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THREADED JOINTS

Manual

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UDC 744 (075.8)
C 51

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Geometrical parameters and dimensions of a screw thread profile and thread classification are represented. Basic types of threaded joints applied in machinery are mentioned. Calculation methods of threaded joints geometrical parameters are also considered.

Reference sources on threaded fastenings and some technological elements are given in appendix.

For students of mechanical specialties for carrying out threaded joints assignments and as reference data on fastenings and some shaft components.

Подано геометричні параметри і розміри та класифікацію профілю нарізок. Розглянуто основні типи нарізних з'єднань, що застосовуються у машинобудуванні.

Викладено розрахункові методи геометричних параметрів нарізних з'єднань.

У додатках наведено довідкові матеріали і приклади виконання завдань.

Для студентів технічних спеціальностей усіх форм навчання.

Illustrations 43. Tables 40. Bibliography: 13 names УДК 744 (075.8)

GSCREW THREADS

If a cylindrical rod is rotated at a constant speed, and simultaneously, if a pointed tool, just touching the rod is moved parallel to the axis of the rod at a constant speed, the cut made by the tool on the rod will be continuous and of a helical form. A screw thread is formed by cutting a helical groove on a cylindrical or conical surface. The threaded rod is called a ***screw***. It engages in a corresponding threaded hole inside a nut or a machine part.

The screws are used for joining two parts temporary. Therefore such a joint is known as the ***detachable joint*** or ***temporary joint***.

Definitions

Threads are generally cut on a machine called a *lathe***.** On a small-size screw, thread is often cut by means of a tool called a *die*. A small-size hole is threaded by means of a tool called a *tap*. Such a hole is called a *tapped hole*.

Threads should be cut so accurately that nuts having a particular form and size of thread, freely engage with screws having the same form and size of thread. The thread-cutting tool should, therefore, be shaped in an exact manner according to the dimensions of the required thread form.

Various parts of a screw thread are shown in Fig. 1 and defined below.

Crest: The crest is the outer-most part of a thread.

Root: The root is the inner-most portion of a thread.

Flank: The surface between the crest and the root is called the flank of the thread.

Angle: It is the angle between the flanks, measured on an axial plane.

Depth: The depth is the distance between the crest and the root, measured at right angles to the axis. It is equal to half the difference between the outside diameter and the core diameter.

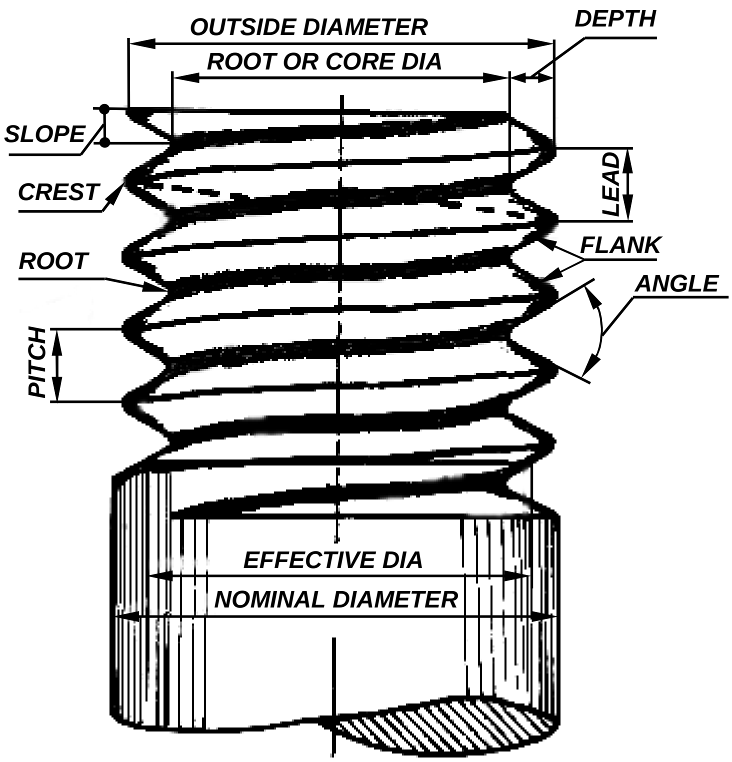


Fig. 1. Parameters of a Screw Thread

Nominal diameter: It is the diameter of the cylindrical piece on which the thread is cut. The screw is specified by this diameter.

Outside or major diameter: It is the diameter at the crest of the thread measured at right angles to the axis of the screw.

Core or minor diameter: It is the diameter at the core or root of the thread. It is the smallest diameter of the screw and is equal to the outside diameter minus twice the depth of the thread.

Effective diameter: It is equal to the length of the line, perpendicular to and passing through the axis, and measured between the points where it cuts the flanks of the thread.

Pitch: It is the distance measured parallel to the axis, between a point on one thread form and a corresponding point on the adjacent thread form, i.e. from crest to crest or root to root. It may also be described as the reciprocal of the number of thread forms per unit length, i.e. $p = 1/n$.

Lead: It is the distance measured parallel to the axis from a point on a thread to a corresponding point on the same thread after one complete revolution. It can also be described as the distance moved by a nut in the axial direction in one complete revolution. The lead is equal to the pitch in case of single-start threads.

Slope: The slope of a thread is equal to half the lead.

Forms of screw threads

There are two main forms of screw threads: triangular or V thread (Fig. 2, a, b) and square thread (Fig. 2, e). Other forms are either modified forms of a square or triangular thread or a combination of the two forms.

Metric thread (Fig. 2, a): This thread is based on metric standard system and recommended for use in many countries where metric standard system is in use. The form of thread is based on triangular or V thread profile. The angle of the thread is 60°. Root of a thread is round ed, while the crests are cut parallel to the axis of the screw.

Metric thread is designated by the letter M followed by the nominal diameter, e.g. M 20, where 20 is the nominal diameter of the screw in millimeters. Refer to GOST 2.311-68.

Whitworth thread (Fig. 2, b): This form of thread is also known as British Standard Whitworth (B.S.W.) thread or inch thread and has been adopted as a standard form in the United Kingdom and other countries where inch standard system is in use. The angle is 55°. Root and c rest of a thread are rounded.

Square thread (Fig. 2, e): This thread has its flanks or sides normal to the axis and hence, parallel to each other. It is generally used for transmission of power. It is also used for obtaining larger axial movement of the nut or the screw per revolution. For the same nominal diameter of the screws, the pitch of the square thread is usually greater than that of the triangular thread. The depth and the thickness of the thread are each equal to half the pitch.

Acme thread (Fig. 2, c): This thread is a modification of the square thread (Fig. 2, e) and is also known as trapezoidal thread. It is easier to cut and is stronger at the root than the square thread. It is particularly used where the nut, which is made in two parts, is required to engage with or disengage from a screw at frequent intervals as in the lead-screw of the lathe. The thread angle is 30°.

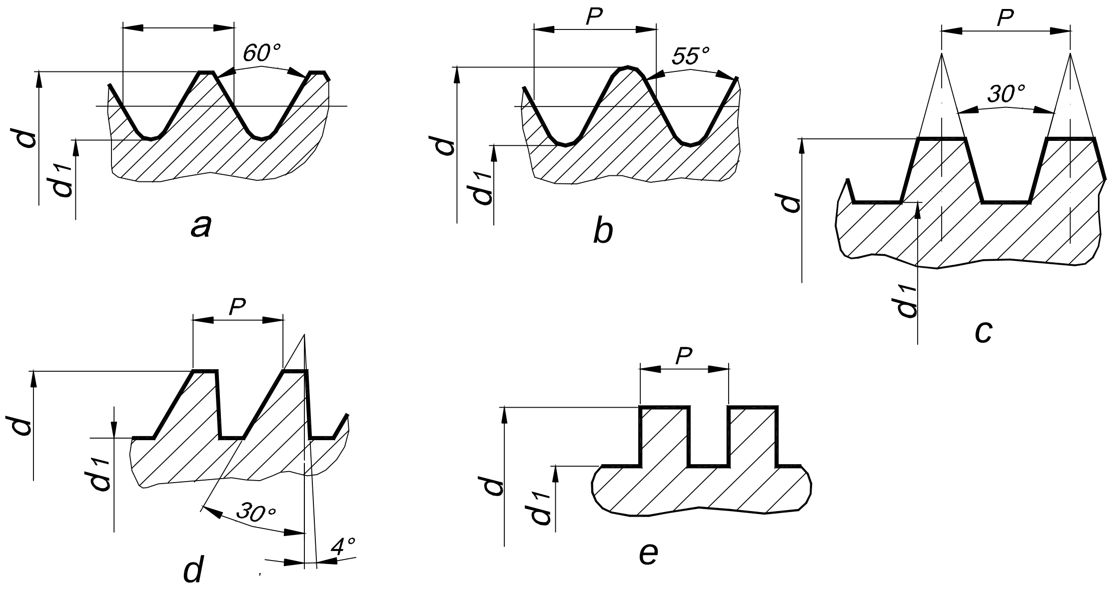


Fig. 2. Thread profiles: ***a*** – Metric, ***b*** – Whitworth, ***c*** – Acme, ***d*** – Buttress, ***e*** – Square; ***d*** – outside diameter, d_1 – root (core) diameter, ***p*** – pitch

Buttress thread (Fig. 2, d): This thread is a combination of the triangular and the square threads. One flank of the thread is almost perpendicular to the axis of the screw (inclination angle 4°), while the other flank is inclined to the axis at 30°. Thus the angle between two flanks is 34°. Root and crest of a thread are cut parallel to the axis of the screw. This thread is suitable only when the force acts entirely in one direction form almost perpendicular flank. Its use is commonly made in the screw of a bench-vice.

Knuckle thread: This thread is also a modification of the square thread. It is formed by rounding off the corners of the square thread to such an extent that it has a completely rounded profile. Its section comprises of semi-circles of radius R = 0.25P. This thread can withstand heavy wear and rough usage. They are used in coupler of railway carriages and electrical bulbs.

Classification of screw threads

– Destination: *fastening* and *sliding* threads.

Fastening threads are used in screwed joints to provide permanent connection between two or more parts in assembly, like between vacuum camera and mounting flange, or between cylinder-cover and engine cylinder, etc. (Fig. 3).

Sliding threads are generally used for transmission of power. They are also used to transform rotational motion into translational one and vice versa like in worm-gearing. They are used in lead-screw of lathe machine, jack screws and vices.

– Location: *external* and *internal* threads.

A thread, cut on the surface of a screw, is called an external thread, while that cut in a hole, is called an internal thread.

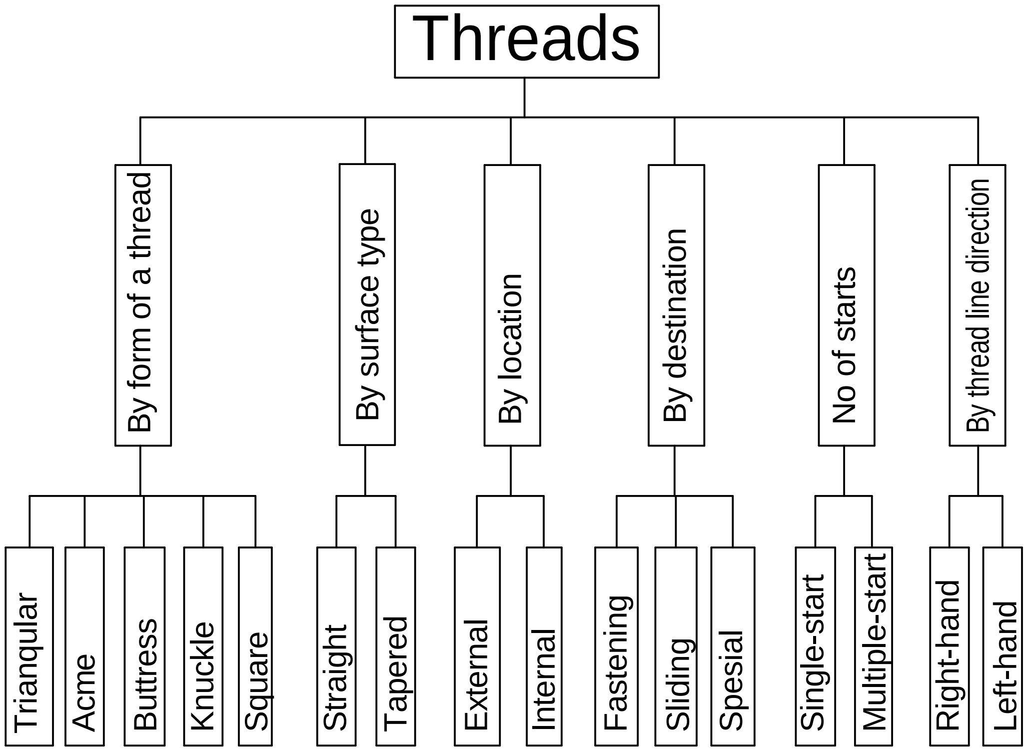


Fig. 3. Classification of screw threads

– Thread line direction: *Right-hand* and *Left-hand* threads.

If a nut, when turned in clockwise direction screws on a bolt, the thread is a right-hand thread; but if it screws off the bolt when turned in the same direction, the thread is said to be a left-hand thread. Note that when the axis of the screw is vertical, the lines slope downwards from right to left in case of the right-hand thread. They slope in the reverse direction, i.e. from left to right downwards when it is a left-hand thread. For indicating a left-hand thread, an abbreviation L.H. is used. Unless otherwise stated, a thread should always be assumed to be a right-hand one.

– Surface type: *Straight* or *taper(ed)* threads.

A thread, cut on the cylindrical surface of a screw or a nut, is called a straight thread, while that cut on the conical surface, is called a taper or tapered thread.

– No of starts: *Single* or *multiple start* threads.

In a single-start thread, the pitch is equal to the lead (see Fig. 1). Since the depth of the thread is dependent on the pitch, greater the lead, greater will be the depth of the thread and smaller will be the core diameter. When a nut is required to move a considerably long axial distance in one revolution (i.e. when the lead is large), the core diameter of the screw, in a single-start thread, will be so much reduced as to make the screw too weak. This is avoided by cutting what are known as multiple-start threads, in which two or more threads having the same pitch as in a single-start thread, but with increased lead, run parallel to one another.

The pitch being the same, the depth of the thread remains the same as in a single-start thread and the core diameter also remains unaffected.

The slope **S** of a thread is equal to one-half the corresponding lead **L**. The relationship between lead and pitch is shown in Table 1.

Table 1. **Relationship between lead and pitch in multiple start threads**

No. of starts	**Pitch, P**	**Lead, L**
Single start	P	L=P
Double start	P	L=2P
Triple start	P	L=3P
In general, 'N' start	P	L=N P

Conventional representation of threads

The true form of a screw thread is helical and it would take considerable time and labour to draw the same. In actual practice, threads are usually shown by conventional methods.

External threads: These threads in outside view (Fig. 4, a) are shown by means of two continuous thin lines drawn parallel to the axis, thus indicating the minor or root diameter of the threads. The limit of the length of the thread is shown by a continuous thick line drawn perpendicular to the axis and up to the major or outside diameter of the threads. The runout of a thread is shown by lines drawn at an angle of 30° or 45° to the axi s. The runout may not be shown if there is no likelihood of any misunderstanding.

External thread in section (Fig. 5) is shown in the same manner. The section lines (hatching) are drawn crossing the thin lines.

Internal threads: These threads in outside view are shown by dashed lines indicating major and minor diameters, but representation of internal treads without sectioning is rear in use.

Internal thread in section (see Fig. 4, b, 5) is shown by continuous thick and thin lines indicating respectively the minor and major diameters. The section lines are drawn crossing the thin lines.

Metric thread is designated by the letter **M** followed by the nominal diameter **d**, e.g. **M d** × **P** (see Fig. 4), where **d** is a nominal diameter of a screw in millimetres and **P** is a pitch of a thread in millimetres. In case of a regular thread pitch is not mentioned.

In the side view of the external thread (see Fig. 4, a) the minor or root diameter is represented by a part of a continuous thin-line circle about three quarters of the circumference; while in the side view of the internal thread (see Fig. 4, b) the major or outside diameter is shown in the similar manner.

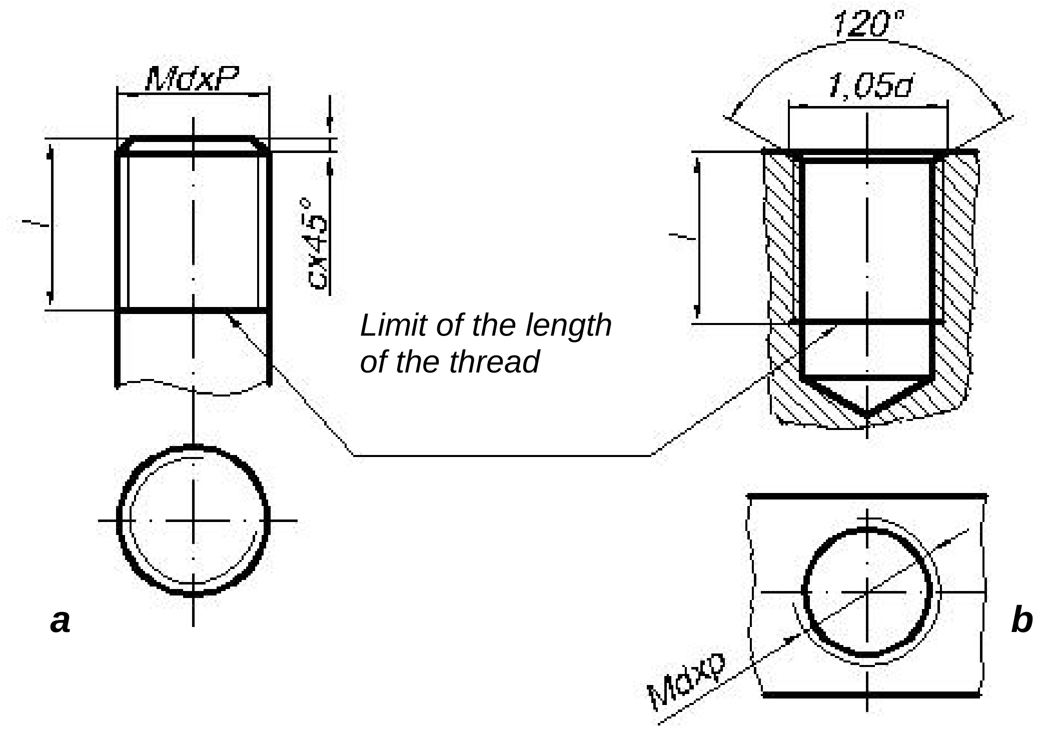


Fig. 4. Representation of a thread: ***a*** – external, ***b*** – internal

In sectional views where threaded parts are assembled together, externally threaded parts are always shown covering the internally threaded parts as shown in Fig. 5.

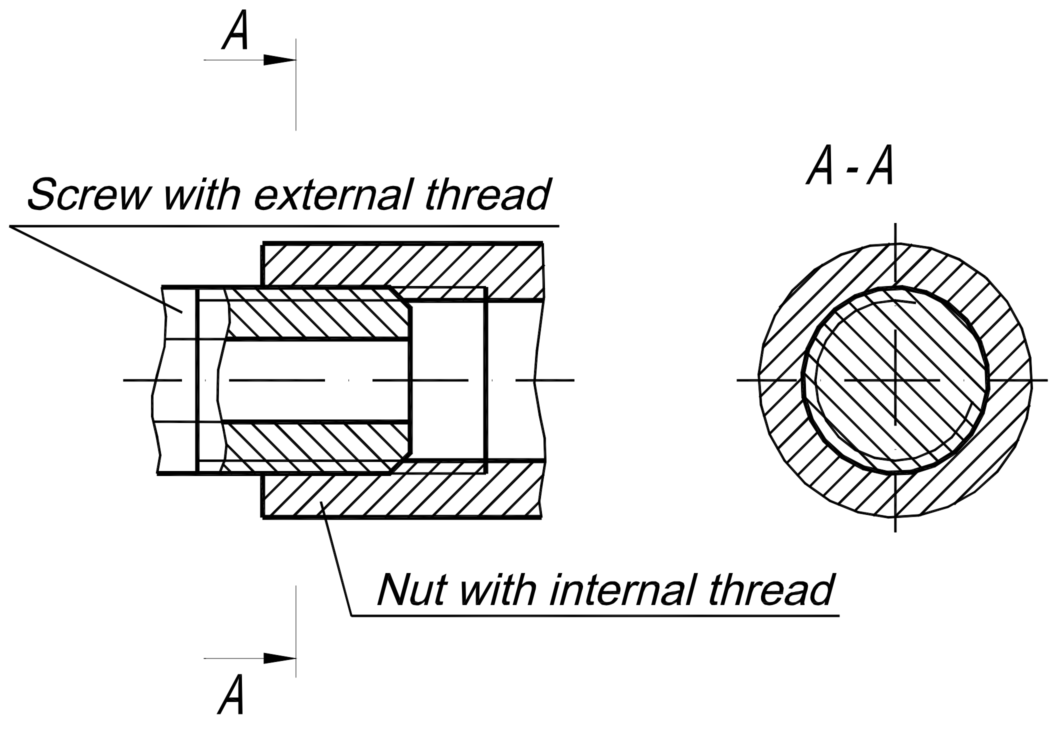


Fig. 5. Representation of a screw thread joint

SCREWED FASTENINGS

A machine is an assembly of different parts arranged in definite order and is used to transform energy for doing some useful work. The connection between two parts can be either temporary or permanent. The temporary joints are: *screwed* joints, *keys*, *cotter* and *pin* joints, *pipe* joints. As the parts thus connected can be easily separated by screwing off the nut or removing the cotter or the pin, the fastening is said to be temporary. In permanent joints, the connected parts cannot be easily separated. They are *riveted* and *welded* joints.

Stud joint

Stud joint is an assembly unit which consists of a stud, nut, washer and fastening parts. Stud represents a cylindrical shank threaded at both ends (Fig. 6).

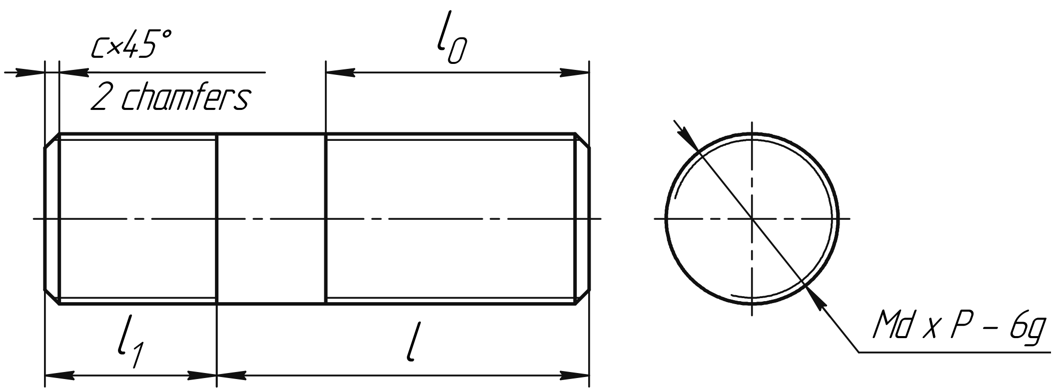


Fig. 6. Drawing of a stud: l_1 - length of the *metal-end* of a stud, l_0 - length of the *nut-end* of a stud, l - length of a stud

The *nut-end* l_0 is threaded for a length slightly more than the thickness of a nut or nuts to be used.

The other end l_1, called the *metal-end* is threaded for a length at least equal to the diameter of the stud. The length of the plain part between the two ends depends upon the thickness of the piece adjoining the nut.

The stud is used in place of a bolt, when there is insufficient space to accommodate the bolt-head or to avoid use of an unnecessarily long bolt. Studs are commonly used to connect cylinder-covers to engine cylinders (GOST 22032-76 - GOST 22040-76).

Stud joint is carried out as follows: in one of joining parts make a blind or through threaded hole, and in the other - a hole without thread by a diameter $d_{hole}=1.1d$ (see Table A.2). Stud is screwed up by the screwed end of a length l_1 in the first hole and freely passes through second, then on the prominent end of stud put on a washer and screw a nut. The formation of joint is shown in a Fig. 7. The sizes of studs are determined by GOST 22032-76 - GOST 22040-76 (see Table A.3) depending on length of the metal end l_1, which depends on material of a part with a threaded hole.

Areas of stud's application are listed in the Table 2 in dependence of value l_1.

Length l of a stud is defined by the formula

$$l = B + H + S + a + c, \quad (1)$$

where B – thickness of a joining part;

H – height of a nut (~0,8 d) GOST 5915-70 (see Table A.13);

S – height of a washer, GOST 6402-70 (see Table A.15);

a – prominence of a stud from a nut (1–2 pitches);

c – height of a chamfer (see Table A.18).

Found stud length l is verified with standard values from the table A4 and accepted equal to a nearest standard size.

Conventional designation of a stud, according to the standard, writes down in the following order:

- the name of a product;
- designation of a thread with a proper tolerance band;
- a mark "x";
- length of a stud and a dot;
- designation of a strength class and a dot (see Table A.5);
- conventional designation of coating thickness (see Table A.7);
- GOST number of a stud.

Example of designation: **Stud M16-6gx100.66.026 GOST 22032-76**.

Table 2. **Standards of studs depending on the length l_1**

Length of the metal end.	GOST	Area of application
$l_1 = d$	22032-76	For threaded holes in steel, bronze and brass parts where δs >8% and in parts made from titanium alloys
$l_1 = 1{,}25\ d$	22034-76	For threaded holes in parts made from malleable cast or grey iron where δs >8%
$l_1 = 1{,}6\ d$	22036-76	For threaded holes in parts made from malleable cast or grey iron. Allowed to apply in steel and bronze parts if δs < 8%
$l_1 = 2\ d$	22038-76	For threaded holes in parts made from light alloys. Allowed to apply in steel parts
$l_1 = 2{,}5\ d$	22040-76	

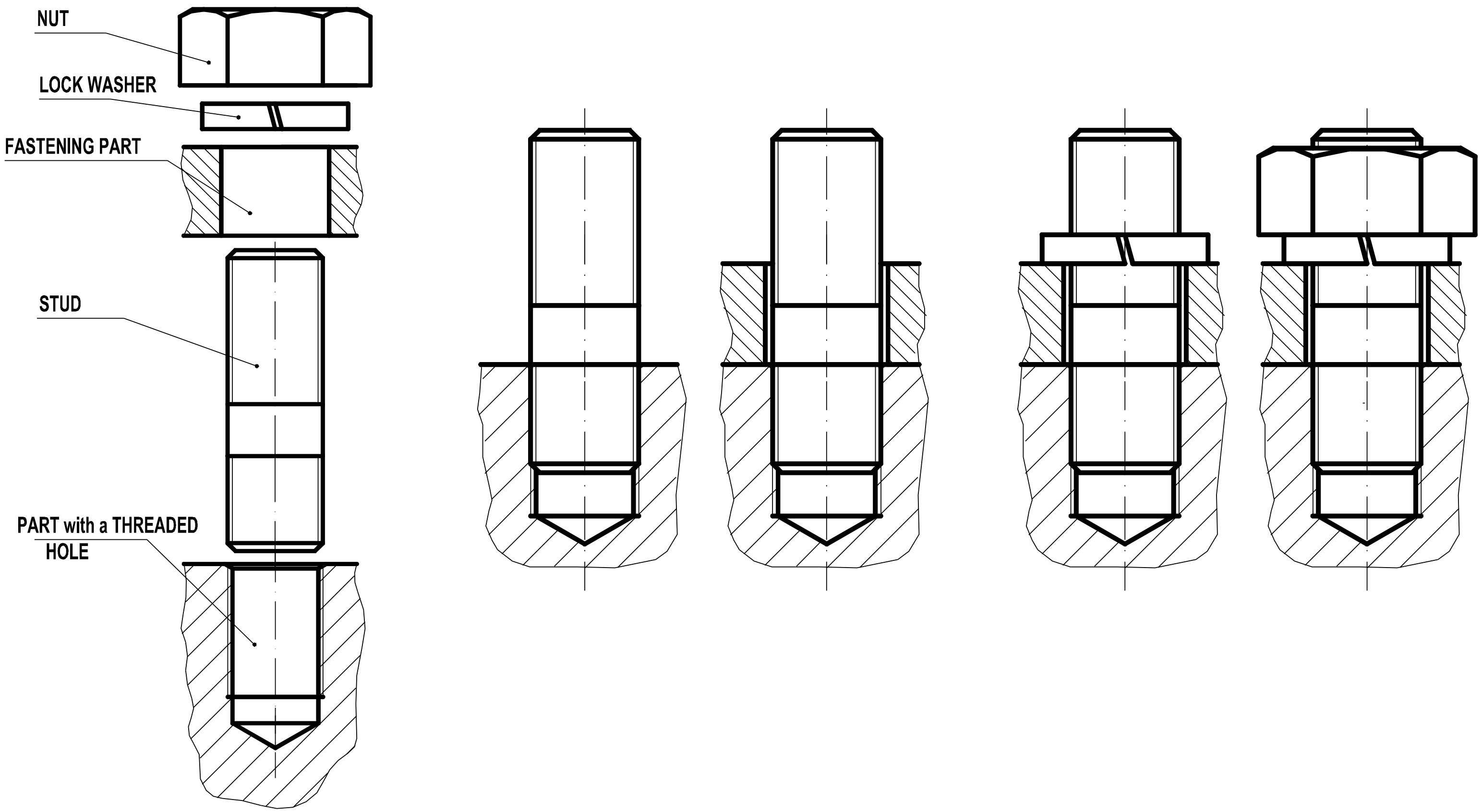


Fig. 7. Sequence of implementation of stud joint

Succession of stud joint drawing

1. Wright down the source data of given variant (see Table 3).

2. Drawing of a Stud joint has to be carried out on a blank white drawing paper of A3 size. Scale of a drawing (common for entire drawing) has to be chosen depending on real sizes of a stud joint. Drawing should be divided to a few parts, each part for a proper image (Fig. 8).

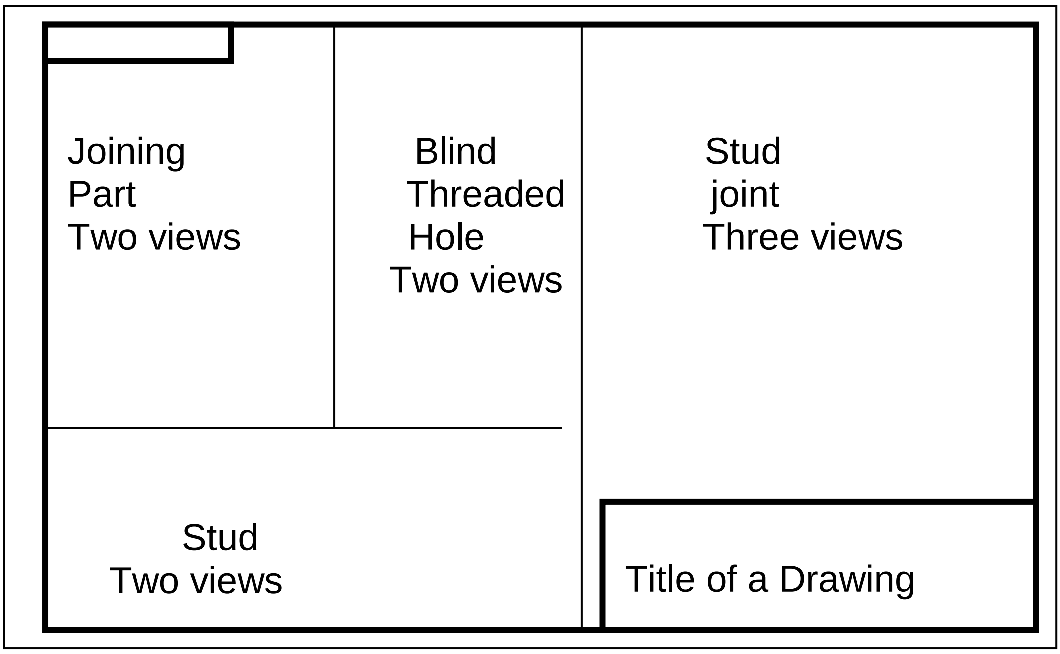


Fig. 8. Placement of images on a drawing

3. Draw front sectioned view and top view of a joining part with through hole (Fig. 9):

– define through hole diameter of a joining part (GOST 11284-75) (see Table A.2), or calculate it by formula $d_{hole}=1,1d$, where d – major thread diameter;

– place following dimensions: through hole diameter d_{hole} and joining part thickness B.

4. Draw front and top view of a blind thread hole. Make a full section on a front view (Fig. 10):

– define depth of a blind hole (l_{hole}), which depends on the length of a metal end l_1 of a stud, by formula

$$l_{hole}= l_1+2P+4P= l_1+6P,$$

where 2P – reserve of thread, 4P – thread runout;

– calculate length of thread in a hole:

$$l_p= l_1+2P;$$

– determine sizes of chamfer by GOST 10549-80 (Table A.18) depending on major thread diameter ***d:*** $\boldsymbol{d_c = 1{,}05\, d}$;

– place following dimensions: designation of Internal Thread, Thread Length, Thread Depth, Chamfer sizes (angle 120º and Chamfer diameter $\boldsymbol{d_c}$).

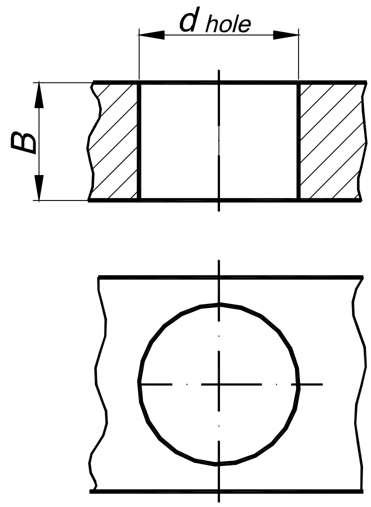


Fig. 9. Joining part

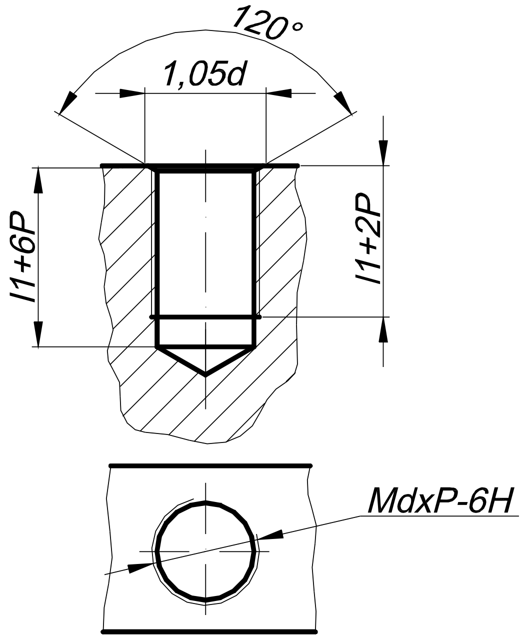


Fig. 10. Blind Thread Hole

5. Draw front and top view of a Stud (see Fig. 6).

To do this:

– define length of a screwed end l_1=**1d** *or* **1,25d**, *or* **1,6d** *,or* **2d**.

– compare calculated value l_1 to the standard one (see Table A.3) and assign to l_1 nearest standard value;

– calculate stud length l by formula (1);

– compare calculated length l to the standard one (see Table A.4) and assign to l nearest standard value from the Table A.4;

– define thread length of the nut end of a stud l_0 (see Table A.4);

– place following dimensions and text: thread designation, distances l, l_1, l_0, chamfer distances.

6.Draw three views (front view, top view and side view) of a Stud joint.

– To prevent nut self-unfastening use Lock Washer. Lock washer offers stiff resistance when compressed by tightening of the nut and keeps the thread in the nut gripped with the thread on the bolt. Sizes of a lock washer define depending on the core diameter the lock washer to be put on (GOST 6402-70 (Table A.15)). Examples how to draw a nut and lock washer on a front view of a stud joint are given in Fig. 11 and 12;

– draw full sectioned front view of a stud joint;

Table 3. **Variants of tasks**

Variant number	Stud fastening		Part Thickness *B*
	Studs GOST 22032-76 – GOST 22040-76 made from steel 45, thread tolerance 6g. Nut GOST 5915 - 70 made from steel 45, thread tolerance 6H. Washer GOST 6402-70 Regular Series, made from steel 65G. All the parts are without coating		
	Thread	l_1	
1	M 20 x 1,5	1,6 *d*	22
2	M 24 x 2	*d*	25
3	M 8	1,25 *d*	10
4	M 24 x 2	1,25 d	25
5	M 10	*d*	12
6	M 6	*d*	8
7	M 30 x 2	1,25 *d*	28
8	M 8 x 1	1,6 *d*	10
9	M 8 x 1	*d*	10
10	M 24 x 2	1,25 *d*	25
11	M 10	1,25 *d*	12
12	M 24 x 2	1,25 *d*	25
13	M 6	*d*	6
14	M 8	1,6 *d*	12
15	M 24	1,25 *d*	25
16	M 30 x 2	1,25 *d*	30
17	M 12 x 1,25	*d*	12
18	M 30 x 2	*d*	35
19	M 10	1,25 *d*	12
20	M 30 x 2	1,6 *d*	22
21	M 6	1,25 *d*	6
22	M 30 x 2	*d*	28
23	M 24 x 2	1,6 *d*	25
24	M 12 x 1,25	1,25 *d*	12
25	M 8	2 *d*	12
26	M 10 x 1	1,6 *d*	12
27	M 12	1,6 *d*	12
28	M 20 x 1,5	2 *d*	25
29	M 27 x 2	1,25 *d*	28
30	M 10 x 1,25	1,6 *d*	12

– performing threaded joint on assembly drawing (in this case stud joint can be considered as a fragment of assembly drawing) thread in a hole should be drawn throughout all the hole depth – simplification (unlike design or working drawing);

– place dimensions: stud length *l*, joining part thickness ***B***, thread designation in stud joint;

– designations of standard parts (Stud, Nut and Washer) should be placed on leaders.

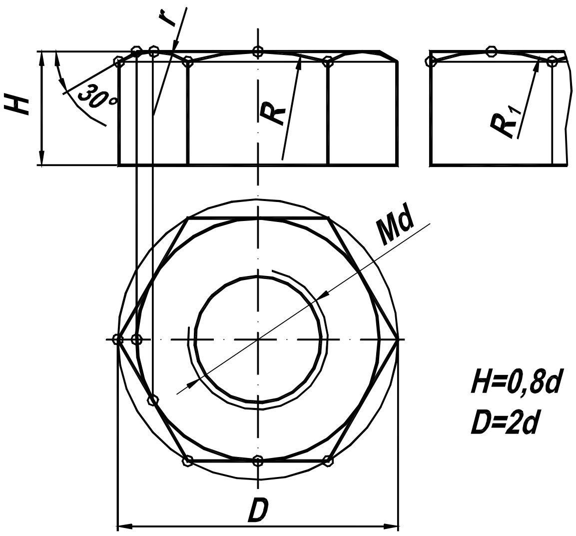


Fig. 11. Drawing of a Nut by relative dimensions

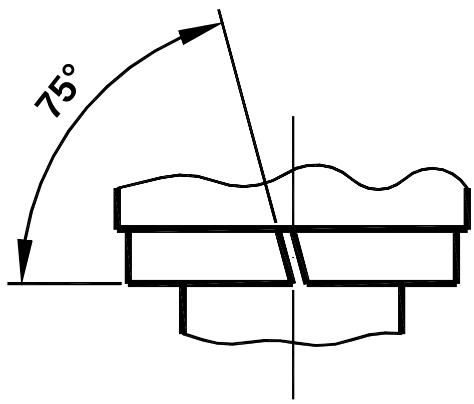


Fig. 12. Drawing of a Lock Washer

Sample of drawing execution is given in the appendix.

Screwed joint

Screwed joint is an assembly unit consisting of the screw and fastened parts. By destination metal screws are classified on machine screws and set screws (Fig. 13).

Machine screws are used in detachable joints to join parts. They represent a cylindrical rod with one threaded end which is screwed in one joining part and a head of a various form on the other end.

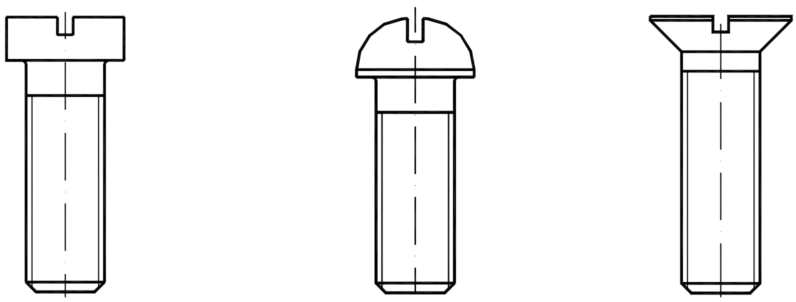
Set-screws are similar to machine screws, but are threaded practically throughout all the length. They are used to prevent relative movement between two parts. They are screwed into a tapped hole in the part adjoining the screw-head, while its end presses on the other part, thus preventing relative rotation or sliding. Heads of set-screws except those which can be operated by spanners or wrenches are provided with screw-driver slots.

Conventional designation of a screw according to the standard is putting as follows:

– name of a product;

– designation of accuracy rating (**B** – normal, **A** – fine);
– designation of a thread with matching tolerance zone;
– length of a screw;
– designation of a strength class (see Table A.5);
– designation of a coating and its thickness (see Table A.7);
– GOST number.

GOST 1491-80 GOST 17473-80 GOST 17475-80



a b c

Fig. 13. Screws with cylindrical or cheese (a), round or cap (b) and countersunk (c) heads

<u>Designation</u> of a screw of an extended precision with nominal thread diameter d = 8 mm, fine thread with pitch 1 mm, tolerance zone 6g, length l = 50 mm, strength class 4.8, coating 01 of a thickness 6 mcm with cylindrical head by GOST 1491-80:

Screw A.M8 x 1 – 6g x 50.48.016 GOST 1491-80.

Screw joint is similar to a stud joint. To join two parts with a screw the one should be provided with a tapped hole and the other with a smooth through hole. The screw is inserted into a smooth hole and screwed into a tapped hole (Fig. 14).

The screw, unlike the stud, is screwed up with a stock of several thread coils before a margin between fastened parts while the stud is screwed for all the length of a metal end.

Succession of screwed joint drawing

1. Wright down the source data of given variant from the Table 4:
– screw GOST;
– thread designation;
– screw length;
– designation of screw material;
– designation of coating;
– thickness of a joining part.

Table 4. **Variants of tasks**

Screwed joint							
Variant number	Washer GOST 6402-70 Regular Series, made from steel 65G, without coating						Joining part thickness *B*
	Screws						
	Screw GOST	Thread nominal diameter, tolerance zone 6g	Screw Length *l*	Material	Coating		
					Type	Thickness, mcm	
1	17475-80	M 12	35	Steel 45	Oxide	6	10
2	1491-80	M 8×1	30	Steel 10	Zinc	4	12
3	17475-80	M 10	30	Steel 20	Cadmium	8	15
4	1491-80	M 16×1,5	45	Steel 45	Oxide	9	15
5	1491-80	M 8x1	35	Steel 10	Copper	7	15
6	17475-80	M 8	30	Steel 10	Zinc	5	10
7	1491-80	M 8x1	25	Steel 20	Cadmium	10	15
8	17475-80	M 6	16	Steel 45	Oxide	4	6
9	1491-80	M 10	30	Steel 45	Copper	9	10
10	1491-80	M 6	20	Steel 20	Cadmium	7	6
11	17475-80	M 4	14	Steel 35	Copper	8	4
12	1491-80	M 12	40	Steel 45	Copper	4	12
13	1491-80	M 20	50	Steel 45	Oxide	9	15
14	17475-80	M 8	25	Steel 10	Zinc	6	8
15	1491-80	M 16	45	Steel 20	Cadmium	5	12
16	1491-80	M 20×1,5	55	Steel 45	Oxide	11	20
17	17475-80	M 8	25	Steel 45	Copper	5	12
18	1491-80	M 8×1	30	Steel 10	Zinc	12	12
19	1491-80	M 12	35	Steel 35	Copper	7	10
20	17475-80	M 10×1,25	30	Steel 45	Oxide	4	12
21	1491-80	M 20	55	Steel 20	Cadmium	6	18
22	17475-80	M 12	40	Steel 10	Zinc	9	15
23	17475-80	M 8×1	25	Steel 45	Brass-nickel	8	8
24	1491-80	M 6	20	Steel 45	Oxide	4	5
25	1491-80	M 12×1,25	40	Steel 10	Zinc	5	12
26	17475-80	M 20x1,5	55	Steel 20	Cadmium	11	18
27	1491-80	M 20	35	Steel 35	Brass-nickel	6	15
28	17475-80	M 12×1,25	30	Steel 20	Oxide	10	14
29	1491-80	M 8×0,75	25	Steel 45	Copper	9	10
30	1491-80	M 18×1,5	45	Steel 10	Zinc	8	12

2. Working field of a sheet A4-size divide into two equal areas by vertical thin continuous line. Drawing of a screwed joint is shown in Appendix B.

3. Draw two views of a screwed joint (front view and top view). Scale of a drawing is chosen depending on the real sizes of a screwed joint.

– the depth of a tapped hole is calculated in the same way as for stud joint.

$$l_{hole}=l_1+6P,$$

where l_1 – length of the part of a screw, screwed into a tapped hole.

– draw front full sectioned view of screwed joint.

The length of a part of the screw, screwed in a tapped hole l_1 is determined differently depending on a design of the screw:

– for countersunk-headed screws $l_1 \cong l - B$, where l – length of the screw, B – thickness of a joining part (Fig. 14, Table A.8);

– for round-headed and cylindrical-headed screws $l_1 = l - B - S$, where l – length of a screw, B – thickness of a joining part, S – height of a washer (see Table A.9);

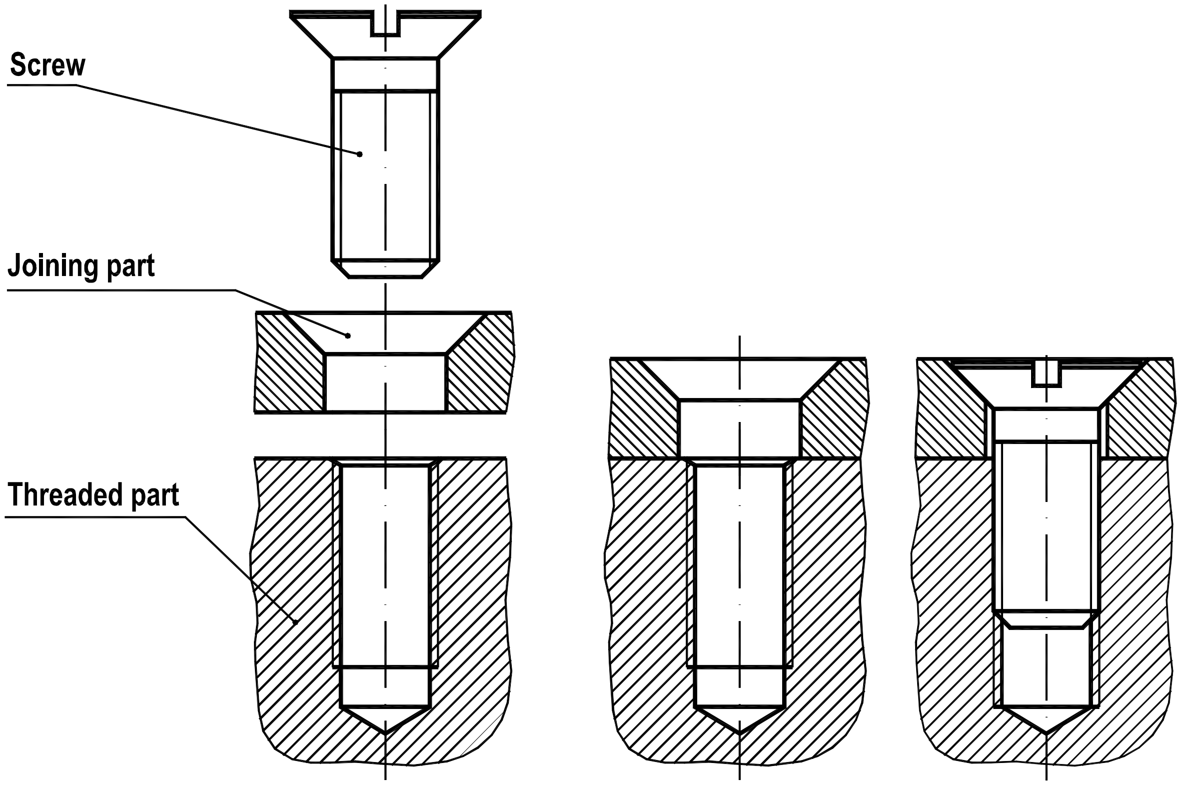


Fig. 14. Stages of screwed joint drawing

Make a through hole in a joining part:

– for round-headed and cylindrical-headed screws the hole is made smooth and cylindrical according to GOST 11284-75 (see Table A.2), otherwise diameter can be calculated by formula $d_{hole} \cong 1,1\ d$, where d – nominal thread diameter (see Fig. 9);

– for countersunk-headed screws hole design and dimensions can be found according to GOST 12876-67 (see Table A.19);

If round-headed and cylindrical-headed screws are used in a screwed joint set lock washer between head of a screw and joining part. Dimensions of the lock washer can be taken from GOST 6402-70 (see Table A.15). Image of a lock washer is placed on the Fig.12.

Screw-driver slot on a screw head should be drawn inclined at an angle 45º to a centerline of a screw on the view, perpendicular to the screw axis (top view in our case).

– place dimensions: screw length l, joining part thickness B, thread designation in screwed joint;

– designations of standard parts (Stud and Washer) should be placed on leaders.

Sample of drawing is given in the appendix.

Bolted joint

Bolted joint is an assembly unit which consists of a bolt, nut, washer and fastening parts. A nut and a bolt comprise what is known as a screw pair (Fig. 15). Such a pair is used for fastening together parts, used in engineering construction.

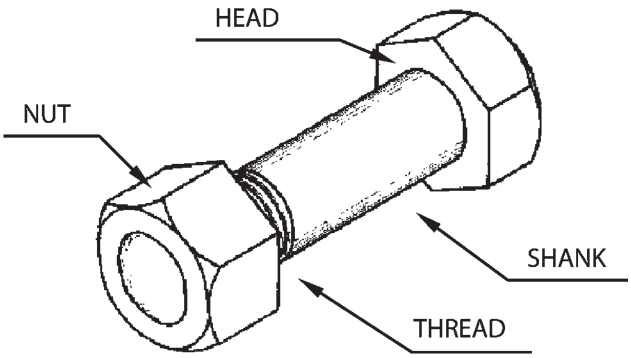


Fig. 15. Screw Pair

A bolt comprises of two parts — a shank and a head. The shank is cylindrical and is threaded at the tail end for a sufficient length so as to effectively engage with a nut. The shape of the head depends upon the purpose for which the bolt is required. While considering the length of the bolt, the thickness of the head is not taken into account.

Diameters of holes in joining parts as a role are a little more then bolt diameter:

$d_{hole} = (1,05 \ldots 1,1)\ d$, where d – nominal thread bolt diameter.

To prevent nut self-unfastening in bolted joints in this case use cotter pins. To set cotter pins threaded ends of bolts are provided with special holes and screwed in special slotted nuts.

Conventional designations of bolts according to the standard are putting as follows:

– the name of a product;
– designation of bolt series;
– designation of a thread with matching tolerance zone;
– length of the bolt;
– designation of a strength class (refer Table A.5);
– designation of coating and its thickness (refer Table A.7);
– number of GOST.

Designation of a bolt series 2 with nominal thread diameter d = = 16 mm, fine thread with pitch 1.25 mm, tolerance zone 8g, length l = = 60 mm, strength class 5.8, coating 01 thickness 6 mcm with hexagonal head GOST 7798-70:

Bolt 2.M16 x 1.25 – 8g x 60.58.016 GOST 7798-70.

Length l of a bolt is defined by the formula:

$$l = B_1 + B_2 + S + H + a + c, \qquad (2)$$

where B_1 and B_2 – thickness of joining parts;

S – height of a plain washer, GOST 11371-68 (see Table A.17);

H – height of a slotted nut GOST 5918-70 (see Table A.14);

a – prominence of a stud from a nut (1–2 pitches);

c – height of a chamfer (see Table A.18).

Found bolt length l is verified with standard values from the Table A.12 and accepted equal to a nearest standard size.

Succession of bolted joint drawing

1. Wright down the source data of given variant from the Table 5:
   – bolt GOST;
   – thread designation;
   – thickness of joining parts.
2. Drawing of the bolted joint locates in the left part of sheet, as it shown on the Fig. 16.
3. Draw two views of a bolted joint (front view and top view). Scale of a drawing is chosen depending on the real sizes of a bolted joint:

– calculate bolt length by formula 2 and verify it with Table A.12;

– select bolt from Tables A.10, A.11 and find parameter d_3 of the selected bolt;

– by found parameter d_3 select cotter pin from the Table A.16;

Table 5. **Variants of tasks**

Variant number	Bolted joint			
	Bolt made from steel 45, thread tolerance 8g. Nut GOST 5918-73 steel 45, thread tolerance 7H. Washer GOST 11371-78, material group 06. Cotter Pin GOST 397-79, material sub-group 00. All the parts in bolted joint are without coating.			
	Bolt		B_1	B_2
	Thread	GOST		
1	M 16	7798-70	20	20
2	M 20x1,5	7798-70	12	25
3	M 24x2	7798-70	25	30
4	M 20x1,5	7798-70	12	20
5	M 24	7798-70	20	35
6	M 16	7798-70	15	25
7	M 24	7798-70	25	40
8	M 24x2	7798-70	30	45
9	M 20	7798-70	20	40
10	M 12	7798-70	10	30
11	M 16	7798-70	15	25
12	M 12	7798-70	15	30
13	M 16	7798-70	10	25
14	M 20	7798-70	30	25
15	M 12	7805-81	20	25
16	M 12	7805-81	10	35
17	M 20	7805-81	20	25
18	M 20x1,5	7805-81	25	35
19	M 10	7805-81	25	20
20	M 20	7805-81	15	25
21	M 16	7805-81	18	35
22	M 12	7805-81	15	15
23	M 24	7805-81	30	30
24	M 20	7805-81	30	22
25	M 10	7805-81	12	16
26	M 6	7805-81	10	12
27	M 16	7805-81	20	30
28	M 12x1	7805-81	15	25
29	M 10x1,25	7798-70	10	30
30	M 16x1,5	7798-70	20	15

– determine through hole diameter of joining part by GOST 11284-75 (see Table A.2);

– draw full sectioned front view of the bolted joint.

4. Place dimensions: bolt length l, thickness of joining parts B_1 and B_2, thread designation in bolted joint:

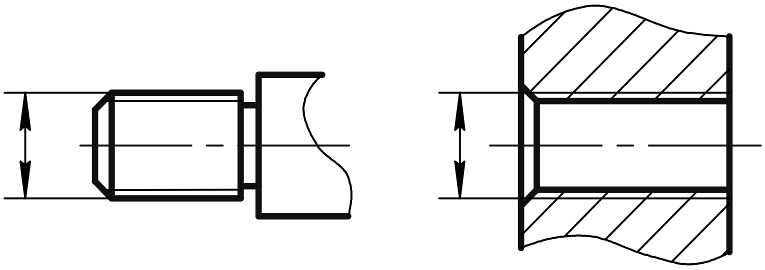
– designations of standard parts (Bolt, Nut, Washer and Cotter Pin) should be placed on leaders.

Sample of drawing execution is given in the appendix.

APPENDIX A

Threads

Cylindrical threads



Metric thread

M12-6g	–	Metric thread of nominal thread diameter 12 mm, regular pitch, outer;
M12-6H	–	Metric thread of nominal thread diameter 12 mm, regular pitch, inner;
M16x1-6g	–	Metric thread of nominal thread diameter 16 mm, fine pitch 1 mm, outer;
M16x1-6H	–	Metric thread of nominal thread diameter 16 mm, fine pitch 1 mm, inner.

Acme thread

Tr40x7-7e	–	Acme thread of nominal thread diameter 40 mm, pitch 7 mm, outer;
Tr48x8-7H	–	Acme thread of nominal thread diameter 48 mm, pitch 8 mm, inner;
Tr20x8(P4)-8e	–	Acme double thread of nominal thread diameter 20 mm, lead 8 mm, pitch 4 mm, outer.

Buttress thread

S80x10-7e	–	Buttress thread of nominal thread diameter 80 mm, pitch 10 mm, outer;
S48x8LH-7H	–	Buttress thread of nominal thread diameter 48 mm, pitch 8 mm, left hand, inner;
S80x20(P10)-8e	–	Buttress double starts thread of nominal thread diameter 80 mm, lead 20 mm, pitch 10 mm, outer;

Table A.1. **Metric Thread. Diameters and Pitches**

(extract from GOST 8724-2002)

Nominal Thread Diameter d, mm			**Pitch P, mm**	
1-st row	**2-nd row**	**3-rd row**	**regular**	**fine**
1	—	—	0,25	0,2
—	**1,1**	—	0,25	0,2
1,2	—	—	0,25	0,2
—	**1,4**	—	0,30	0,2
1,6	—	—	0,35	0,2
—	**1,8**	—	0,35	0,2
2	—	—	0,40	0,25
—	**2,2**	—	0,45	0,25
2,5	—	—	0,45	0,35
3	—	—	0,50	0,35
—	**3,5**	—	0,60	0,35
4	—	—	0,70	0,5
—	**4,5**	—	0,75	0,5
5	—	—	0,80	0,5
—	—	**5,5**	—	0,5
6	—	—	1	0,75; 0,5
—	—	**7**	1	0,75; 0,5
8	—	—	1,25	1; 0,75; 0,5
—	—	**9**	1,25	1; 0,75; 0,5
10	—	—	1,5	1,25; 1; 0,75; 0,5
—	—	**11**	1,5	1; 0,75; 0,5
12	—	—	1,75	1,5; 1,25; 1; 0,75; 0,5
—	**14**	—	2	1,5; 1,25; 1; 0,75; 0,5
—	—	**15**	—	1,5; 1
16	—	—	2	1,5; 1; 0,75; 0,5
—	—	**17**	—	1,5; 1
—	**18**	—	2,5	2; 1,5; 1; 0,75; 0,5
20	—	—	2,5	2; 1,5; 1; 0,75; 0,5
—	**22**	—	2,5	2; 1,5; 1; 0,75; 0,5
24	—	—	3	2; 1,5; 1; 0,75
—	—	**25**	—	2; 1,5; 1
—	—	**26**	—	1,5
—	**27**	—	3	2; 1,5; 1; 0,75
—	—	**28**	—	2; 1,5; 1
30	—	—	3,5	3; 2; 1,5; 1; 0,75
—	—	**32**	—	2; 1,5
—	**33**	—	3,5	3; 2; 1,5; 1; 0,75
—	—	**35**	—	1,5
36	—	—	4	3; 2; 1,5; 1

Nominal Thread Diameter d, mm			**Pitch P, mm**	
1-st row	**2-nd row**	**3-rd row**	**regular**	**fine**
—	—	**38**	—	1,5
—	**39**	—	4	3; 2; 1,5; 1
—	—	**40**	—	3; 2; 1,5
42	—	—	4,5	4; 3; 2; 1,5; 1
—	**45**	—	4,5	4; 3; 2; 1,5; 1
48	—	—	5	4; 3; 2; 1,5; 1
—	—	**50**	—	3; 2; 1,5
—	**52**	—	5	4; 3; 2; 1,5; 1
—	—	**55**	—	4; 3; 2; 1,5
56	—	—	5,5	4; 3; 2; 1,5; 1
—	—	**58**	—	4; 3; 2; 1,5
—	**60**	—	5,5	4; 3; 2; 1,5; 1
—	—	**62**	—	4; 3; 2; 1,5
64	—	—	6	4; 3; 2; 1,5; 1
—	—	**65**	—	4; 3; 2; 1,5
—	**68**	—	6	4; 3; 2; 1,5; 1
—	—	**70**	—	6; 4; 3; 2; 1,5
72	—	—	—	6; 4; 3; 2; 1,5; 1
—	—	**75**	—	4; 3; 2; 1,5
—	**76**	—	—	6; 4; 3; 2; 1,5; 1
—	—	**78**	—	2
80	—	—	—	6; 4; 3; 2; 1,5; 1
—	—	**82**	—	2
—	**85**	—	—	6; 4; 3; 2; 1,5
90	—	—	—	6; 4; 3; 2; 1,5
—	**95**	—	—	6; 4; 3; 2; 1,5
100	—	—	—	6; 4; 3; 2; 1,5
—	**105**	—	—	6; 4; 3; 2; 1,5
110	—	—	—	6; 4; 3; 2; 1,5
—	**115**	—	—	6; 4; 3; 2; 1,5
—	**120**	—	—	6; 4; 3; 2; 1,5
125	—	—	—	6; 4; 3; 2; 1,5

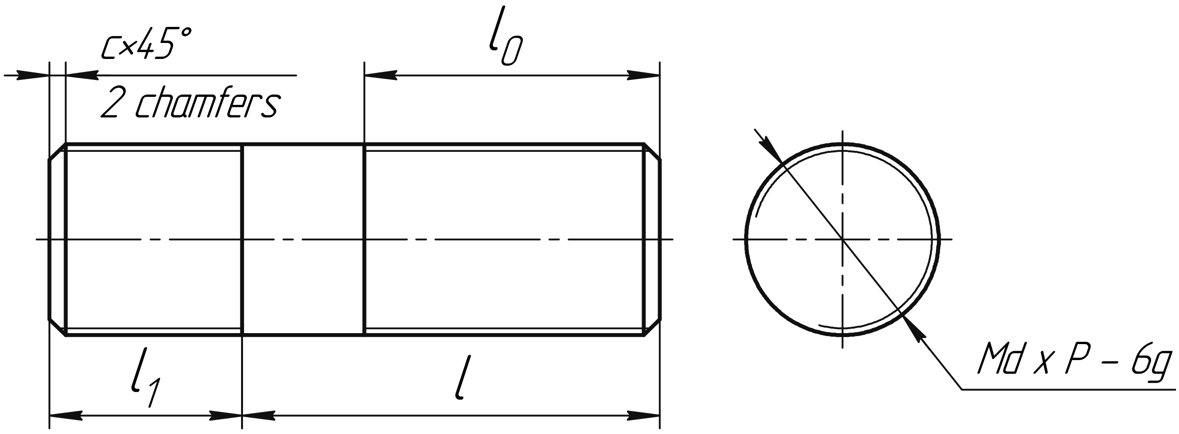
Comments:

Choosing thread diameter, give preference to the 1-st row, then to the second and only then to the third one.

Table A.2. **Through holes for fastening parts** (GOST 11284-75)

Diameters of cores of fastenings		6	8	10	12	16	20	24	30
Through Hole Diameters	1-st row	6,4	8,4	10,5	13	17	21	25	31
	2-nd row	6,6	9,0	11	14	18	22	26	33

Table A.3. **Studs** (GOST 22032-76 – GOST 22040-76)



Example of designation: **Stud M16x1 - 6g x 100.66.026 GOST 22032-76**.

Designation of a Stud of extended precision with nominal thread diameter d = 16 mm, fine thread with pitch 1 mm, tolerance zone 6g, length l = 100 mm, strength class 6.6, coating 02 of a thickness 6 mcm with cylindrical head by GOST 22032-76.

Nominal Thread Diameter **d**		**5**	**6**	**8**	**10**	**12**	**16**	**20**	**24**	**30**	**36**	**42**	**48**
Pitch	regular	0,8	1	1,25	1,5	1,75	2	2,5	3	3,5	4	4,5	5
	fine	–	–	1	1,25		1,5		2		3		
l_1 = 1d		5	6	8	10	12	16	20	24	30	36	42	48
l_1 = 1,25d		6,5	7,5	10	12	15	20	25	30	38	45	52	60
l_1 = 1,6d		8	10	14	16	20	25	32	38	48	56	68	76
l_1 = 2d		10	12	16	20	24	32	40	48	60	72	84	95
l_1 = 2,5d		12	16	20	25	30	40	50	60	75	88	105	120

Table A.4. **Length of a Stud *l* and length of a nut end l_0 of a stud**

Length of a Stud *l*	Nominal Thread Diameter *d*											
	5	**6**	**8**	**10**	**12**	**16**	**20**	**24**	**30**	**36**	**42**	**48**
	Length of a nut end l_0											
12	x	x	x	–	–	–	–	–	–	–	–	–
14	x	x	x	–	–	–	–	–	–	–	–	–
16	x	x	x	x	–	–	–	–	–	–	–	–
20	16	x	x	x	–	–	–	–	–	–	–	–
25	16	18	x	x	x	x	–	–	–	–	–	–
30	16	18	20	x	x	x	–	–	–	–	–	–
35	16	18	20	26	x	x	–	–	–	–	–	–
40	16	18	20	26	30	x	x	–	–	–	–	–
45	16	18	20	26	30	x	x	x	–	–	–	–
50	16	18	20	26	30	38	x	–	–	–	–	–
55	16	18	20	26	30	38	x	–	–	–	–	–
60	16	18	20	26	30	38	46	x	x	–	–	–
65	16	18	20	26	30	38	46	x	x	–	–	–
70	16	18	20	26	30	38	46	–	x	x	–	–
75	16	18	20	26	30	38	46	–	x	x	–	–
80	16	18	20	26	30	38	46	54	x	x	x	x
85	16	18	20	26	30	38	46	54	66	x	x	x
90	16	18	20	26	30	38	46	54	66	x	x	x
100	16	18	20	26	30	38	46	54	66	78	x	x
110	16	18	20	26	30	38	46	54	66	78	90	x
130	22	24	28	32	36	44	52	60	72	84	96	x
140	22	24	28	32	36	44	52	60	72	84	96	106
150	22	24	28	32	36	44	52	60	72	84	96	106
160	22	24	28	32	36	44	52	60	72	84	96	106
170	22	24	28	32	36	44	52	60	72	84	96	106
180	22	24	28	32	36	44	52	60	72	84	96	106
190	22	24	28	32	36	44	52	60	72	84	96	106
200	22	24	28	32	36	44	52	60	72	84	96	106
220	–	–	–	–	49	57	65	60	72	84	96	121
240	–	–	–	–	–	–	65	73	85	97	109	121

Notice: 1. Sizes placed in brackets are not recommended for usage.

2. Mark “X” labels studs with screwed end length

$$l_0 = l - 0{,}5d - 2P,$$

where P – pitch of the thread.

Table A.5. **Strength classes for studs, bolts and screws made from carbon and alloyed steel** (GOST 1759-70)

Steel mark	St3kp 10	10kp	20	10* 10kp*	35 45 40G	35**, 35H, 38HA, 45G	40H, 30HGSA	35HGSA
Strength class	3.6	4.6	5.6	5.8	6.6	8.8	10.9	12.9

* For studs, bolts and screws thread diameter up to 12 mm.
** For studs, bolts and screws thread diameter up to 16 mm.

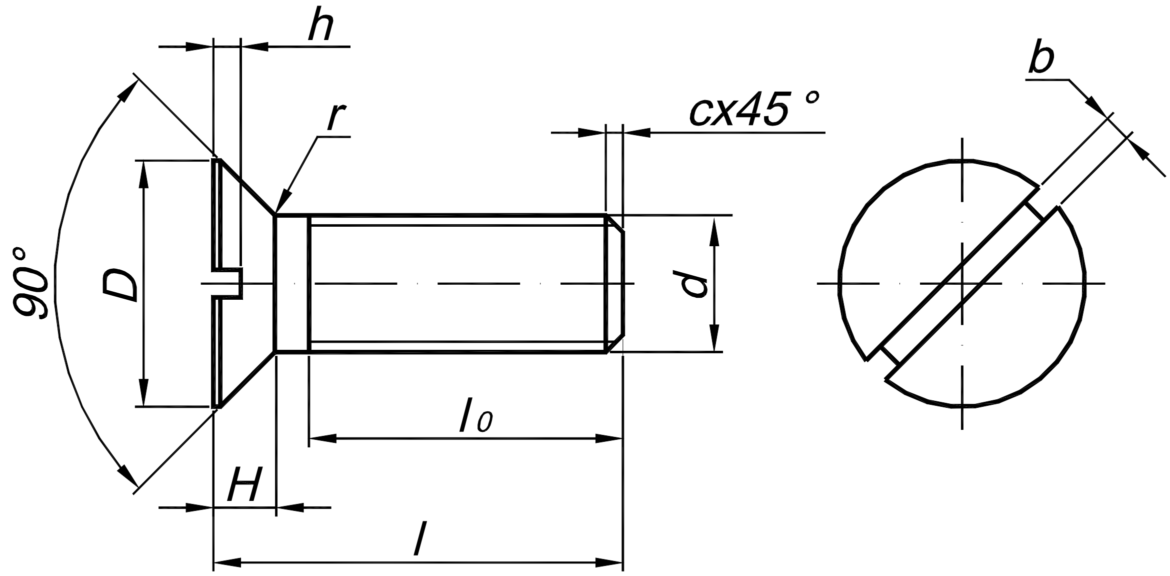
Table A.6. **Strength classes for nuts made from carbon and alloyed steels** (GOST 1759-70)

Steel mark	St3kp	10 kp, 10, 20	St5, 15, 15kp, 35	20, 20kp, 35, 45	35H, 38HA	40H, 30HGSA	35HGSA, 40HNMA
Strength class	4	5	6	8	10	12	14

Table A.7. **Types and designation of coatings for bolts, screws, studs and nuts** (GOST 1759-70)

Designation	Types of coatings	Designation	Types of coatings
00	Without coating	05	Oxide
01	Zinc with chromating	06	Phosphate with oiling
02	Cadmium with chromating	07	Stannic
03	Multilayer brass-nickel	08	Copper
04	Multilayer brass-nickel-chrome	09	Zinc

Table A.8. **Countersunk-headed Screws** GOST 17475-80



Nominal Thread Diameter **d**		4	6	8	10	12	16	20
Pitch of the thread	Regular	0,7	1	1,25	1,5	1,75	2	2,5
	Fine	–	–	1	1,25	1,25	1,5	1,5
D		7,5	11	15	18	22	29	36
H		2	3	4	4,8	5,6	7	9
b		1	1,5	2	2,5	3	4	4
h		1	1,5	2	2,3	2,5	3,5	4
r		0,2	0,2	0,25	0,3	0,4	0,5	0,5
l_0		12	16	20	26	30	38	46
c		0,7	1	1,4	1,6	1,6	2	2,5

Examples of Designations:

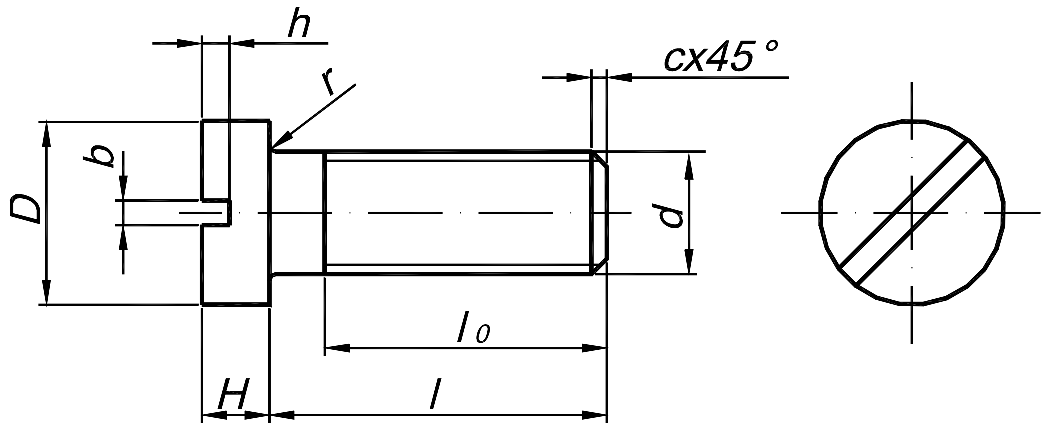
– screw with nominal thread diameter d=12 mm, regular thread, tolerance zone 6g, length 50 mm, strength class 5.8, without coating:

Screw M12-6g x 50.58 GOST 17475-80;

– screw with nominal thread diameter d=12 mm, fine thread with pitch 1.25 mm, tolerance zone 6g, length 50 mm, strength class 5.8, coating 01 thickness 9 mcm:

Screw M12 x1,25-6g x 50.58.019 GOST 17475-80.

Table A.9. **Cylindrical-headed Screws** GOST 1491-80



Nominal Thread Diameter **d**		**4**	**6**	**8**	**10**	**12**	**16**	**20**
Pitch of the thread	Regular	0,7	1	1,25	1,5	1,75	2	2,5
	Fine	–	–	1	1,25	1,25	1,5	1,5
D		7	10	12,5	15	18	24	30
H		2,5	3,5	5	6	7	9	11
b		1	1,5	2	2,5	3	4	4
h		1,4	2	2,5	3	3,5	4	4,5
r		0,2	0,2	0,5	0,6	0,8	1	1
l_0		12	16	20	26	30	38	46
c		0,7	1	1,4	1,6	1,6	2	2,5

Examples of Designations:

– screw with nominal thread diameter d=12 mm, regular thread, tolerance zone 6g, length 50 mm, strength class 5.8, without coating:

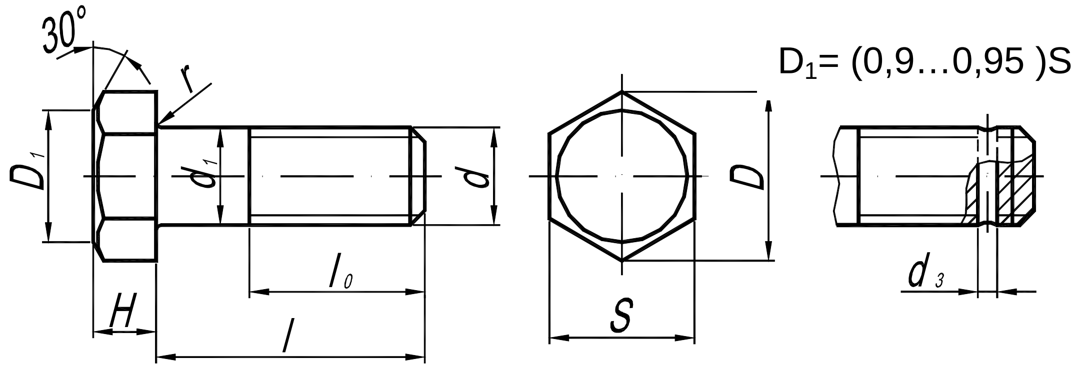
Screw M12-6g x 50.58 GOST 1491-80;

– screw with nominal thread diameter d=12 mm, fine thread with pitch 1.25 mm, tolerance zone 6g, length 50 mm, strength class 5.8, coating 01 thickness 9 mcm:

Screw M12 x1,25-6g x 50.58.019 GOST 1491-80.

Table A.10. **Hexagonal-headed Bolts of a single precision**
GOST 7798-70

Series 1 Series 2



Nominal Thread Diameter **d**		**6**	**8**	**10**	**12**	**16**	**20**	**24**
Pitch of the thread	Regular	1	1,25	1,5	1,75	2	2,5	3
	Fine		1	1,25	1,25	1,5	1,5	2
d_1		6	8	10	12	16	20	24
S		10	13	17	19	24	30	36
H		4	5,5	7	8	10	13	15
D		10,9	14,2	18,7	20,9	26,5	33,3	39,6
r	Min	0,25	0,4	0,4	0,6	0,6	0,8	0,8
	Max	0,6	1,1	1,1	1,6	1,6	2,2	2,2
d_3		1,6	2	2,5	3,2	4	5	5

Table A.11. **Hexagonal-headed Bolts of an extended precision**
GOST 7805-70

Nominal Thread Diameter **d**		**6**	**8**	**10**	**12**	**16**	**20**	**24**
Pitch of the thread	Regular	1	1,25	1,5	1,75	2	2,5	3
	Fine		1	1,25	1,25	1,5	1,5	2
d_1		6	8	10	12	16	20	24
S		10	13	17	19	24	30	36
H		4	5,5	7	8	10	13	15
D		11	14,4	18,9	21,1	26,8	33,6	40,3
r	Min	0,25	0,4	0,4	0,6	0,6	0,8	0,8
	Max	0,6	0,6	0,6	1,1	1,1	1,2	1,2
d_3		1,6	2	2,5	3,2	4	5	5

Table A.12. **Bolt length l and Length of the treaded end l_0**

Bolt length l	Nominal Thread Diameter d												
	6	**8**	**10**	**12**	**(14)**	**16**	**20**	**(22)**	**24**	**(27)**	**30**	**36**	**42**
	Length of the treaded end l_0												
16	X	X	X	X	X								
(18)	X	X	X	X	X	X							
20	X	X	X	X	X	X							
(22)	18	X	X	X	X	X							
25	18	X	X	X	X	X	X						
(28)	18	22	X	X	X	X	X	X					
30	18	22	X	X	X	X	X	X					
(32)	18	22	26	X	X	X	X	X	X				
35	18	22	26	30	X	X	X	X	X	X			
(38)	18	22	26	30	X	X	X	X	X	X			
40	18	22	26	30	34	X	X	X	X	X	X		
45	18	22	26	30	34	38	X	X	X	X	X		
50	18	22	26	30	34	38	X	X	X	X	X	X	
55	18	22	26	30	34	38	46	X	X	X	X	X	X
60	18	22	26	30	34	38	46	50	X	X	X	X	X
65	18	22	26	30	34	38	46	50	54	X	X	X	X
70	18	22	26	30	34	38	46	50	54	60	X	X	X
75	18	22	26	30	34	38	46	50	54	60	66	X	X
80	18	22	26	30	34	38	46	50	54	60	66	X	X
(85)	18	22	26	30	34	38	46	50	54	60	66	X	X
90	18	22	26	30	34	38	46	50	54	60	66	78	X
(95)		22	26	30	34	38	46	50	54	60	66	78	X
100		22	26	30	34	38	46	50	54	60	66	78	X
(105)			26	30	34	38	46	50	54	60	66	78	90
110			26	30	34	38	46	50	54	60	66	78	90
(115)			26	30	34	38	46	50	54	60	66	78	90
120			26	30	34	38	46	50	54	60	66	78	90

Notes: 1. Dimensions in brackets are not recommended for usage.

2. Mark “X” labels bolts threaded throughout all the length ($l = l_0$).

Designations:

– bolt series 1 with nominal thread diameter d = 12 mm, regular thread, tolerance zone 6g, length l = 50 mm, strength class 5.8, without coating:

Bolt M12 – 6g x 50.58 GOST 7798 – 70;

– bolt series 2 with nominal thread diameter d = 12 mm, fine thread with pitch 1.25 mm, tolerance zone 8g, length 50 mm, strength class 5.8, coating 01 thickness 9 mcm:

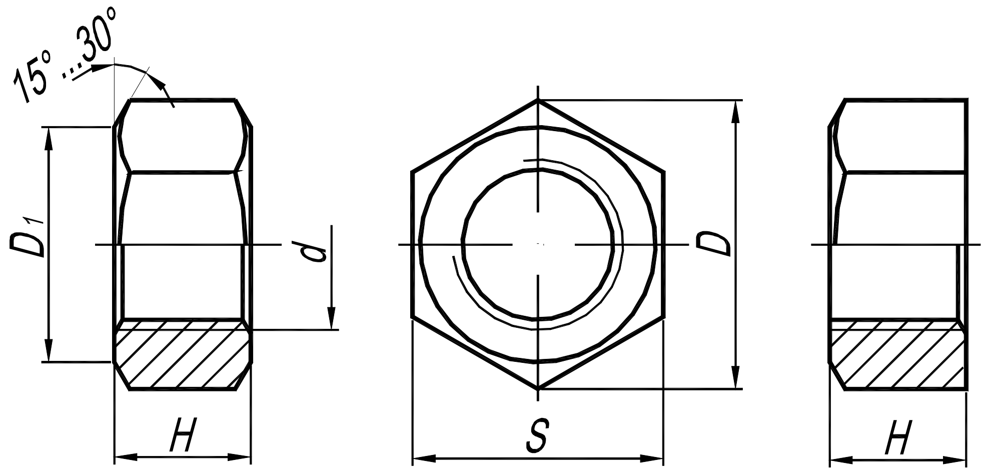
Bolt 2 M12 x1,25 – 6g x 50.58.019 GOST 7798 – 70;

– bolt series 1 with nominal thread diameter d = 12 mm, regular thread, tolerance zone 6g, length l = 50 mm, strength class 5.8, without coating:

Bolt M12 – 6g x 50.58 GOST 7805 – 70.

Table A.13. **Hex Nuts of a single precision** by GOST 5915-70

Series 1 Series 2



$$D_1 = (0{,}9 \ldots 0{,}95)\,S$$

Nominal Thread Diameter **d**		**6**	**8**	**10**	**12**	**16**	**20**	**24**	**30**
Pitch	Regular	1	1,25	1,5	1,75	2	2,5	3	3,5
	Fine	–	1	1,25	1,25	1,5	1,5	2	2
S		10	13	17	19	24	30	36	46
H		5	6,5	8	10	13	16	19	24
D		10,9	14,2	18,7	20,9	26,5	33,3	49,6	50,9

Example of designation:

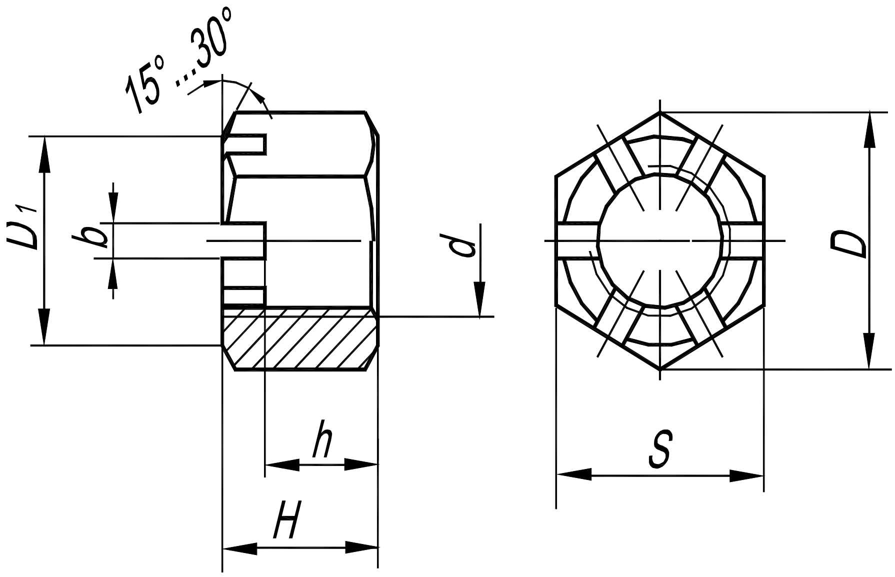
– Hex Nut series 1 with nominal thread diameter d=12 mm, regular thread, tolerance zone 6H, strength class 5, without coating:

Nut M12-6H.5 GOST 5915 – 70;

– Hex Nut series 2 with nominal thread diameter d=12 mm, fine thread with pitch 1.25mm, tolerance zone 6H, strength class 5, coating 01, thickness 9 mcm:

Nut 2 M12 x1.25-6H.5.019 GOST 5915 – 70.

Table A.14. **Slotted Hex Nuts of a single precision** by GOST 5918-70



D_1 = (0,9…0,95) S

Nominal Thread Diameter **d**		**6**	**8**	**10**	**12**	**16**	**20**	**24**	**30**
Pitch	Regular	1	1,25	1,5	1,75	2	2,5	3	3,5
	Fine		1	1,25	1,25	1,5	1,5	2	2
S		10	13	17	19	24	30	36	46
H		7,5	9,5	12	15	19	22	27	33
D		10,9	14,2	18,7	20,9	26,5	33,3	39,6	50,9
b		2	2,5	2,8	3,5	4,5	4,5	5,5	7
h		5	6,5	8	10	13	16	19	24
Cotter Pin		1,6x16	2x20	2,5x25	3,2x32	4x36	4x40	5x45	6,3x60

Example of designation:

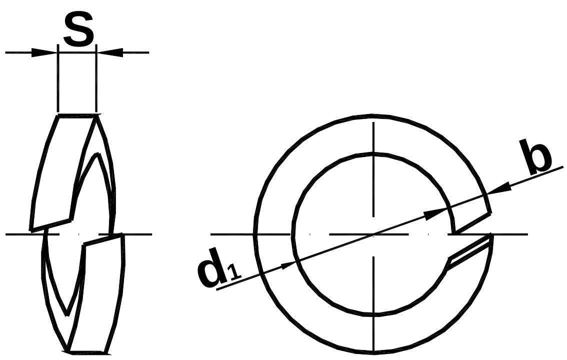
– Slotted Hex Nut with nominal thread diameter d=12 mm, regular thread, tolerance zone 6H, strength class 5, without coating:

Nut M12-6H.5 GOST 5918 – 70;

– Slotted Hex Nut with nominal thread diameter d=12 mm, fine thread with pitch 1.25 mm, tolerance zone 6H, strength class 5, coating 01 thickness 9 mcm:

Nut M12x1.25-6H.5.019 GOST 5918 – 70.

Table A.15. **Lock Washers** (GOST 6402-70)



Nominal Thread Diameter of fastening part ***d***	Nominal Lock Washer Diameter ***d_1***	Dimensions ***S*** and ***b***			
		Light Series		Regular Series	Heavy Series
		S	***b***	***S = b***	***S = b***
5	5,1	1,2	1,6	1,4	1,6
6	6,1	1,4	2,0	1,6	2,0
8	8,1	1,6	2,5	2,0	2,5
10	10,1	2,0	3,0	2,5	3,0
12	12,1	2,5	3,5	3,0	3,5
14	14,2	3,0	4,0	3,5	4,0
16	16,3	3,2	4,5	4,0	4,5
18	18,3	3,5	5,0	4,5	5,0
20	20,5	4,0	5,5	5,0	5,5
22	22,5	4,5	6,0	5,5	6,0
24	24,5	5,0	7,0	6,0	7,0
27	27,5	5,5	8,0	7,0	8,0
30	30,5	6,0	9,0	8,0	9,0
36	36,5	–	–	9,0	10,0
42	42,5	–	–	10,0	12,0
48	48,5	–	–	12,0	–

Examples of designations:

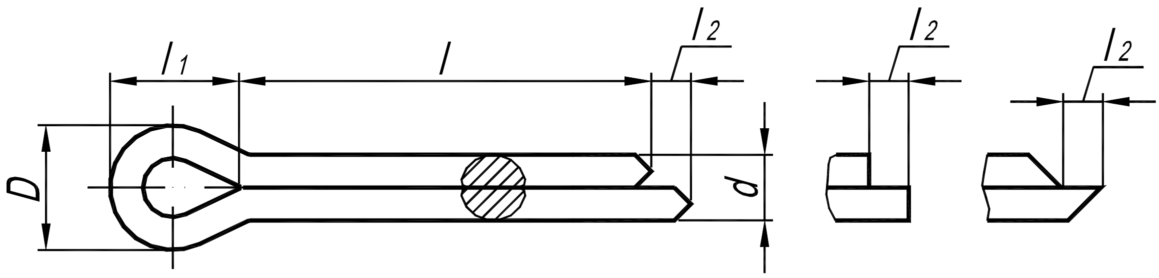
– Lock Washer for bolt, screw or stud with nominal thread diameter 12 mm, Light Series, made from bronze mark BrKMz3-1, without coating:

Washer 12L.BrKMz3-1 GOST 6402-70;

– Lock Washer for bolt, screw or stud with nominal thread diameter 12 mm, Light Series, made from steel 65G, cadmium coating thickness 9 mcm:

Washer 12.65G.02.9 GOST 6402-70.

Table A.16. **Cotter Pins** (GOST 397-79)



Conventional Cotter Pin Diameter, equal to Hole Diameter	1	1,2	1,6	2	2,5	3,2	4	5
d	0,9	1	1,3	1,8	2,2	2,7	3,6	4,6
D	1,9	2,25	2,8	3,8	4,7	5,7	7,1	9,1
l_1 ≈	2,5	3	3,5	5	6	7,5	9	11,5
l_2	1,6	2,5	2,5	2,5	2,5	4	4	4
Recom-mended Bolt Diame-ters	From 3,6 to 4,5	From 4,5 to 5,5	From 5,5 to 7	From 7 to 9	From 9 to 11	From 11 to 14	From 14 to 20	From 20 to 28
l	6-25	8-16	8-40	8-45	10-50	12-60	16-70	16-80

Dimension l within given limits accept from row: 6, 8, 10, 12, 14, 16, 18, 20, 22, 25, 28, 32, 36, 40, 45, 50, 60, 70, 80, 90.

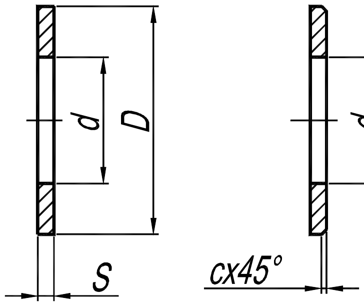
Example of designation:

Cotter Pin of conventional diameter 5 mm, length 28 mm, from low-carbon steel, without coating:

Cotter Pin 5x28 GOST 397-79.

Table A.17. **Plain Washers** (GOST 11371 – 78)

Series 1 Series 2



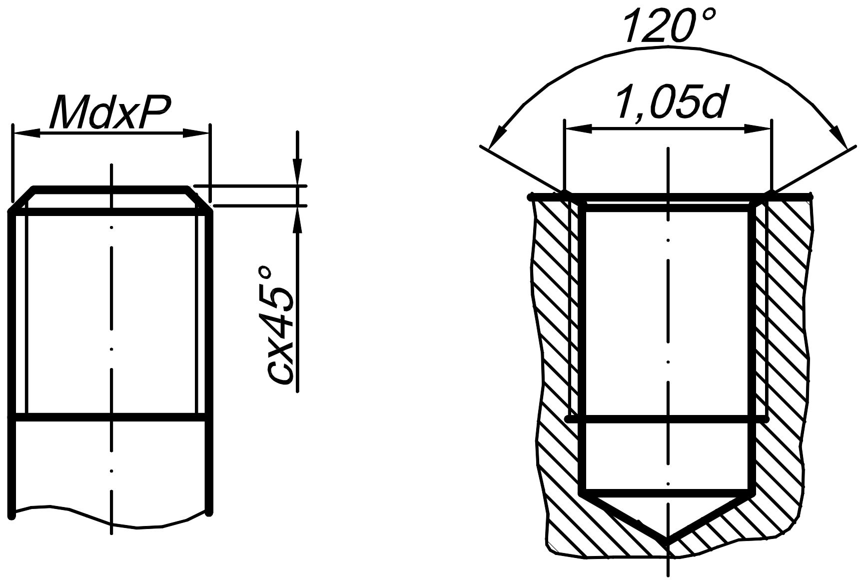
Core Diameter of fastening part	*d*	*D*	*S*	c
2	2,2	5	0,3	–
3	3,2	7	0,5	–
4	4,3	9	0,8	-
5	5,3	10	1,0	0,3
6	6,4	12,5	1,6	0,4
8	8,4	17	1,6	0,4
10	10,5	21	2,0	0,5
12	13	24	2,5	0,6
14	15	28	2,5	0,8
16	17	30	2,5	0,8
18	19	34	3,0	0,8
20	21	37	3,0	1,0
22	23	39	3,0	1,0
24	25	44	4,0	1,0
27	28	50	4,0	1,2
30	31	56	4,0	1,2
36	37	66	5,0	1,6
42	43	78	7,0	1,6

Example of designation:

Plain Washer series 1 Core Diameter 12 mm, given thickness, material group 01, with coating type 05:

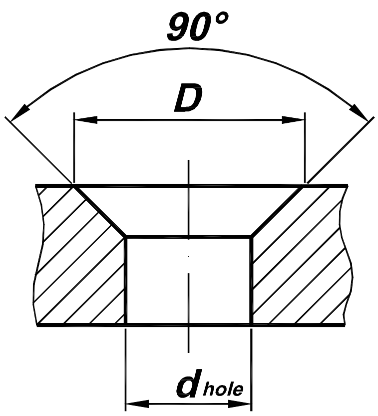
Washer 12.01.05 GOST 11371 – 78.

Table A.18. **Chamfers for External and Internal Metric Thread fastenings** by GOST 10549 – 80



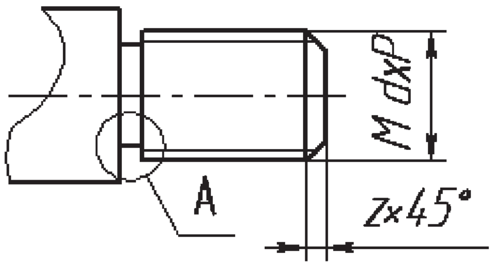
Pitch P, mm	0,5	0,75	1,0	1,25	1,5	1,75	2	2,5	3	3,5	4
Chamfer Distance **c**, min	0,5	1,0	1,0	1,6	1,6	1,6	2,0	2,5	2,5	2,5	3,0

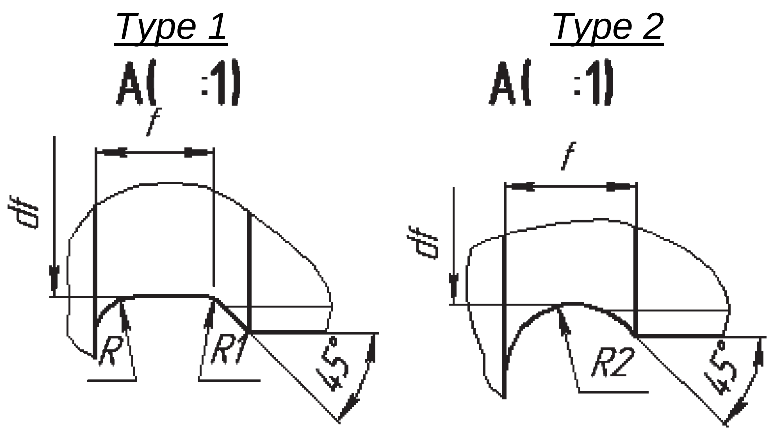
Table A.19. **Holes for countersunk-headed screws**
(Extract from GOST 12876-67)



Nominal Thread Diameter ***d***	4	6	8	10	12	14	16	18	20
D	8,3	12,3	16,5	20	24	28	31	35	39

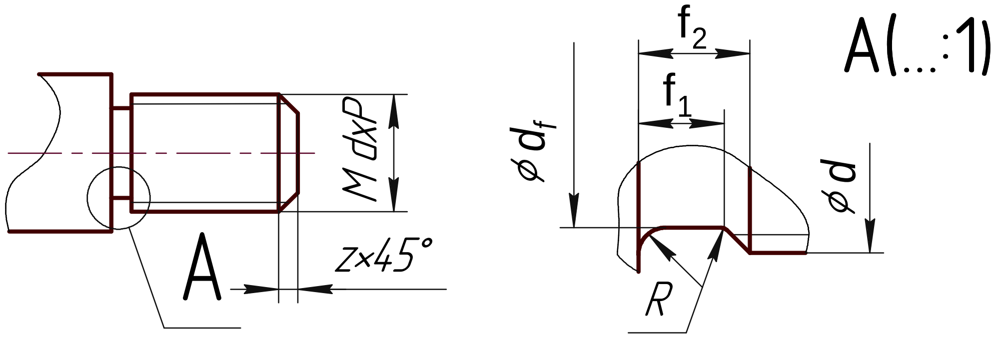
Table A.20. **Grooves for external metric thread**
(extract from GOST 10549-80), mm





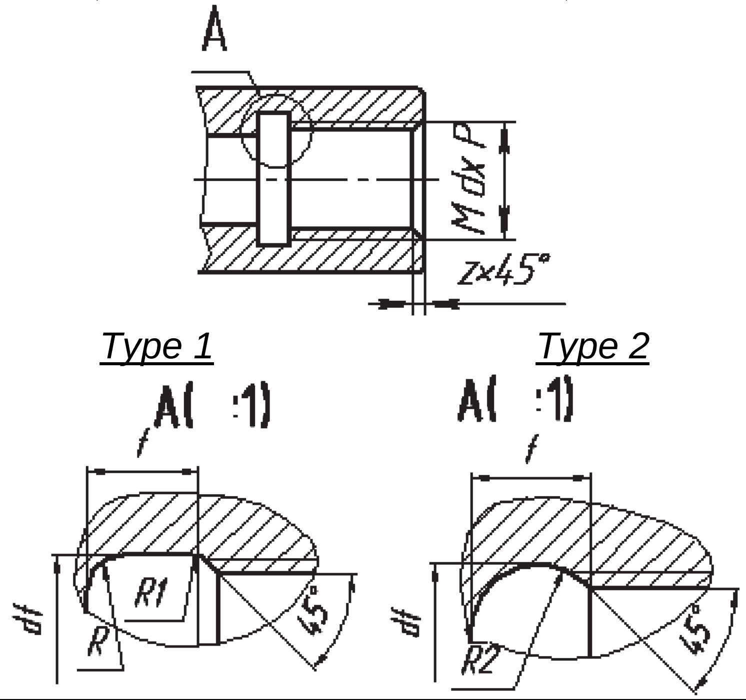
Thread Pitch *P*, mm	**Groove sizes**									**Chamfer *z*, mm**
	Type 1						**Type 2**		***df***	
	normal			**narrow**						
	f	***R***	R_1	***f***	***R***	R_1	***f***	R_2		
0,2	–	–	–	–	–	–	–	–	–	0,2
0,25										
0,3										
0,35									*d* - 0,6	0,3
0,4	1,0	0,3	0,2							
0,45									*d* - 0,7	
0,5	1,6	0,5	0,3	1,0	0,3	0,2			*d* - 0,8	0,5
0,6									*d* - 0,9	
0,7	2,0			1,6	0,5	0,3			*d* - 1,0	
0,75									*d* - 1,2	1,0
0,8	3,0	1,0	0,5							
1				2,0			3,6	2,0	*d* - 1,5	
1,25	4,0			2,5	1,0	0,5	4,4	2,5	*d* - 1,8	1,6
1,5							4,6		*d* - 2,2	
1,75							5,4	3,0	*d* - 2,5	
2	5,0	1,6		3,0			5,6		*d* - 3,0	2,0
2,5	6,0		1,0	4,0			7,3	4,0	*d* - 3,5	2,5
3							7,6		*d* - 4,5	
3,5	8,0	2,0		5,0	1,6		10,2	5,5	*d* - 5,0	
4							10,3		*d* - 6,0	3,0
4,5	10,0	3,0		6,0		1,0	12,9	7,0	*d* - 6,5	
5							13,1		*d* - 7,0	4,0
5,5	12,0			8,0	2,0		15,0	8,0	*d* - 8,0	
6							16,0	8,5	*d* - 9,0	

Table A.21. **Grooves for external metric thread**
(extract from GOST 10549-80), mm



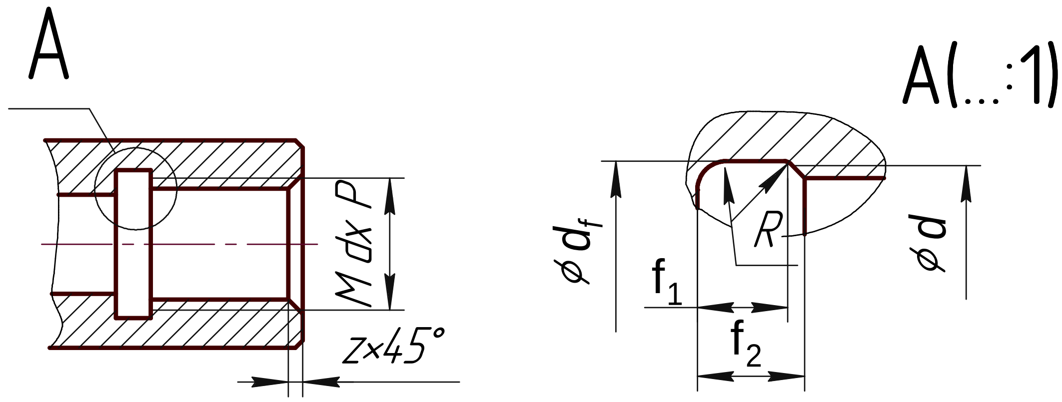
Thread Pitch, P	f_1, min		f_2, min		d_f	R≈0,5P
	normal	narrow	normal	narrow		
0,2	0,45	0,25	0,7	0,5	d – 0,3	0,1
0,25	0,55	0,25	0,9	0,5	d – 0,5	0,12
0,3	0,6	0,3	1,05	0,75	d – 0,5	0,15
0,35	0,7	0,4	1,2	0,9	d – 0,5	0,17
0,4	0,8	0,5	1,4	1,0	d – 0,7	0,2
0,45	1,0	0,5	1,6	1,1	d – 0,7	0,22
0,5	1,1	0,5	1,75	1,25	d – 0,8	0,25
0,6	1,2	0,6	2,1	1,5	d – 1,0	0,3
0,7	1,5	0,8	2,45	1,75	d – 1,1	0,35
0,75	1,6	0,9	2,6	1,9	d – 1,2	0,4
0,8	1,7	0,9	2,8	2,0	d – 1,3	0,4
1,0	2,1	1,1	3,5	2,5	d – 1,6	0,5
1,25	2,7	1,5	4,4	3,2	d – 2,0	0,6
1,5	3,2	1,8	5,2	3,8	d – 2,3	0,75
1,75	3,9	2,1	6,1	4,3	d – 2,6	0,9
2,0	4,5	2,5	7,0	5,0	d – 3,0	1,0
2,5	5,6	3,2	8,7	6,3	d – 3,6	1,25
3,0	6,7	3,7	10,5	7,5	d – 4,4	1,5
3,5	7,7	4,7	12,5	9,0	d – 5	1.75
4,0	9,0	5,0	14,0	10,0	d – 5,7	2,0
4,4	10,5	5,5	16,0	11,0	d – 6,4	2,25
5,0	11,5	6,5	17,5	12,5	d – 7	2,5
5,6	15,5	7,5	19,0	14,5	d – 7,7	2,75
6,0	14,0	8,0	21,0	15,0	d – 8,3	3,0

Table A.22. **Grooves for internal metric thread (extract from GOST 10549-80), mm**



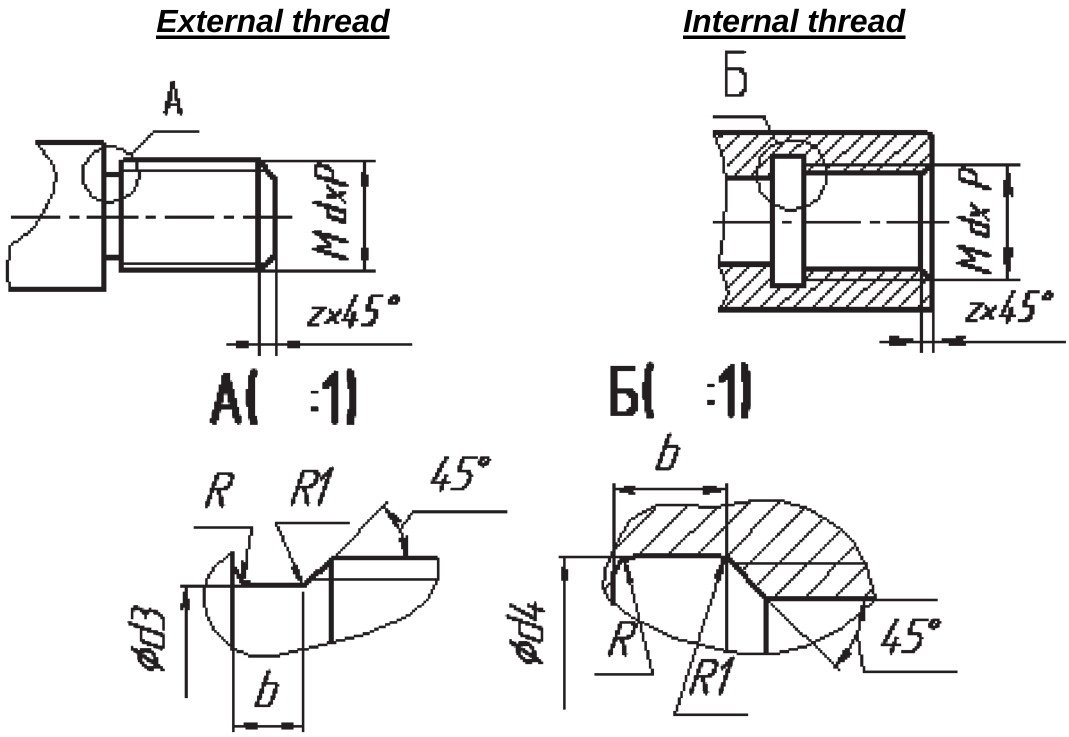
<table>
<tr><th rowspan="4">Thread Pitch
P, mm</th><th colspan="9">Groove sizes</th><th rowspan="4">Chamfer
z, mm</th></tr>
<tr><th colspan="6">Type 1</th><th colspan="2">Type 2</th><th rowspan="3">*df*</th></tr>
<tr><th colspan="3">normal</th><th colspan="3">narrow</th><th colspan="2"></th></tr>
<tr><th>*f*</th><th>*R*</th><th>R_1</th><th>*f*</th><th>*R*</th><th>R_1</th><th>*f*</th><th>R_2</th></tr>
<tr><td>**0,2**</td><td rowspan="6">–</td><td rowspan="6">–</td><td rowspan="6">–</td><td rowspan="6">–</td><td rowspan="6">–</td><td rowspan="6">–</td><td rowspan="11">–</td><td rowspan="11">–</td><td rowspan="6">–</td><td rowspan="4">0,2</td></tr>
<tr><td>**0,25**</td></tr>
<tr><td>**0,3**</td></tr>
<tr><td>**0,35**</td></tr>
<tr><td>**0,4**</td><td rowspan="2">0,3</td></tr>
<tr><td>**0,45**</td></tr>
<tr><td>**0,5**</td><td>2,0</td><td>0,5</td><td>0,3</td><td>1,0*</td><td>0,3</td><td>0,2</td><td>*d* + 0,3</td><td rowspan="3">0,5</td></tr>
<tr><td>**0,6**</td><td rowspan="2">–</td><td rowspan="2">–</td><td rowspan="2">–</td><td rowspan="2">–</td><td rowspan="2">–</td><td rowspan="2">–</td><td rowspan="2">–</td></tr>
<tr><td>**0,7**</td></tr>
<tr><td>**0,75**</td><td>3,0</td><td>1,0</td><td>0,5</td><td>1,6*</td><td>0,5</td><td>0,3</td><td>*d* + 0,4</td><td rowspan="3">1,0</td></tr>
<tr><td>**0,8**</td><td>–</td><td>–</td><td>–</td><td>–</td><td>–</td><td>–</td><td>–</td></tr>
<tr><td>**1**</td><td>4,0</td><td>1,0</td><td rowspan="2">0,5</td><td>2,0</td><td>0,5</td><td>0,3</td><td>3,6</td><td>2,0</td><td rowspan="2">*d* + 0,5</td></tr>
<tr><td>**1,25**</td><td>5,0</td><td rowspan="3">1,6</td><td rowspan="2">3,0</td><td rowspan="2">1,0</td><td rowspan="5">0,5</td><td>4,5</td><td>2,5</td><td rowspan="3">1,6</td></tr>
<tr><td>**1,5**</td><td>6,0</td><td rowspan="11">1,0</td><td>5,4</td><td>3,0</td><td rowspan="2">*d* + 0,7</td></tr>
<tr><td>**1,75**</td><td>7,0</td><td rowspan="2">4,0</td><td rowspan="2">1,0</td><td>6,2</td><td rowspan="2">3,5</td></tr>
<tr><td>**2**</td><td>8,0</td><td>2,0</td><td>6,5</td><td rowspan="2">*d* + 1,0</td><td>2,0</td></tr>
<tr><td>**2,5**</td><td rowspan="3">10</td><td rowspan="8">3,0</td><td>5,0</td><td rowspan="3">1,6</td><td>8,9</td><td>5,0</td><td rowspan="2">2,5</td></tr>
<tr><td>**3**</td><td>6,0</td><td rowspan="7">1,0</td><td>11,4</td><td>6,5</td><td rowspan="2">*d* + 1,2</td></tr>
<tr><td>**3,5**</td><td>7,0</td><td>13,1</td><td>7,5</td><td rowspan="2">3,0</td></tr>
<tr><td>**4**</td><td>12</td><td>8,0</td><td>2,0</td><td>14,3</td><td>8,0</td><td rowspan="2">*d* + 1,5</td></tr>
<tr><td>**4,5**</td><td>14</td><td rowspan="2">10</td><td rowspan="4">3,0</td><td>16,6</td><td>9,5</td><td rowspan="4">4,0</td></tr>
<tr><td>**5**</td><td rowspan="3">16</td><td>18,4</td><td rowspan="3">10,5</td><td rowspan="2">*d* + 1,8</td></tr>
<tr><td>**5,5**</td><td rowspan="2">12</td><td>18,7</td></tr>
<tr><td>**6**</td><td>18,9</td><td>*d* + 2,0</td></tr>
</table>

Table A.23. **Grooves for internal metric thread (extract from GOST 10549-80), mm**



Thread Pitch, P	f_1, min		f_2, min		d_f	R≈0,5P
	normal	narrow	normal	narrow		
0,2	0,8	0,5	1,2	0,9	d + 0,1	0,1
0,25	1,0	0,6	1,4	1,0	d + 0,1	0,12
0,3	1,2	0,75	1,6	1,25	d + 0,1	0,17
0,35	1,4	0,9	1,9	1,4	d + 0,2	0,17
0,4	1,6	1,0	2,2	1,5	d + 0,2	0,2
0,45	1,8	1,1	2,4	1,7	d + 0,2	0,22
0,5	2,0	1,25	2,7	2,0	d + 0,3	0,25
0,6	2,4	1,5	3,3	2,4	d + 0,3	0,3
0,7	2,8	1,75	3,8	2,75	d + 0,3	0,35
0,75	3,0	1,9	4,0	2,9	d + 0,3	0,4
0,8	3,2	2,0	4,2	3,0	d + 0,3	0,4
1,0	4,2	2,5	5,2	3,7	d + 0,5	0,5
1,25	5,0	3,2	6,7	4,9	d + 0,5	0,6
1,5	6,0	3,8	7,8	6,6	d + 0,5	0,75
1,75	7,0	4,3	9,1	6,4	d + 0,5	0,9
2,0	8,0	5,0	10,3	7,3	d + 0,5	1,0
2,5	10	6,3	13,0	9,3	d + 0,5	1,25
3,0	12	7,5	15,2	10,7	d + 0,5	1,25
3,5	14	9,0	17,0	12,7	d + 0,5	1,75
4,0	16	10,0	20,0	14,0	d + 0,5	2,0
4,4	18	11,0	23,0	16,0	d + 0,5	2,25
5,0	20	12,5	26,0	18,5	d + 0,5	2,5
5,6	22	14,0	28,0	20,0	d + 0,5	2,75
6,0	24	15,0	30,0	21,0	d + 0,5	3,0

Table A.24. **Grooves for internal Acme thread (extract from GOST 10549-80), mm**



Thread Pitch *P*, mm	b, мм	R, mm	R1, mm	d3, mm	d4, mm	Chamfer *z*, mm
1,5	2,5	1,0	0,5	d-2,5	d+1,0	1,0
2	3	1,0	0,5	d-3,0	d+1,0	1,6
3	5	1,6	0,5	d-4,2	d+1,0	2,0
4	6	1,6	1,0	d-5,2	d1,1	2,5
5	8	2,0	1,0	d-7,0	d+1,6	3,0
6	10	3,0	1,0	d-8,0	d+1,6	3,5
7	12	3,0	1,0	d-0,9	d+1,6	4,0
8	12	3,0	1,0	d-10,2	d+1,8	4,5
9	14	3,0	1,0	d-11,2	d+1,8	5,0
10	16	3,0	1,0	d-12,5	d+1,8	5,5
12	18	3,0	1,0	d-14,5	d+2,1	6,5
14	20	5,0	2,0	d-16,5	d+2,5	8,0
16	25	5,0	2,0	d-19,5	d+2,8	9,0
18	25	5,0	2,0	d-22,5	d+3,0	10,0
20	25	5,0	2,0	d-24,0	d+3,0	11,0
22	30	5,0	2,0	d-26,0	d+3,0	12,0
24	30	5,0	2,0	d-28,0	d+3,5	13,0
28	40	5,0	2,0	d-32,0	d+3,5	16,0
32	40	5,0	2,0	d-36,5	d+3,5	17,0
36	50	5,0	2,0	d-45,5	d+4,0	20,0
40	50	5,0	2,0	d-44,5	d+4,0	21,0
44	60	5,0	2,0	d-48,5	d+4,0	25,0

Table A.25. **Basic dimensions of taper pipe thread**
(from GOST 6211-81)

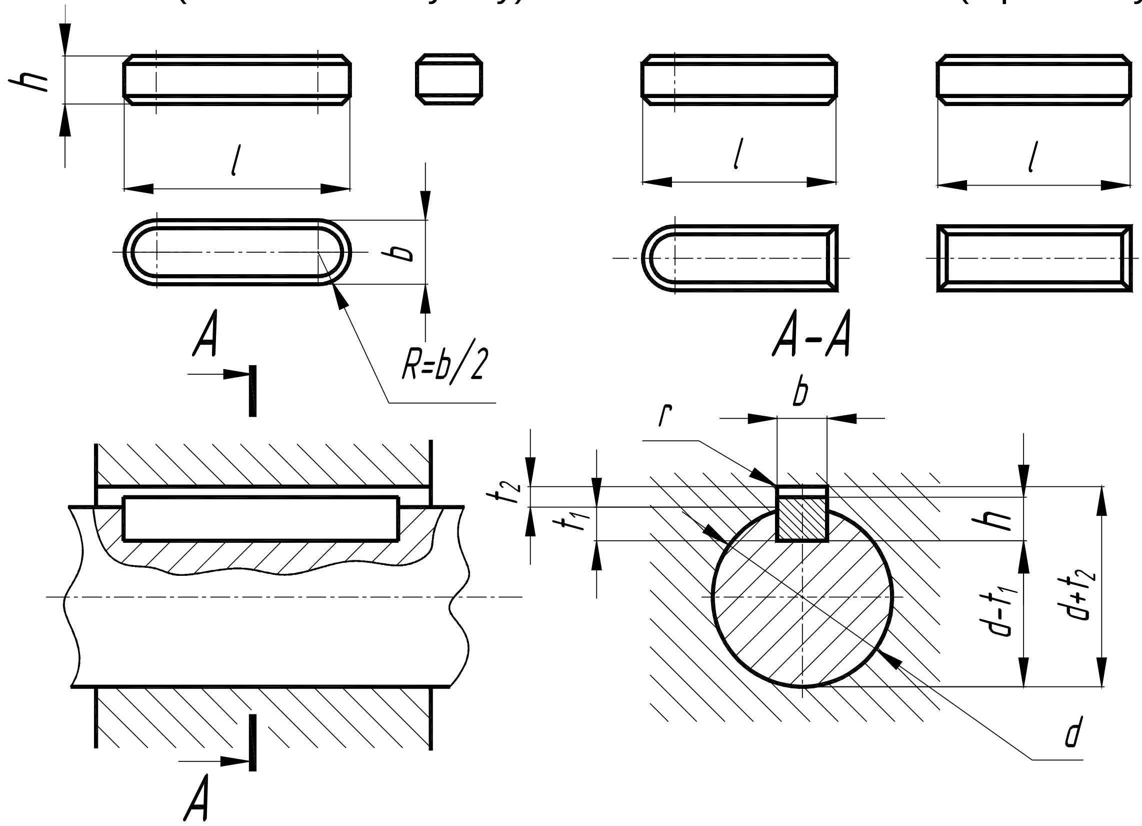
Designation of a thread *d,* inch	**Pitch *P*, mm**	**outer diameter *d*, mm**
1/4	1,337	13,157
3/8		16,662
1/2	1,814	20,955
3/4		26,441
1	2,309	33,249
1 ¼		41,910
1 ½		47,803
2		59,614
2 ½		75,184
3		87,884
3 ½		100,330
4		113,030

Table A.26. **Basic dimensions Acme single-start and multi-start thread**
(from GOST 9484-73)

Thread diameter d, мм		**Pitch *P*, mm**	**Number of starts, n**		
Row 1	**Row 2**		**2**	**3**	**4**
			Lead		
10	–	1,5	3	4,5	6
		2	4	6	8
12	–	2	4	6	8
		3	6	9	12
16	–	2	4	6	8
		4	8	12	16
20	–	2	4	6	8
		4	8	12	16
24	–	(2)	4	6	8
		3	6	9	12
		5	10	15	20
		8	16	24	32
–	**28**	(2)	4	6	8
		3	6	9	12
		5	10	15	20
		8	16	24	32
32	–	3	6	9	12
		6	12	18	24
		10	20	30	40
–	**36**	3	6	9	12
		6	12	18	24
		10	20	30	40
40	–	3	6	9	12
		(6)	12	18	24

Table A.27. **Standard keys and keyways** (by GOST 23360-78), mm

Series 1 (Pratt & Whitney key) Series 2 Series 3 (square key)



Shaft Diameter	Nominal Key Size		Dimensions		Keyway fillet radius r		Key length
			Keyseat	Keyway			
d	**b**	**h**	**t_1**	**t_2**	**min**	**max**	**L**
From 8 to 10 **From 10 to 12**	3 4	3 4	1,8 2,5	1,4 1,8	0,08	0,16	6-28 8-32
From 12 to 17 **From 17 to 22** **From 22 to 30**	5 6 7;8	5 6 7	3 3,5 4	2,3 2,8 3,3	0,16	0,25	10-45 14-56 18-70
From 30 to 38 **From 38 to 44** **From 44 to 50** **From 50 to 58** **From 58 to 65**	10 12 14 16 18	8 8 9 10 11	5 5 5,5 6 7	3,3 3,3 3,8 4,3 4,4	0,25	0,4	22-90 28-110 36-140 45-180 50-200

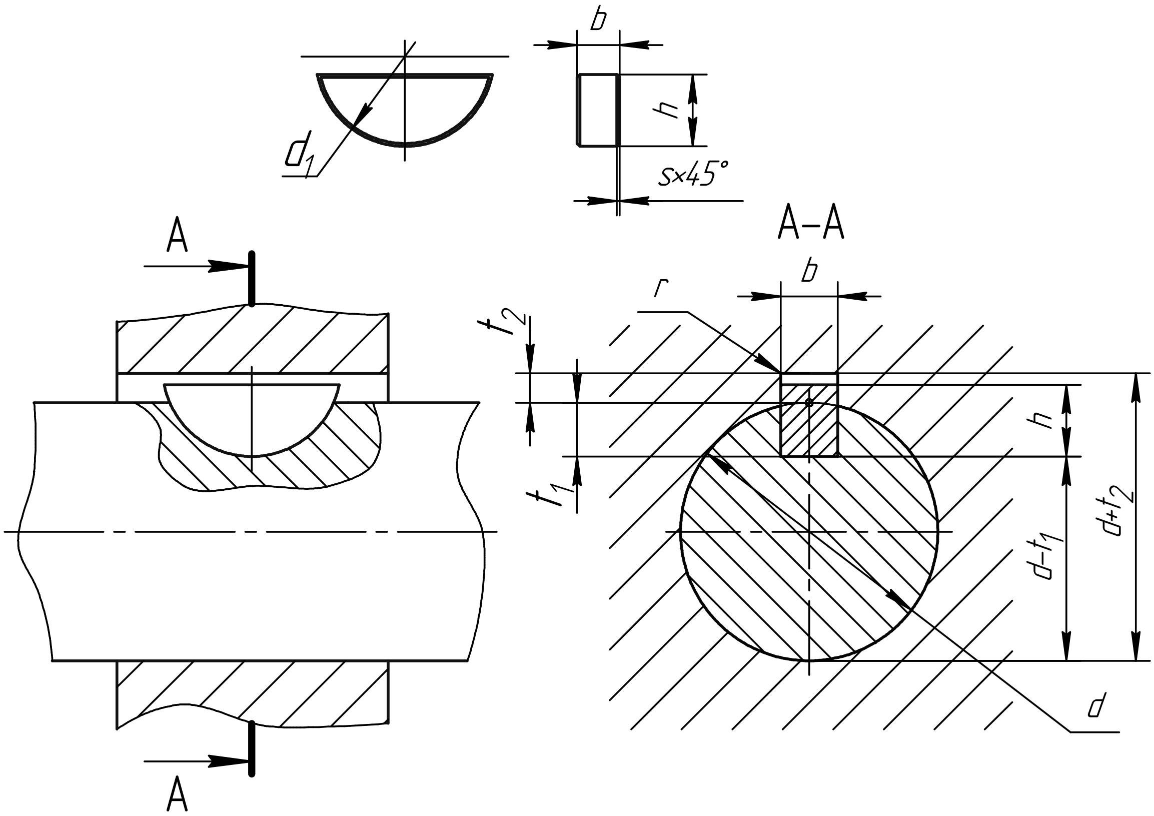
Row of normal key length: 6, 8, 10, 12, 14, 16, 18, 20, 22, 25, 28, 32, 40, 45, 50, 56, 63, 70, 80, 90, 100, 110, 125.

Example of designation – ***Key 2-18x11x60 GOST 23360-78***;

where ***2*** - series (series ***1*** won't indicate),

18x11 – nominal key size (***18*** - width, ***11*** - height), ***60*** - length.

Table A.28. **Woodruff keys, keyseats and keyways**
(by GOST 24071-97)

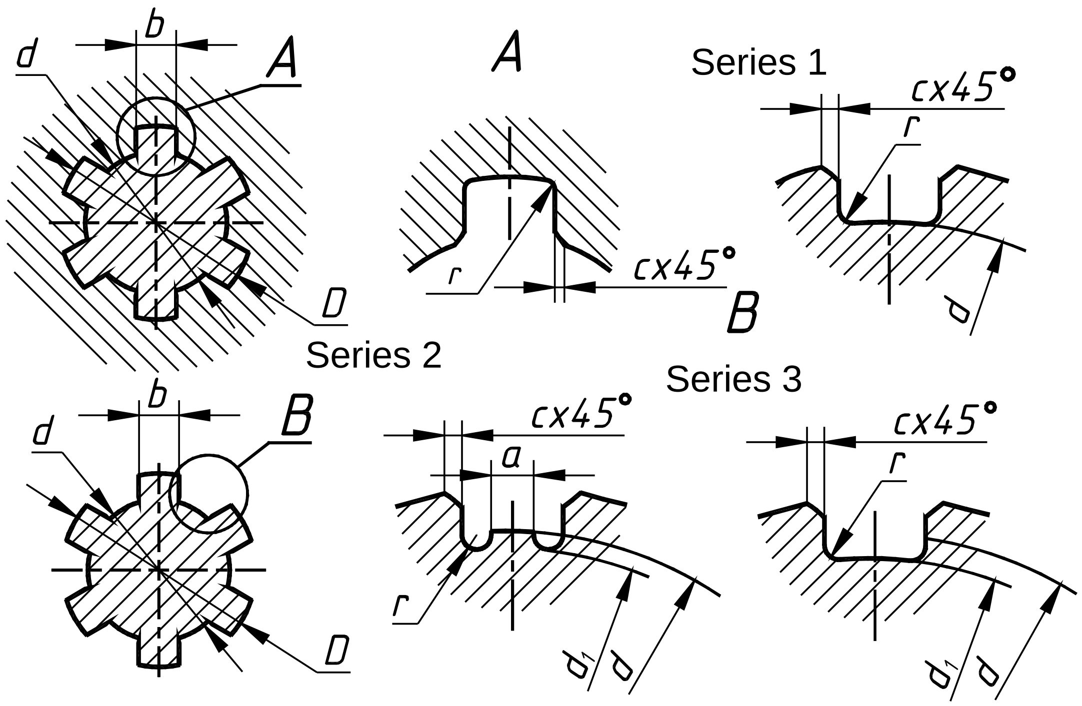


Shaft diameter D		Nominal Key Size			Keyseat t_1	Keyway t_2	Fillet radius r	
Rotational moment transmission	**Element fixation**	**b**	**h**	**d**			**min**	**max**
from 8 to 10	from 12 to 15	3	5	13	3,8	1,4	0,08	0,16
from 10 to 12	from 15 to 18		6,5	16	5,3			
from 12 to 14	from 18 to 20	4			5	1,8	0,16	0,25
from 14 to 16	from 20 to 22		7,5	19	6			
from 16 to 18	from 22 to 25	5	6.5	16	4.5	2,3		
from 20 to 22	from 28 to 32		9	22	7			
from 22 to 25	from 32 to 36	6			6,5	2,8		
from 25 to 28	from 36 to 40		10	25	7,5			
from 25 to 32	from 40	8	11	28	8	3,3	0,25	0,40
from 32 to 33	from 40	10	13	32	10			

Example of designation:

– ***Key 9x6,5 GOST 24071-80***, where *5* – key width, *6,5* – key height.

Table A.29. **Splined shaft**, mm (by GOST 1139-80)



Nominal size ZxdxD	Z	d	D	b	d min	d-d1 min	c nominal	r min
6x23x26	6	23	26	6	22,1	3,54	0.3	0,2
6x26x30	6	26	26	6	24,6	3,85		
6x29x32	6	28	32	7	26,7	4,03		
8x32x36	8	32	36	6	30,4	2,71	0,4	0,3
8x36x40	8	36	40	7	34,5	3,46	0,4	0,3
8x42x46	8	42	45	8	40,4	5,03	0,4	0,3
8x46x50	8	46	50	9	44,6	5,75	0,4	0,3
8x52x58	6	52	58	10	49,7	4,89	0,5	0,5
8x62x68	8	62	68	12	53,6	6,38	0,5	0,5
16x72x78	10	72	78	12	69,6	5,45	0,5	0,5
10x82x88	10	82	88	12	79,3	8,62	0,5	0,5

Example of designation:

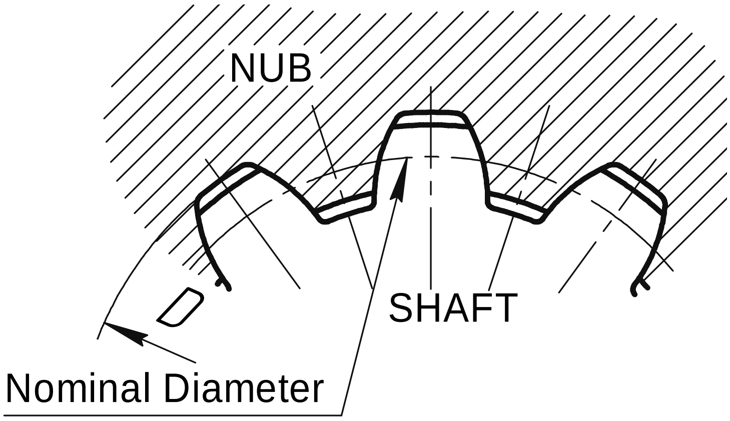
shaft - ***d* - 8x36e8x40a11x7f8 GOST 1139-80**,

hub ***- d - 8x36H7x40H12x7D9 GOST 1139-80,***

combination- ***d - 8x36H7/e8x40H12/a11x7D9/f8 GOST 1139-80,***

where d – centering by inner diameter (D – centering by outer diameter, b – centering by width); 8 – number of teeth; 36 – inner diameter with tolerances for hub H7 and for shaft – e8; 40 – outer diameter with tolerances for hub – H12 and for shaft – a11; 7 – tooth width with fits D9 и f8.

Table A.30. **Involute splined shaft**, mm (by GOST 6033-80)



Nominal Diameter D, mm	Number of teeth Z with module m, mm					Nominal Diameter D, mm	Number of teeth Z with module m		
	0,5	0,8	1,25	2	3		3	5	8
6	10	6	–	–	–	85	27	15	–
8	14	8	–	–	–	90	28	16	–
10	18	11	–	–	–	95	30	16	–
12	22	13	–	–	–	100	32	18	–
15	28	17	–	–	–	110	35	20	–
17	–	20	12	–	–	120	38	22	–
20	–	23	14	–	–	140	45	26	–
25	–	30	18	–	–	160	52	30	18
30	–	36	22	–	–	180	56	34	21
35	–	–	26	16	–	200	–	38	24
40	–	–	30	18	–	220	–	42	26
45	–	–	34	21	–	240	–	46	28
50	–	–	38	24	–	260	–	50	31
55	–	–	–	26	17	300	–	58	36
60	–	–	–	28	18	340	–	–	41
65	–	–	–	31	20	380	–	–	46
70	–	–	–	34	22	400	–	–	48
75	–	–	–	36	24	440	–	–	54

Example of designation:

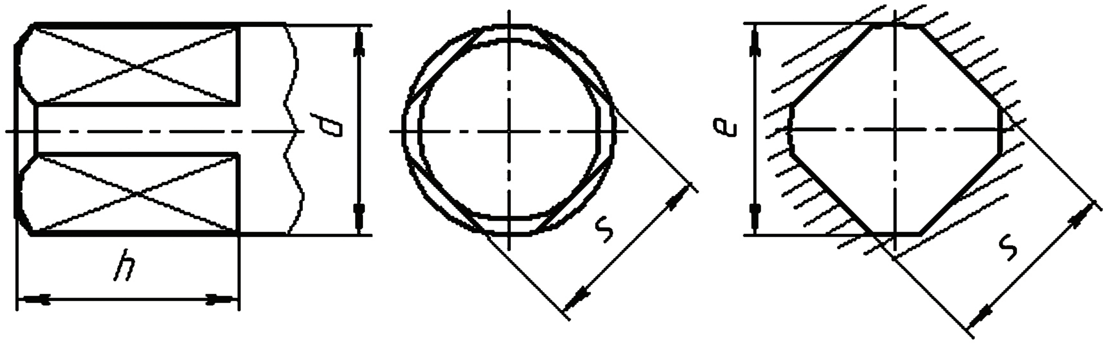
for shaft – ***50x2 -9g GOST 6033-80,***

for hub – ***50x2x9H GOST 6033-80,***

for combination – ***50x2x9H/9g GOST 6033-80,***

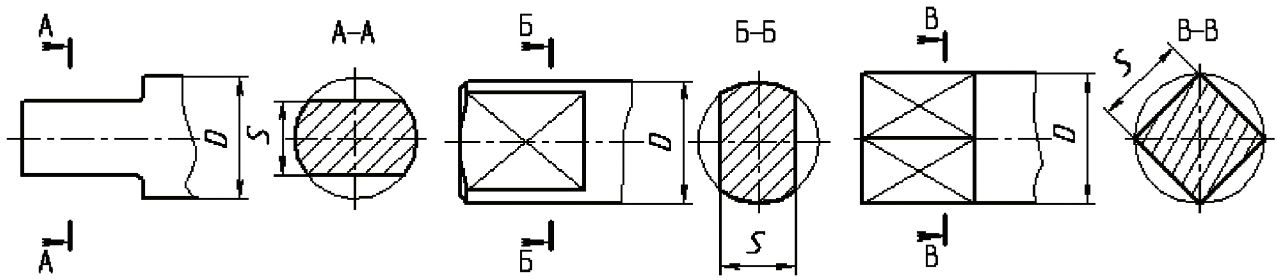
where ***50*** – nominal diameter, ***2*** – module, ***9H*** и ***9g*** – tolerances.

Table A.31. **Shaft and hub wrenches**, mm (by GOST 9523-84)



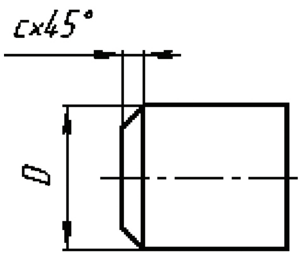
d	*s*	*h*	e_{min}	*d*	*s*	*h*	e_{min}
7,1	5,6	8	7,65	28,0	24,0	26	30,21
8,0	6,3	9	8,65	31,5	25,0	28	33,75
9,0	7,1	10	9,65	35,5	28,0	31	37,75
10,0	8,0	11	10,78	40,0	31,5	34	42,75
11,2	9,0	12	11,98	45,0	35,5	38	47,75
12,5	10,0	13	13,38	50,0	40,0	42	53,3
14,0	11,2	14	15,18	56,0	45,0	46	60,3
16,0	12,5	16	17,18	63,0	50,0	51	67,3
18,0	14,0	18	19,21	71,0	56,0	56	75,3
20,0	16,0	20	21,41	80,0	63,0	62	85,35
22,4	18,0	22	23,81	90,0	71,0	68	95,35
25	20,0	24	26,71	100,0	80,0	75	106,35

Table A.32. **Nominal wrench sizes**
(by GOST 6424-73)



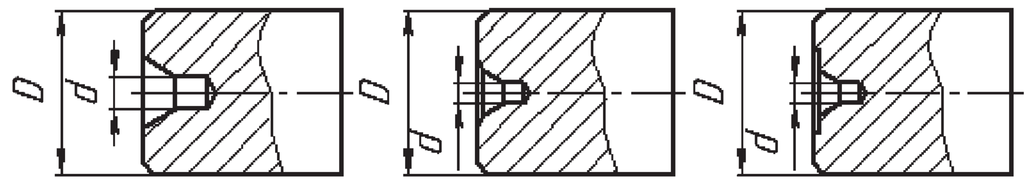
S, мм	7	8	10	12	14	17	19	22	24	27	30	32	36	41	46

Table A.33. **Chamfers for smooth shafts**



Shaft diameter *D*, mm	16 … 20	20…30	30…50	50…100	> 100
Chamfer, *c*, mm	1	1,5	2	3	4

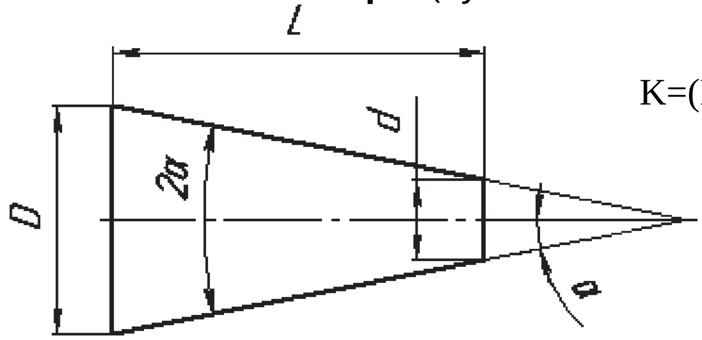
Table A.34. **Recommended diameters for center holes**
(by GOST 14034-74)



Type A Type B Type C

Shaft diameter D_{min}, mm	4	6	10	14	20	30	40	60	80	100
Hole diameter *d*, мм	1	1,6	2	2,5	3,15	4	5	6,3	8	10

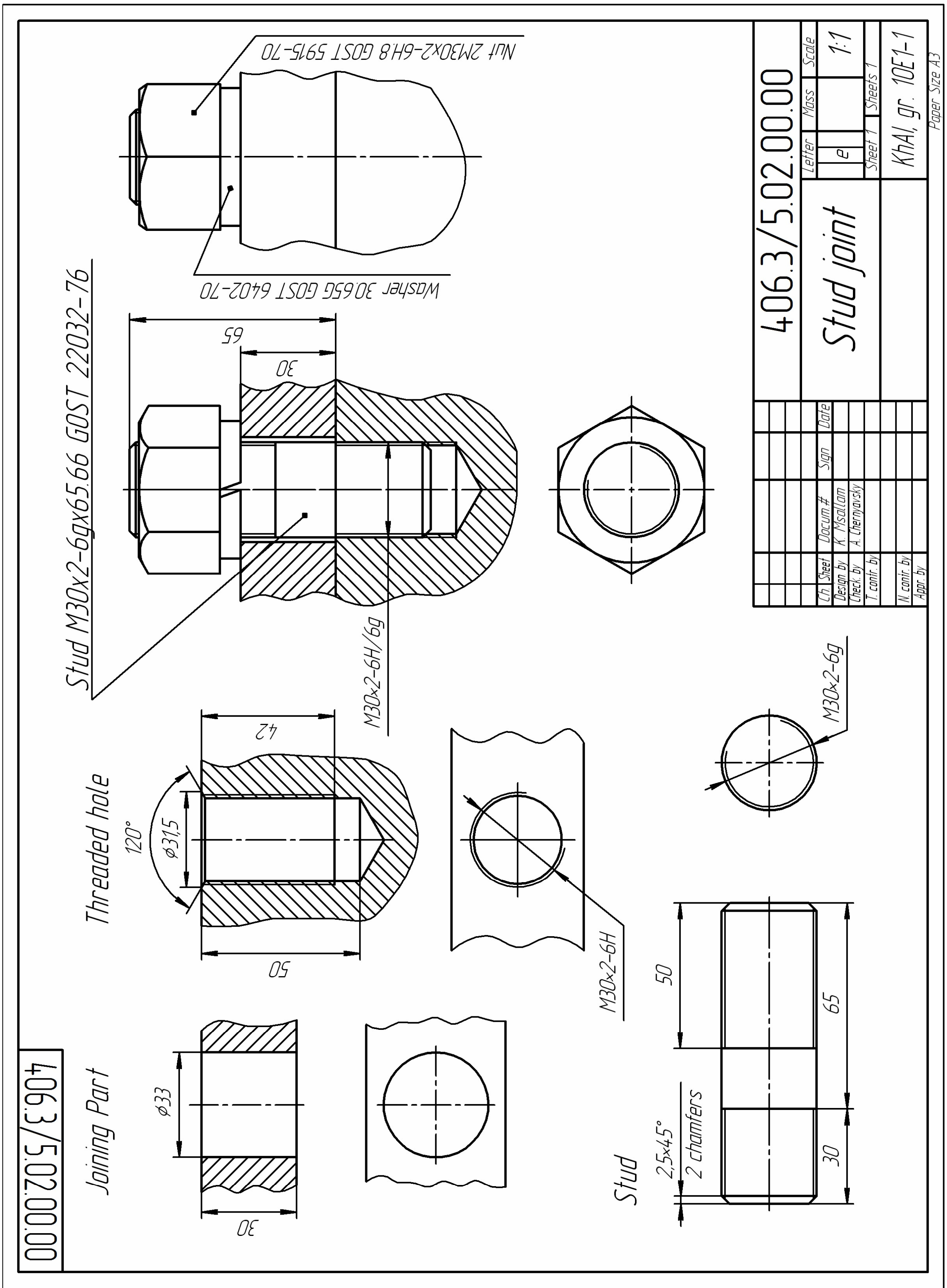
Table A.35. **Standard taper** (by GOST 8593-81)

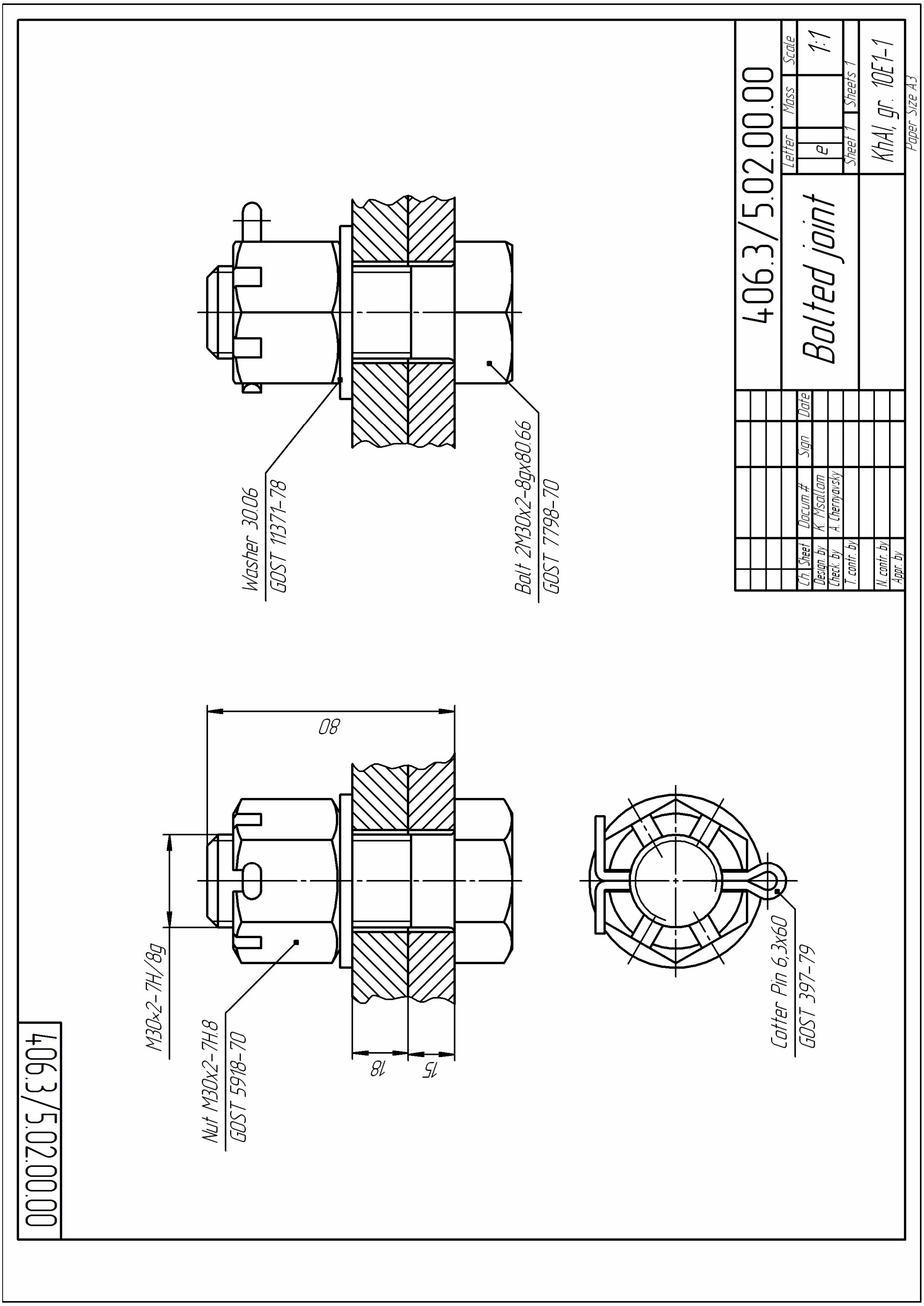


$$K=(D-d)/L=2tg\alpha$$

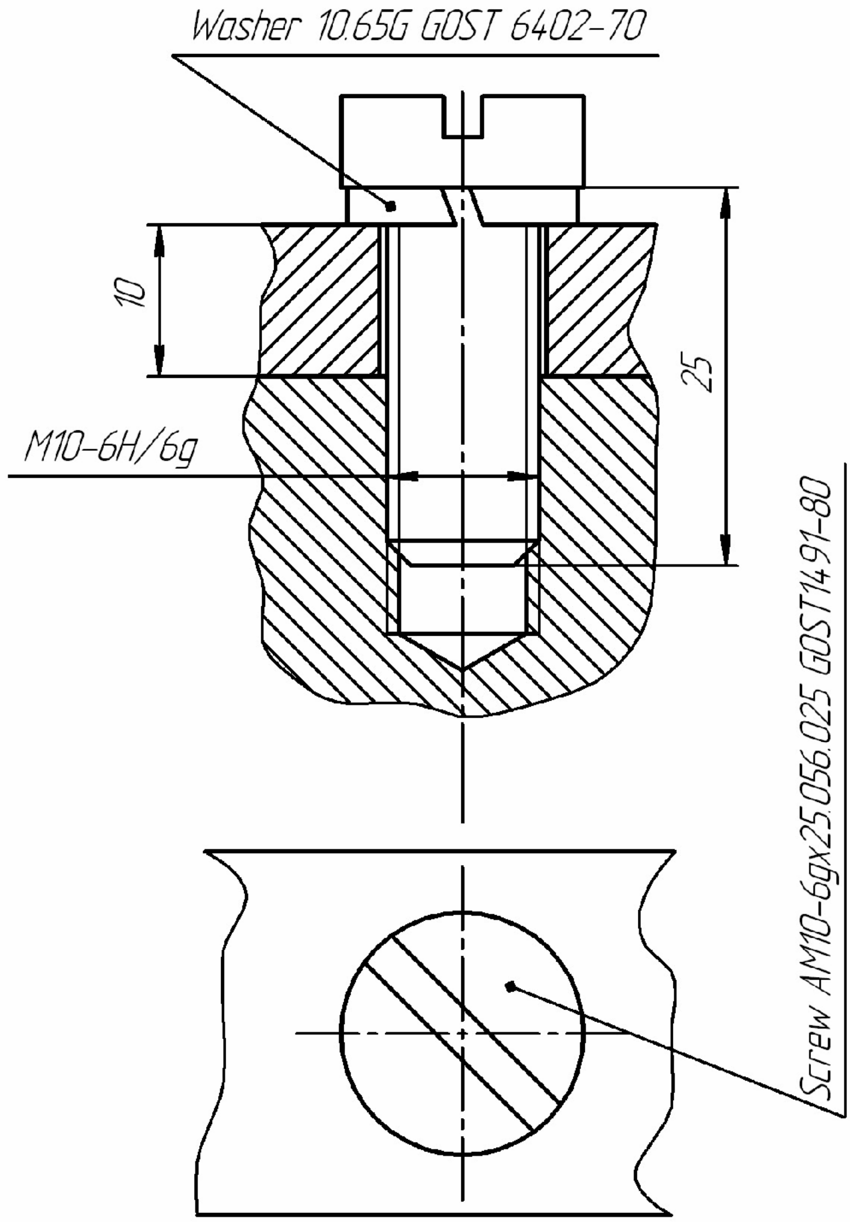
Taper ratio	**Cone angle 2α**	**Taper ratio**	**Cone angle 2α**
1:200	17’ 11”	1:6	9º 31’ 38”
1:100	34’ 22”	1:5	11º 25’ 16”
1:50	1º 8’ 45”	1:4	14º 15’ 10”
1:30	1º 54’ 35”	1:3	18º 55’ 29”
1:20	2º 51’ 51”	1:1,866025	30º
1:15	3º 49’ 6”	1:1,207107	45º
1:12	4º 46’ 19”	1:0,866025	60º
1:10	5º 43’ 29”	1:0,651613	75º
1:8	7º 9’ 10”	1:0,500000	90º
1:7	8º 10’ 16”	1:0,288675	120º

APPENDIX B
SAMPLES OF THE DRAWINGS




Washer 30.06
GOST 11371-78
Bolt 2M30x2-8gx80.66
GOST 7798-70
80
M30×2-7H/8g
Nut M30x2-7H.8
GOST 5918-70
18
15
Cotter Pin 6,3x60
GOST 397-79
406.3/5.02.00.00
406.3/5.02.00.00
Bolted joint
Letter
Mass
Scale
e
1:1
Sheet 1
Sheets 1
KhAI, gr. 10E1-1
Paper Size A3
Ch. Sheet
Docum.#
Sign
Date
Design. by
K. Msallam
Check. by
A. Chernyavsky
T. contr. by
N. contr. by
Appr. by

406.3/5.02.00.00



406.3/5.02.00.00

Screwed joint

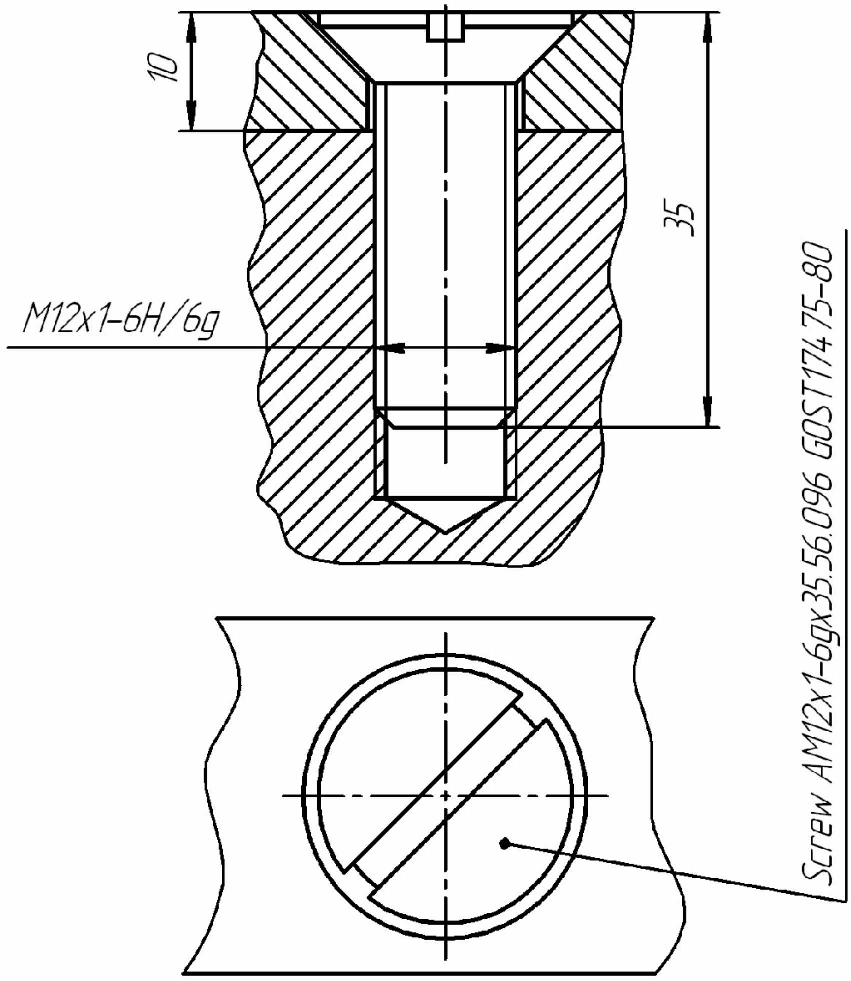
Ch.	Sheet	Docum.#	Sign	Date
Design. by		K. Msallam		
Check. by		A. Chernyavsky		
T. contr. by				
N. contr. by				
Appr. by				

Letter	Mass	Scale
e		2,5:1
Sheet 1	Sheets 1	

KhAI, gr. 10E1-1

Paper Size A4

406.3/5.02.00.00



Ch.	Sheet	Docum.#	Sign	Date	406.3/5.02.00.00			
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Check. by		A. Chernyavsky				Sheet 1	Sheets 1	
T. contr. by								
N. contr. by						KhAI, gr. 10E1-1		
Appr. by								

Paper Size A4

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CONTENT

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Замовлення 46. Ціна вільна

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Свідоцтво про внесення суб'єкта видавничої справи до державного реєстру видавців, виготовлювачів і розповсюджувачів видавничої продукції, серія ДК № 391, видане Державним комітетом інформаційної політики, телебачення та радіомовлення України від 30.03.2001 р.