Spanner Jaw Sizes

Courtesy: Paul Crawford

This page has a useful chart for comparing spanner sizes (a wrench in the USA) and common nut/bolt use. Although it is believed to be correct, use the suggestions and data provided on this web page at your own risk! Please read the disclaimer first. From here you can just jump directly to the Jaw Size Table but I think you should read the whole page at least once for advice (or twice if you are a judge for the "most boring web page" competition). Here is the table of contents:

BSF = British Standard Fine
BSW = British Standard Whitworth
BSC = British Standard Cycle
CEI = Cycle Engineers Institute
AF = American Fraction or Across Flat
SAE (AS) = Aerospace Standard
BA = British Associated
AUC = American Unified Course

09.01.19 NGW

Background

For the 'British' sizes, the nut/bolt size corresponds to the spanner marking (i.e. a 1/2" W spanner fits a Whitworth bolt with a shank/thread diameter of 1/2"). The original Whitworth sizes were standardised in 1841 by Sir Joseph Whitworth (1803-87) and featured a significant head oversize to accommodate the crude tolerances of the production methods of the day. In 1908 the standard was revised to include the option for a finer thread and became BSF (British Standard Fine) and BSW (British Standard Whitworth). The BSW bolts/nuts use the same coarse thread as the original Whitworth proposal, which is suited to soft or coarsely crystalline materials (e.g. aluminium, cast iron), while the BSF bolts have the same thread profile but a finer cut (i.e. higher TPI value) and, with an adequate length of thread engagement, provide a stronger fastener and better vibration resistance for high tensile materials

The BSF head size was one step smaller than BSW (e.g. a 1/4" BSW bolt was the same head as a BSF 5/16" bolt, etc, avoiding the need for new tools) up to 1924 but there was demand for a similar BSW version so the "British Standard Whitworth (Small hexagon)" standard BSWS was introduced in 1929 in B.S. 129 (also known as "Auto-Whit" presumably from its use in the automotive industry). During the Second World War the standards were revised again as "War Emergency B.S. 916 : 1940" as an austerity measure to reduce steel consumption and this resulted in the normal BSW head sizes being reduced by one step, basically making the BSW = BSWS = BSF head size, also bringing them closer to the size range commonly used today:

- Across flats jaw size = bolt diameter * 1.5 (approximately, only the BA standard has a simple fixed relationship factor at 1.75)

It is not clear post-WW2 if manufacturers returned to the older standard for BSW but it is unlikely as most changes were driven by the adoption of the American and metric systems. The British Standard B.S. 192 of 1924 states that spanners should be marked with both the BSW and BSF sizes, but by 1954 the revised B.S. 192 is referring to "Whitworth large hexagons" so the implication is the WW2 emergency change was permanent and the larger size unusual. That 1954 revision was using the example of 'BS' to refer to the BSF/BSW size and 'W' for the original large hexagon size. Thus you will see spanners marked along the lines of '1/4 W 5/16 BS' indicating the jaws are sized for a 1/4" large hexagon Whitworth bolt, or the next step up at 5/16" for BSF/BSW and that is probably of 1954 or later. However, you sometimes see them marked just as 'BS' and they are the typically the smaller BSF (and WW2-era BSW size), but also I have seen some just with 'W' and referring to the large (original) hexagon size.

Typically you will find BSF/BSW in use in British equipment designed before 1948 (and of course equipment using parts or sub-assemblies designed in that era, for example, some Land Rover gearboxes), or similar equipment from members of the former British empire (commonwealth) such as Australia. One notable continued use of Whitworth's standard is the camera tripod mount, typically they used the 1/4" BSW thread (3/8" is on larger cameras), but recently UNC has replaced this in a rather unsporting move by the standards bodies.

The BA (British Association) sizes were formulated in 1884 and standardised in 1903. Later it was recommended to use them for all sizes below 1/4" instead of BSW/BSF. They are mostly used in electrical and instrumentation applications and continued in common use in the UK more or less until metrication in the 1970s when its use started to decline. Although odd numbered BA sizes have been made and are listed, they are quite rare. In the UK the even number sizes from 0BA down to 8BA are still readily available from electronic component suppliers such as RS Components, but the smaller or odd number sizes are often only available from model-making suppliers and companies offering parts for restoration work.

The AF sizes (UNF/UNC for Unified National Fine/Coarse) are seen mostly in USA equipment and cars, and British stuff designed from post-1948 (when it was decided to drop BSW/BSF as the preferred series of fasteners) up to metrication a couple of decades ago (say end of the 1970s). There is a 'heavy series' of nuts that have slightly larger AF sizes for a given bolt size, this table just shows the common ones. For smaller bolts they use 'numbers' rather than explicit sizes, but only the even numbers are in common use. Recently, even the USA has made significant moves towards metric sizes due to their international adoption.

The metric nut/bolt sizes listed are the common ISO sizes of the 1985 era (mostly same as the DIN standard), but there have been ISO/ANSI recommendations for some head sizes to be reduced from 1992 onwards, but not everyone followed. Therefore you may find M10 with 16mm AF size instead of 17mm (or possibly even 14mm or 15mm), M12 with 18mm, and M14 with 21mm. The 'non-preferred' sizes are still quite common, so don't be surprised to find you need such spanners, and occasionally (e.g. older Citroen cars!) you find oddities like M7 used. The M3.5 size is not listed in my 1985 copy of "Industrial Fasteners" but is very commonly used in UK electrical installation work (e.g. light switches, etc) presumably due to its closeness to the older 4BA size.

Postscript: It is a common view that the odd Whitworth/BS spanner sizes are 'illogical' and that the newer metric system is much more 'logical', but consider this: To cover 1/4" to 3/4" in both fine (BSF) and coarse (BSW) threads, the British system defines 9 diameters and requires 9 spanners (or 10 if you also include the original large head Whitworth sizes as well). The UNF/UNC system defines 8 diameters for the same range but requires 11 spanners. For the broadly equivalent range in metric of M6 to M18 using all the common metric standards in use, there are 8 diameters defined but a total of 15 spanners are required! (i.e. 69% more spanners per diameters than the British system). Is this progress?
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Using the Table

The table was created from a spreadsheet. The white cells are for AF sizes, they were entered as the fraction (e.g. "=5/16" in an EXCEL formula) and printed to 3 decimal places (so 5/16 = 0.3125 = 0.313 when rounded for display), the exact value was then converted to metric by multiplying by 25.4 and then printed to 2 decimal places (so 0.3125 * 25.4 = 7.9375 = 7.94 when rounded). The light blue/green cells have the metric size defined, and the inch size computed by dividing by 25.4 and rounding to 3 decimal places (e.g. 8mm / 25.4 = 0.314960... = 0.315 rounded). The yellow cells are like the white ones, except the fractional inch value is entered as the 3 decimal place value from tables of BA/Whitworth data, then converted as per AF sizes.

The table has a 'Diff' column for showing the difference in jaw size between that row and the previous row, computed from the 'exact' mm values then rounded to 2 decimal places (so they may not always match the result of subtracting the rounded values). If this is small (e.g. around 0.2mm, but depending on the overall size of course) you will probably find either spanner will do. If the difference is ***really*** small, it is probably just rounding from the same figure taken from different sources or happy coincidence (e.g. 27mm and 1-1/16" AF).

What ever you do, select a spanner or socket that fits properly and use a 'reasonable' torque for the application. Most critical bolts (e.g. engine cylinder head) will have a torque setting, tightening sequence, and possibly a final tightening angle specified to reach the correct pre-load force - use this information! Also use any specified tightening sequence ***in reverse for loosening*** any bolts to avoid warping the assembly.
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Selecting Spanners

My own choice of spanner is usually the Abingdon King Dick brand, as they offer quality tools and a good range of British sizes, but there are others that are good in my own experience, for example, Beta Tools (Italy), Stahlwille (Germany) or Snap-On (USA, though more expensive). I also have some Britool spanners, which were good but the holding company (Facom) closed the UK factory around 2000. I think the brand lives on, however, I don't have any experience of them since then and suspect the old 'Made in England' quality has gone.

Of course, quality is not usually cheap in any line of work, but some on-line prices are not bad. For example, Abbot Tools, Lawson HIS, or A & R Sheldon are worth trying for King Dick stuff (and other tools). It is worth checking out all 3 site's prices, and take in to account postage cost and any large-order discounts they offer.

If you are buying a tool set without any significant existing collection, and are planning on working on new equipment, then my suggestion it to get a comprehensive metric set (certainly the ISO bolt sizes) covering the range you expect (e.g. smaller sizes are typically needed for a motorbike than a car, etc) and remember that sizes above 32mm or so become more expensive so it is probably best to buy them as needed. Then use the table to add any odd sizes you expect to find occasionally.

As a car tool kit, you should ***check*** the sizes you need for a number of key items: wheel nuts/bolts, battery fixing nuts/bolts, battery terminals, alternator fixing & adjusting nuts/bolts, and spark plug size. Note that a 3/8" square drive set is generally not strong enough for rusted or over-tightened wheel nuts, so 1/2" drive is the suggested minimum for that job (or use a dedicated single wheel nut wrench or the 'spider' style of wheel brace).

For small electrical/electronic work, it makes sense to buy a set of open ended spanners covering 5, 5.5, 6, 7, 8 and 10mm and a 1/4" drive socket set covering this range (e.g. King Dick TKS424). A 1/4" square drive to hex bit holder, and set of hex (Allen key) and Torx bits to go with this is also a good idea. Alternatively, buying 'nut drivers' (also known as a 'nut spinners', they look like screwdrivers but have a hex socket end) or a box spanner set in place of the socket set can be a cost effective solution.

In the UK it is useful to add a few more, for example, having combination spanners for 2BA and 4BA for older electrical systems (and near equivalents, e.g. 4BA covers for 1/4" AF), plus a few of the common AF sizes (or buy near metric equivalents, such as 11mm for 7/16" AF and 16mm for 5/8" AF) and/or any BSF sizes depending on what you expect to work on.

Usually a few of the ISO metric spanners will cover common AF sizes quite well (for example, 8mm for 5/16", 19mm for 3/4", 22mm is often passable for 7/8", 24mm for 15/16" and 27mm for 1-1/16") but if you expect to work a lot on AF based equipment, then get the proper sizes where your metric selection are not very close (e.g. 3/8", 1/2", 9/16", 11/16" and 13/16" AF as a start). The same applies for British sizes, some are well covered by metric (e.g. 18mm for 3/8W and 21mm for 7/16W) but others are best bought if you need them. If fact, some of the metric sizes that are available seem to exist simply to cover for British sizes (e.g. some companies offer 33mm which is perfect for 3/4W)!

If only buying spanners, then get an open set and a ring set (e.g. King Dick TKO8M & TKR8M) so you can hold both nut and bolt. If you are also buying a good socket set, then combination spanners (one end open, other end ring) make some cost saving sense as the open end is often essential (e.g. nut on a pipe, etc) and the ring end can sometimes fit in where a socket can't reach, so something like the King Dick TKC10M spanners and TKS682 3/8" drive set is a comprehensive option for smaller stuff (to 22mm), but I would add at least a 16mm combination spanner to the TKC10M set. Alternatively (or in addition, depending on your budget) the TKS883 1/2" drive set for larger stuff (to 32mm), maybe also adding to the TKC10M set spanner sizes 27mm, 30mm and 32mm for completeness, or going all the way and buying the TKO12M and TKR12M open & ring sets.

The larger socket sets, such as 3/4" and 1" square drive, are normally used for sizes of around 27mm and above. Typically you need this if you work on large equipment (tractors, lorrys, trains, ships, etc) or for the largest and/or unusually high torque nuts on cars (e.g. drive shaft, occasional suspension bolt, etc). Unless you need it often, it may be better to hire such tools as needed.

Finally, if you really are looking for a minimum size/weight kit, then probably you should buy combination spanners in the ISO preferred sizes 8,10,13,17, and 19mm (possibly also 24mm, alternatively using a list from checking your actual requirements), together with a ***good quality*** 8" or 10" adjustable wrench (e.g. Bacho, King Dick, or a genuine USA-made Crescent).

Never rely on an adjustable wrench for anything high-torque, you will just end up damaging yourself and/or the equipment! Consider an adjustable as your 'last resort' option.

For releasing very tight nuts/bolts you should consider impact sockets and slogging spanners, available from King Dick and others, but you may also want to look at a dedicated supplier of impact tools such as Impact Socket Supplies Ltd who also provide special and/or very large tools (such as bi-square sockets for the railway industry, and up to 3.5" square drive) and Deltec Industries Ltd who make/supply impact sockets (and will do specials, such as unusually deep ones, for a reasonable price).

For tightening you should consider getting a good quality torque wrench (or wrenches, depending on the torque range you require), such as those made by Norbar, Williams Superslim, or Gedore (was Torquleader).

While any engineer's tool box is likely to have at least one steel hammer, it is also a very good idea to have a copper-faced hammer (and also a hide or plastic face for striking softer items such as aluminium castings). A good range is made by Thor Hammers and can be obtained from various

engineering supply places, or directly from the company.
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Safe Use

It is very important to use spanners and sockets, indeed any tools, correctly for the following reasons:

- To avoid injury to yourself or others.
- To avoid damaging the equipment you are working on.
- To have a long and reliable tool lifetime.

Here are some obvious (and less obvious) do's and dont's (and please do not pedantically read the "don't + never" type of statement as a positive endorsement!):

DO: Avoid overreaching yourself and consider the consequences of the spanner slipping, or the fastener suddenly breaking or coming loose. If the result is likely to involve a fall, or the removal of flesh from your knuckles, then reconsider your approach!

DO: Use the correct fitting tool. Excess play leads to a greater chance of damage to the fastener or possibly the tool. A very rough guide to maximum acceptable free play for a spanner or socket ranges from around 0.2mm to 1mm from the smallest to largest size in the table.

DO: Use high quality tools, they will cost less in the long run since they should last longer and lead to less chance of damage or injury. You need not always buy the most expensive choice, but if your tools set costs much the same as a child's toy, what do you expect?

DO: Regularly inspect tools for any signs of wear or damage. Repair (if possible, e.g. ratchet mechanism) or replace any that are not in good condition. Periodically verify (and/or return for proper calibration) any measuring tools such as torque wrenches.

DO: Look after your tools. Clean them after use and store in a dry location, preferably in a proper lockable tool box. A quick wipe with a clean rag and some very light oil (e.g. WD40) will help remove any dirt, rust, and moisture, but make sure they are not left in a slippery condition.

If you have high quality chrome plated tools, it is a good idea to initially and then *occasionally* polish them with automotive metal polish such as Autoglym Metal Polish, or the less abrasive silicone paintwork polish for more regular use. As well as cleaning the surface, the polish typically leaves a water resistant residue that helps prevent rust.

DO: Always use eye protection with any striking or cutting tool (hammer, impact wrench, nut splitter, etc) or when working in a location where falling dirt could enter the eyes (e.g. when under a car).

DO: Assemble fasteners properly, typically making sure they are clean and maybe lightly lubricated with normal oil (e.g. "3-in-1" or light engine oil). Follow any recommendations from the maintenance manual about the correct procedure. In particular, it is important to lubricate stainless steel fasteners to prevent galling, though also you should consider any contamination issues (e.g. in food processing machinery) and use an approved lubricant in those cases.

DO: Make sure fasteners do not loosen unexpectedly due to vibration or thermal cycling. For high stress bolts this is normally OK due to the force when correctly tightened, provided the thickness of the clamped object is greater than the bolt diameter (so there is enough 'spring' action). In other cases where high forces are inappropriate, where creep can be expected (e.g. paint coated metal sheet), or the consequences of failure are serious, then use some form of positive retention: For example, Nylock nuts (or the superior Aerotight type with its PDF data sheet), spring washers (or the superior Nord-Lock design), castled nut & split-pin, thread lock compound, etc.

DO: Use a torque wrench for tightening any critical fasteners where the correct figure is specified. However, never assume the standard tables of torque values are the correct ones for any job. They represent the ***maximum*** for a given fastener size, material and lubrication state, and do not take in to account the stress limits of the object(s) being clamped by the fastener. Use any manufacturer recommended values that are available, and carefully follow any special sequence and/or final tightening angle.

DON'T: Do not mix fasteners from different standards (e.g. using UNC nut with BSW bolt, etc). Even though quite a few sizes have the same outside diameter and TPI values, the difference in thread angles (e.g. 60° for UNC and 55° for BSW) results in a ***serious reduction in strength***. If in doubt, check with a proper thread gauge that you are using the correct replacement part. Note: Some suppliers of "BSW" fasteners are actually offering UNC as it is difficult to find the real stuff these days, but there are still some BSW/BSF manufacturers and BSW/BSF distributors around.

DON'T: Do not replace high tensile steel fasteners with the common stainless types (e.g. A2-70 grade) unless the application allows you to safely adjust the tightening torque downwards to match. As an approximation, A2-70 is equivalent to 7.6 in the typical metric designation, so the yield strength of around 450N/mm^2 is only 70% of the most common 8.8 'high tensile' grade used for bolts, and only 38% of the 12.9 grade used for the better quality (normally black finish) socket cap screws. Unmarked or very cheap 'A2' stainless fasteners may be equivalent to 5.4 grade, so only 33% of the strength of the common 8.8 'high tensile' steel, and basically not much stronger than mild steel (of course, better corrosion resistance). If both strength and corrosion resistant are needed, there are special quality stainless fasteners available from Bumax (available from Precision Technology Supplies in the UK).

DON'T: Avoid using the ***wrong type*** of lubricant when assembling nuts and bolts.

While light oil is usually advantageous, avoid using any extreme pressure lubricant (e.g. gearbox oil, normal lubricating grease, molybdenum disulphide paste, etc) unless this is specifically required. Doing so significantly increases the clamping force of the bolt for a given torque, a factor that needs to be taken in to account for correct tightening. Please note that such extreme pressure lubricants can be a ***very good thing*** to ensure safe and consistent tightening, and to inhibit corrosion, but the torque used has to match. Also check that the lubricant is suitable for the intended environment, not just the operating temperature range, but also any contamination issues or other side effects (e.g. never use copper-based materials where acetylene exposure is expected).

I have seen the suggestion of reducing the common (dry, plain steel) torque table values by 10% for engine oil lubrication, 20% for anti-size paste (e.g. Copaslip style of "copper grease"), and 30-50% for molybdenum disulphide based lubrication paste or other extreme pressure lubricants (e.g. with graphite, PTFE, etc). For a selection of common cases using their lock washers Nord-Lock provide a better example of torque guidelines and so do TR Fastenings for common stainless types.

DON'T: Never use a torque wrench as a long lever to release a rusted or over-tightened fastener! A torque wrench is a ***precision tool*** intended for correct tightening. Instead, use a T-bar or 'jointed nut spinner' for such high torque releasing jobs, or consider using an impact wrench or slogging spanner.

DON'T: Never strike a normal spanner, there are proper "slogging spanners" for that type of job.

DON'T: Never, ever, strike a ratchet driver. If you need more than decent 'single hand' force on the ratchet handle, you should consider using a longer T-bar or breaker bar (also known as a 'jointed nut spinner' e.g. King Dick SNS208X for 1/2" square drive), or possibly a larger size of square drive socket set (e.g. 3/4" as the next size up, etc) if this is a regular problem.

DON'T: Never use a normal socket with an impact driver. Always use to proper type of impact socket (they have thicker walls and normally a black phosphate finish).

DON'T: Do not use 'extension tubes' on spanners or socket set drivers without considering the maximum sensible force. Avoid using an extender on a ratchet handle for high torques, as this will greatly accelerate wear on the mechanism. As an approximate guide, the table below offers some sensible limits on use based on the following assumptions:

- A typical adult (in good health and fitness, and from a safe position) can exert a sensible controlled maximum force of 200N per hand (i.e. just lifting they usual 20kg maximum suitcase weight for an aeroplane with one hand). Clearly someone with above average strength (i.e. a job with lots of heavy work, or regular gym attendance, etc) can do more, but this is already above the Health and Safety recommendations of a 20kg limit for carrying with both hands under good position conditions.
- The common torque wrench/driver ranges are within the sensible limits for each socket set's drive capacity, and where this is lower than the ISO3315 test limits for hand accessories, the lower value should be used.
- Low strength accessories are **not** used (e.g. universal joint, 'wobble' extension bars).
- The equivalent nut/bolt sizes are based on torque wrench tightening of an unlubricated metric coarse thread in the most common grade 8.8 of 'high tensile' steel (equivalent to 'S' grade in Imperial standards).

These lead to the following guide lines:

Square Drive Size	Torque Tool (Nm)	Hand Tool Breaker / T-handle (Nm to ISO3315)	Biggest Bolt/Nut	Socket Size (mm)	Bolt/Nut Torque (Nm)	Length of lever to centre of hand(s) for lower torque limit
1/4"	25	62 / 55	M8	13	25	12cm (one hand)
3/8"	110	202 / 180	M12	19	87	55cm (one hand)
1/2"	350	512 / 455	M18	27	294	88cm (two hands)
3/4"	1500	1412 / 1255	M30	46	1440	313cm (two hands)
1"	4500	2515 / 2236	M42	65	4048[*]	559cm (two hands)

[*] This size and grade of bolt cannot be fully tightened using a "hand tool" so would need a suitable torque wrench or multiplier gearbox.
Notes: Snap-On do not provide maximum torque limits due to the USA's national pastime of litigation, so they have some detailed guidelines that suggest working torque limits of 37, 108, 318, 962 and 1586Nm respectively for the drive sizes listed to offer long life. Stahlwille indicated to me that their key 3/4" drive accessories are good for occasional use to the torque wrench limit of 1500Nm, but 1900Nm was a critical limit. Beta indicated their official limits are the ISO3315 values. King Dick informed me they meet the DIN899 standard and the 3/4" drive is usable up to 1569Nm. Finally, the ISO standard also requires ratchet handles to match the torque limits for breaker bars (referred to in ISO3315 as 'flex head nut spinner') but the endurance test for such items is conducted at much lower torques (e.g. 50,000 cycles at 128Nm for 1/2" drive).

The implications for sensible work are:

- Extenders should not be used on spanners below around 15-17mm.
- With larger spanners extenders can be used if really necessary, but do so with care, as it is easy to slip off due to the large tube needed to clear the opposite head from the one in use. Preferably do this only on ring spanners for maximum strength, and least chance of slippage or fastener damage.
- The 1/4" drive set should not be used with extenders, nor with a converter and 3/8" drive tools in order to increase torque.
- The 3/8" drive tools should not, as a rule, be used with extenders or high forces if a converter and long 1/2" drive handle is in use.
- The 1/2" drive tools can be used with modest extenders on a breaker bar or T-handle to around 50-100cm depending on the care taken and need for maximum user effort. For example, a longer handle is reasonable if you cannot stand in a position to safely use full force of both hands.
- The 3/4" drive tools can be used with fairly long extenders, since there is no way to achieve the needed torque without a long lever (or a torque multiplier gearbox). Again, use a length of pipe extension only on suitable tools such as a T-handle or breaker bar, and if you appear to need a very long extender then consider getting a torque multiplier gearbox instead. Then ***think*** about what the reaction foot will act against, as sheet metal tears quite easily!
- Once you are using 1" drive at its full (torque wrench) capacity, the thought of needing a 1125cm lever (yes, that is greater than 36 feet long!) is just silly, if not plain dangerous. Even the limit for extending a T-handle to 559cm (18 feet!) is inconvenient in most cases. At this point the ***only sensible option*** is a torque multiplier gearbox, or dedicated gearbox and driver tool such as the Norbar 'Pneutorque PT4500' model or similar.
- Finally, if you are of the "7 stone weakling" body build, the table suggestions should be safe, but if you are of the "300lb gorilla" body build, then take extra care not to exceed safe limits! Note that common 3/4" torque wrenches for 1500Nm are only 120-140cm lever length, suggesting ***much*** more than 200N per hand is possible. (Or of course, more hands, claws, or tentacles, depending on your species and/or the lunar cycle...)

DON'T: Never use a ring spanner (or similar) on one jaw of an open ended spanner as a makeshift 'extender'. It is very likely to slip (leading to injury or damage) and can also damage the open jaw, leading to more problems and expense later on. If you need to extend a spanner, which you should think twice about anyway, then use a length of pipe that will apply the force to both to the central bar (i.e. the normal 'handle' area) and to the widest part of the head (i.e. the strongest area) of an open jaw wrench.

DON'T: Do not apply excessive force when undoing fasteners, as that can break them. Use care and some 'common sense' when releasing or tightening fasteners. The use of penetrating oil (e.g. 'PlusGas') helps, and sometimes it is better to occasionally re-tighten a fastener during a difficult removal to clear the build up of rust or dirt in the threads. For a novice engineer, get a few small spare low tensile steel screws & nuts (e.g. M3, M5 and M8) and try breaking them by over-tightening to get a 'feel' for safe torque levels for such fasteners ***before*** tackling a real project...
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Jaw Size Table

Here is the chart for comparing spanner sizes and common nut/bolt use. Not listed are the sizes below M1.6/10BA or above M39 as they are quite rare to encounter in most folk's life, neither are some of the very smallest BSW sizes that were generally dropped in preference for BA sizes at the beginning of the 20th century (for example the 5/32" screws used in the British made Meccano toy sets until the 1970's).

The "jaw size" given is often the maximum tolerance of the across-flats nut dimension, so the actual spanner jaw is likely to be slightly larger to allow for an acceptable fit.

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Spanner Jaw Sizes and corresponding Nut/Bolt Use

Diff (mm)	Jaw Size Millimetres	Jaw Size Inches	Spanner Metric	Spanner AF	Spanner British	Common Nut/Bolt (*=non-preferred)
	2.97	0.117			10BA	
0.23	3.20	0.126	3.2mm			M1.6
0.13	3.33	0.131			9BA	
0.53	3.86	0.152			8BA	
0.11	3.97	0.156		5/32 AF		No.0 UNC
0.03	4.00	0.157	4mm			M2
0.37	4.37	0.172			7BA	
0.39	4.76	0.188		3/16 AF		No.2 UNC
0.14	4.90	0.193			6BA	
0.10	5.00	0.197	5mm			M2.5
0.50	5.50	0.217	5.5mm			M3
0.06	5.56	0.219		7/32 AF		
0.03	5.59	0.220			5BA	
0.37	5.95	0.234		15/64 AF		
0.05	6.00	0.236	6mm			M3.5*
0.30	6.30	0.248			4BA	
0.05	6.35	0.250		1/4 AF		No.4 UNC
0.65	7.00	0.276	7mm			M4
0.14	7.14	0.281		9/32 AF		
0.02	7.16	0.282			3BA	
0.77	7.94	0.313		5/16 AF		No.6 UNC & No.10 UNC (bolt)
0.06	8.00	0.315	8mm			M5
0.23	8.23	0.324			2BA	
0.36	8.59	0.338			1/8 W; 3/16 BSF	
0.15	8.73	0.344		11/32 AF		No.8 UNC
0.27	9.00	0.354	9mm			

0.27	9.27	0.365			1BA	
0.25	9.53	0.375		3/8 AF		No.10 UNC (nut)
0.48	10.00	0.394	10mm			M6
0.49	10.49	0.413			0BA	
0.51	11.00	0.433	11mm			M7*
0.11	11.11	0.438		7/16 AF		1/4 UNF
0.19	11.30	0.445			3/16 W; 1/4 BSF	
0.70	12.00	0.472	12mm			
0.70	12.70	0.500		1/2 AF		5/16 UNF
0.30	13.00	0.512	13mm			M8
0.33	13.34	0.525			1/4 W; 5/16 BSF	
0.67	14.00	0.551	14mm			
0.29	14.29	0.563		9/16 AF		3/8 UNF
0.71	15.00	0.591	15mm			
0.24	15.24	0.600			5/16 W; 3/8 BSF	
0.64	15.88	0.625		5/8 AF		7/16 UNF (bolt)
0.13	16.00	0.630	16mm			
1.00	17.00	0.669	17mm			M10
0.46	17.46	0.688		11/16 AF		7/16 UNF (nut)
0.54	18.00	0.709	18mm			
0.03	18.03	0.710			3/8 W; 7/16 BSF	
0.97	19.00	0.748	19mm			M12
0.05	19.05	0.750		3/4 AF		1/2 UNF
0.95	20.00	0.787	20mm			
0.64	20.64	0.813		13/16 AF		9/16 UNF (bolt)
0.19	20.83	0.820			7/16 W; 1/2 BSF	
0.17	21.00	0.827	21mm			
1.00	22.00	0.866	22mm			M14*
0.22	22.23	0.875		7/8 AF		9/16 UNF (nut)
0.78	23.00	0.906	23mm			
0.37	23.37	0.920			1/2 W; 9/16 BSF	
0.44	23.81	0.938		15/16 AF		5/8 UNF
0.19	24.00	0.945	24mm			M16
1.00	25.00	0.984	25mm			
0.40	25.40	1.000		1 AF		
0.25	25.65	1.010			9/16 W; 5/8 BSF	
0.35	26.00	1.024	26mm			
0.99	26.99	1.063		1-1/16 AF		
0.01	27.00	1.063	27mm			M18*
0.94	27.94	1.100			5/8 W; 11/16	

					BSF	
0.06	28.00	1.102	28mm			
0.57	28.58	1.125		1-1/8 AF		3/4 UNF
1.43	30.00	1.181	30mm			M20
0.48	30.48	1.200			11/16 W; 3/4 BSF	
1.27	31.75	1.250		1-1/4 AF		
0.25	32.00	1.260	32mm			M22*
1.02	33.02	1.300			3/4 W; 7/8 BSF	
0.32	33.34	1.313		1-5/16 AF		7/8 UNF
0.66	34.00	1.339	34mm			
1.31	35.31	1.390			13/16 W?	
0.69	36.00	1.417	36mm			M24
0.51	36.51	1.438		1-7/16 AF		
1.08	37.59	1.480			7/8 W; 1 BSF	
0.41	38.00	1.496	38mm			
0.10	38.10	1.500		1-1/2 AF		1 UNF
2.03	40.13	1.580			15/16 W?	
0.87	41.00	1.614	41mm			M27*
0.27	41.28	1.625		1-5/8 AF		
1.14	42.42	1.670			1 W; 1-1/8 BSF	
0.44	42.86	1.688		1-11/16 AF		1-1/8 UNF
3.14	46.00	1.811	46mm			M30
0.04	46.04	1.813		1-13/16 AF		
1.21	47.24	1.860			1-1/8 W; 1-1/4 BSF	
0.38	47.63	1.875		1-7/8 AF		1-1/4 UNF
2.38	50.00	1.969	50mm			M33*
0.80	50.80	2.000		2 AF		
1.27	52.07	2.050			1-1/4 W; 1-3/8 BSF	
0.32	52.39	2.063		2-1/16 AF		1-3/8 UNF
2.61	55.00	2.165	55mm			M36
0.56	55.56	2.188		2-3/16 AF		
0.83	56.39	2.220			1-3/8 W; 1-1/2 BSF	
0.76	57.15	2.250		2-1/4 AF		1-1/2 UNF
2.85	60.00	2.362	60mm			M39*

[top]

Understanding Whitworth BSF AF BA and metric tools

Older cars and bikes,made before the 60's often use fixings that need imperial or inch based tools.Whitworth,BSF,BA or AF spanners are all called imperial and are the tools used on these early vehicles allthough some much later specialised vehicles carried on using whitworth for years after others had stopped..Many vehicles made up to the mid 70's use bolts that need AF spanners or sockets and later ones use mainly metric.There are no dates set in stone,but the older the vehicle the more chance your metric tools won't fit the majority of the nuts and bolts that hold it together.So,how do you tell the difference?.

First the easy bit.Metric tools fit metric threaded nuts and bolts.the odd one might fit a whitworth,BSF,BA or UNF nut or bolt but it wasn't designed to.If it says 19mm on the spanner it's made to fit a nut or bolt 19mm across the flats (ie) wide.Thats it,simple and really rather boring.Metric measurements are gradually being forced on the UK, and modern vehicles and machinery use metric fastenings,so little manufacturing takes place in the UK now that most of what you buy is made abroad anyway.

Older machinery,especially that made in the days when the UK had a manufacturing industry and exported rather than simply importing,will often have fixtures and fittings using imperial measurements.

Remember the term "across flats" ?. If you find a spanner marked say 1/2 AF,it means the spanner is designed to fit a fastening 1/2 inch wide or across flats (ie) a.f. The spanner might simply be marked 1/2 or 1/2 SAE some are even marked something like .50 SAE (the decimal equivalent of 1/2 inch) for example.The thread of the bolt should be either UNF or UNC but the spanner carries the head sizes stamped on it,all simple easy stuff.

With British Standard Whitworth (Whit) or BSF the spanner or socket might carry the markings for two sizes for example 7/16 inch whitworth and 1/2 inch BSF.This means the tool will fit nuts and bolts with those thread sizes.Sometimes only one standard will be marked on the spanner but a 7/16 whit will always fit a 1/2 bsf and all through the range the spanners are will fit both standards always one size apart so you only need one set of spanners to do both! British Standard Whitworth incidentally was one of the first attempts at a standard or universal thread and is named after the British engineer who invented it,BSF stands for "British Standard Fine" it is in effect the fine version of Whitworth.Thread guages which look a bit like a miniature saw blade are the easiest way to identify the different threads,a lot of bolts are marked but it's almost impossible to list all the markings that have been used by different manufacturers over the years.A spanner or socket should fit snugly on a nut or bolt in good clean condition,if it's loose its probably the wrong one.

The other 'imperial' size to confuse things is BA. BA fittings are used on lots of older machinery especially electricl stuff,the common sizes are 4 and 2 BA.The smaller the number the bigger the spanner and they go from 0 to 11BA.All BA fixings have a set thread and head size so a 2BA spanner fits a 2BA socket or bolt.We sell a big variety of imperial based tools so the people who tell you whitworth,BA and af are obsolete or expensive are wrong,we sometimes list some of these tools on ebay,all at 99p reserve.

Some nuts and bolts although of different thread forms and sizes are similar enough that they can be swapped over although seeming to be either lose or tight,for example some whitworth and UNC fittings can be similar enough to screw onto one another.This practice is wrong and in certain circumstances like highly stressed fittings on brakes or suspension components can be dangerous.Once again using a thread gauge will avoid using incorrect fittings and mixing incomparable imperial,or mixing imperial and metric fixings.

Complicated? Maybe but all part of the fun of owning a vehicle or machinery made before the days when plastic and planned obsolescence became the norm.Best of luck with it.

References & Links

Sources of information relating to this (but not necessarily correct or complete), and also to related business of thread sizes and selecting tools, include the following:

http://en.wikipedia.org/wiki/Wrench (general information on spanners and wrenches)

http://www.jag-lovers.org/xk-lovers/library/whitworth_system.html (has history, BSW head sizes, and other references)
http://www.timebus.co.uk/rlh/whitworth.htm (has another jaw size table)
http://www.sizes.com/tools/socket_wrenches_metric.htm (common metric bolt/nut sizes and sockets to match)
http://www.sizes.com/tools/socket_wrenches.htm (common 'American' bolt/nut sizes and sockets to match)
http://www.team.net/sol/tech/SpannerSize.html (another jaw size table, limited to 0.25-1")
http://www.gewinde-normen.de/en/index.html (lots of thread data)
http://mdmetric.com/fastindx/inxtst.htm (range of technical data, metric, from USA site)

http://stainlessautomotivefastenings.co.uk/ (UK supplier of a wide selection of stainless fastenings. Web site was flaky when I tried on-line ordering, but a phone call found the owner to be very helpful and knowledgeable).
http://www.smithbullough.com/ (UK manufacturers of BSW (Whit), BSF, UNC, UNF & Metric bolts & industrial fasteners)
http://www.thomassmithfasteners.com/ (UK distributors of BSW (Whit), BSF, UNC, UNF & Metric bolts & industrial fasteners, also offer mixed packs BSF/BSW)
https://www.boellhoff.com/gb-en/products-and-services/special-fasteners/thread-inserts-helicoil.php (was Armstrong Precision Components Ltd, thread repair inserts)
http://www.wti-fasteners.co.uk/ (WTI Fasteners Ltd, thread repair inserts)
http://www.apexstainless.com/manufacturing (UK, manufacturer of "Aerotight" nuts and other stuff)
http://www.namrick.co.uk/ (UK, supplier of British, UNC/UNF and metric fasteners)
http://www.acornfasteners.co.uk/ (UK, wide range of fasteners, will make specials at a price)
http://www.britishfasteners.com/ (USA, supplier of British fasteners, also King Dick tools)
http://www.metricmcc.com/ (USA, supplier with large metric range and good British range of fasteners)
http://www.westspecialfasteners.co.uk/index.html (UK, manufacturer of fasteners in specialist alloys from M3 to M64 Metric and 3/16" to 2-1/2" Imperial)
https://www.pts-uk.com/ (UK supplier of stainless steel fasteners, very large selection including high tensile Bumax)

http://www.meddings.co.uk/ (UK, high quality drill press, our one is still working after 40+ years!)

http://euler9.tripod.com/bolt-database/22.html (advice for USA adoption of metric fasteners)
http://www.oldengine.org/members/diesel/Articles/rrchapt1.htm (engine rebuild, example of general

advice)
http://www.tb-training.co.uk/TOOLS.htm (guide to building up a tool kit)
http://www.lrfaq.org/index.html (Land Rover information, an example of the need for a wide range of tools!)
http://www.series123.com/ (another Land Rover site, the "Tech Articles" link has a useful A-Z of topics)

http://www.roymech.co.uk/Useful_Tables/Screws/Preloading.html (detailed information about torque on fasteners)
http://www.boltscience.com/index.htm (software and support for accurate torque and tightening design)
http://www.boltdepot.com/fastener-information/bolts/US-Recommended-Torque.aspx (basic torque table for UNF/UNC sizes)
http://www.boltdepot.com/fastener-information/bolts/Metric-Recommended-Torque.aspx (very basic metric torque table)
http://www.nord-lock.com/products/wedge-locking/washers/torque-guidelines/ (torque guidelines for some bolt and lubrication cases, using their lock washers)

However, it is not clear in some cases where these sites get their information. Also used was "Industrial Fasteners Handbook", 3rd Edition, Trade & Technical Press Ltd, ISBN 85461-097-9 as a reference book, the ISO3315:1996 standard "Assembly tools for screws and nuts - Driving parts for hand-operated square drive socket wrenches - Dimensions and tests", and the King Dick catalogue.

Acknowledgements

I would like to thank Laurie Barlow for a personal communication on the BA spanner size, and Dave Reeves for a personal communication covering the WW2 austerity measures for BSW/BSF head size and providing excerpts from his copy of "British Standards for Workshop Practice", Third Impression May 1945.

I would also like to note my thanks to the late Ron Bingham for his personal communication on the Whitworth sizes. He pointed out that the original (pre-1940) standards **almost** follows the formula AF = 1.5 * bolt diameter + 0.15", but not quite. It would be nice to know just how and why those odd spanner sizes for BSW/BSF were actually chosen, the above history sections suggest is was simply the sizes of common hex bar at the time, but Ron's observation suggests a little more than this.

Thanks also to Nigel Graham for his comments and feedback.

I am grateful to Tony Pay for his interest & learned advice, and his suggested tag line for the disclaimer.

I would like to thank Mike Inglehearn for his research in to the BSF/BSW head sizes and for the documentation he supplied to assist.

Understanding Whitworth BSF AF BA and Metric Tools
https://www.ebay.co.uk/gds/Understanding-Whitworth-BSF-AF-BA-and-metric-tools-/10000000003499809/g.html

Disclaimer (careless torque costs lives)

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Before you use any of the information provided by this page, or its links, for anything important check with the relevant official standards first or obtain specialist advice. Errors can be costly and potentially fatal, as this incredible example illustrates.

[top]

Courtesy: Last Updated on 30Nov-2018 by Paul Crawford (revised history for BSF/BSW head size)

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