	-	-	184.1484	-	-	1.0152		
220 &	-	8 5/8 & 8 3/4	-	-	-	187.3234	-	-	1.0145		

55 Revendications

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



5

10

15

20

25

30

35

40

45

50

55

- 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 "r₁" 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 "R₁" 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 r₁ et R₁ 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 R₁ est plus grand que r₁.
 6. Outil selon la revendication 5, dans lequel le rapport R₁/r₁ 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 :

5

10

15

20

25

30

35

40

45

50

55

Combinaisons de dimensions nominales				Dimension Nominale				RAPPORT Maximum	
SYSTEME METRIQUE (en mm)	ANGLAIS en POUCES				(en mm)				
	Norme US		Norme Britannique		Norme US		Norme Britannique		
	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 &	5/64 &	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													
ANGLAIS en POUCES													
Norme US													
Norme Britannique													
W Whitworth													
BS													
AF & SAE													
BA													
Norme US													
Norme Britannique													
W & BS													
RAPPOR 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



5
10
15
20
25
30
35
40
45
50
55

Combinaisons de dimensions nominales				Dimension Nominale (en mm)			RAPPORT Maximum
SYSTEME METRIQUE (en mm)	ANGLAIS en POUCES			Norme Britannique			
	Norme US	BA	W Whitworth	BS	AF & SAE	BA	
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	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	-	-	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	1.0490
10 &	7/16	-	-	-	11.1124	-	1.0102
11 &	7/16 &	0BA	-	-	11.1124	10.4901	1.0593
11 &	7/16	-	-	-	11.1124	-	1.0275
11 &	7/16 &	-	3/16W &	1/4BS	11.1124	-	1.0079
12 &	15/32	-	-	-	11.9061	-	1.0236
13 &	1/2	-	-	-	12.6999	-	1.0500
13 &	1/2 &	-	1/4W &	5/16BS	12.6999	13.3349	1.0714
14 &	9/16 &	-	1/4W &	5/16BS	14.2874	13.3349	1.0205
14 &	9/16	-	-	-	14.2874	-	1.0054
15 &	19/32	-	-	-	15.0811	-	1.0160
15 &	19/32 &	-	5/16W &	3/8BS	15.0811	15.2399	1.1429
16 & 15 & 14 &	9/16 &	-	5/16W &	3/8BS	14.2874	15.2399	1.0499
16 &	5/8 &	-	5/16W &	3/8BS	15.8749	15.2399	1.0499



5
10
15
20
25
30
35
40
45
50
55

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



5

10

15

20

25

30

35

40

45

50

55

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

38



6

10

15

20

25

30

35

40

45

50

55

Combinaisons de dimensions nominales ANGLAIS en POUCES				Dimension Nominale (en mm)			RAPPORT Maximum		
SYSTEME METRIQUE (en mm)	Norme US		Norme Britannique		Norme US			BA	W & BS
	AF & SAE	BA	W Whit- worth	BS	AF & SAE	BA			
135 & -	5 3/8 & 5 1/4 & -	-	3 1/2W & 3 3/4BS	3 3/4BS	136.5238 133.3488	-	131.5709	1.0376	
140 & -	5 1/2 & 5 5/8 & -	-	3 3/4W & 4BS	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	-	-	1.0189	
175 & -	6 7/8 & -	-	-	-	171.4485	-	-	1.0022	
180 & -	7 & 7 1/8 & -	-	-	-	174.6235 177.7985	-	-	1.0178	
185 & -	7 1/4 & 7 3/8 & -	-	-	-	180.9734 184.1484	-	-	1.0172	
190 & -	7 1/2 & 7 3/8 & -	-	-	-	187.3234 190.4983	-	-	1.0169	
190 & -	7 5/8 & -	-	-	-	187.3234	-	-	1.0193	
195 & -	7 3/4 & -	-	-	-	193.6733 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	