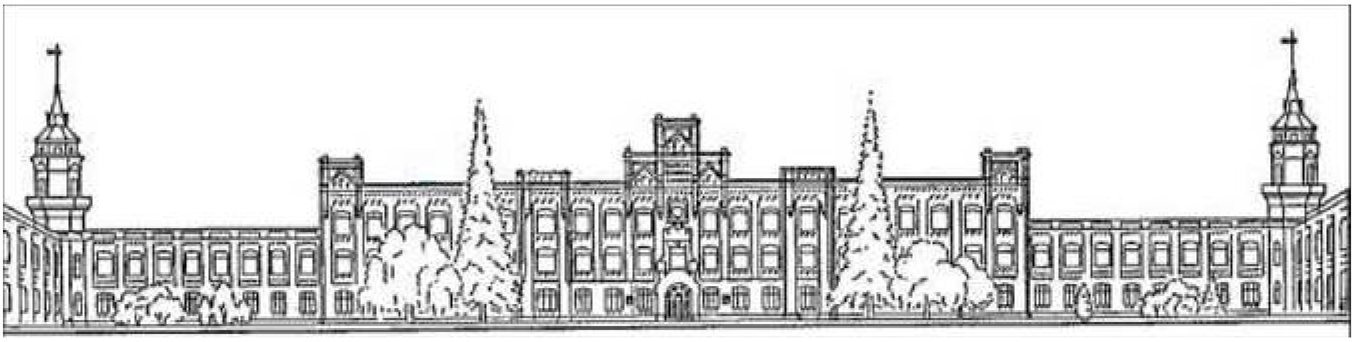

МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ
НАЦІОНАЛЬНИЙ ТЕХНІЧНИЙ УНІВЕРСИТЕТ УКРАЇНИ
«КИЇВСЬКИЙ ПОЛІТЕХНІЧНИЙ ІНСТИТУТ
імені ІГОРЯ СІКОРСЬКОГО»

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ІНЖЕНЕРНА ГРАФІКА

РОБОЧІ КРЕСЛЕНИКИ ДЕТАЛЕЙ
WORKPIECES ENGINEERING DRAWINGS

для самостійної роботи іноземних студентів
англійською мовою

Рекомендовано Методичною радою КПІ ім. Ігоря Сікорського
як навчальний посібник для здобувачів ступеня бакалавра
за освітньою програмою «Біомедична інженерія»
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за освітньою програмою «Електроніка»,
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за освітньою програмою «Інженерія авіаційних та
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ракетно-космічних систем»

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для самостійної роботи іноземних студентів англійською мовою

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За редакцією укладачів.

INTRODUCTION

The economic development of society requires the acceleration of scientific and technical production, the growth of labor productivity. This makes it necessary to raise the level of training of specialists in technical specialties.
This tutorial is designed to explore the topic of "Working Drawings and Sketches of Workpieces" in the discipline "Engineering Graphics". The manual includes reference material, recommendations for the execution of sketches of typical workpieces , a list of questions for self-examination and preparation for control works, samples of works. The manual provides a large amount of illustrative material that allows you to describe in more detail and competently the shape of the workpiece.
The manual corresponds to the program in engineering graphics and can be used for independent work by students of all specialties.
A workpiece (part) is a product made of homogeneous material without useing assembly operations (GOST 2.101-68 (1995)).
The working drawing of the individual workpiece is the basic design document which contains both the image and the information necessary for its production and control (GOST 2.102-2013 and DSTU3321: 2003), using standard drawing scale whith drawing tools.
A sketch of a workpiece is a drawing without useing of drawing tools on an arbitrary scale.
The functional purpose of the workpiece and the requirements of the technology of its manufacturing cause the presence of various structural and technological elements.
Working on the section "Working drawings of workpieces" involves the study and application by students of some general information on the design and manufacture of workpieces.

1. THREAD AND ELEMENTS OF THREADED WORKPIECES

Thread is an element of a part formed by helical movement of a profile on a cylindrical (Fig. 1.1) or conical surface. The thread is one of the structural elements of the workpiece.

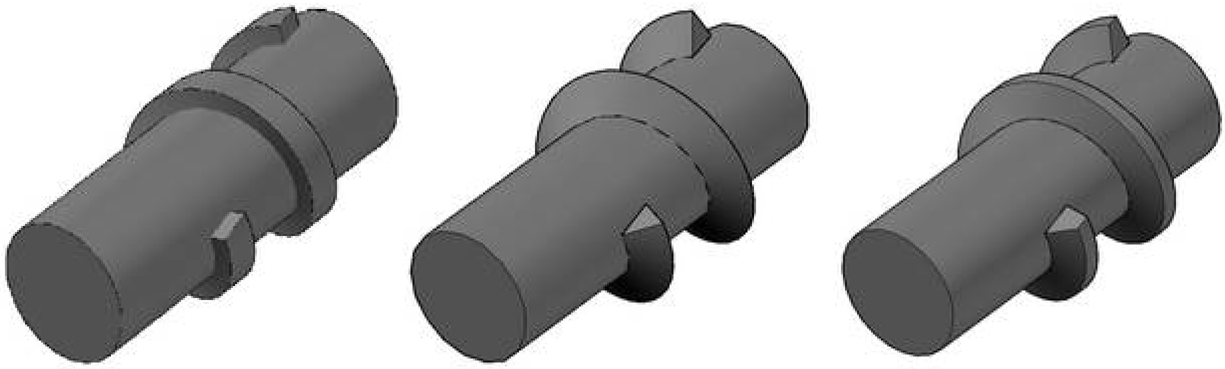


Fig. 1.1

1.1. Classification of threads

Thread

- By shape profile
  - Triangular
  - Trapezoidal
  - Square
  - Rectangular
  - Round
- By the nature of the surface
  - Cylindrical
  - Taper
- By shape location
  - External
  - Internal
- By appointment
  - Fastening
  - Running
  - Special
- By measures number
  - Singlestart
  - Multistart
- By the helix direction
  - Right-hand
  - Left-hand

Depending on the nature of the surfaces , the threds are divided into cylindrical and taper.

Cylindrical (parallel) thread is made on the surface of the cylinder.

A taper one is made on the surface of a cone.

Depending on the location of the threaded surfaces, the threads are divided into external and internal.

The external (outer) thread is located on the outer surface of the workpiece (Fig. 1.2). It is performed on the covered part (on the screw, bolt, stud,

..., on the shaft).

Internal (inner) thread is formed on the inner surface of the workpiece (Fig. 1.3). It is performed in the enclosing part (in the nut, in holes).

According to the start number , the threads are divided into singlestart (Fig. 1. 4) and multistart: double-, three-, ... and so on. (Fig. 1.5).

Singlestart thread begins in the end section with one helix (Fig. 1.4).

A multistart one begins in the end section with more than one helix (Fig. 1.5).

Right-hand thread is formed by a clockwise rotating profile and moves along an axis in the direction away from the observer (see Fig. 1.4 and 1.5).

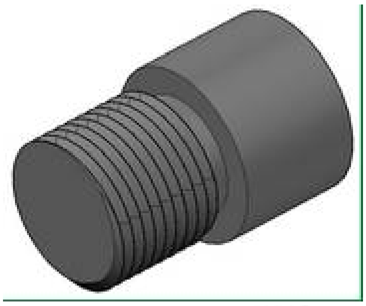


Fig. 1.2

Fig. 1.3

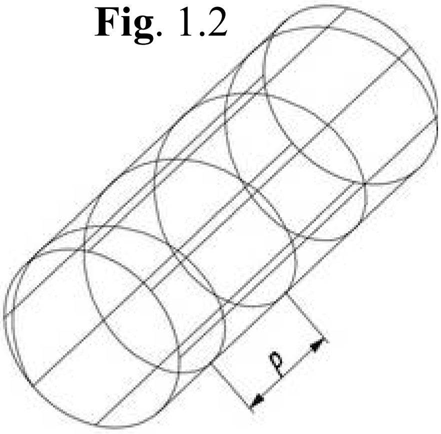


Fig. 1.4

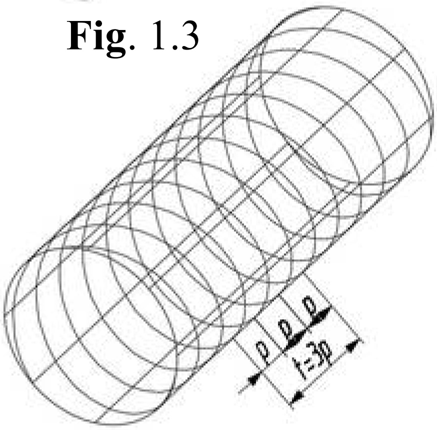


Fig. 1.5

t = P (**Course** = t, **Pitch** = P)

t = n x P (**Course** = t, **Start number** = n, **Pitch** = P)

Left-hand thread is formed by a profile that rotates counterclockwise.

By appointment the threads are divided into fastening (screw) and running (kinematic).

Screw thread - a thread that is cutting on products designed for fixed connection of workpieces together (metric and pipe).

Running or kinematic thread - is cutting on products designed to transmit motion, such as jacks (trapezoidal, stubborn, rectangular).

1.2 The main parameters of the thread

The thread axis is the axis relative to which the helical thread surface is formed (Fig. 1.6).

The thread profile is the crests and thred vees profile in the axial section (Fig. 1.6).

The angle of the thred profile α ° is the angle between the adjacent lateral surfaces in the axial section (Fig. 1.7).

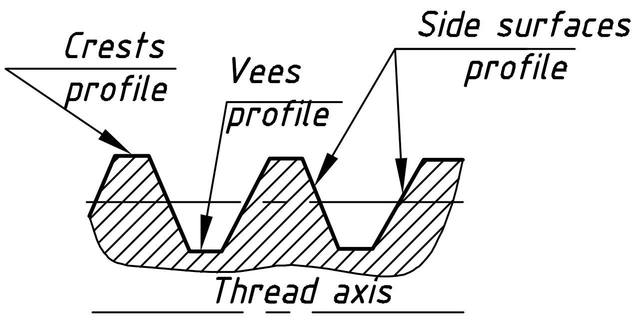


Fig. 1.6

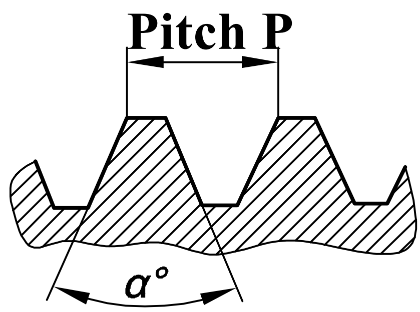


Fig. 1.7

The outer diameter of the cylindrical thred is d or D (Fig. 1.8) - diameters of the described cylinder around the crests of the outer thred or around the vees of the inner one.

The inner diameter of the cylindrical thred is d1 or D1 (Fig. 1.8) - diameter of the inscribed cylinder around the vees of the outer thread or the crests of the inner one.

Thread pitch P is the distance between nearest flanks of the same name (Fig. 1.4, 1.5, 1.7).

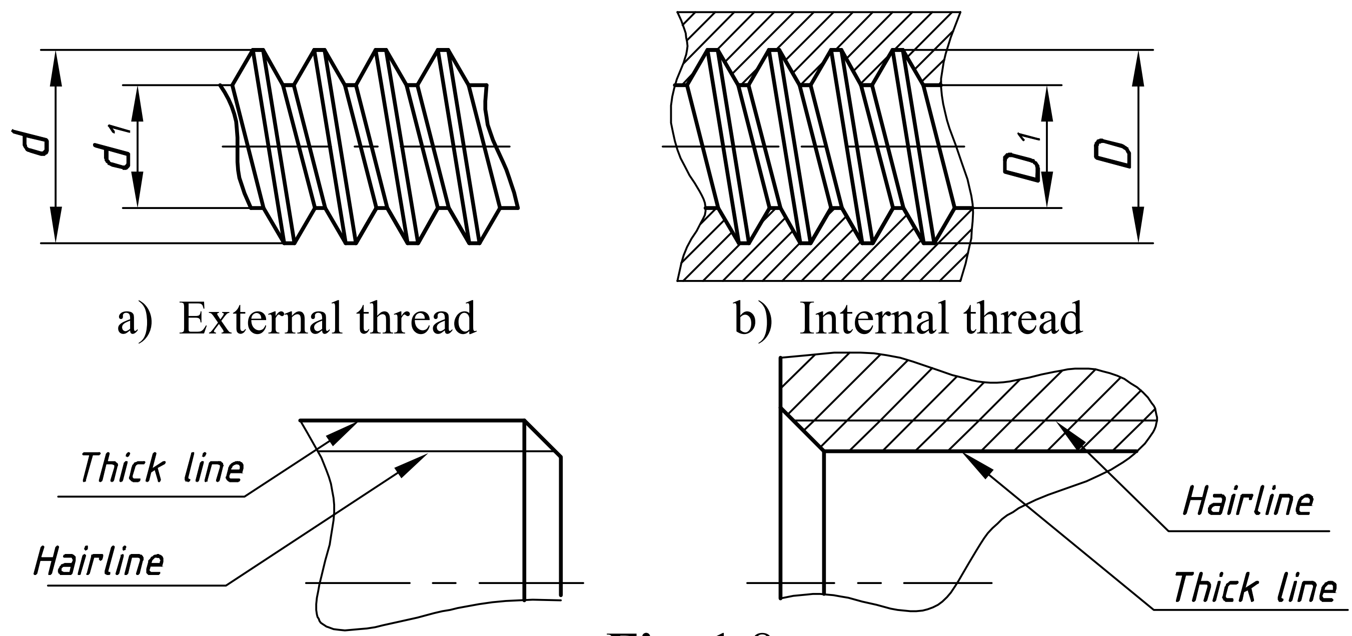
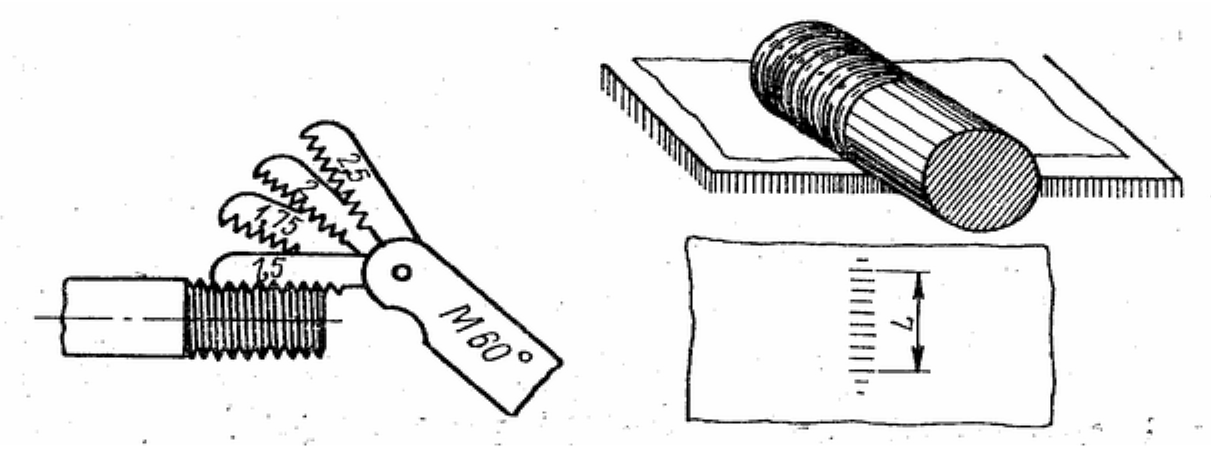


Fig. 1.8

1.3 Determining the thread pitch

A pedometer is used to determine the thread pitch (Fig. 1.9). To do this, select the plates with teeth, which can be inserted into the thread vees. Then read the pitch indicated on the plate (or the number of turns per inch for the pipe cut). The outer diameter of thred d is measured in usual way using calipers(for example,optical thred calipers). In the absence of a pedometer, the thred pitch is determined using the imprint on the paper for the pipe thread by the number of turns per inch, while the threaded rod is pressed against the paper (at least ten times), (Fig. 1.9).



a) using a pedometer b) by imprint

Fig. 1.9

We can find P by measuring distance L between the extreme clear lines (Fig. 1.9 b) and count the number of pitches n along it (remembere: the number n is less than the number of dashes per unit) for metric,trapezoidal,stubborn scrue-thread. Therefore, the pitch P is determined :

$$P = L / n.$$

Thread course t - it is the length of nut relative movent for one full turn (fig. 1.4 and 1.5):

for a single thred $t = P$,

for multistart one $t = n P$, where n - is the start number.

In this way, the number of measures

$$n = t / P$$

The screw-thread length l and the full screw-thred profile length l1 are shown on Fig. 1.10.

Length of thread runout l2- is the length of incomplete profile thread site. On this site the cutter gradually comes out of the metal (Fig. 1.10).

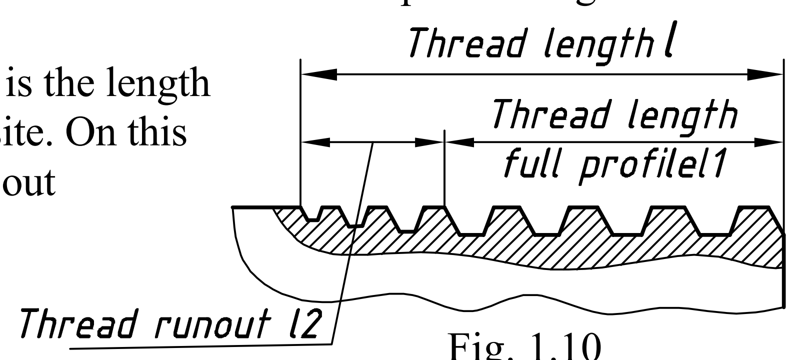


Fig. 1.10

1.4 Metric cylindrical thread

The diameter and pitch of the metric thread are set by GOST 8724-2002 (ISO 261: 1998).
For each diameter cut up to 68 mm there is one coarse pitch and a few fine ones (Table 1.1).
For diameters 70 ... 600 mm only fine pitchs are installed. Thred profile is set in accordance with GOST 9150-2002.
It is equilateral triangle with angle $\alpha = 60°$ (Fig. 1.11).

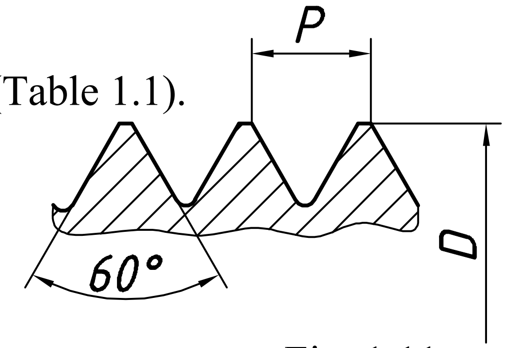


Fig. 1.11

Table 1. 1 Label of diameters and pitches of metric thread

D			Pitch ***P***		***D***			Pitch ***P***	
1st line	2nd line	3d line	coarse	fine	1st line	2nd line	3d line	coarse	fine
2	-	-	0,4	-	-	-	25	-	2; 1,5; (1)
-	2,2	-	0,45	-	-	-	26	-	1,5
2,5	-	-	0,45	0,35	-	27	-	3	2; 1,5; 1; 0,75
3	-	-	0,5	0,35	-	-	28	-	2; 1,5; 1
-	3,5	-	(0,6)	0,35	30	-	-	3,5	(3); 2; 1,5; 1; 0,75
4	-	-	0,7	0,5	-	-	32	-	2; 1,5
-	4,5	-	0,75	0,5	-	33	-	3,5	(3); 2; 1,5; 1; 0,75
5	-	-	0,8	0,5	-	-	35	-	1,5
-	-	5,5	-	0,5	36	-	-	4	3; 2; 1,5; 1
6	-	-	1	0,75; 0,5	-	-	38	-	1,5
-	-	7	1	0,75; 0,5	-	39	-	4	3; 2; 1,5; 1
8	-	-	1,25	1; 0,75; 0,5	-	-	40	-	(3); (2); 1,5
-	-	9	(1,25)	1; 0,75; 0,5	42	-	-	4,5	(4); 3; 2; 1,5; 1
10	-	-	1,5	1,25; 1; 0,75; 0,5	-	45	-	4,5	(4); 3; 2; 1,5; 1
-	-	11	(1,5)	1; 0,75; 0,5	48	-	-	5	(4); 3; 2; 1,5; 1
12	-	-	1,75	1,5; 1,25; 1; 0,75; 0,5	-	-	50	-	(3); (2); 1,5
-	14	-	2	1,5; 1,25; 1; 0,75; 0,5	-	52	-	5	(4); 3; 2; 1,5; 1
-	-	15	-	1,5; (1)	-	-	55	-	(4); (3); 2; 1,5
16	-	-	2	1,5; 1; 0,75; 0,5	56	-	-	5,5	4; 3; 2; 1,5; 1
-	-	17	-	1,5; (1)	-	-	58	-	(4); (3); 2; 1,5
-	18	-	2,5	2; 1,5; 1; 0,75; 0,5	-	60	-	(5,5)	4; 3; 2; 1,5; 1
20	-	-	2,5	2; 1,5; 1; 0,75; 0,5	-	-	62	-	(4); (3); 2; 1,5
-	22	-	2,5	2; 1,5; 1; 0,75; 0,5	64	-	-	6	4; 3; 2; 1,5; 1
24	-	-	3	2; 1,5; 1; 0,75	-	-	65E	-	(4); (3); 2; 1,5

Notes:
1. The standard provides for thread diameters d = 1E600 mm;
thread pitch d = 0.2E6 mm.
2. The diameters of the 1st line should be preferred.
3. The pitch of the threads, taken in brackets, if possible, not to use.

1.4.1 Designation of metric cylindrical threads. The symbol is given in table. 1.2, the mark on the drawings is shown on Fig. 1.12.

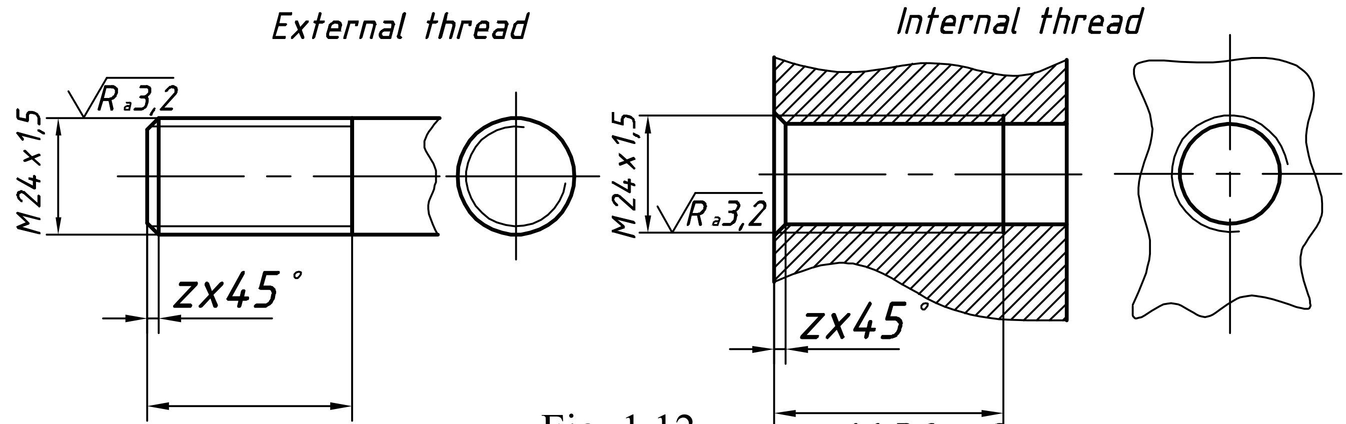


Fig. 1.12

An example of sizing on the drawing of a blind threaded hole is shown on Fig.1.13

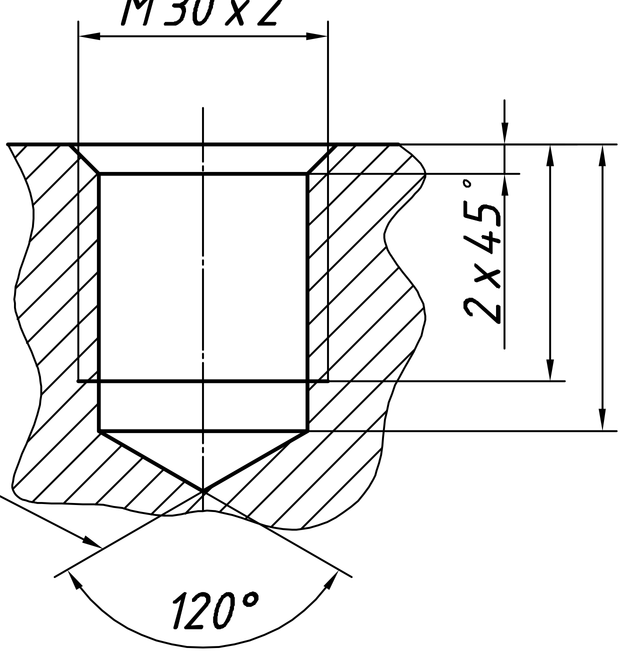


Fig. 1.13

Table 1.2 Metric thread label

Metric thread		*Rigth-hand*		*Left-hand*	
		coarse thread	*fine thread*	*coarse thread*	*fine thread*
Singlestart	***GOST 8724:2002 ISO 261:1998***	***M24***	***M24xP1,5***	***M24-LH***	***M24xP1,5-LH***
	GOST 8724-81	***M24***	***M24x1,5***	***M24LH***	***M24x1,5LH***
Multistart	***GOST 8724:2002 ISO 261:1998***	***M24xt6P3***	***M24xt6P3***	***M24xt6P3-LH***	***M24xt3P1,5-LH***
	GOST 8724-81	***M24x6(3)***	***M24x3(1,5)***	***M24x6(3)LH***	***M24x3(1,5)LH***

M24 - thread, fastening, metric, 24 - outer (nominal) diameter with a coarse pitch of 3 mm (table 1.2)

M24x1,5 or M24xP1,5 - thred, fastening metric, 24 - outer (nominal) diameter with a fine pitch of 1,5 mm (tab. 1.2)

M24x1,5LH or M24xP1,5- LH -thread, fastening metric, left-hand, 24 - outer (nominal) diameter with a fine pitch of 1,5 mm (Tab. 1.2)

M24x3 (P1.5) LH or **M24xPh3 P1.5- LH** -thread,fastening, metric, doubl-start, left-hand, 24 - outer (nominal) diameter with a fine pitch of 1.5 mm (Tab. 1.2)

1.4.2 Designation of metric taper threads

MK24x1,5LH or **MK24hP1,5-LH** -thread, fastening, metric taper, left-hand, 24 - outer (nominal) diameter with a fine pitch of 1,5 mm (GOST 25229-82)

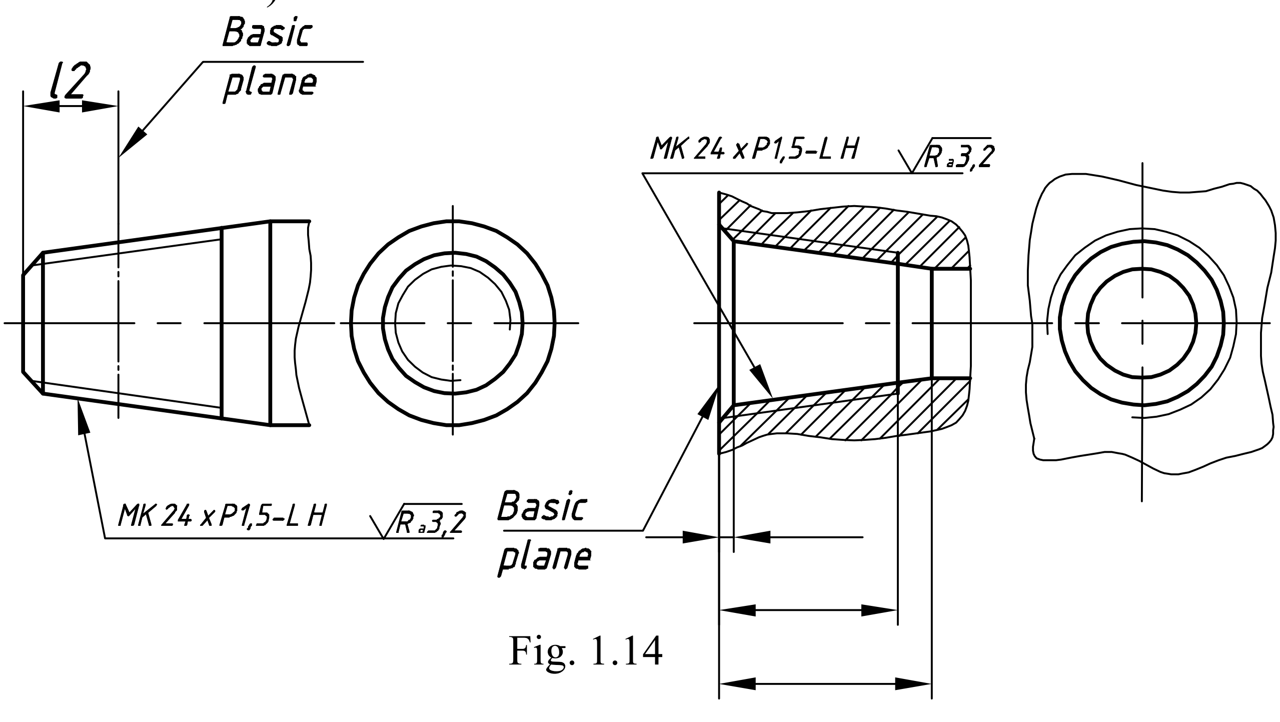


Fig. 1.14

1.4.3 The metric thread run-out is performed for tapping tool outlet .
The dimensions of the thread run-out for the metric thread are set by GOST 10549-80 and are shown in Tables 1.3 and 1.4 (for workpieces manufactured before 1988). An additional image is performed for the thread run-out .This is a remote element on an enlarged scale (Fig. 1.15, 1.16).Exist two types of thead run-outs. On Fig. 1.15 and Fig. 1.16. the image of both of them are shown.
Fig.1.17 shows the image of the thread run-outs by DSTU GOST27148: 2008 (for workpieces, manufactured after 1988).

For workpieces manufactured according to GOST 10549-80.

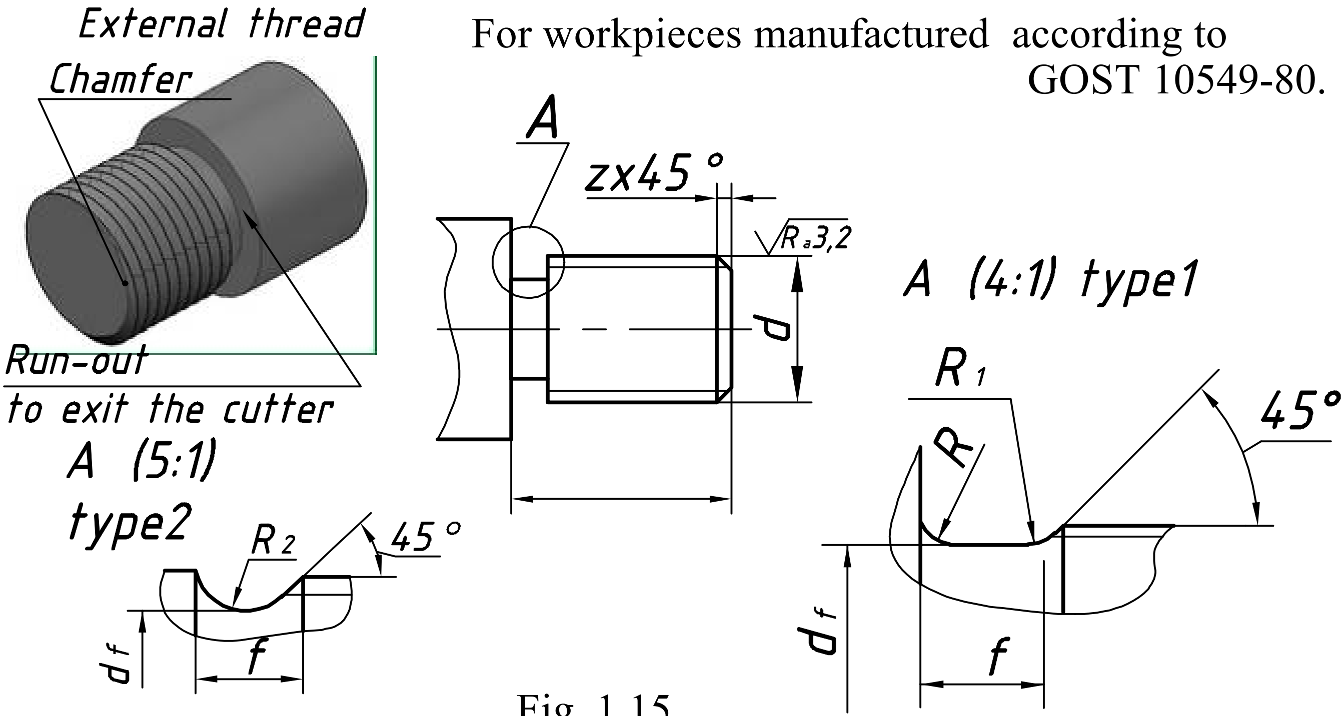


Fig. 1.15

Table 1.3 Run-outs for the external metric thread

Pitch	Type 1						Type 2		Diam of run-out	Chamfer, **z** (Fig.1.15)	
	Normal			Narrow							
P	**f**	**R**	**R_1**	**f**	**R**	**R_1**	**f**	**R_2**	**df**	Type1	Type2
0,4	1	0,3	0,2						d-0,6	0,3	0,3
0,45	1	0,3	0,2						d-0,7	0,3	
0,5	1,6	0,5	0,3	1	0,3	0,2				0,5	
0,6	1,6	0,5	0,3	1	0,3	0,2			d-0,9	0,5	
0,7	2	0,5	3	1,6	0,5	0,3			d-1,0	0,5	
0,75	2	0,5	0,3	1,6	0,5	0,3			d-1,2	1	
0,8	3	1	0,5	1,6	0,5	0,3			d-1,2	1	
1	3	1	0,5	2	1	0,5	3,6	2	d-1,5	1	2
1,25	4	1	0,5	2,5	1	0,5	4,4	2,5	d-1,8	1,6	2,5
1,5	4	1	0,5	2,5	1	0,5	4,6	2,5	d -2,2	1,6	3
1,75	4	1	0,5	2,5	1	0,5	5,4	3	d-2,5	1,6	3,5
2	5	1,6	0,5	3	1	0,5	5,6	3	d-3,0	2	3,5
2,5	6	1,6	1	4	1	0,5	7,3	4	d-3,5	2,5	5
3	6	1,6	1	4	1	0,5	7,6	4	d-4,5	2,5	6,5
3,5	3,5	2	1	5	1,6	0,5	10,2	5,5	d-5,0	2,5	7,5
4	8	2	1	5	2	0,5	10,3	5,5	d-6.0	3.0	8
5,5	12	3	1	8	3	1	15	8	d-8,0	4	10,5
6	12	3	1	8	3	1	16	8	d-9,0	4	10,5

For workpieces manufactured according to GOST 10549-80.

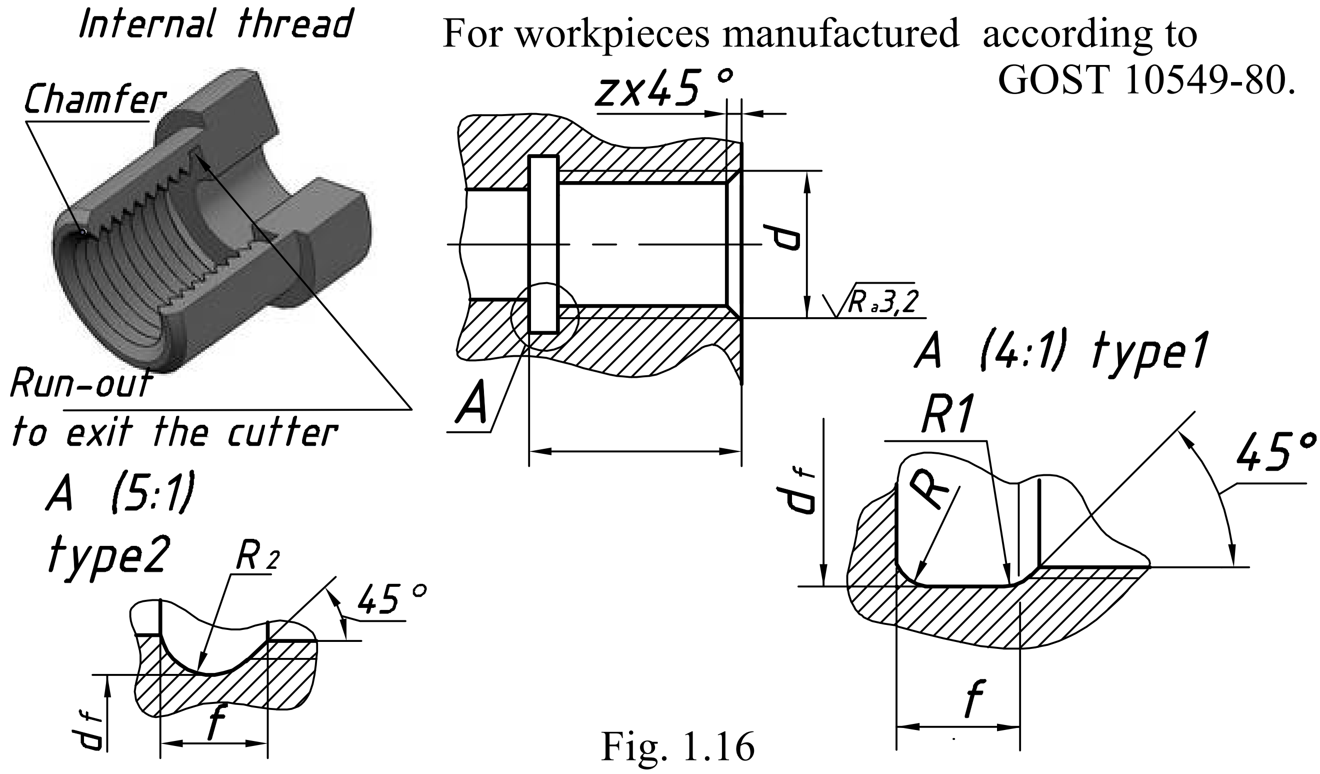


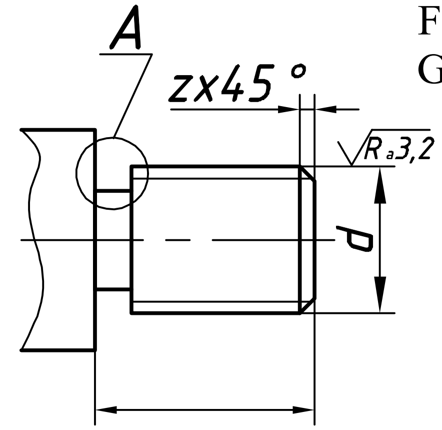
Fig. 1.16

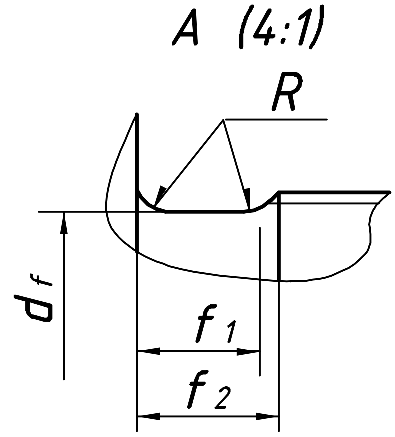
Table 1.4 Run-outs for the internal metric thread

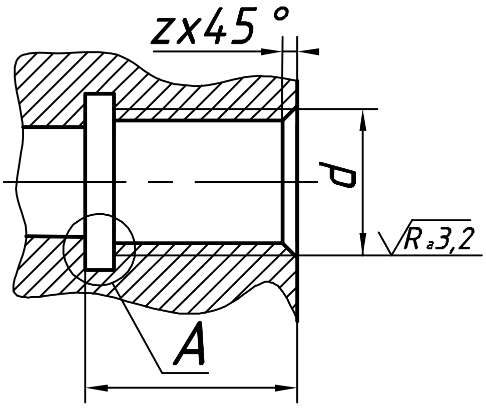
Pitch	Type 1						Type 2		Diam of run-out	Chamfer, **z** (Fig.1.16)	
	Normal			Narrow							
P	**f**	**R**	**R₁**	**f**	**R**	**R₁**	**f**	**R₂**	**df**	Type1	Type2
0,4										0,3	
0,5				—	—	—	—	—		0,3	
0,50	2*	0.5	0,3	1,0*	0.3	0,2.	—	—	d-+0,3	0,5	
0,6	—	—	—	—	—	—	—	—		0.5	
0,7	—	—	—	—	—	—	—	—		0.5	
0,75	3,0*	1,0	0,5	1,6	0.5	0,3	—	—	d+0,4	1,0	
0,8										1.0	
1,0	4,0	1,0	0.5	2,0	0,5	0,3	3,6	2,0	d+0.5	1,0	2,0
1,25	5,0	1,6	0,5	3,0	1,0	0,5	4,5	2,5	d+0.5	1.0	2.0
1,5	6,0	1,6	1,0	3,0	1,0	0,5	5,4	3,0	d+0,7	1,6	2,5
1,75	7,0	1,6	1,0	4,0	1,0	0,5	6,2	3,5	d+0,7	1,6	3,0
2,0	8,0	2,0	1,0	4,0	1.0	0,5	6,5	3,5	d+1,0	2,0	3,0
2,5	10,0	2,0	1.0	5,0	1,6	0,5	8,9	5,0	d+1,0	2,5	4,0
3,0	10,0	3,0	1,0	6.0	1,6	1,0	11,4	6,5	d+1,2	2,5	4,0
3,5	10,0	3,0	1,0	7,0	1,6	1.0	13,1	7,5	d+1,2	3,0	5,5
4,0	12,0	3,0	1.0	8.0	2,0	1,0	14,3	8,0	d+1,5	2,0	5,5
5,5	16,0	3,0	1,0	12,0	3,0	1,0	18,7	10,5	d+1,8	4,0	8,0
6,0	16,0	3,0	1,0	12,0	3,0	1,0	18,9	10,5	d+2,0	4,0	8,5

*For diameters 6 mm and more

For workpieces manufactured according to DSTU GOST27148: 2008.







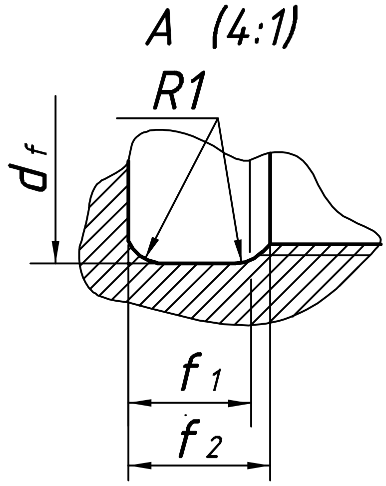


Fig. 1.17

Table 1.5 Run-outs for metric thread

Pitch	**f_1**, not less		**f_2**, not less		**d_f**	***R~0,5P***
	normal	narrow	normal	narrow		
For external thread						
1	2,1	1,1	3,5	2,5	d-1.6	0,5
1,5	3,2	1,8	5,2	3,8	d-2.3	0,75
2	4,5	2,5	7	5	d-3	1
2,5	5,6	3,2	8,7	6,3	d-3.6	1,25
3	6,7	3,73	10,5	7,5	d-4.4	1,5
For internal thread						
1	4	2,5	5,2	3,7	d+0.5	0,5
1,5	6	3,8	7,8	5,6	d+0.5	0,75
2	8	5	10,3	7,3	d+0.5	1
2,5	10	6,3	13	9,3	d+0.5	1,25
3	12	7,5	15,2	10,7	d+0.5	1,5

1.5 Pipe thread

On pipes and workpiaces of pipe connections (tees, crosspieces, branches, locknuts, etc.) pipe thread is cut. This thread has an output triangular profile with an angle $\alpha = 55°$ (Fig. 1.18). The pipe thread is indicated in inches (1 inch = 25.4 mm). The profile and the basic sizes of a straight pipe thread are set according to the GOST 6357-81 and are given in table 1.6.

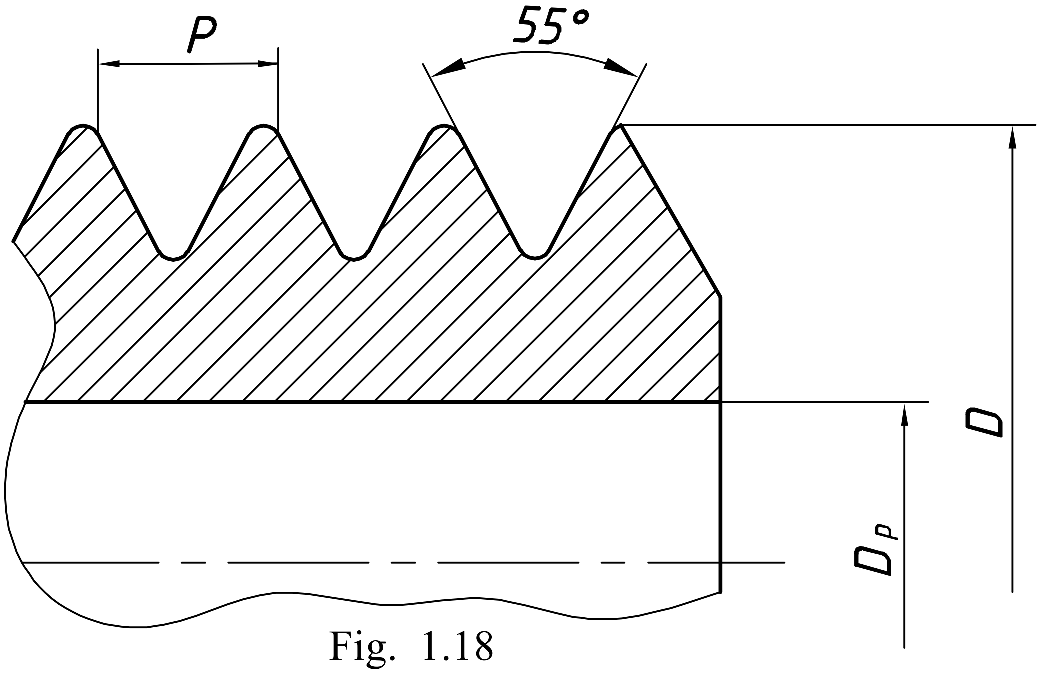


Fig. 1.18

1.5.1 The pipe thread designation is placed on the extension line shelf (Fig. 1.19).

The arrow line rests against the line of visible contour of the thread. The designation of the straight pipe thread indicates not the outer diameter, but the size of the conditional passage of the pipeline, which is approximately equal to the inner diameter of the pipe Dp (Fig. 1.19).

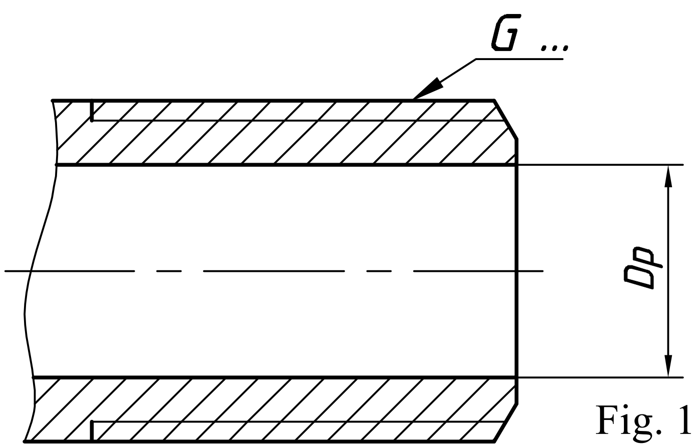


Fig. 1.19

Table 1.6 Designation of the pipe thread size, the corresponding diameter of the conditional passage Dp and the normal values of the outer and inner diameters.

Designation		Pitch, **P**	Conditional passage Dp,mm	Diameter, mm	
1st line	2nd line			outer	inner
G1/4		1,34	8	13,16	11,44
G3/8		1,34	10	16,66	14,95
G1/2		1,81	15	20,95	18,63
	G5/8	1,81	15	22,91	20,59
G3/4		1,81	20	26,44	24,12
	G7/8	1,81	20	30,2	27,88
G1		2,31	25	33,25	30,29
	G1 1/8	2,31	25	37,9	34,94
G1 1/4		2,31	32	41,91	38,95
	G1 3/8	2,31	32	44,32	41,36
G1 1/2		2,31	40	47,81	44,85
	G1 3/4	2,31	40	53,75	50,79
G2		2,31	50	59,62	56,66
G2 1/2		2,31	55	75,19	72,23
	G2 3/4	2,31	55	81,53	78,58
G3		2,31	80	87,89	84,93

Examples of the symbol of the pipe thread:

G1½-A, G1½ LH-B

where 1½ is the diameter of the conditional passage in inches;
LH - designation of the left-hand thread;
A and B - accuracy raiting.

1.5.2 Designations examples of the pipe tapered thread (R, Rc)

Dimensions according to GOST 6211-81: for external thread R 1½, for the inner thread Rc 1½. Where 1½- is the diameter of the conditional passage in inches, related to the main plane (Fig. 1.20, 1.21).

The dimensions are given in table 1.6, as for the pipe thread.

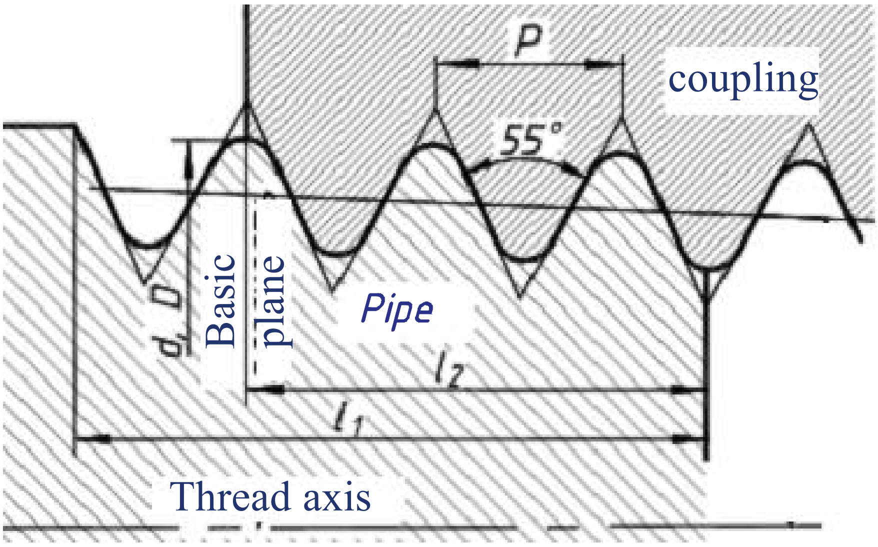


Fig. 1.20

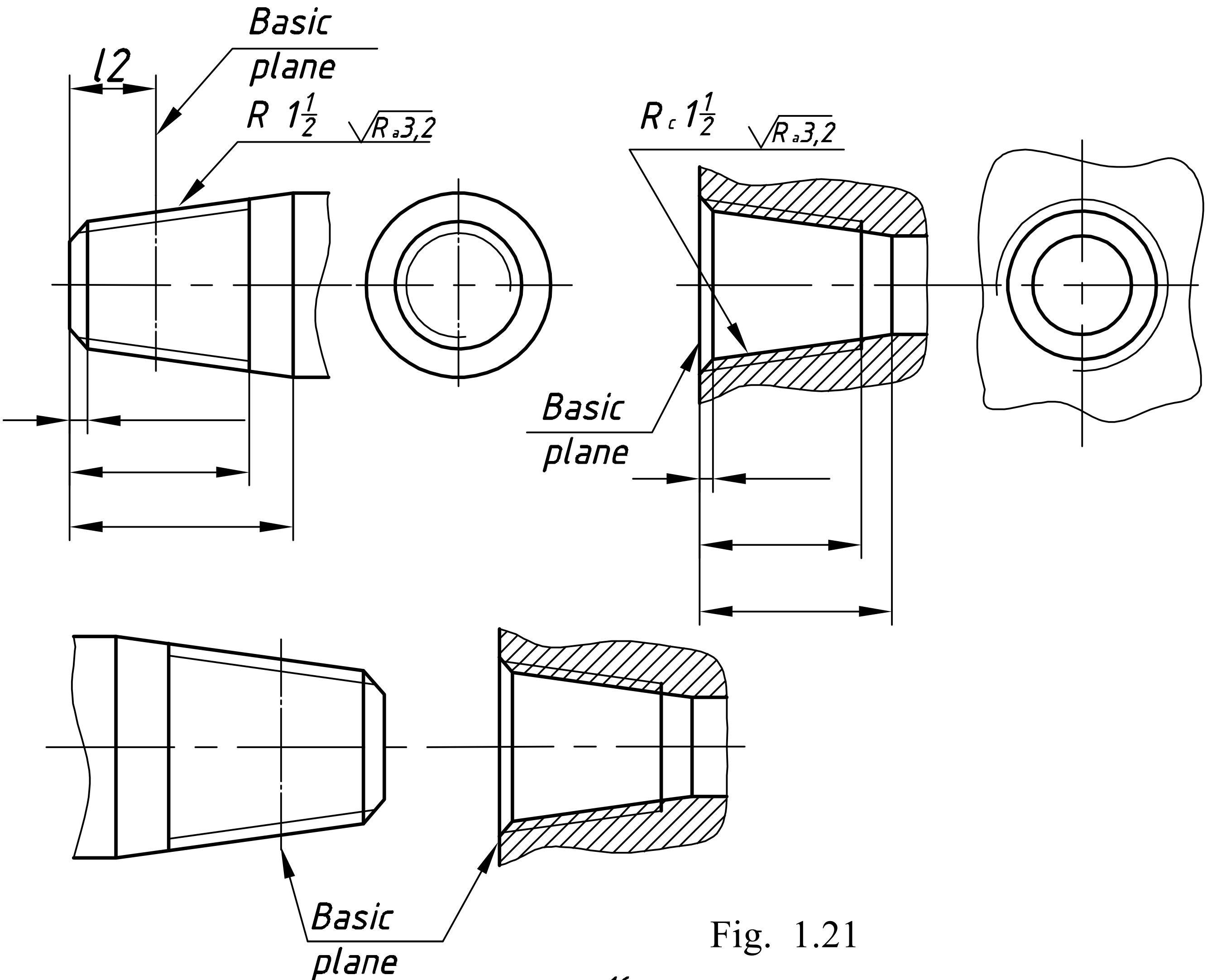


Fig. 1.21

1.5.3 Run-outs for pipe thread.

The sizes of run-outs for a pipe thread are given in tab. 1.7 and 1.8, and the image of the run-outs is given on Fig. 1.22, 1.23.

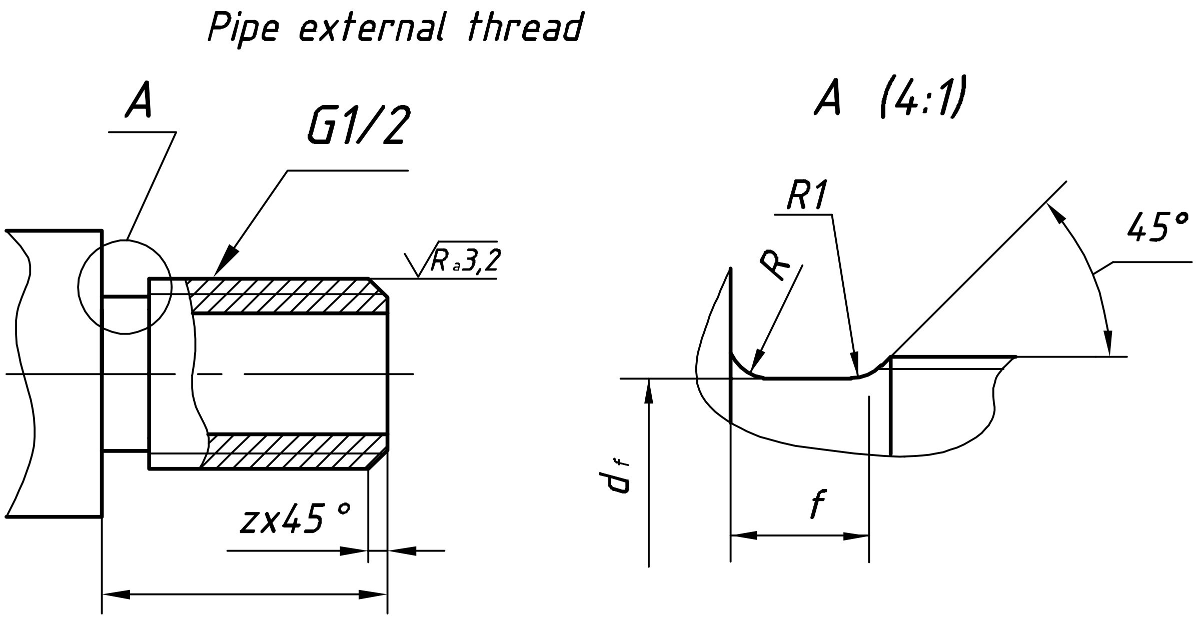


Fig. 1.22

Table 1.7 Run-outs for the external pipe thread

Designa-tion,inch	Normal			Narrow			**df**	Chamfer **z** (Fig.1.22)
	f	**R**	**R1**	**f**	**R**	**R1**		
G1/8	2,5	1	0,5	1,6	0,5	0,3	8	1
G1/4	4	1	0,5	2,5	1	0,5	11	1,6
G3,8	4	1	0,5	2,5	1	0,5	14,5	1,6
G1/2	5	1,6	0,5	3	1	0,5	18	2
G3/4	5	1,6	0,5	3	1	0,5	23,5	2
G1	6	1,6	1	4	1	0,5	29,5	2,5
G1 1/4	6	1,6	1	4	1	0,5	38	2,5
G1 1/2	6	1,6	1	4	1	0,5	44	2,5
G13/4	6	1,6	1	4	1	0,5	50	2,5
G2	6	1,6	1	4	1	0,5	56	2,5
G2 1/4	6	1,6	1	4	1	0,5	62	2,5
G2 1/2	6	1,6	1	4	1	0,5	71,5	2,5
G2 3/4	6	1,6	1	4	1	0,5	78	2,5
G3	6	1,6	1	4	1	0,5	84	2,5

Pipe internal thread

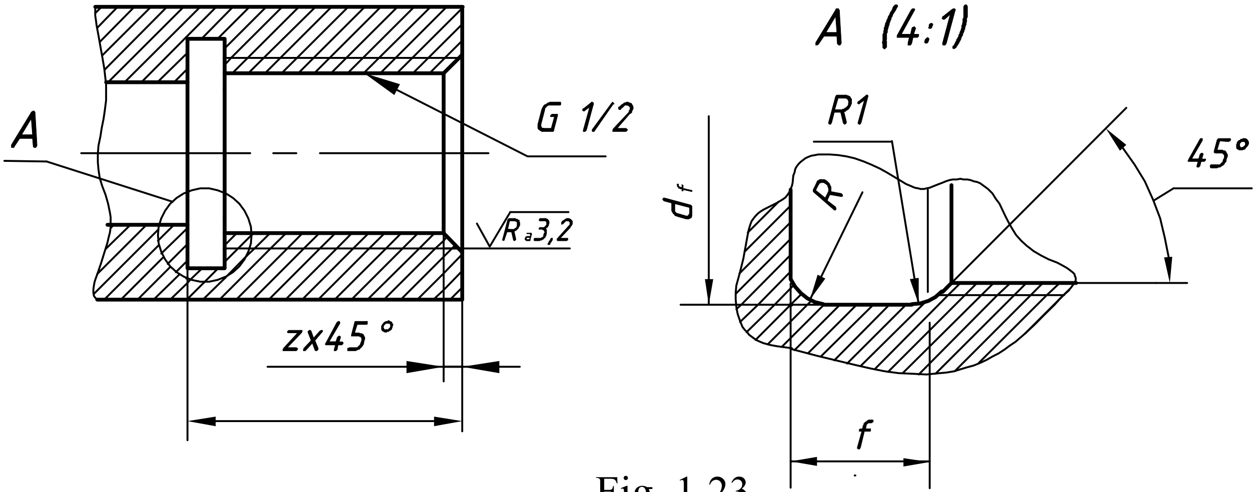


Fig. 1.23

Table 1.8 Run-outs for the internal pipe thread

Designa-tion,inch	Normal			Narrow			**df**	Chamfer **z** (Fig.1.23)
	f	**R**	**R1**	**f**	**R**	**R1**		
G1/8	4	1	0,5	2,5	1	0,5	10	1
G1/4	5	1,6	0,5	3	1	0,5	13,5	1
G3/8	5	1,6	0,5	3	1	0,5	17	1
G1/2	8	2	1	5	1,6	0,5	21,5	1,6
G3/4	8	2	1	5	1,6	0,5	27	1,6
G1							34	
G1 1/4							43	
G1 1/2							48,5	
G1 3/4							54,5	
G2							60,5	
G2 1/4	10	3	1	6	1,6	1	66,5	1,6
G2 1/2							76	
G2 3/4							82,5	
G3							89	

1.6 Trapezoidal thread

The trapezoidal thread has a profile of an equilateral trapezoid. For each diameter GOST 24737-81 sets two or more pitches, so the thread mark always indicates the pitch.

GOST 24738-81 sets the dimensions of the nominal diameters (8..640 mm) and pitches(1.5...8 mm) of the trapezoidal thread (Table 1.9). Profile angle α = 30 ° (Fig. 1.24)

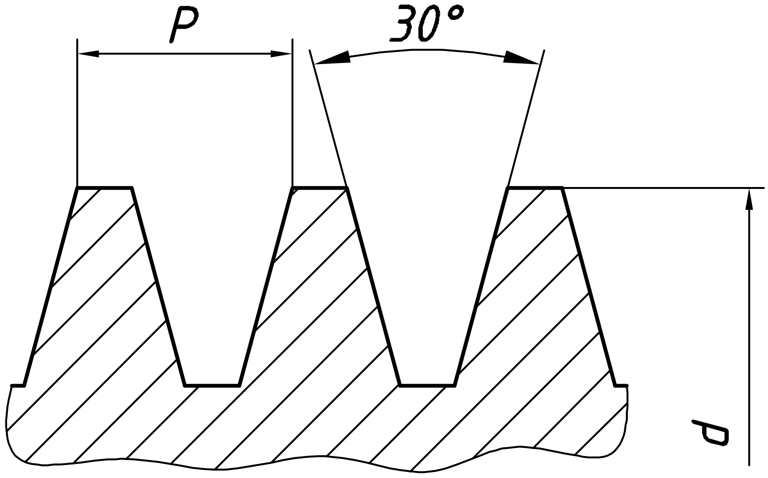


Fig. 1.24

Table 1. 9 Diameters and pitches for the trapezoidal thread

Singlestart thread [GOST 24738-81] ,mm

Diameter ***d***		Pitch ***P***
1st line	2nd line	
8		1,5; 2
10	9	1,5; 2
	11	2; 3
12	14	2; 3
16		2; 4
20	18	2; 4
	22	2; 3; 5; 8
24	26	2; 3; 5; 8
28		2; 3; 5; 8
32	30	3; 6; 10
36	34	3; 6; 10
	38	3; 6; 7; 10
40	42	3; 6; 7; 10

Multistart thread [GOST 24739-81],mm

Diameter *d*	Pitch ***P***	***n***				
		2	3	4	6	8
		Thread lead t				
10	1,5	3	4,5	6	9	12
	2	4	6	8	12	16
12	2	4	6	8	12	16
	3	6	9	12	18	-
16	2	4	6	8	12	16
	4	8	12	16	24	-
20	2	4	6	8	12	16
	4	8	12	16	24	32
24	3	6	9	12	18	24
	5	10	15	20	30	-
	8	16	24	32	-	-
28	3	6	9	12	18	24
	5	10	15	20	30	40

Notes:
1.The standard GOST 24738-81provides for thread diameters up to 640 mm.
2. The diameters of 1st line should be prefered .
3.The standard GOST 24739-81 provides diameters up to 140 mm.

1.6.1 Designations examples (GOST 9484-81)

singlestart thread: Tr 20x4 (20 - external diameter of the thread d, 4 - thread course t, t = p), (Fig. 1.25);
multistart thread: Tr 20x4 (P2) (20 - external diameter of the thread d, 4 - thread course t, P2 - pitch)

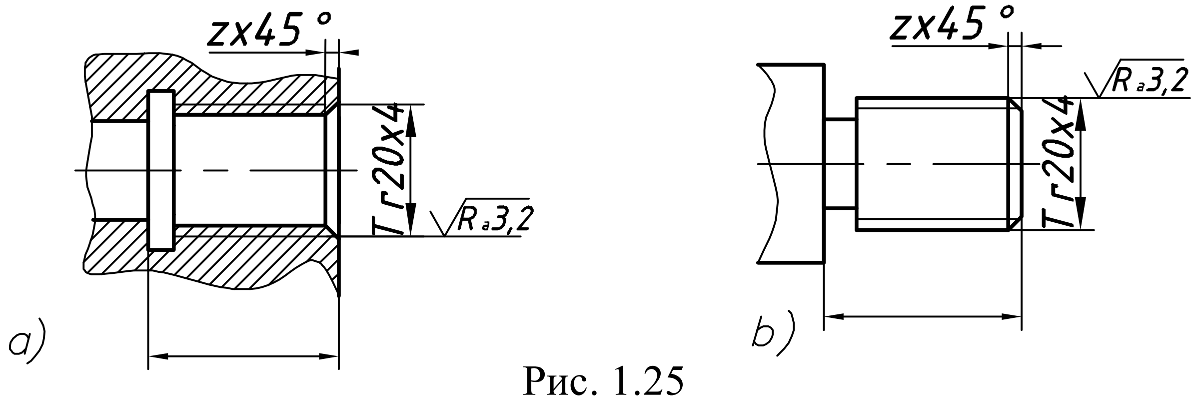


Рис. 1.25

Table 1.10 The trapezoidal thread designations

Trapezoidal thread	Right-hand	Left-hand
Singletstart thread	***Tr20x4***	***Tr20x4LH***
Multistart thread n=2	***Tr20x8(P4)***	***Tr20x8(P4)LH***

1.7 Buttress thread

GOST 10177-82 sets for each diameter (10..640 mm) from one to four pitches (2… 24 mm). The dimensions are given in table. 1.11, and the angle of the profile - in Fig. 1.26.

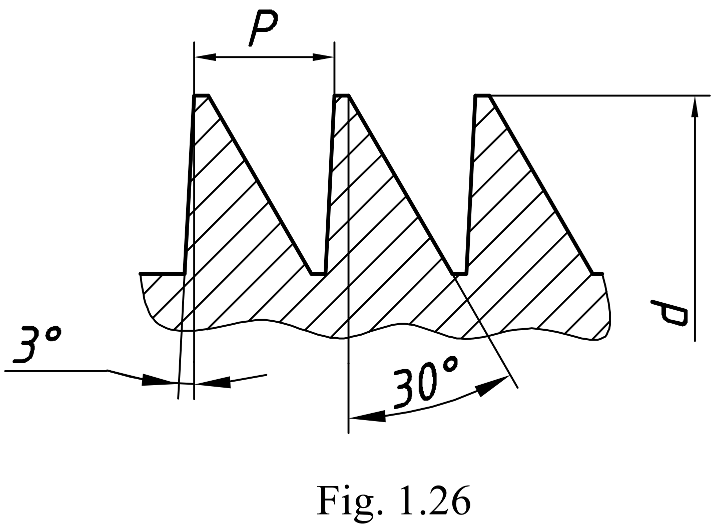


Fig. 1.26

Table 1.11 Dimensions of the buttress thread

Diameter d,mm		Pitch *P*		Diameter d,mm		Pitch *P*
1st list	2nd list			1st list	2nd list	
10		2			46	3; 8; 12
12	14	2; 3		48	50	3; 8; 12
16	18	2; 4		52		3; 8; 12
20		2; 4			55	3; 9; 14
	22	3; 5; 8		60		3; 9; 14
24	26	3; 5; 8			65	4; 10; 16
28		3; 5; 8		70	75	4; 10; 16
	30	3; 6; 10		80		4; 10; 16
32	34	3; 6; 10			85	4; 12; 18; 20
36		3; 6; 10		90	95	4; 12; 18; 20
	38	3; 7; 10		100	110	4; 12; 20
40	42	3; 7; 10		120	130	6; 14; 22
44		3; 7; 12		140E		6; 14; 24

Notes:
1. The standard provides diameters d up to 200 mm.
2. The diameters of 1st line should be prefered .

1.7.1 Designation examples (Fig. 1.27), table. 1.12:

singlestart thread S 80x10,
where is S- a symbol of the thread type; 80 -is the nominal diameter of the thread, mm; 10 - the thread pitch, mm;
multistart thread S 80x 20 (P10),
where is 80-the nominal diameter of the thread, mm; 20 -is the thread lead, mm; P10 -the thread pitch, mm;
left hand thread- S 80x 20 (10) LH;
mark with tolerance field (external) S 80x 20 (10) LH - 7h

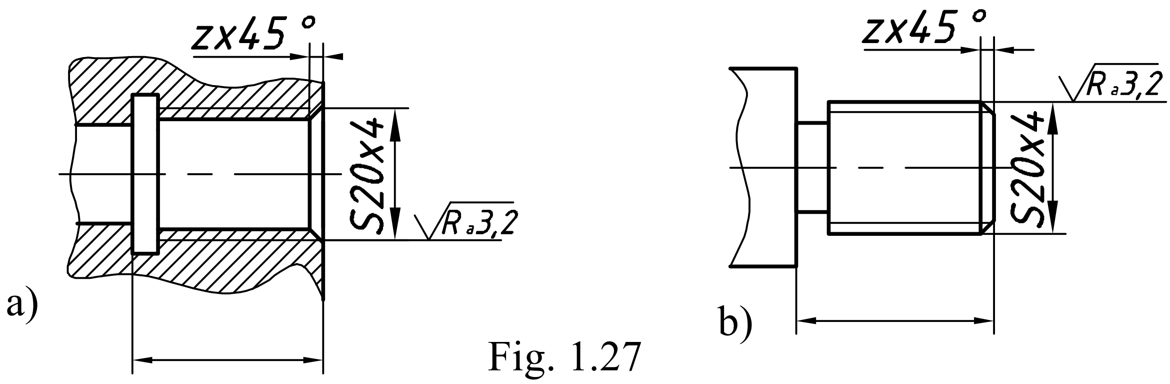


Fig. 1.27

Tabl. 1.12 The buttress thread designations

Buttress thread	Right-hand	Left-hand
Singlestart thread	***S80x10***	***S80x10LH***
Multistart thread n = 2	***S80x20(P10)***	***S80x20(P10)LH***

1.7.2 Run-outs for trapezoidal and buttress thread . The sizes of run-outs and chamfers for an external and internal singlestart thread are given in Tab. 1.13.

For a multistart run-out the width of it is taken equal to the singlestart one, the pitch of which is equal to the course of the multistart run-out (Fig. 1.28).

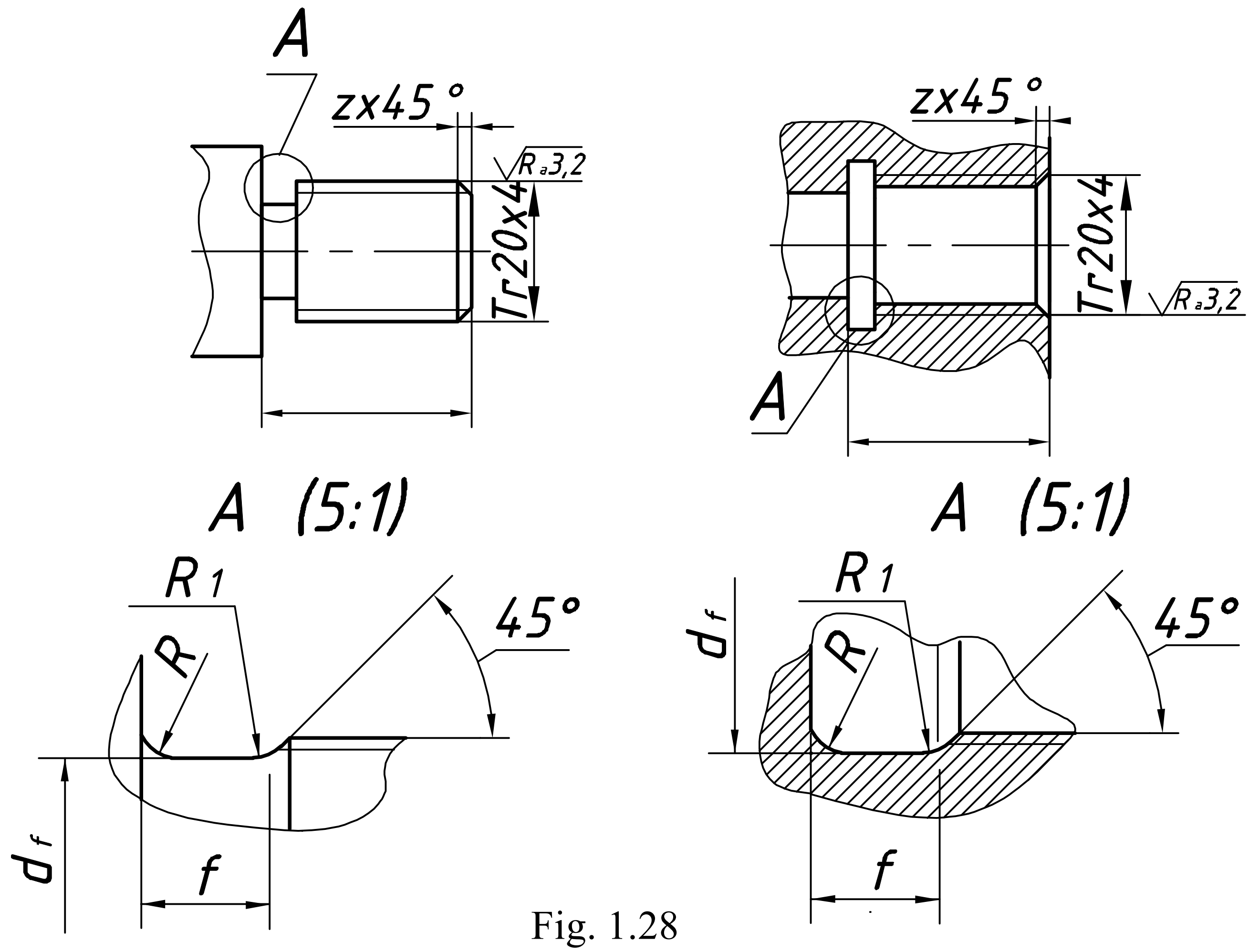


Fig. 1.28

Table 1.13 Run-out and chamfer dimensions for trapezoidal and buttress threads.

Pitch **P**	**f**	**R**	**R1**	**run-out diameter df**		Chamfer, **z** (Fig. 1.28)
				external	internal	
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
4	6	1,6	0,5	d- 5,2	d+1,1	2,5
5	8	2	1	d-7,0	d+1,6	3
6	10	3	1	d- 8,0	d+ 1,6	3,5
8	12	3	4	d-10,2	d+1,8	4,5

1.8 Round thread for electrical fittings

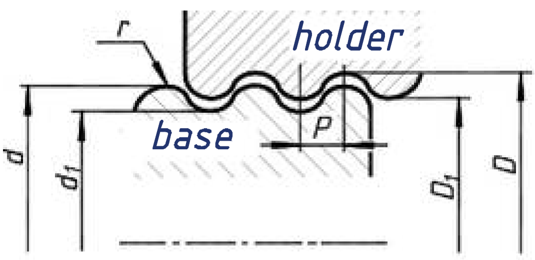


Fig. 1.29

Standard: GOST 28108-89 Edison round thread. Profiles, sizes and size limits. Designations: Letter E, thread number, if it is non-metallic element- with the letter N through a slash (/) and GOST number, for example

E 27 GOST 28108-89

or E 27 / N GOST 28108-89.

Table 1.14 Dimensions of the round thread for the bases and holders of electric lamps

Series	*d*		d_1		*D*		D_1		*P*	*r*
	min	max	min	max	min	max	min	max		
E5	5,23	5,33	-	4,77	5,39	5,49	4,83	4,93	1 000	0,293
E10	9,36	9,53	8,34	8,51	9,61	9,78	8,59	8,76	1 814	0,531
E14	13,70	13,89	12,10	12,29	13,97	14,16	12,37	12,56	2 822	0,822
E27	26,05	26,45	23,96	24,26	26,55	26,85	24,36	24,66	3 629	1 025
E40	39,05	39,50	35,45	35,90	39,60	40,05	36,00	36,45	6 350	1 850

Thread metric with MJ profile. Profile, diameters and pitches, tolerances 01.01.2004 existing Title (English): Basic norms of interchangeability. Metrical MJ theads. Profile, general plan, tolerances. Scope: the existing standard applies to metric thread with MJ profile, which is used in conditions where increased fatigue strength of threaded joints is required, primarily for aerospace products, and sets the thread profile, diameters and pitches, tolerances and limit deviations, and symbols for this thread.

Round tread for sanitary fittings, Kr.

The profile of the round thread is formed by circles on the crests and vees, connected by straight lines with the angle of the profile near the vertex 30 °. The thread is used for spindles, valves, faucets, toilet and water taps, ie: round thread for sanitary fittings. Profile, basic dimensions, tolerances. Designation of the round thread: the letters Kr, the nominal diameter of the thread, pitch and standard.

Thread Eg M
Threaded holes for wire threaded inserts for metric threads. It is used to strengthen the load-bearing capacity of the thread or to repair a damaged thread in the body of the workpieces.

Thread UTS (Unified Thread Standard)
Inch thread is widely distributed in the United States, the angle at the crest of 60 °, the theoretical height of the profile is H = 0,866025P. Depending on the pitch is divided into:
UNC (Unified Coarse);
UNF (Unified Fine);
UNEF (Unified Extra Fine);
8UN; UNS (Unified Special).

Thread BSW (British Standard Whitworth)
The inch thread is the British standard proposed by Joseph Whitworth in 1841, the angle at the crest is 55 °, the theoretical profile height is H = 0.960491P.
The fine pitch is called: BSF (British Standard Fine).

Thread NPT (National pipe thread)
Standard / B1.20.1 inch pipe connection thread. Conical (NPT) with a taper of 1:16 (cone angle = 3 ° 34'48 ") or cylindrical (NPS). The profile angle at the crest is 60 °, the theoretical height of the profile is H = 0.866025P.
The standard provides thread sizes from 1/16 " to 24" for pipes according to ANSI / ASME B36.10M, BS 1600, BS EN 10255 and ISO 65 standards.

Thread of oil country tubular goods.
The threads of the oil country tubular goods for connecting pipes in oil wells are taper to ensure high tightness. The shape of the profile are triangular, with a profile angle of 60 °, and trapezoidal non-equilateral, with angles from 5 ° to 60 ° (the so-called Batress thread). Thread of oil country tubular goods is mainly made in accordance with the standards of the American Petroleum Institute (API).
Domestic standards:
GOST 631-65 - Drill pipes with the landed ends of couplings to them.
GOST 632-70 - Casing pipes and couplings to them.
GOST 633-70 - Pump-compressor pipes and couplings to them.

Questions for self-examination

1. Write the designation of the right singlestart thread with a nominal diameter of 20 mm and a fine pitch of 2 mm.

2. Write down the number of the picture, which shows a workpiece with a thread.

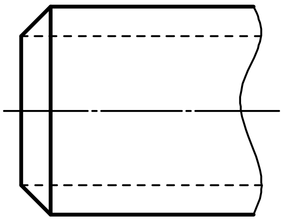


Fig. a

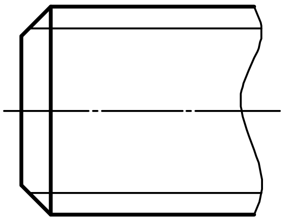


Fig. b

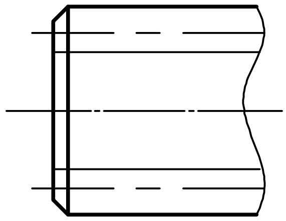


Fig. c

3. Which of the following threads has a course of 6 mm? Write down the answer number.

1) MK6 2)S40x6 3)Tr30x6(p3) 4)M6

4.Write down the number of the picture, which shows a workpiece with a thread.

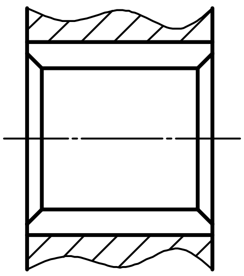


Fig. a

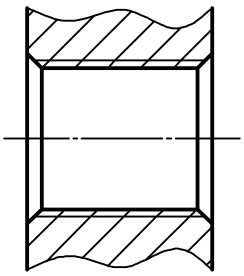


Fig. b

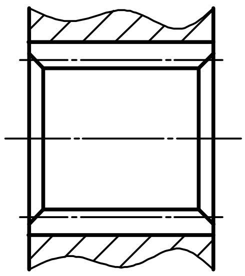


Fig. c

5.Write down the number of the picture, which shows a workpiece with a thread.

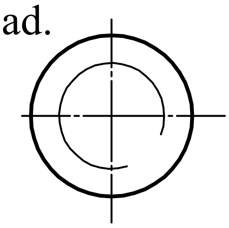


Fig. a

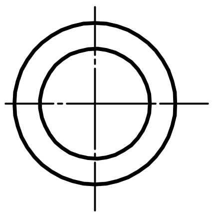


Fig. b

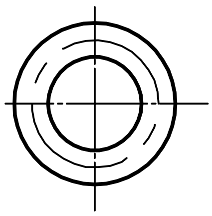
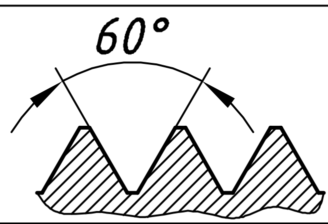
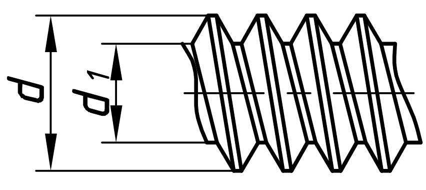


Fig. c

6. The profile of which thread is shown in the figure. Write the name and symbol.



7. Which diameter (d or d1) is considered to be the nominal diameter of the thread shown in the figure?



2. CONSTRUCTION MATERIALS DESIGNITION

Information about the material of the workpiece is entered in a special column of the main inscription (Fig. E.1-E.6). The material label must contain the name of the material, the brand, if it is installed for it, and the number of the standard (Table 2.1).

Table 2.1 Examples of material labels

Material name	Material designation in the drawing
Carbon steel of normal quality	Ст3 ДСТУ 2651: 2005/ГОСТ380-2005
High quality structural steel	Сталь 20 ГОСТ 1050-88
	Сталь 25 ГОСТ 1050-88
	Сталь 30 ГОСТ 1050-88
	Сталь 35 ГОСТ 1050-88
	Сталь 45 ГОСТ 1050-88
Alloy structural steel	Сталь 40Х ГОСТ 4543-71
Cuprum	МОК ГОСТ 859-78
	М Ір ГОСТ 859-78
Cast iron gray	СЧ15 ГОСТ 1412-85
Malleable cast iron	КЧ35-10ГОСТ1215-79
Foundry tin bronze	Бр05ЦС5ГОСТ613-79
Aluminium bronze	БрА9МцГОСТ493-79
Plastic bronze	БрОЦС4-4-2,5ГОСТ 5017-2006
Foundry bronze	ЛЦОС ГОСТ 17711-93
Wrought bronze	Л63 ГОСТ 15527-70
Multi-component deformable brass	ЛС59-1 ГОСТ15527-70
Aluminum casting alloy	АЛ7 ДСТУ 2839-94 (ГОСТ 1583-93)
Wrought aluminum alloy	ДІ2 ГОСТ 4784-97
Phenoplast	ФенопластЭ3-340-65ГОСТ 5689-79
Aminoplast	АминопластКФАІ ГОСТ 9359-80
Pressing material	Пресс-материалАГ-4 ГОСТ 20437-75
Polystyrene	Полістерол МСД ГОСТ 20282-74
	Полістерол ПСМД ГОСТ 20282-74
Sheet electric textolite	Текстоліт А-10,0 ГОСТ2910-74
	Текстоліт В4-0,5 ГОСТ2910-74
Caoutchouc	Гума ГОСТ 7338-75

3. SURFACE ROUGHNESS DESIGNATION

There are micro-irregularities of different pitches and sizes on the workpiace surface .

Surface roughness is a set of irregularities with relatively small steps, which is measured at a certain base length
(DSTU 2409-94).

3.1 Surface roughness parameters.

Surface roughness is estimated by six parameters.

Height - Ra, Rz, Rmax.

Ra is the arithmetic mean deviation of the profile. This is the arithmetic mean of the absolute values of the deviations of the profile within the base length;

Rz is the height of the profile irregularities at 10 points. This is the sum of the arithmetic mean absolute deviations of the heights of the five largest crests of the profile and the depths of the five deepest vees of the profile within the base length;

Rmax - the maximum height of the profile irregularities.

Step - Sm, S, tr.

Sm is the average step of inequalities;

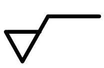
S is the average step of inequalities along the crests;

tr - relative reference length.

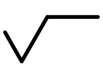
It is better to use the parameter Ra to indicate the roughness. Recommended values of the parameter Ra according to GOST 2789-73: 100; 50; 25; 12.5; 6.3; 3.2; 1.6; 0.8; 0.4; 0.2; 0.1; … mkm. Examples of the selection of the roughness parameter Ra are given in table. 3.1

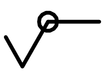
3.2 Signs of roughness

We are using four symbols for the roughness of the surfaces on the drawings (GOST2.309-73):


- to mark the surface roughness formed by removing a layer of material, for example: drilling, turning, grinding;


- to mark the surface roughness formed without removing the layer of material, such as casting, stamping;


- used in cases where the type of surface treatment is not set by the designer.


- used if the closed contour of the part has the same surface roughness.

The dimensions of the sign

h -height of dimensional numbers on the drawing
H =(1,5...5)***h*** ;

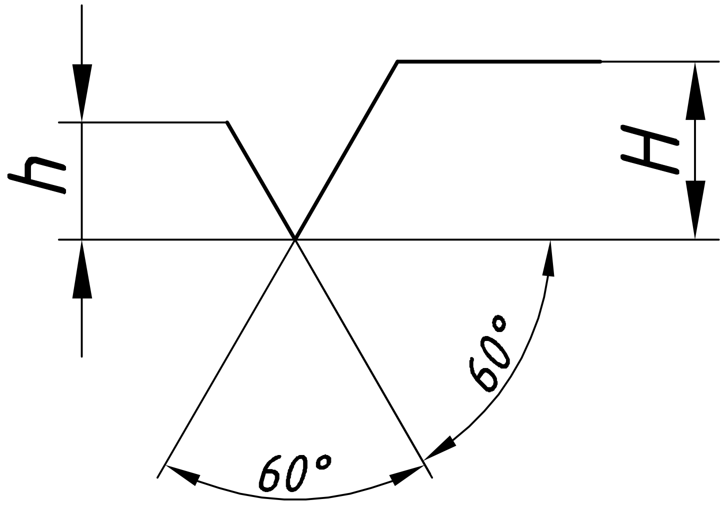
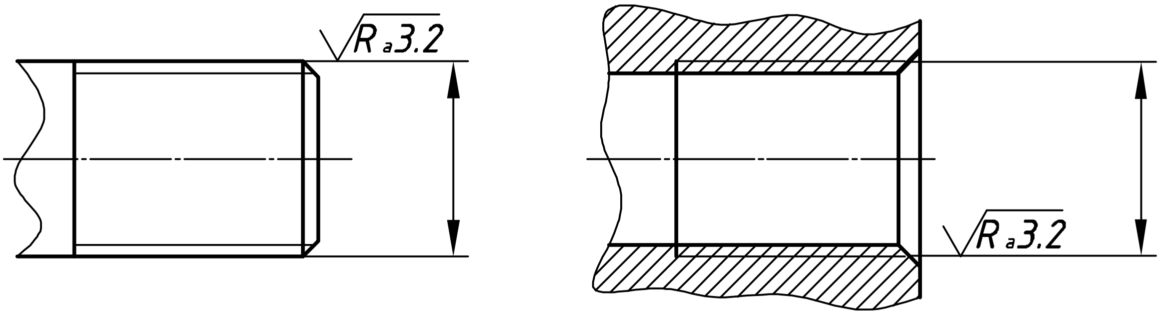


Table 3.1 Examples of selection of the roughness parameter Ra

Treatment type	Foundry	Ln a sand mold	50
		Ln the chill mold	12.5; 6.3
		Under pressure	3,2
	Excision		12.5; 6.3
	Turning	Semi-finished	6.3; 3.2
		Finishing	6.3; 3.2; 1.6
		Thin	0.8; 04
	Milling	Rough	12.5; 6.3
		Finishing	3.2; 1.6
		Thin	0.8; 0.4
	Drilling	Diameter up to 15 mm	6.3; 3.2
		With a diameter of more than 15 mm	12.5; 6.3
	Polishing	Получистовое	3.2; 1.6
		Finishing	0.8; 0.4
		Thin	0.2; 0.1
	Threading	Dies and tap	6.3; 3.2; 1.6;
		Cutter, comb, milling cutter	3.2; 1.6
		Rolling with a roller	0.8; 0.4

3.3 Examples of roughness mark

Roughness on the surface of the thread.



Roughness on a cylindrical surface.

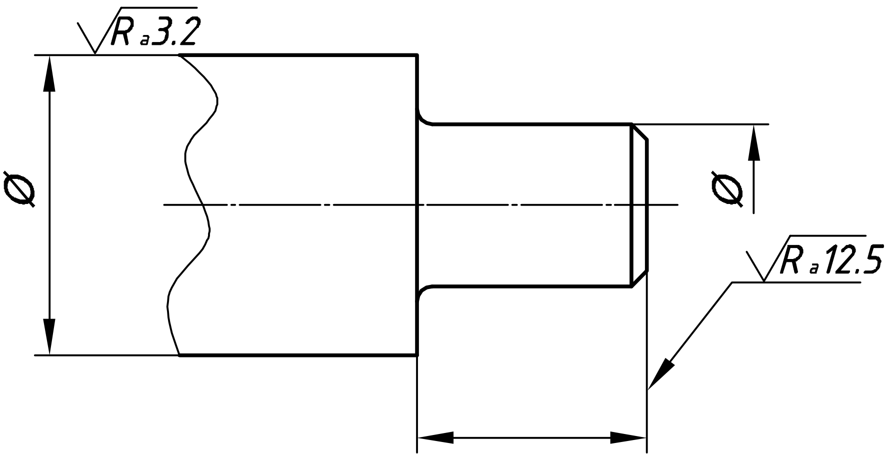


Fig. 3.1

If all surfaces of the workpiece have the same roughness, then its mark is placed in the upper right corner of the drawing (Fig. 3.2). If only part of the surfaces of the workpiece has the same roughness ($\sqrt{R_a 12{,}5}$), and the roughness of the others is indicated in the image, it is indicated in the upper right corner, as shown in Fig. 3.3, or in Fig. E1 - E6 (pp. 78 - 85).

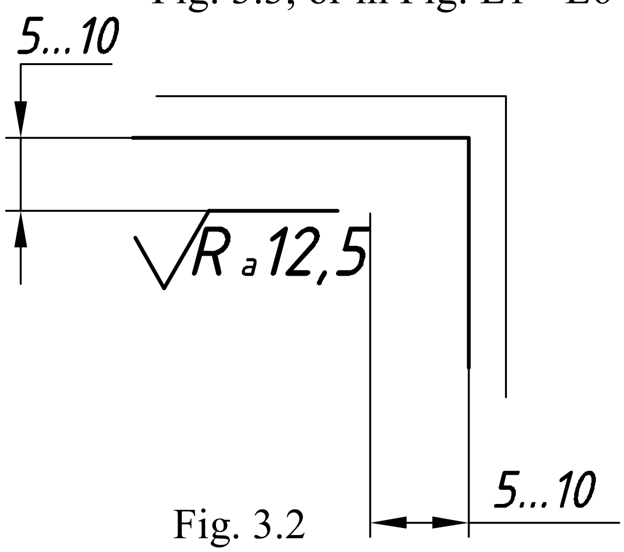


Fig. 3.2

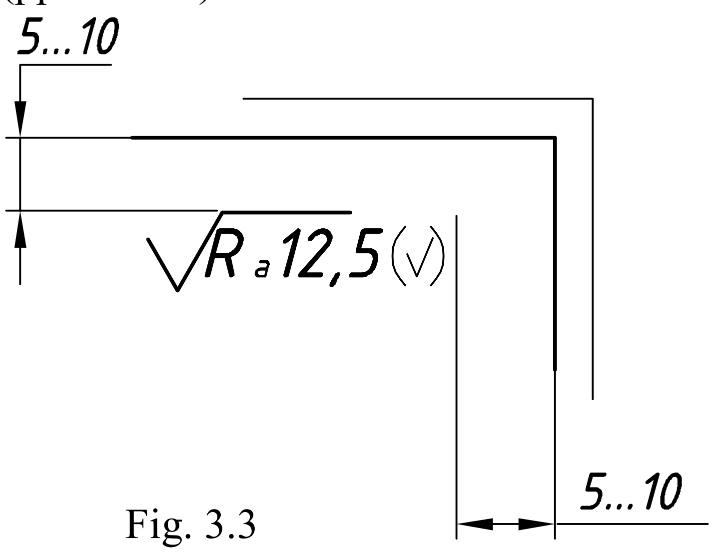


Fig. 3.3

Examples of roughness marks.

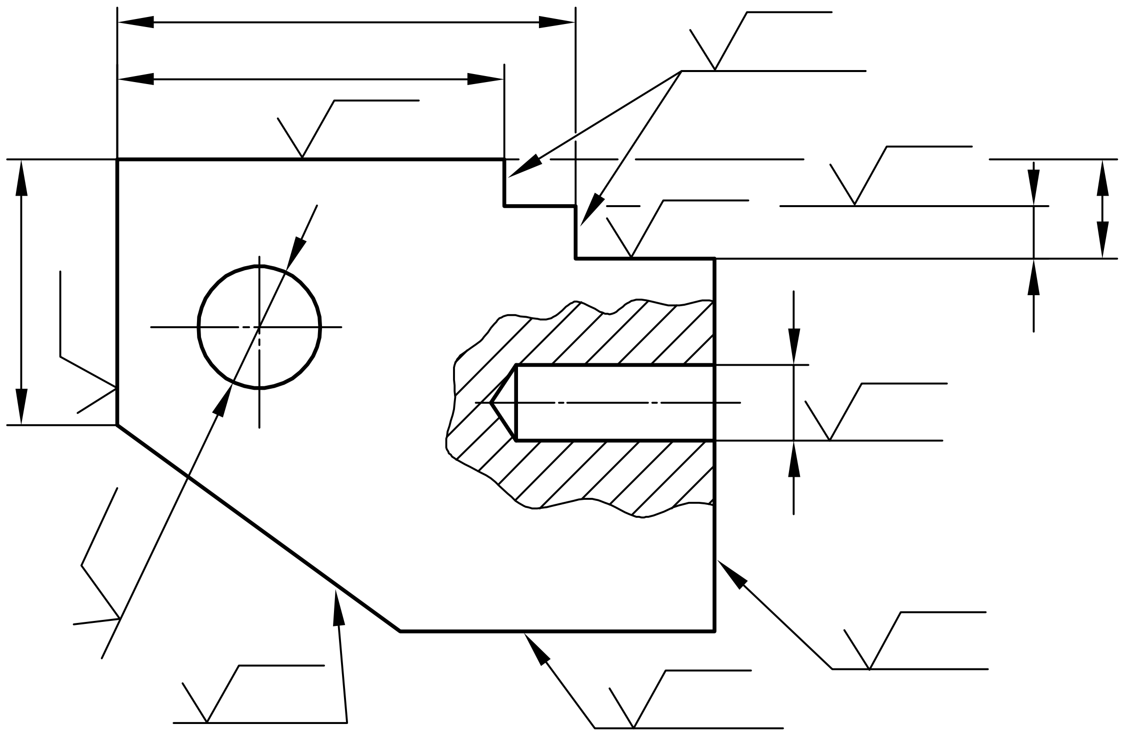
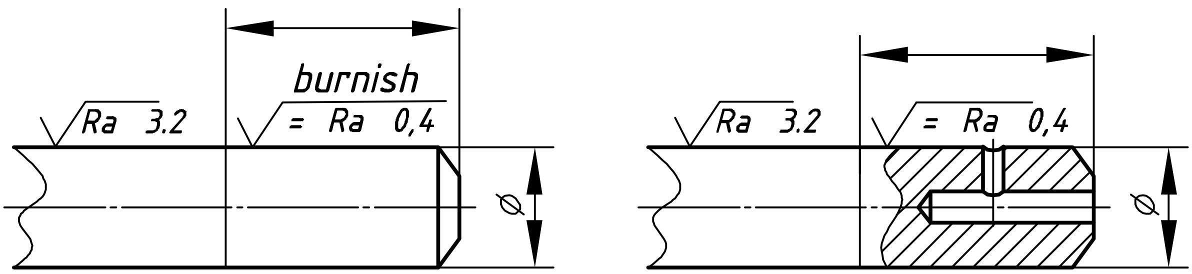


Fig. 3.4

Examples of grinding marks.



4. SOME INFORMATION ABOUT SIZING

DSTU GOST 2.307: 2013 adjusts sizing on drawings.
It recommends to measure workpieces so that each element of this one has the dimensions of the form and the dimensions of the position relative to the bases.
The base is a surface, a plane or their elements (a straight line, a point) from which sizes of other elements of workpiece are counting . (Fig. 4.1).

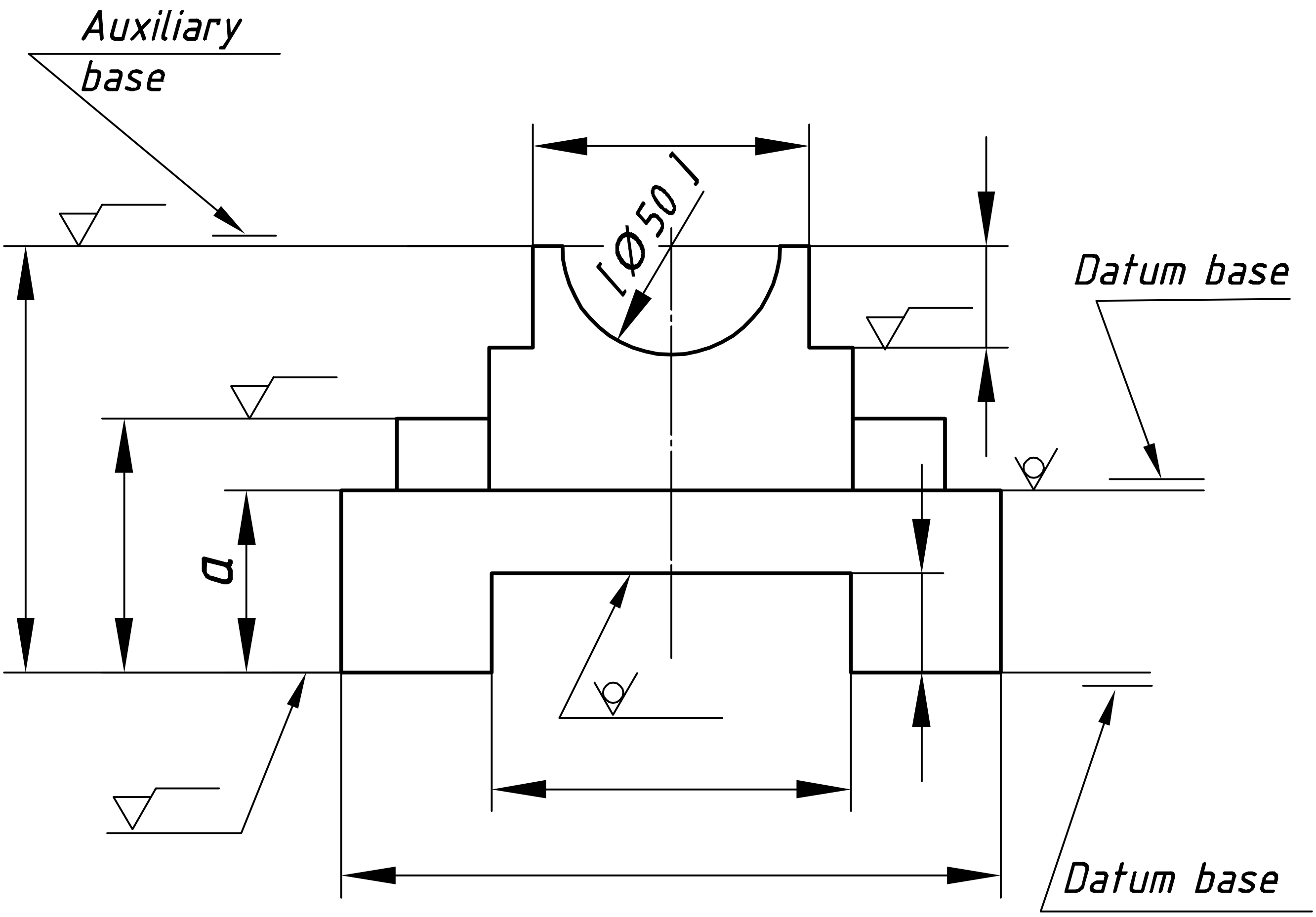


Fig. 4.1

The number of dimensions on the drawing should be minimal, but sufficient for the manufacture and control of the workpiece.

The choice of sizes that ensure the manufacturability of the workpiece and its interchangeability is reduced to two conditions:

-development of the constructive sizes which cause correct interaction of workpieces in operation process;

-development of technological dimensions associated with the technological process of its manufacturing.

In the first case use constructive, in the second- technological bases.

Sketching a workpiece, the dimensions are applied using technological bases.

Technological bases are the surfaces, which process the first and relative to which a workpiece in the course of manufacturing is orient.

Technological bases are divided into draft, main and auxiliary:

datum (foundry, stamping, forging) - no processing surfaces. They come into contact with the mounting surfaces of the devices during machining of parts;

main - first treated surfeces; the position of these bases on the foundry parts is determined relative to the draft bases (Fig. 4.1 - size a);

auxiliary - auxiliary surfaces required in the measurement process. Their position is determined relative to the main bases.

4.1 Basic requirements for sizing

Making a working drawings of workpieces, which are made by casting, stamping, forging or rolling, followed by machanical restoration a part of surface , show in each coordinate direction not more than one size that connects machined surfaces with surfaces not subject to machining (Fig. 4.2 - size 24 mm).

At the next sizing the processed surfaces connect the sizes with the processed surfaces (Fig. 4.2 - the size of 14 mm).

Untreated surfaces are associated with dimensions only with untreated surfaces (Fig. 4.2 - dimensions 110 and 8 mm).

The dimensions of the same element, for example, hole, groove, etc., are grouped if possible in the image, where the shape of the element is shown most fully (Fig. 4.3, Ø8,8; 5; ,814 - in one image).

The diameters of the holes are put down on its cuts (Fig. 4.3, dimensions Ø 14 and Ø8.8 mm), and the location of the axes of the holes - on the views obtained by projection on a perpendicular plane to the axes of the holes (Fig. 4.3, sizes 35 and 55 mm) .

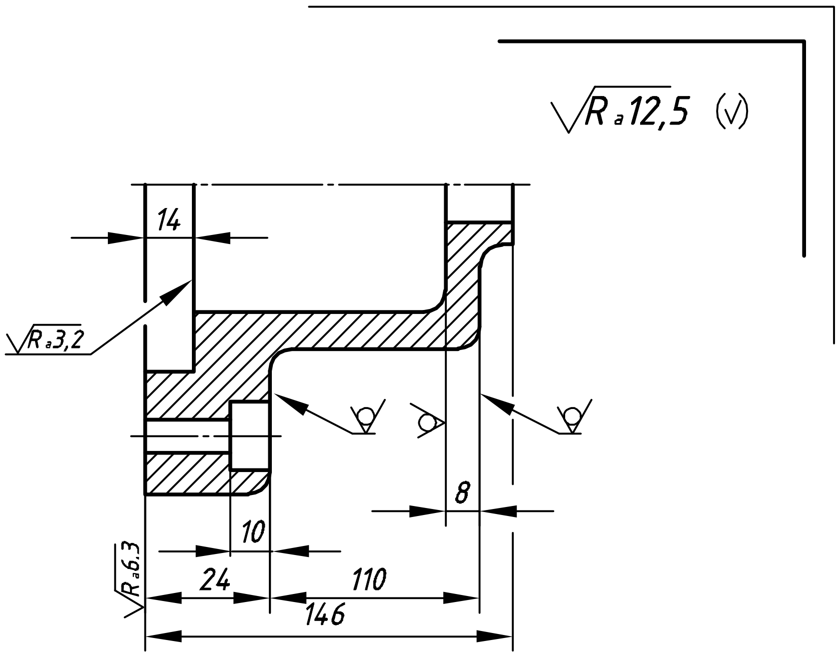


Fig. 4.2

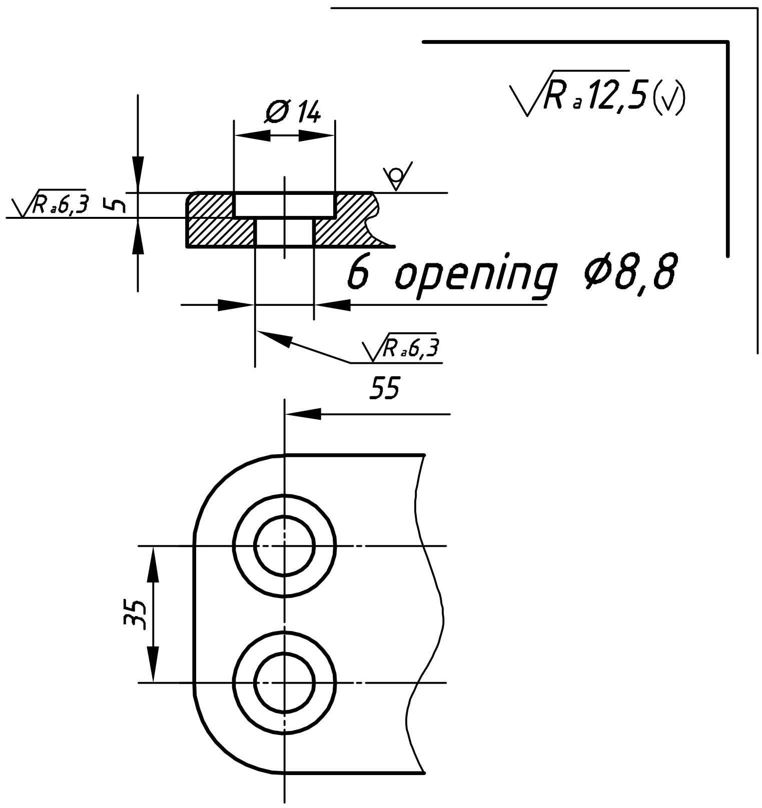


Fig. 4.3

The dimensions of the internal elements are placed on the side of the section (Fig. 4.4, dimensions 12 and 20 mm), and the dimensions of the external surfaces - on the side of the view (Fig. 4.4, dimensions 8, 26, 40 mm and the chamfers dimentions).

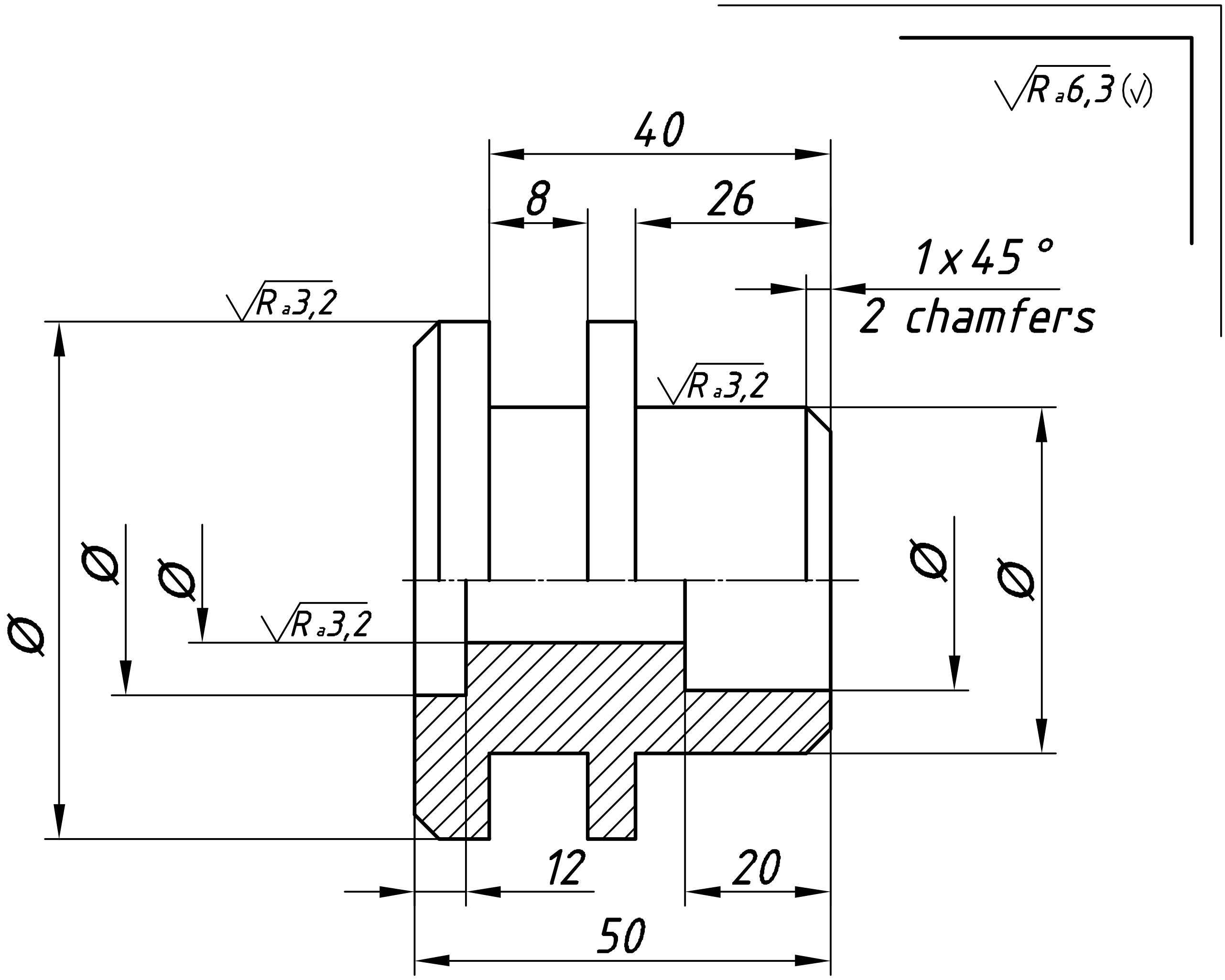


Fig. 4.4

The sizes of two symmetrically located elements (exept holes) put once, without showing their number.

The number of holes with the same diameter is always shown by type: 6 holes. Ø8.8 (Fig. 4.3).

Sometimes in designs there is a necessity of joint processing of details (or their elements) which are a part of the given product (for example, a hole Ø 50 in the case consisting of two halves) (Fig. 4.1). Sizes of together processed elements are given in square brackets (Fig. 4.1, size: [Ø 50]), and in the technical requirements write: "Processing by size in square brackets to perform together with the part ..."

5. THREAD WORKPIECE DRAWING

Axonometric drawing of a workpiecel with a thread is shown in fig. 5.1.

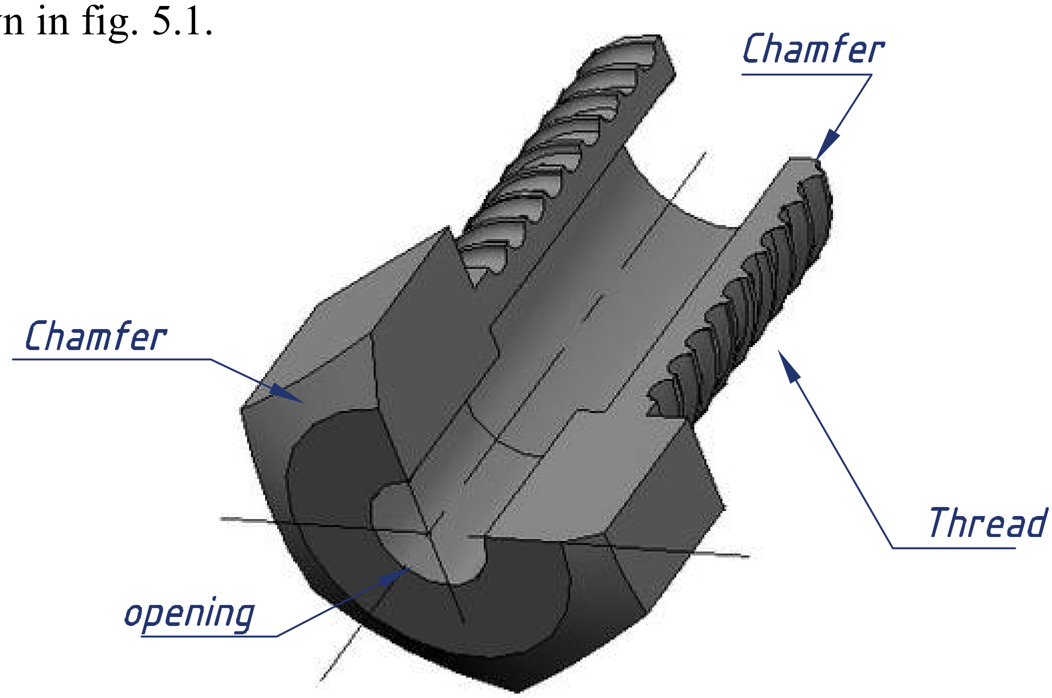
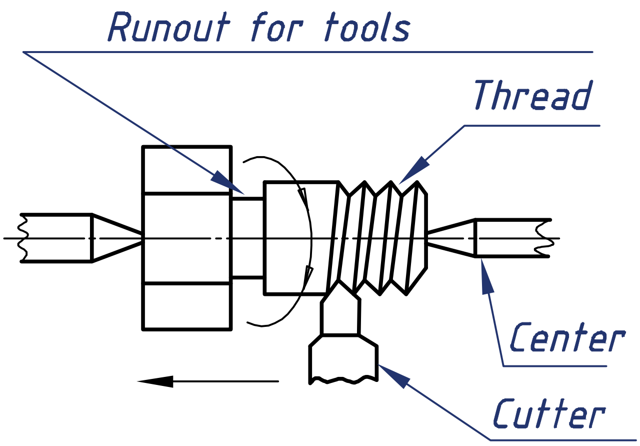


Fig. 5.1

5.1 The outer cut is made with a die or on a lathe cutter (Fig. 5.2). In the process of machining, the part rotates, and the cut is obtained by the cutting edge of the cutter, which moves along the axis of the part.



5.2 Runout (Fig. 5.1, 5.2) is a technological element for the cutter output when the thread is cutting . The shape and size of the runout depend on the type of thread, its diameter and pitch. The sizes of these runouts are given in tab. 1.3, 1.4, 1.13.

Fig. 5.2 Cutting the thread

5.3 Chamfer (Fig. 5.4) is a feather-edge of the workpiece or at surface transition, which has a conical type of surface. Chamfers provide a more convenient and faster connection of workpieces in the process of assembling and eliminate the sharp edge that is formed on the sides of the ends in their manufacturing. In Fig. 5.3 shows the chamfers for outer (a) and inner (b) thread. The dimensions of these chamfers are given in table. 1.3, 1.4, 1.13.

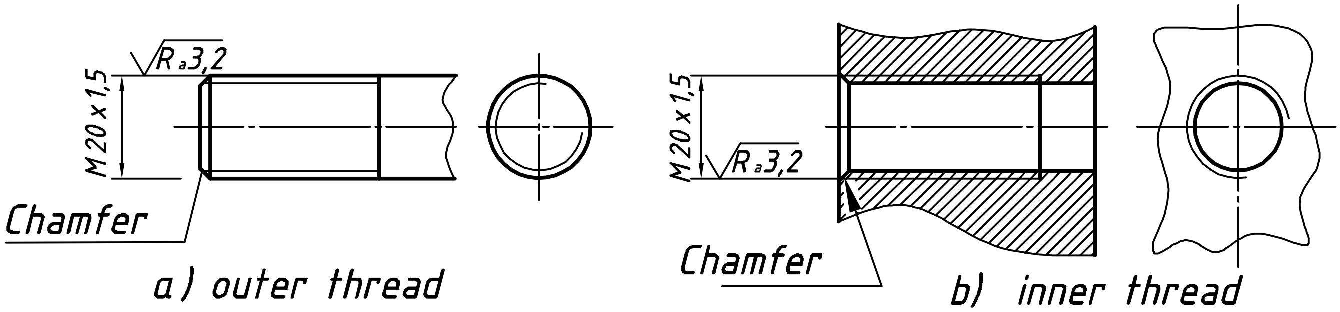


Fig.5.3

A conical chamfer with an angle of 30 ° is performed on the outer hexagonal prismatic surface (Fig. 5.4). Bevel cut lines with prism faces - hyperbolas. Hyperbolas of cut lines on technical drawings are replaced by arcs of circles. The construction of arcs of circles is shown in Fig. 5.10.

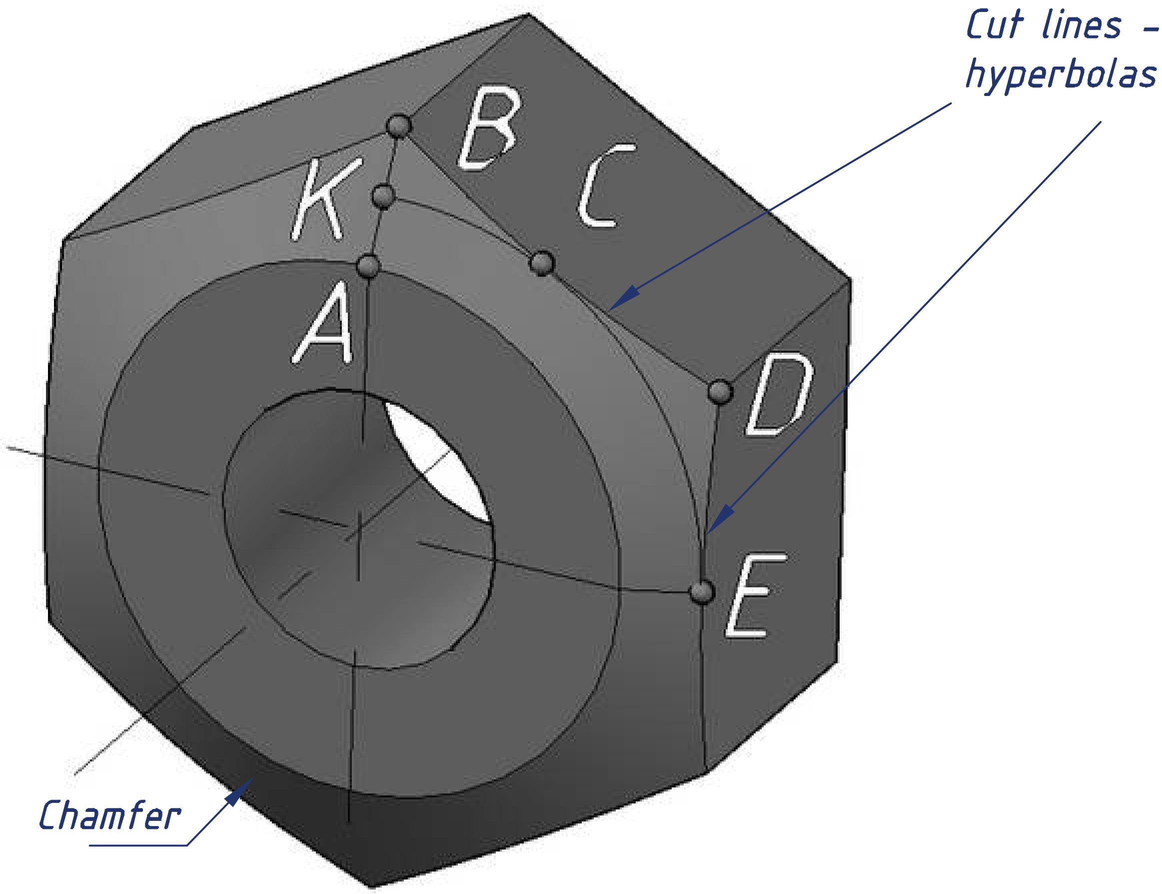


Fig. 5.4

5.4 Wrench size. You can install (screw) the workpiece with a tool - a wrench (Fig. 5.5) or by hand.

A hexagonal prismatic or other surface is done to work with a wrench. On the working drawing of a workpiece it is necessary to show the wrench size S (Fig. 5.5).

The following are the dimensions S provided by DSTU GOST 13682: 2008 and the diameters of the circles described around the hexagons:

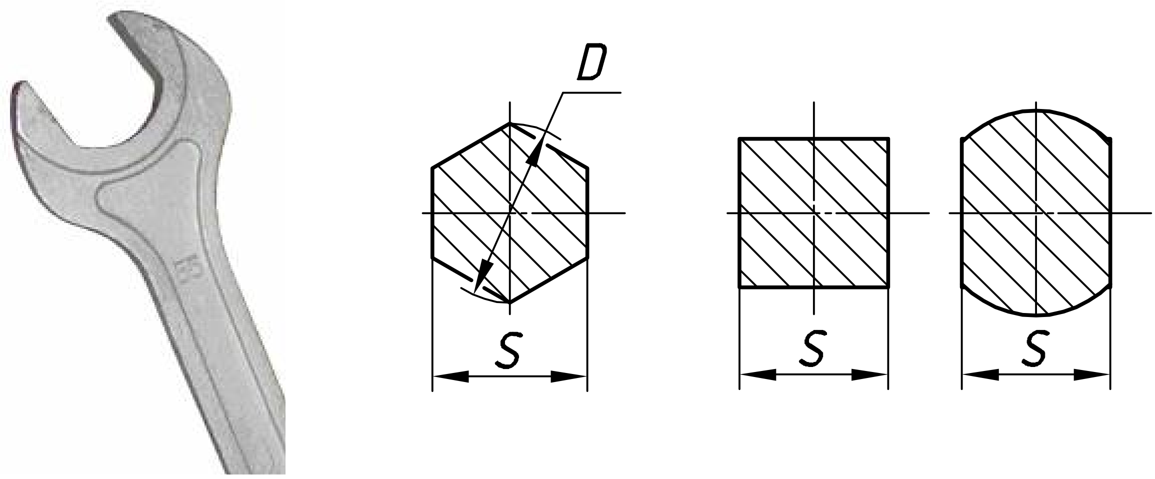


Fig. 5.5

Table 5.1 Dimensions S and diameters of the circles described around the hexagon DSTU GOST 2839: 2008

S	2,5	3	3,2	4	5	5,5	6	7	8	9	10
D no less	2,7	3,3	3,5	4,4	5,5	6	6,1	7,7	8,8	9,8	10,9
S	11	12	13	14	15	17	19	22	24	27	30
D no less	12	13,2	14,2	15,2	16,1	19,7	20,9	24,3	27,7	29,9	33
S	32	36	41	46	50	55	60	65	70	75	80
D no less	35	39,6	45,2	50,9	56,1	60,8	67,4	72,1	78,6	83,4	89

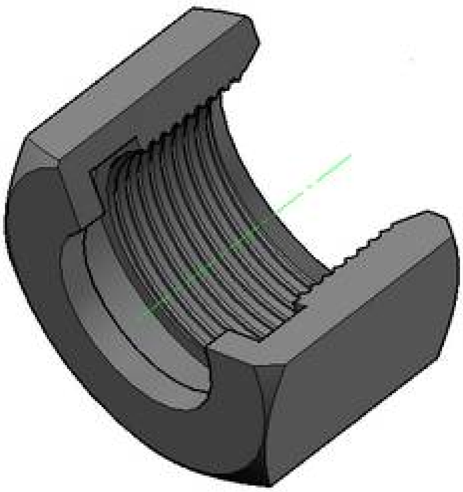


Fig. 5.6

In Fig. 5.6 shows an axonometric projection of a threaded part, and in Fig. 5.11 - an example of a working drawing of this part. Its main type corresponds to the position of the part on the lathe during machining.

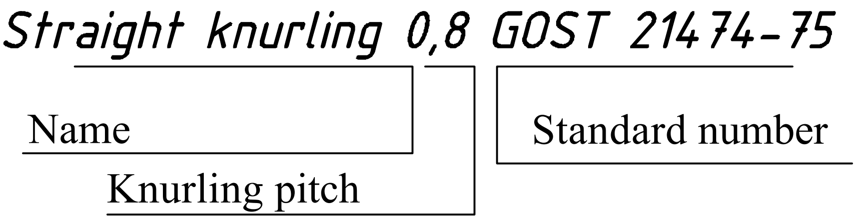
The view on the left specifies the shape of the side face surface (wrench size S = 41 mm). In order to reveal the shape and dimensions of the runout for the thread, the detail drawing A of this runout is made on a scale (5: 1).

5. Knurling. For convenience of installation of a workpiece carry out knurling of a surface which can be straight (Fig. 5.7, a) and double (Fig. 5.7, b).

Knurling pitch P is the distance between adjacent knurling combs. It depends on diameter D, width B of a rolling surface and on material of preparation. The knurling sizes are provided by GOST 21474-75 and are shown in Tab. 5.2.

Table 5.2 Dimensions of knurling

Material Billets	Width rolled surface, **B**, mm	Diameter of the rolled surface **D**, mm			
		to 8	Over 8 to16	Over 16 to 32	Over32 to 63
		Knurling pitch P , мм			
Straight knurling					
All materials	To 4	0,5	0,5	0,6	0,6
	Over 4 to 8	0,5	0,6	0.6	0,6
	Over 8 to 16	0,5	0,6	0,8	0,8
	Over 16 to 32	0,5	0,6	0,8	1
	Over 32	0,5	0,6	0,8	1
Double knurling					
Non-ferrous metals and alloys	To 8	0,5	0,6	0,6	0,6
	Over 8 to 16	0,5	0,6	0,6	0,8
	Over to 32	0,5	0,6	0,o	1
	Over 32	0,5	0,6	0,8	1
Steel	To 8	0,5	0,6	0,8	0,8
	Over 8 to 16	0,5	0,8	1	1
	Over to 32	0,5	0,8	1	1,2
	Over 32	0,5	0,8	1	1,2


Straight knurling 0,8 GOST 21474-75
Name
Knurling pitch
Standard number

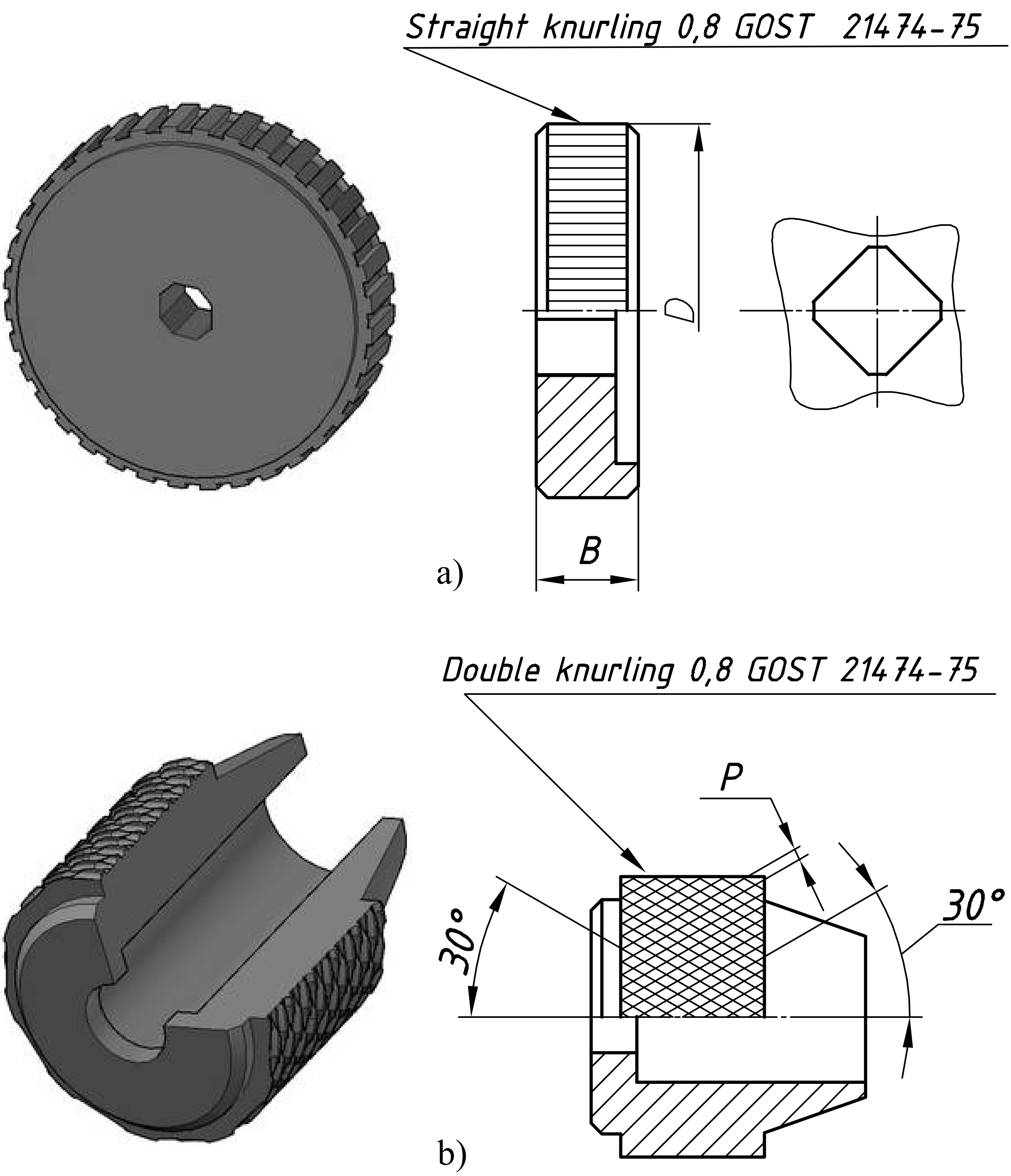

Straight knurling 0,8 GOST 21474-75
D
B
a)
Double knurling 0,8 GOST 21474-75
P
30°
30°
b)

Fig. 5.7

5.6 The order of the thread workpiece sketch

1. Analyze the shape of the part, determine its structural and technological elements: holes, grooves,runouts, threads, chamfers, flats, knurling.
2. Select the main view of the part if it is machining on a lathe. Therefore, the axis of the main view is located horizontally. The main view should provide the most complete information about the shape and size of the part. Hence, the maximum number of faces must be given on the main view (Fig. 5.8).
3. Set the image on the A3 size paper with a screen . Use a pencil brand M, 2M (or B, 2B).

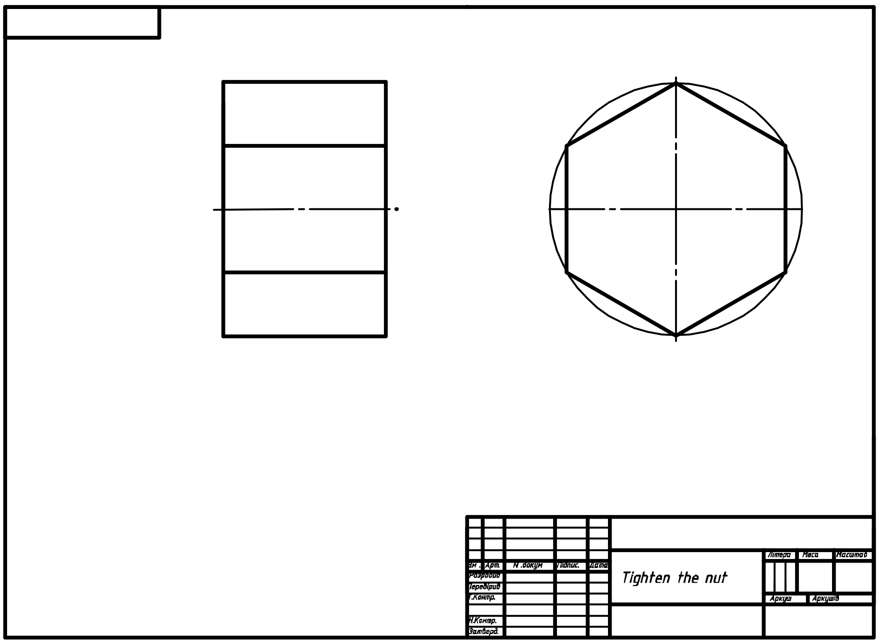


Fig. 5.8

4. Identify the necessary images: views, sections, sections and removal elements. The example (Fig. 5.8) shows the main view and the view on the left, because the part is faceted, you need to apply a "turnkey size" S, and you need to make a remote element of the runout to exit the cutter.
5. Determine the ratio of the dimensions of the part, notice the location of the images on the drawing, draw the axis of symmetry (Fig. 5.8).

6. Follow the outer contours of images, following proportions of workpiece elements. Show chamfers and grooves.
7. Make a section and a remote element (Fig. 5.9).
8. Draw a sketch with a solid base line, 1 mm thick and perform hatching of the section and the remote element.

Draw extension and dimension lines. The dimensions of the outer elements should be placed on the side of the view, and the inner ones on the side of the section.

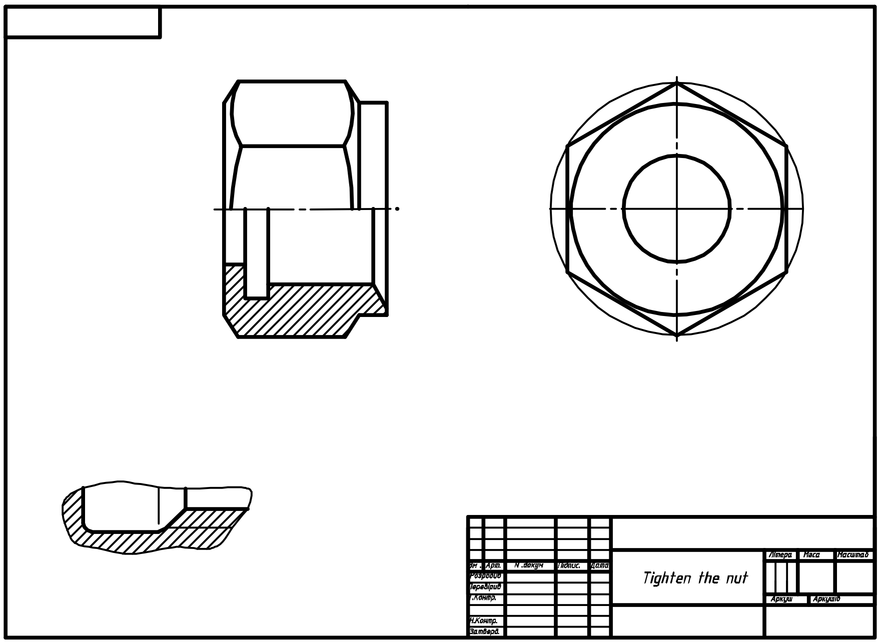


Fig. 5.9

9. On the outer hexagonal prismatic surface is a conical chamfer with an angle of 30 ° (Fig. 5.9, 5.11). Bevel cut lines with prism faces - hyperbolas. Hyperbolas of cut lines on technical drawings are replaced by arcs of circles. The construction of arcs of circles is shown in Fig. 5.10.

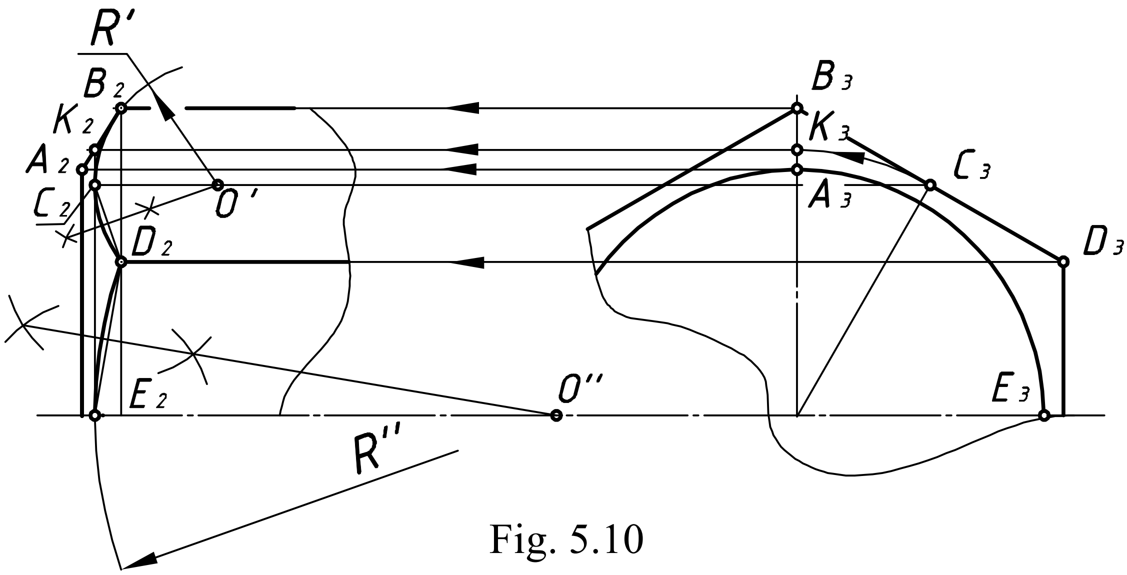


Fig. 5.10

10. Measure the part and plot the dimensional numbers. Measure the diameter and pitch of the thread (Fig. 5.11). Clarify their values according to tab. 1.1. The sizes of elements of a groove choose from tab. 1.3, 1.4. Specify the "turnkey size" S after measurement according to tab. 5.1.

11. Determine the surface roughness and mark it on the sketch.

12. Put the technical requirements and fill in the main inscription.

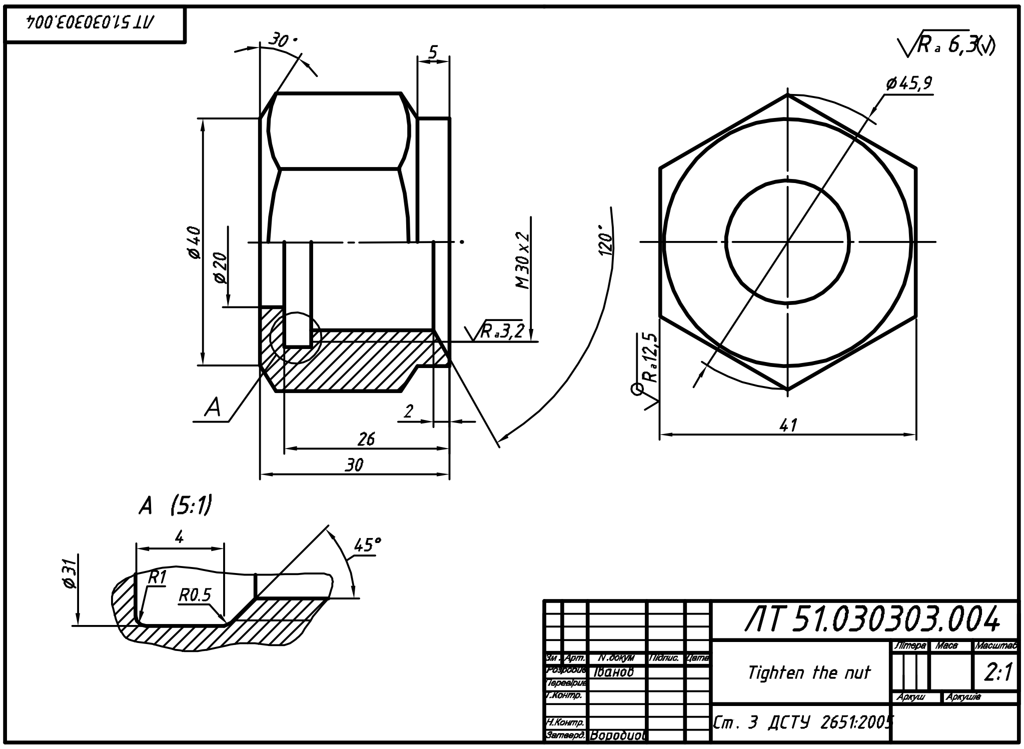


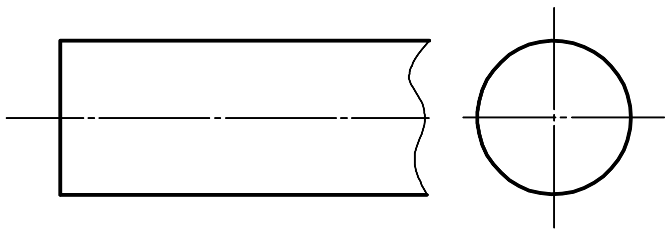
Fig. 5.11

Questions for self-preparation

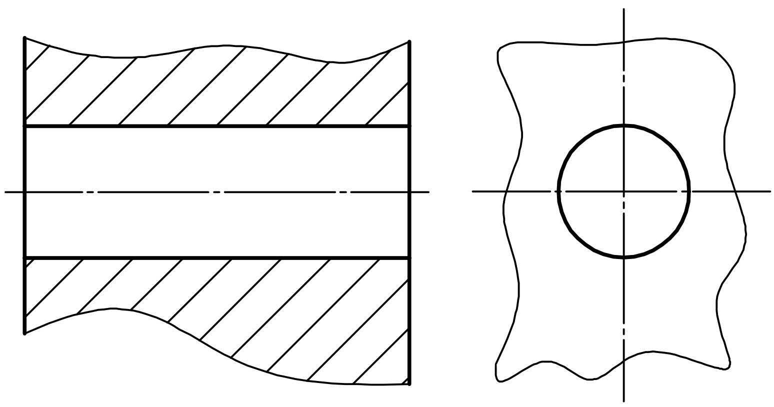
1. Write down the dimensions of the normative runout for the inner thread M20x1.5

R= R1= f = df = z=

2. Show and mark a metric thread, the nominal diameter of which is 30 mm with a coarse pitch P=3.5 mm.



3. Show and mark the metric thread, the diameter of which is 42 mm with a fine pitch P=4 mm.



4. What drawings are named "working drawings"?
5. What drawings are named "sketches"?

6. WORKING DRAWING OF "SHAFT"- TYPE WORKPIECE

Shaft - is a moving workpiece of the machine, which is fixed and rotates in two support bearings for torque transmission with the help of mounted parts on it (gearwheels, pulleys, etc.).

Regardless of the complexity of the shaft, the designer performs it as a set of simple geometric bodies or parts. A part of a workpiece that has a specific technological or design purpose is called "a workpiece element". In Fig. 6.1 shows an axonometric drawing of the shaft, which shows its structural and technological elements (centre holes, chamfers, fillets, grooves(runout), keyseats, thread, collars, flats).

6.1 Centre holes. They are performed at the ends of shafts, axles and other workpiaces for their installation (fixing) on the turning lathe for machining.

Standard DSTU GOST 14034: 2008 set 8 types of the centre holes shapes : A, B, C, E, R, F, H, T. The centre hole shape is depending on the shaft diameter and additional technological requirements.

Form A. The centre hole is not a multiply used base.

Form B. The centre hole is saved in the finished product.

Form C. For large shafts - similar to form A.

Form E. For large shafts - similar to form B.

Form R. With increasing processing precision.

Form T. For fines and calibers.

Forms F and N. For installation works and at storage and transportation of a shaft in vertical position.

The centre hole is not depicted in the drawing, but above the shelf footnotes write its symbol (Fig. 6.2, 6.3).

Symbol of the centre hole

Centre hole A3.15 DSTU GOST 14034: 2008

Item name

Standard number

Center hole shape.

Diameter **d** center hole.

An example of a working drawing of the shaft is given in D.5 (p. 94) and D.4-D.7 (p.93-96).

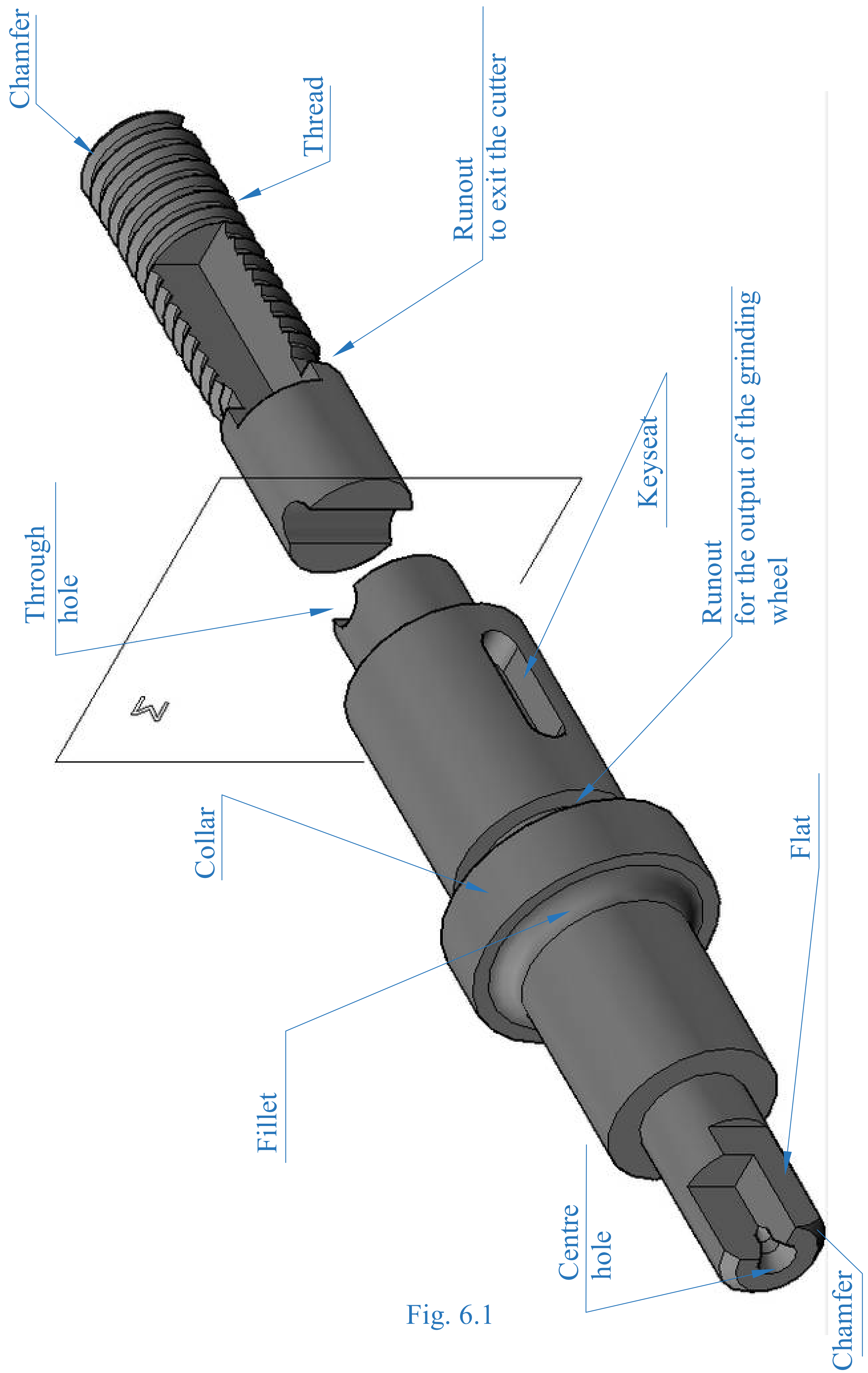

Chamfer
Thread
Runout
to exit the cutter
Through
hole
Keyseat
Runout
for the output of the grinding
wheel
Collar
Flat
Fillet
Centre
hole
Chamfer

Fig. 6.1

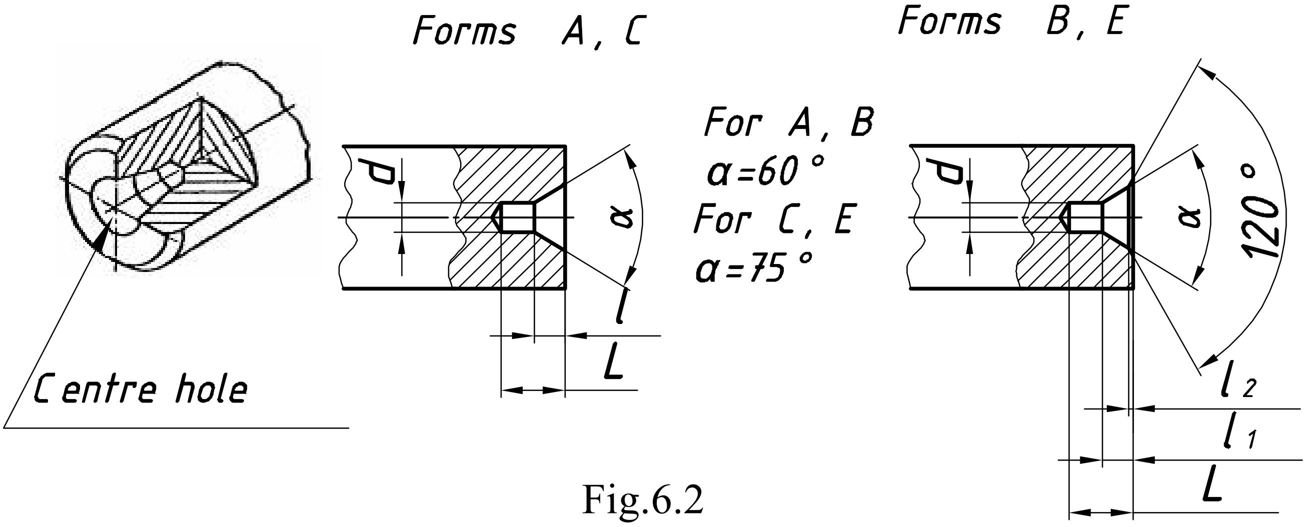
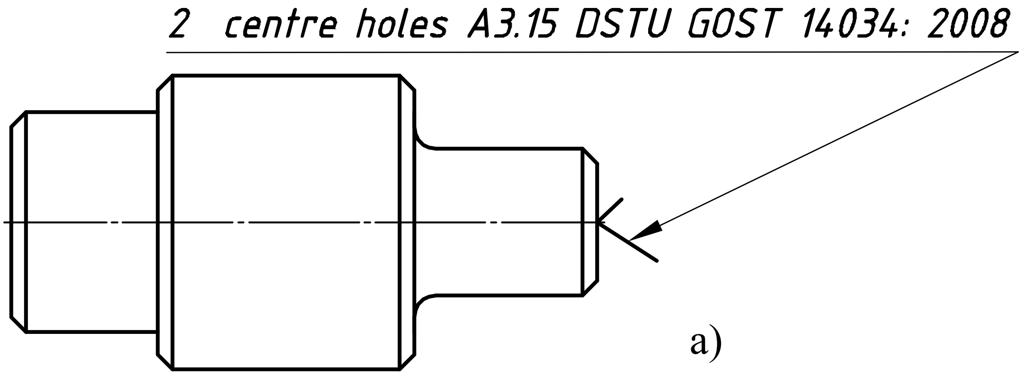


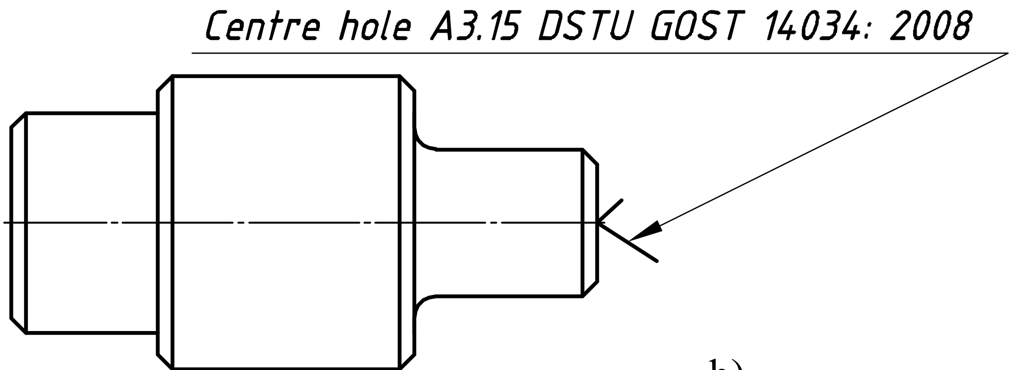
Fig.6.2

If the same centre holes are made at the both ends, the designation will be written as in Fig. 6.3, a.



a)

And if the centre hole on the main end of the part, then its designation has the form (Fig. 6.3, b):



b)

Fig 6.3

The diameters d of the centre holes should correspond to the dimensions of DSTU GOST 14034: 2008 and depend on the diameter D of the shaft blank. Dimensions d for form A are given in table. 6.1.

Table. 6.1 Diameters of centre holes d

D,мм	10	14	20	30	40	60
d_t, мм	2	2,5	3,15	4	5	6,3
l, мм	2,5	3,1	3,9	5	6,3	8
l_1, мм	1,95	2,42	3,07	3,94	4,75	5,95

Cylindrical surfaces are processed after making the centre holes, starting with the largest diameters. Smaller diameters are processed by layer-by-layer removal of the material. An example of step-by-step processing of a "Shaft"-type workpiece is shown in Fig. 6.4.

Stage 1. Making centre holes and diameter **D**

Stage 2. Making a cylindrical surface element with diameter **D_1** and length **l_1**.

Stage 3. Making a cylindrical surface element with diameter D_2 and length l_2.

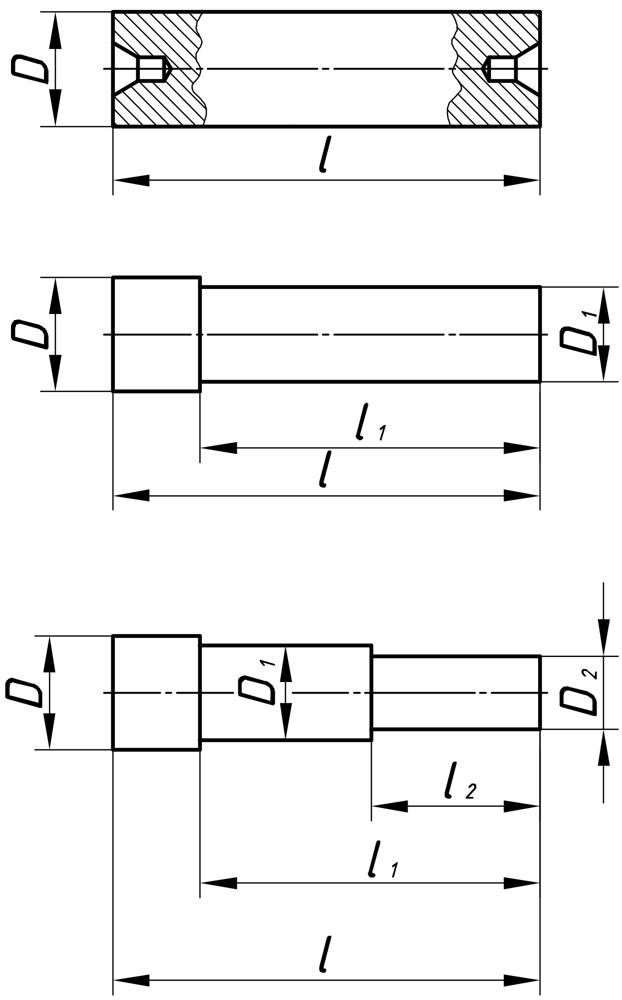


Fig. 6.4

6.2. Chamfers. Workpieces chamfered according to GOST 10948-64 (Fig.6.5,Tab.6.2) for the purpose of convenience of installation and protection of a shaft against damages .

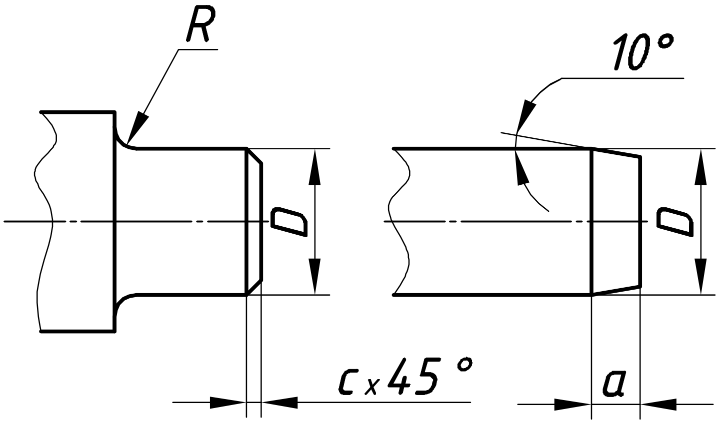
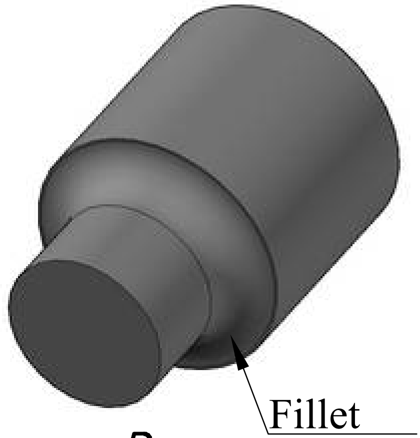


Fig. 6.5

Table 6.2. Dimensions of chamfers, mm

D	до 30	30-46	понад 46
c	2	2,5	2,5
a	0,5	1	1

6.3 Fillet. Fillet- a smooth transition along a curved surface from one stage of the shaft to another in places of a sharp diametr change (Fig. 6.6). The fillets increase the strength of the workpiece in places of abrupt transition, reducing internal stresses in this area. The sizes of fillets correspond GOST 10948-64 (Table 6.3).



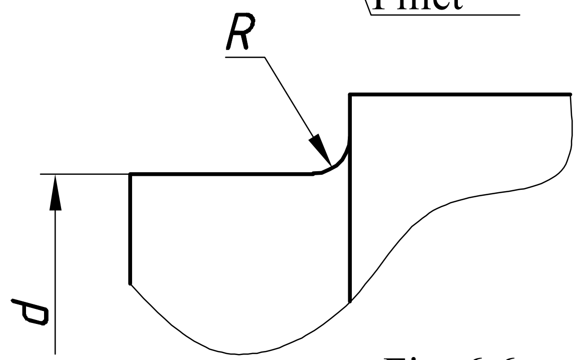


Fig. 6.6

Table 6.3 Fillet sizes, mm

d	10	15	20	25	50
R	0,5	0,7	I	1,25	2,5

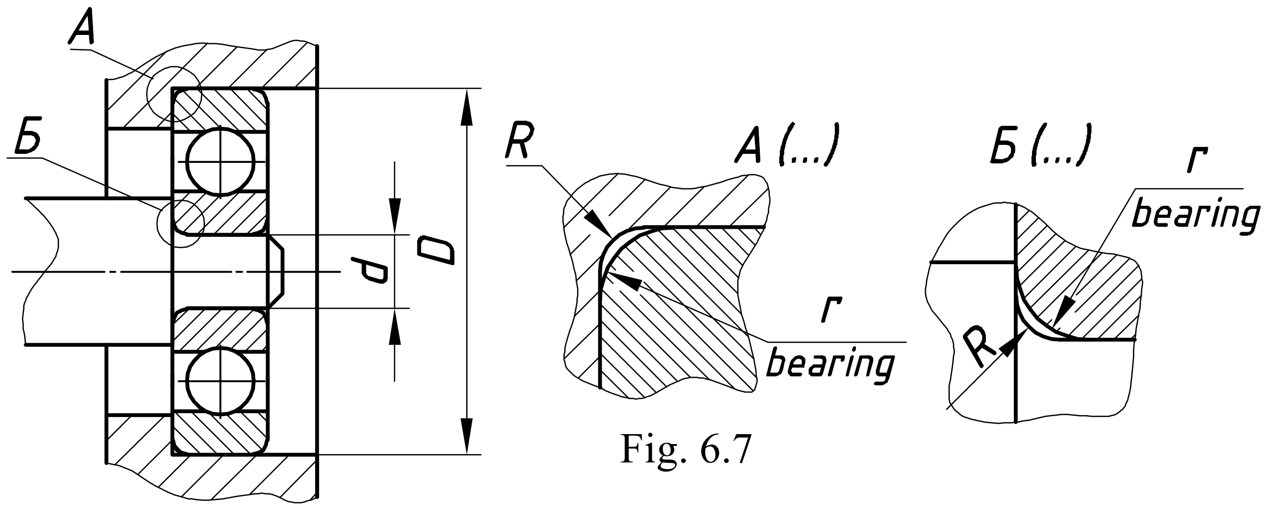


Fig. 6.7

The sizes of a shaft and body fillets for ball bearings according to GOST 3478-2012 (Fig. 6.7, Tab. 6.4).

Table 6.4 Single row ball bearings (GOST 3189-89)

Special light series					Easy series				
Bearing mark.	**d**	**D**	**r** bearing	**R**	Bearing mark.	**d**	**D**	**r** bearing	**R**
17; 18; 100; 101	7-12	19-26	0,5	0,3	27	7	22	0,5	0,3
104; 105	20-25	42-47	1	0,6	29-203	9-17	30-40	1	0,6
106; 110	30-50	55-75	1,5	1	204-206	20-30	47-62	1,5	1
111; 117	55-85	90-130	2	1	207-210	35-50	72-90	2	1

6.4. Collar (flange) - a workpiece annular protrusion , designed to create the necessary thrust surface (Fig. 6.8), to prevent the loss of the part (sleeve), Fig. 6.9.

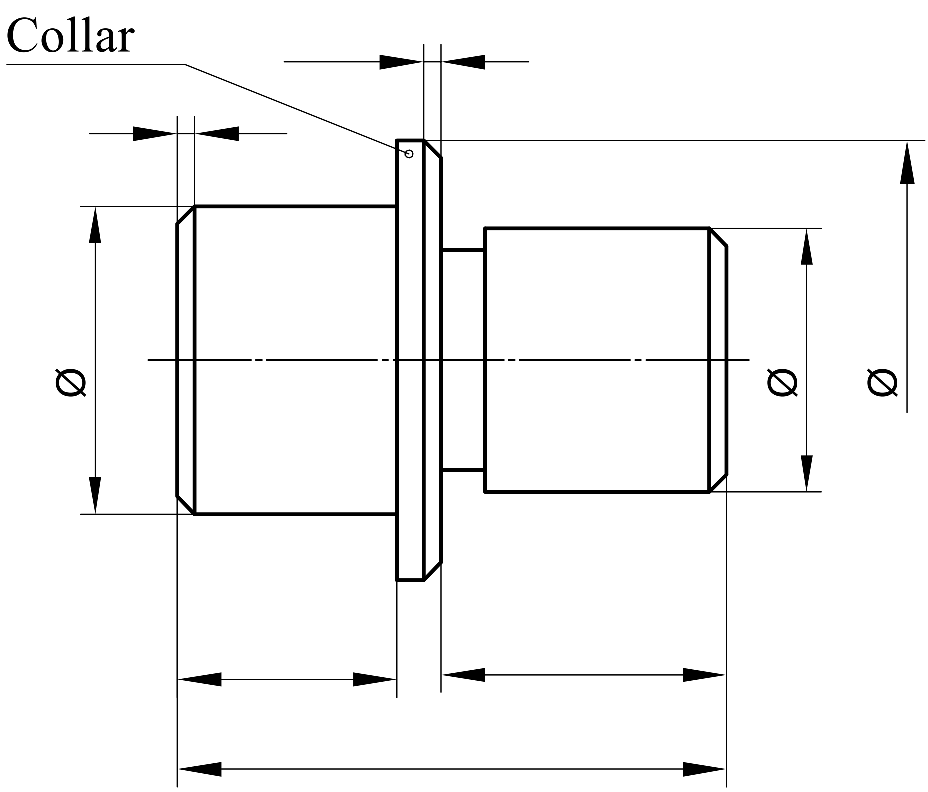


Fig. 6. 8

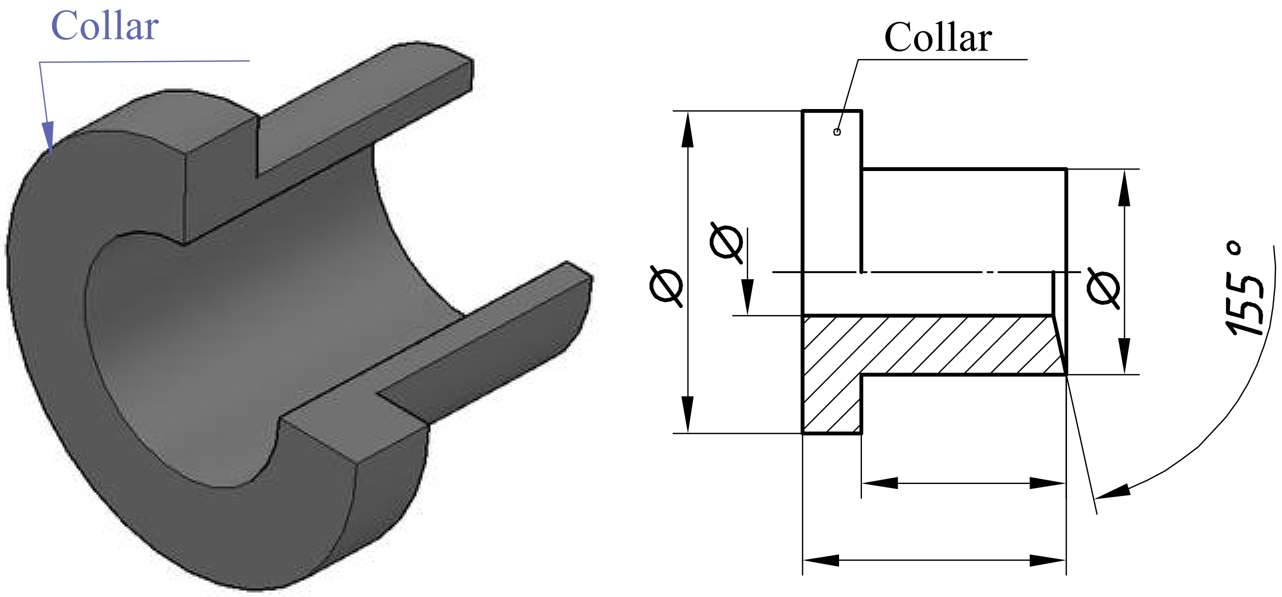


Fig. 6.9

Collars at the fittings outlets (tees, couplings) are necessary for strengthening of these parts (fig. 6.10).

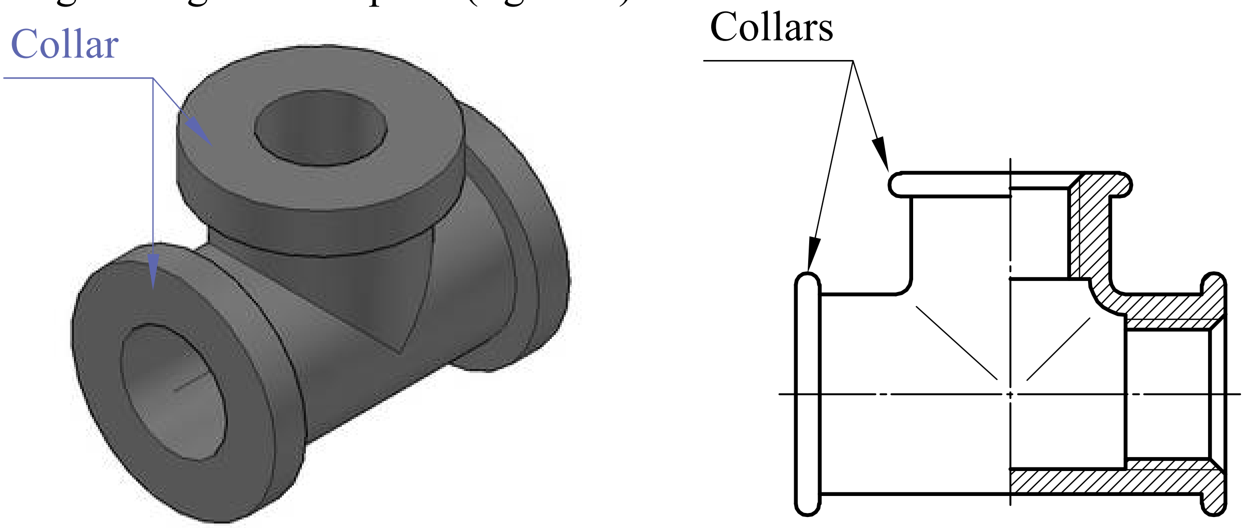


Fig. 6.10

As shown in Fig. 6.9, the thickness of the flange is not specified, because this size is compensating in dimensional chain .

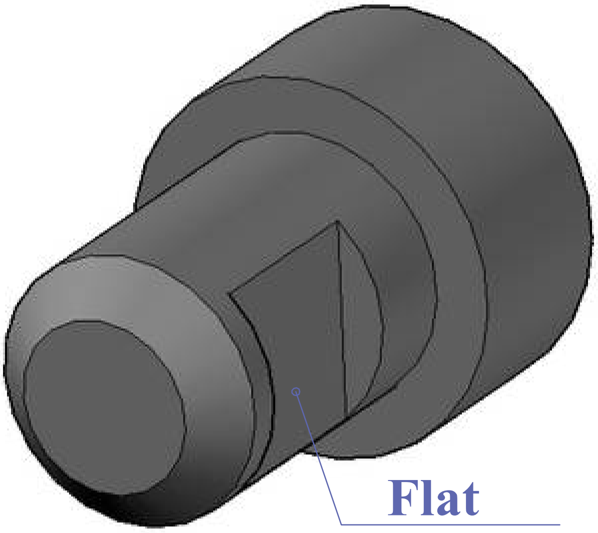
6.5 Flats. It is a flattened surface on the body of rotation. Flats are made on one (Fig. 6.11), on two (Fig. 6.12) or on four sides (Fig. 6.14) of parts for wrapping with a wrench or for connection with another workpiece (Fig. 6.13).

Flats are usually made on the shaft shank (tailpiece).

6.6 The shank (tailpiece) is the end of the workpiece by which this onet is installed and fixed in the holes of other workpiece. Shanks of shafts and spindles are shown in Fig. 6.11-6.14.

The form and the sizes of diameters, squares and flat shanks are set by DSTU GOST 9523: 2008 (ISO 237-75).

The main parameters are given in Table. 6.5.



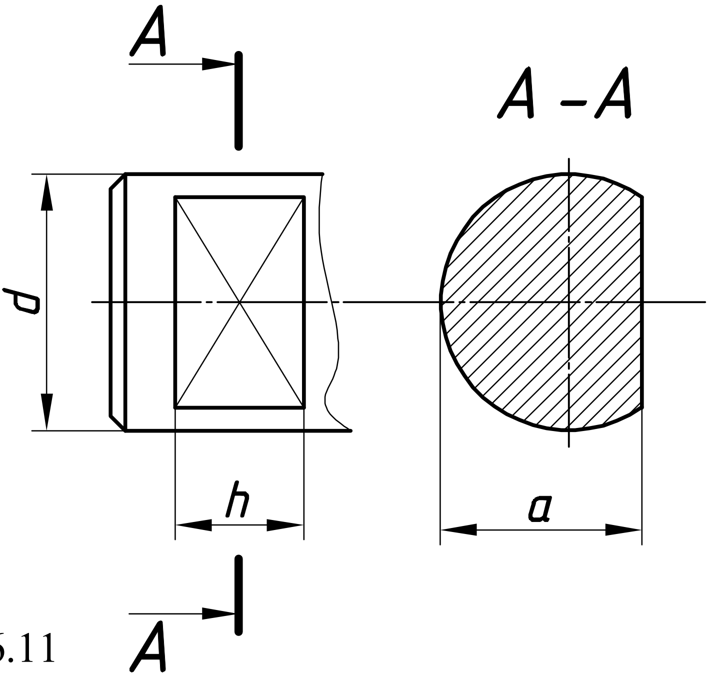
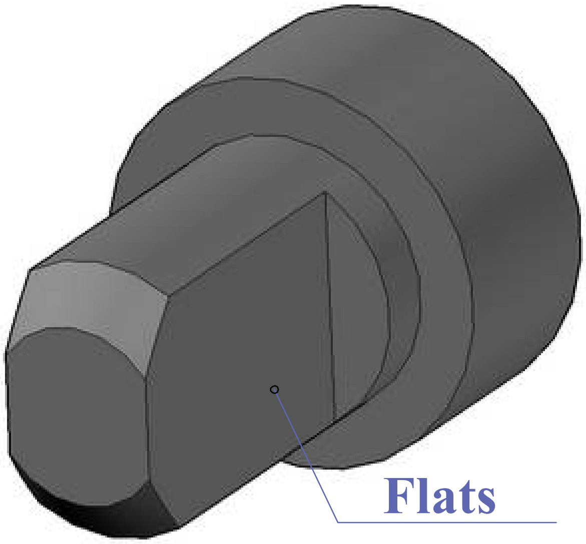


Fig. 6.11



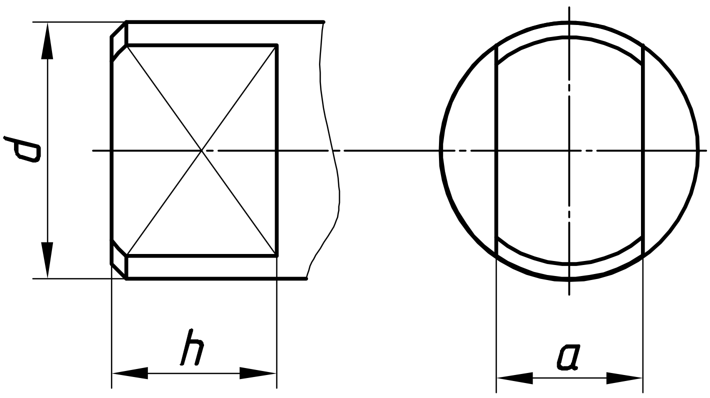
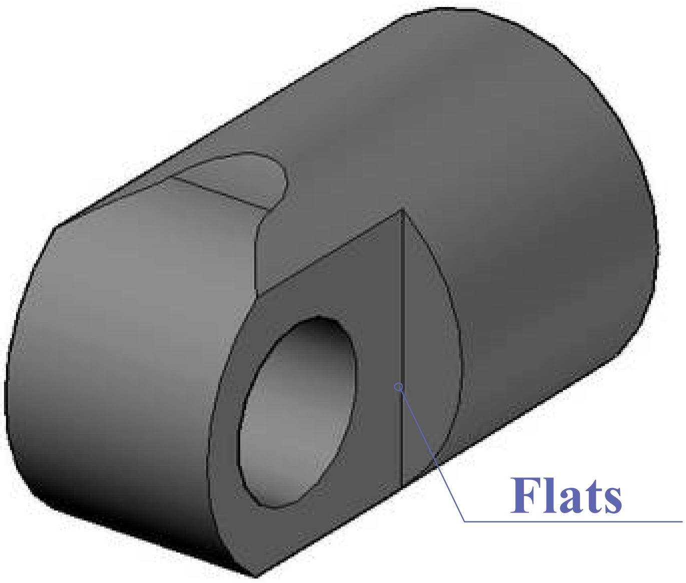


Fig. 6.12



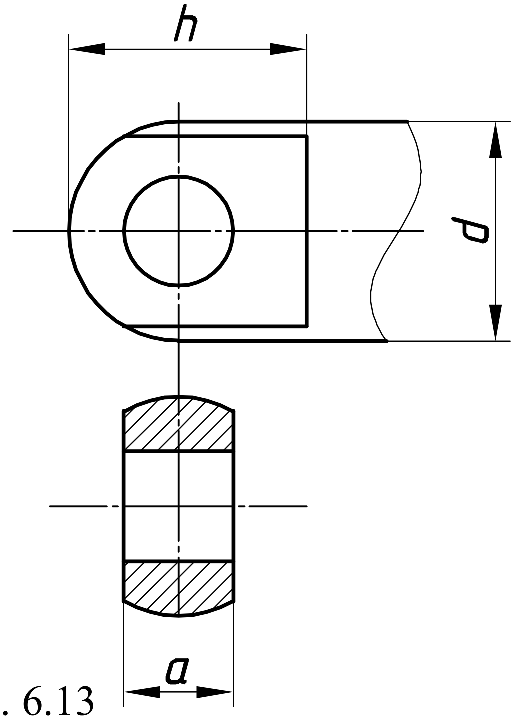


Fig. 6.13

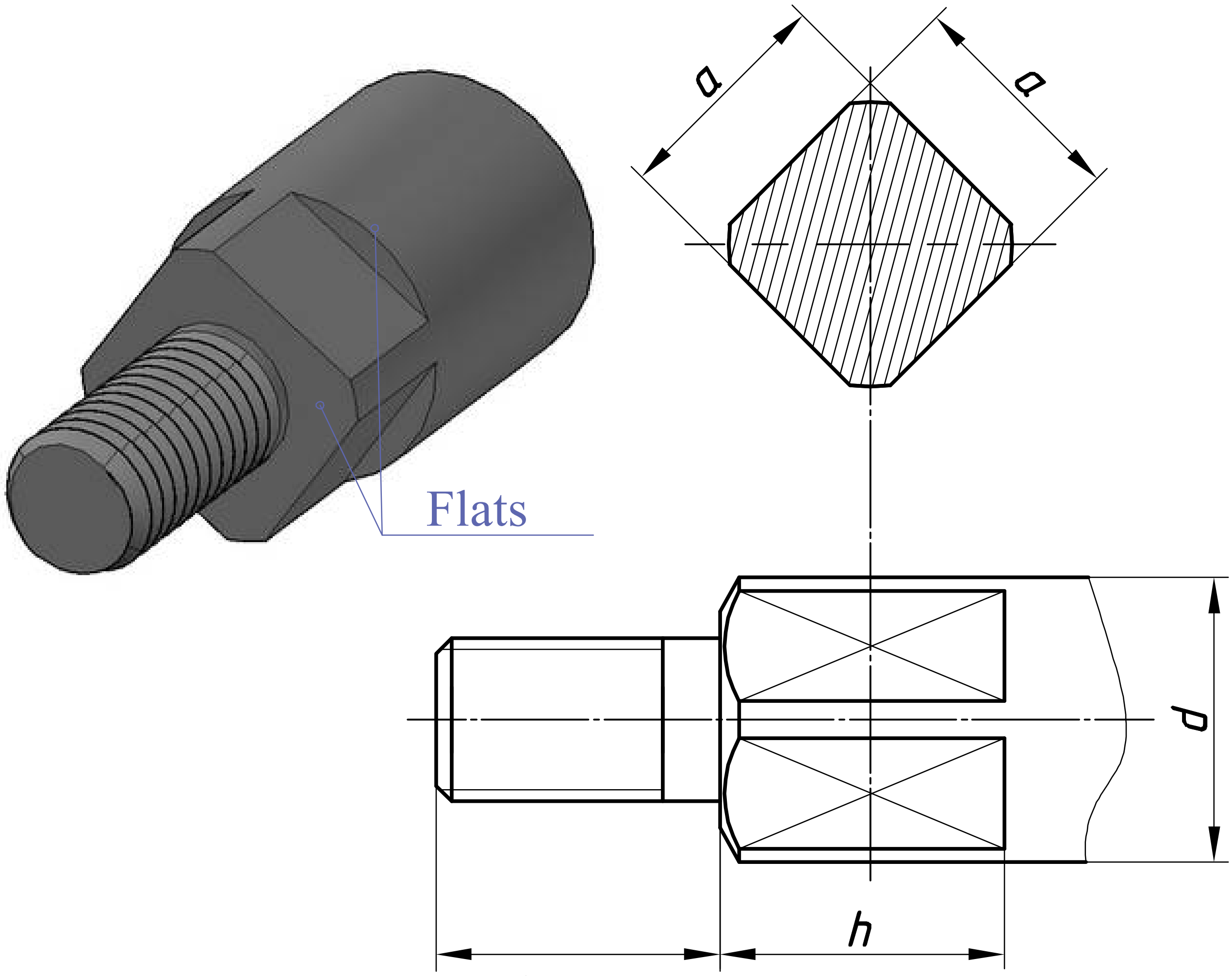


Fig. 6.14

Table 6.5 Dimensions of diameters, squares and flats of shaft shanks DSTU GOST 9523: 2008

Shaft diameter, d, mm	***a*, mm**	**Length h (Fig6.14)**	**Type 2 nd, mm (Fig. 6.11-6.12)**
7,10	5,60	8	
8,00	6,30	9	
9,00	7,10	10	7,00
10,00	8,00	11	
11,20	9,00	12	
12,50	10,00	13	
14,00	11,20	14	9,00
16,00	12,50	16	
18,00	14,00	18	
20,00	16,00	20	
22,40	18,00	23	11,00
25,00	20,00	24	
28,00	22,40	26	

6.7 Runout (groove) for the output of the grinding wheel during internal grinding (Fig. 6.15, 6.16 a), external grinding (Fig. 6.17 a) are set with GOST 8820-69 and shown in Fig. 6.16 and 6.17.

The dimensions are given in Table. 6.6.

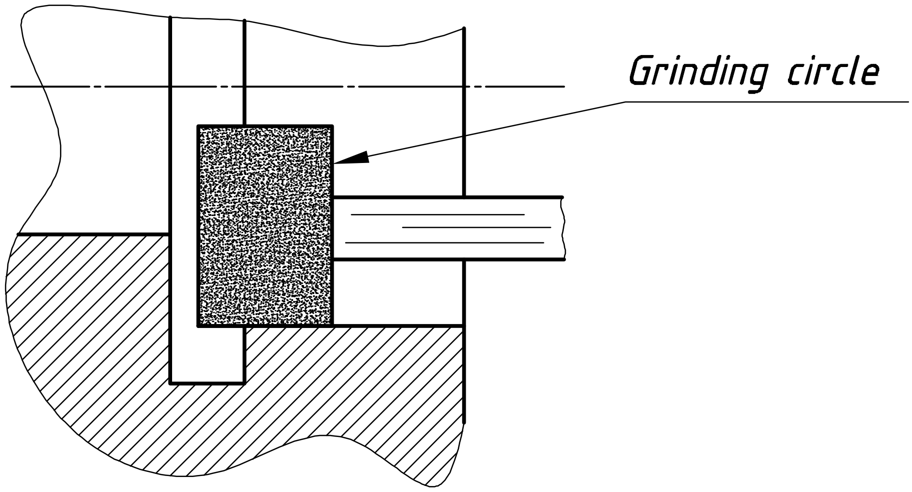


Fig. 6.15

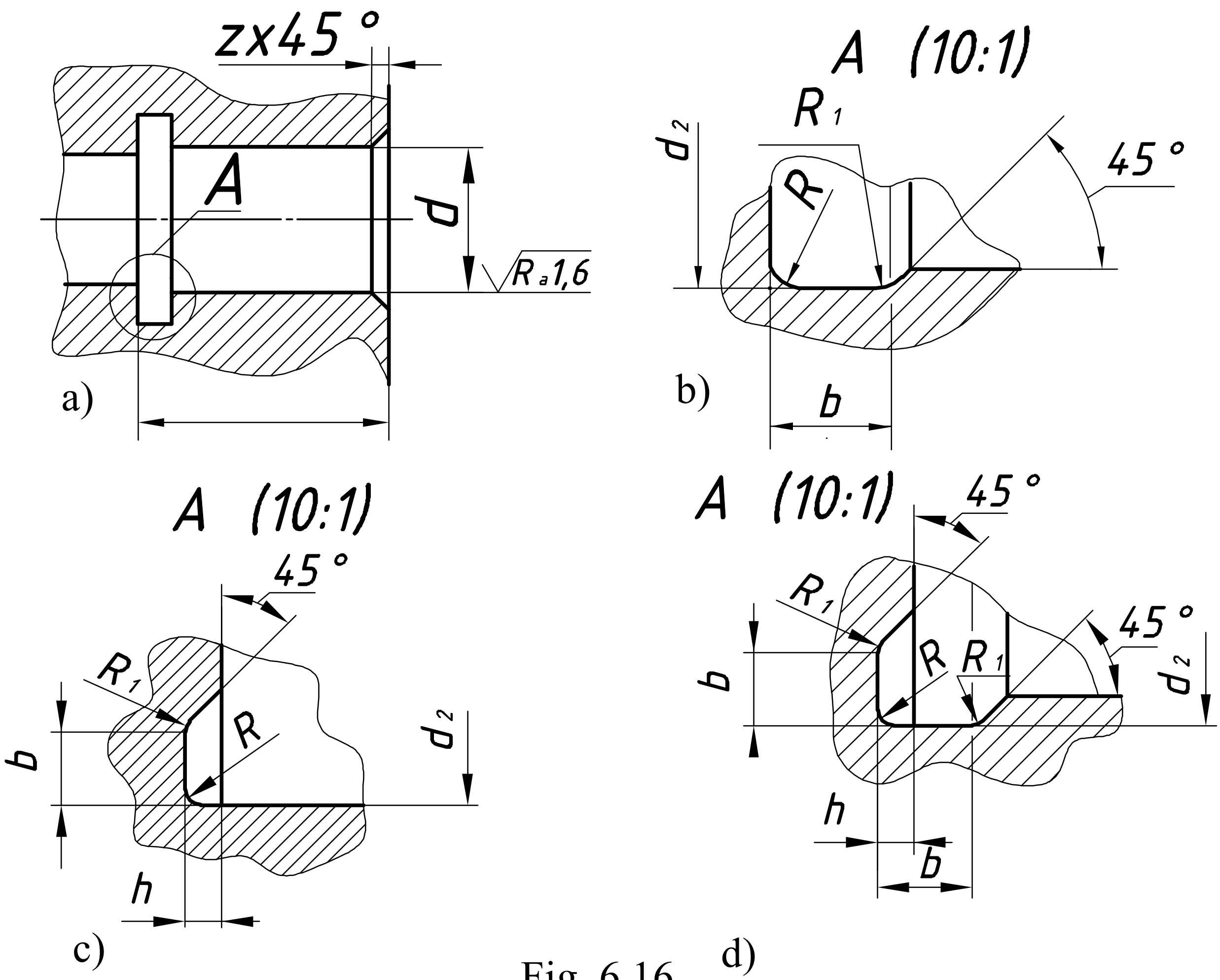


Fig. 6.16

a - runout (groove) for internal grinding; b - on the cylinder; c - on an end face; d - on the end face and the cylinder

Table 6.6 Dimensions of the runouts (grooves) for the grinding exit

d	***b***	***h***	***r***	***r1***	***d₁*** external grinding	***d₂*** internal grinding
<10	1	0,2	0,3	0,2	d - 0,3	d+ 0,3
	1,6	0,2	0,5	0,3	d - 0,3	d+0,3
	2	0,3	0,5	0,3	d - 0,5	d+ 0,5
More than 10 to 50	3	0,3	1	0,5	d - 0,5	d+ 0,5
More than 50 to 100	5	0,5	1,6	0,5	d -1	d+ 1
More than 100	8	0,5	2	1	d -1	d+ 1
	10		3			

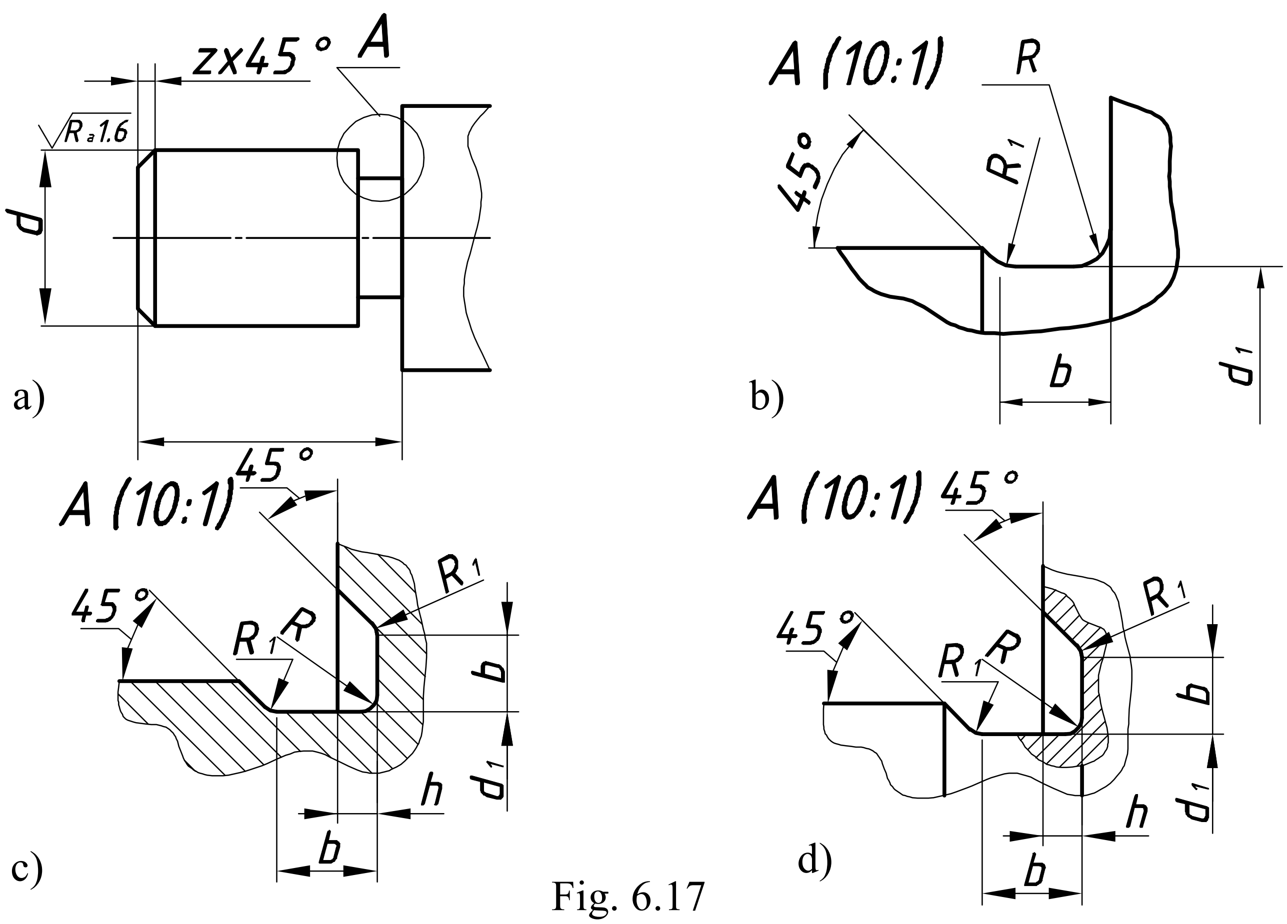
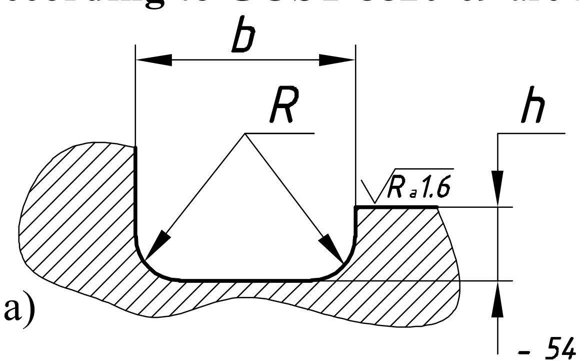


Fig. 6.17

a - grooves for external grinding; b - on the cylinder; c - on an end face; d - on the end face and the cylinder

The grooves for the output of the grinding wheel in flat grinding according to GOST 8820-69 are indicated as follows (Fig.6.18)



b	h	R
2	1,6	0,5
3	2	1,0
5	3	1,6

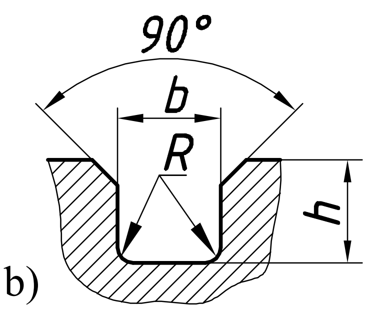
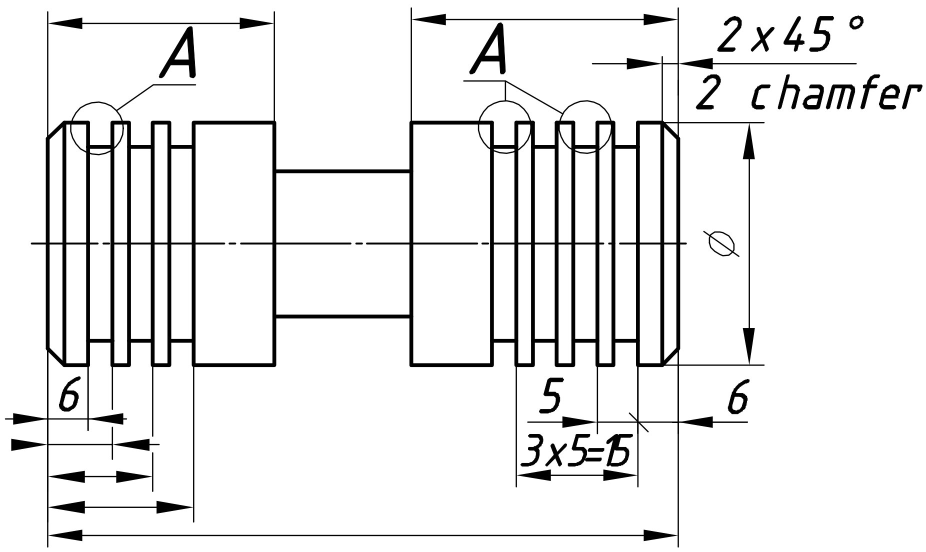
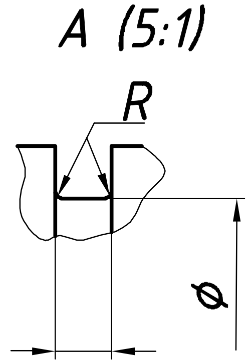


Fig. 6.18

6.8 Oil sealing grooves and grooves for retaining rings are performed on the surfaces of shafts (spools) in hydraulic cylinders and high pressure valves (Fig. 6.19 a, b).





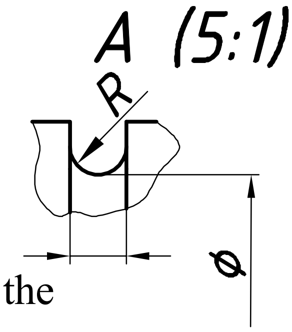


Fig. 6.19 a)

Table 6.7 The main dimensions of the rings and grooves on the shafts GOST 13942-86

Conditional diameter **d**	Inner diameter **d2**	The thickness of the ring **S**	The diameter of the groove of the shaft **d1**	Shaft groove width **m**
9	8,2	1	8,5	1,2
10	9,2		9,5	
11	10,2		10,5	
12	11		11,3	
13	11,9		12,2	
14	12,9		13,2	
15	13,8		14,1	
16	14,7	1,2	15	1,4
17	15,7		16	
18	16,5	1,2	16,8	
19	17,5		17,8	
20	18,2		18,6	
22	20,2		20,6	
23	21,1		21,5	
24	22,1		22,5	
25	23,1		23,5	
26	24		24,5	
28	25,8	1,2	26,5	
29	26,8		27,5	
30	27,8		28,5	
32	29,5		30,2	
34	31,4		32	
35	32,2	1,7	33	1,9
36	33		34	
37	34		35	
38	35		36	
40	36,5		37,5	
42	38,5		39,5	
45	41,5		42,5	
46	42,5		43,5	
48	44,5		45,5	

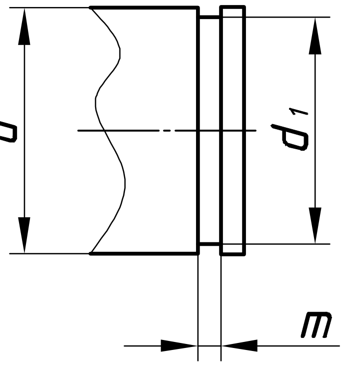


Рис.6.19 b)

Retaining ring

Fig. 6.19 c)

6.9 Keyseat (key groove) .Key groove - a recess or hole of oblong shape, usually made along the axis of the workpiece, bounded on the sides by parallel planes.

The keyseat is intended for a "key" workpiece which provides transfer of the torque and axial force in demountable connections.

By design, keys divided into prismatic (Fig. 6.20, 6.21), wedge and segment (Fig. 6.22).

Key grooves are standardized: for prismatic ones GOST 23360-78, for wedge - GOST 24068-80, for segment DSTU GOST24071: 2005 (ISO 3912: 1977). The sizes of key grooves under these keys (execution 1, 2) are shown in Fig. 6.21, 6.22 and in Table. 6.8, 6.9, 6.10.

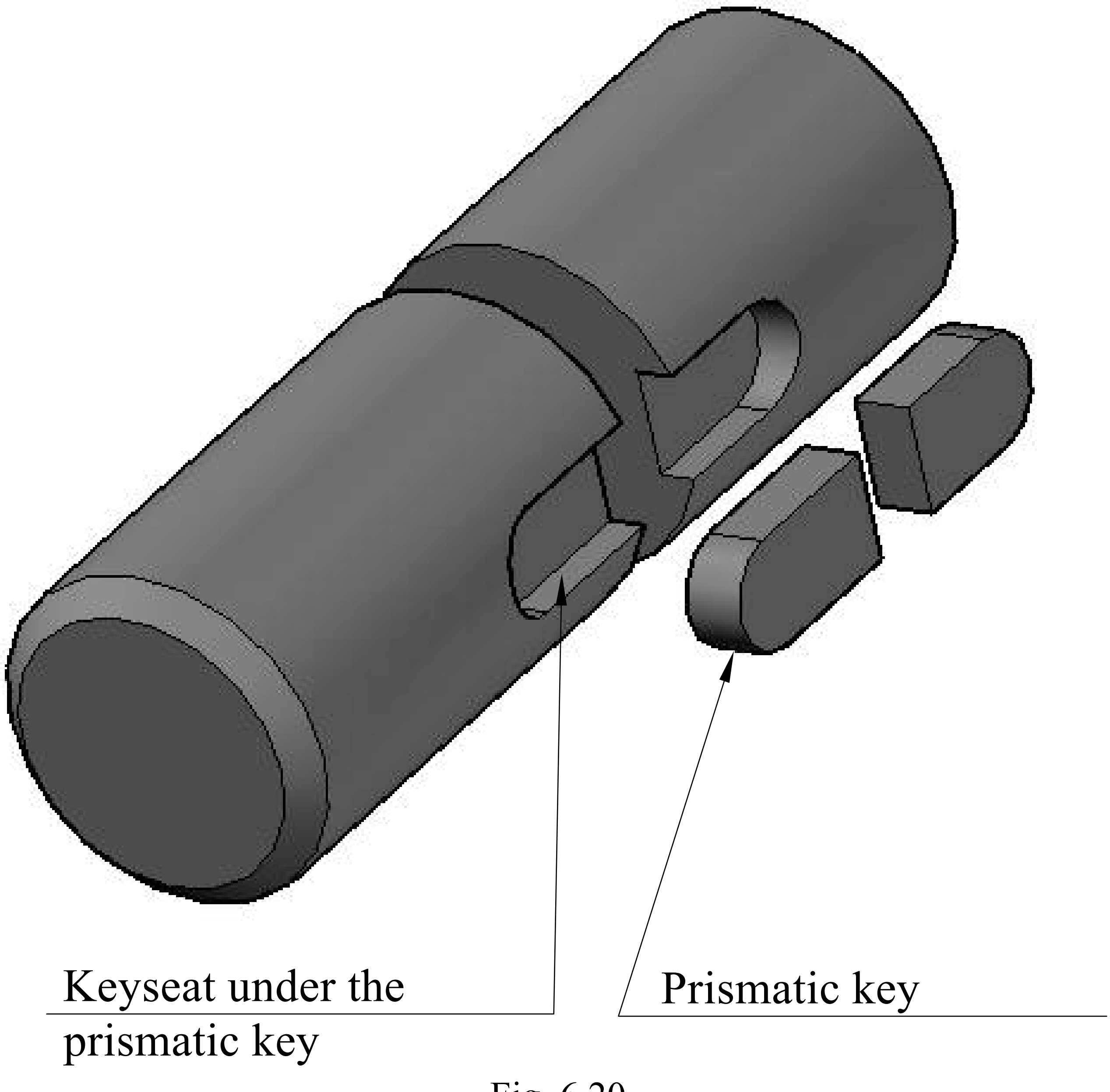


Fig. 6.20

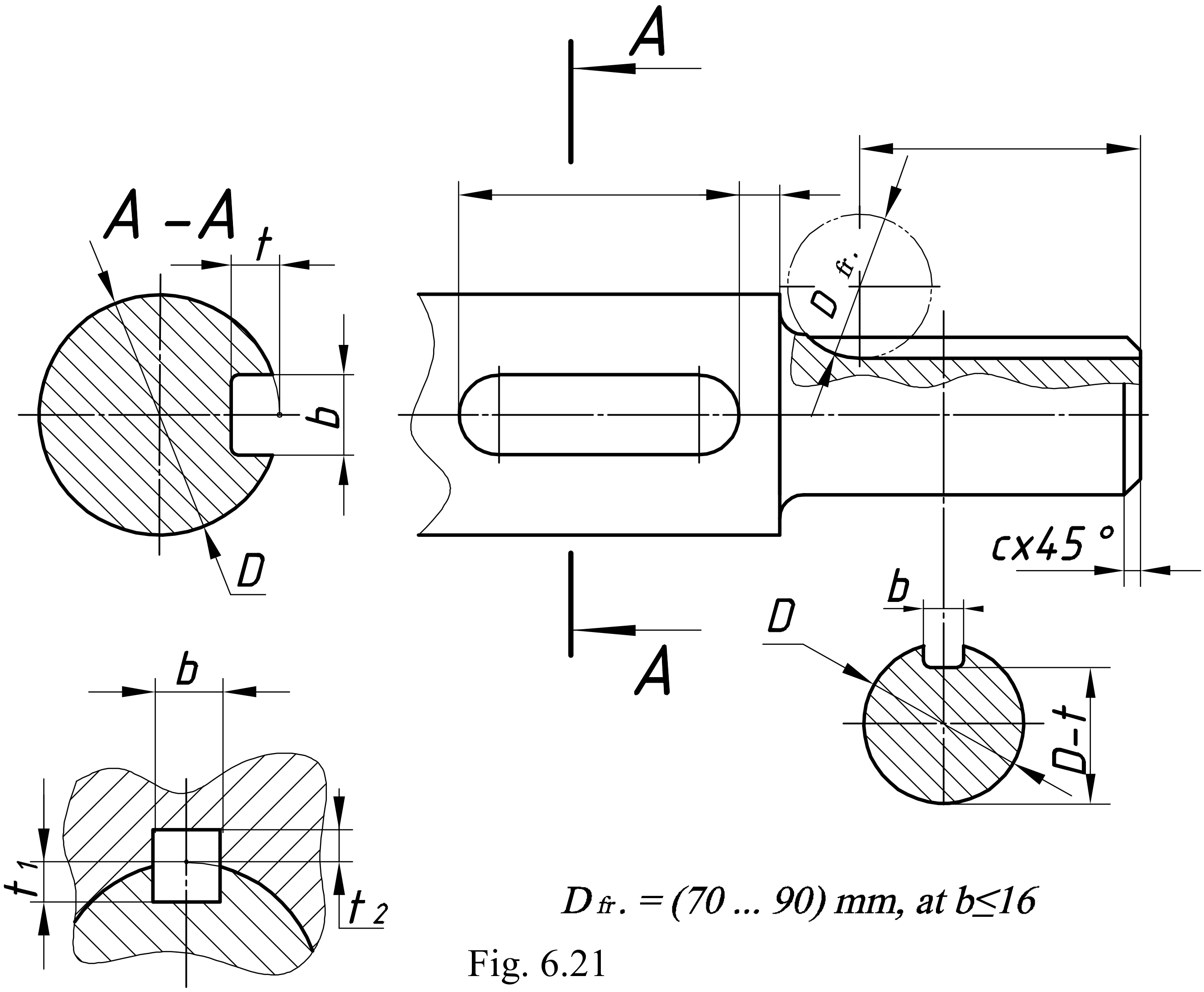


Fig. 6.21

Table 6.8. The sizes of keyseats under prismatic keys, mm

Shaft diameter	Groove width	Groove depth	
D	**b**	shaft **t1**	bushing **t2**
6-8	2	1,2	1
8-10	3	1,8	1,4
10-12	4	2,5	1,8
12-17	5	3	2,3
17-22	6	3,5	2,8
22-30	8	4	3,3
30-38	10	5	3,3
38-44	12	5	3,3
44-50	14	5,5	3,8
50-58	16	6	4,3
58-65	20	7	4,4

Table 6.9 Dimensions of keyseats for wedge keys, mm

Shaft diameter	Groove width	Groove depth	
D	**b**	shaft **t1**	bushing **t2**
6-8	2	1,2	0,5
8-10	3	1,8	0,9
10-12	4	2,5	1,2
12-17	5	3	1,7
17-22	6	3,5	2,2
22-30	8	4	2,4
30-38	10	5	2,4
38-44	12	5	2,4
44-50	14	5,5	2,9
50-58	16	6	3,4
58-65	20	7	3,4

A number of lengths of prismatic keys

6; 8; 10; 12; 14; 16; 18; 20; 22; 25; 28; 32; 36; 40; 45; 50; 56; 63; 70; 80; 90; 100; 110; 125

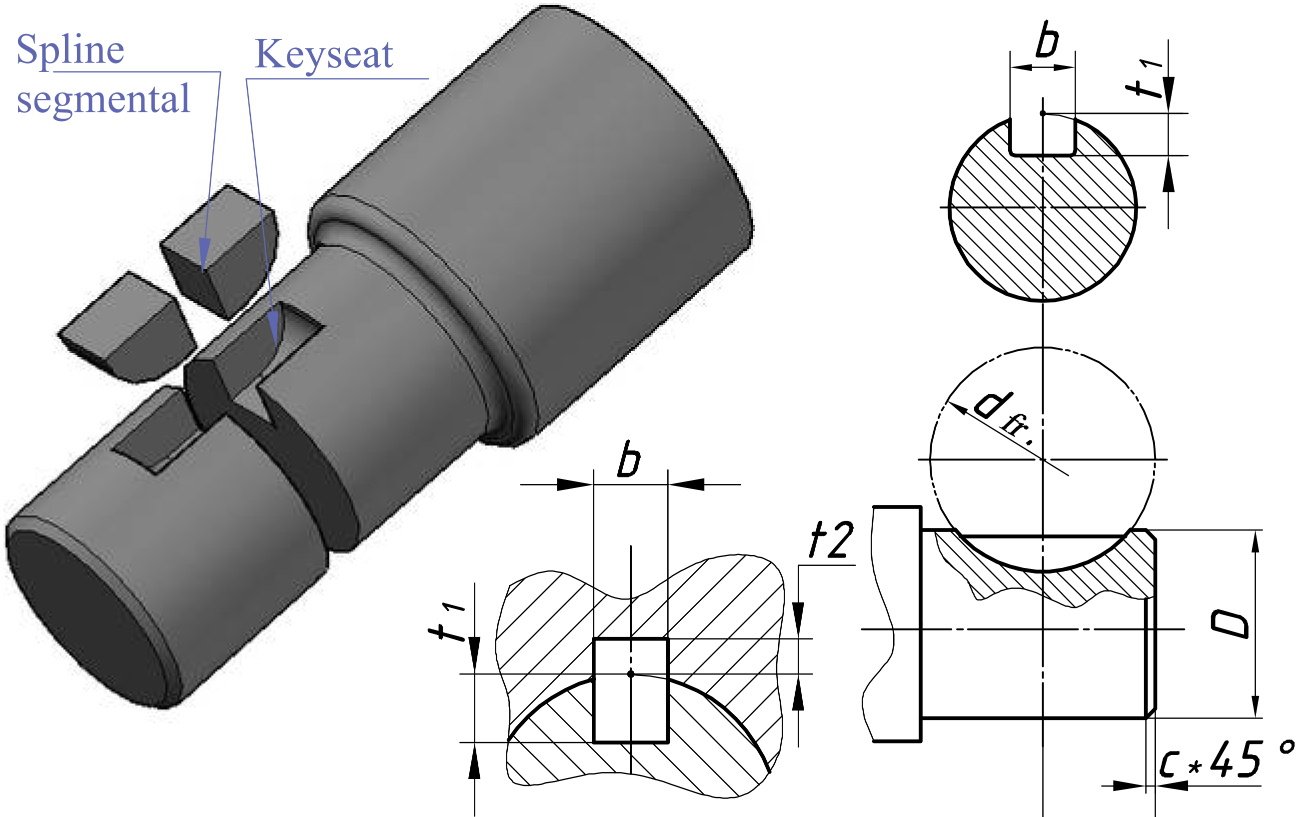


Fig. 6.22 Keyseat under the segment key

Table 28. The sizes of keyseats under a segment key, mm

Shaft diameter	Cutter diameter	Keyway		
		Groove width	Groove depth	
D	**d**	**b**	shaft **t1**	bushing **t2**
3-4	4	1	1	0,6
4-5	7	1,5	2	0,8
5-6	7	2	1,8	1
6-7	10	2	2,9	1
7-8	10	2,5	2,7	1,2
8-10	13	3	3,8	1,4
10-12	16	3	5,3	1,4
12-14	16	4	5	1,8
14-16	19	4	6	1,8
16-18	16	5	4,5	2,3
18-20	19	5	5,5	2,3
20-22	22	5	7	2,3
22-25	22	6	6,5	2,8
25-28	25	6	7,5	2,8
28-32	28	8	8	3,3
32-38	32	10	10	3,3

6.10 The order of the "Shaft" workpiece sketch

1. Analyze the design of the part and determine its structural and technological elements: centre holes, runouts for the grinding wheel exit, threads, chamfers, flats, fillets, collars and others (see Fig. 6.1).
2. Determine the main type of part. The axis of the main view is located horizontally, because the workpiece "Shaft" occupies a horizontal position during machining on a lathe and a more massive part towards the booklet (frame 20 mm.)
3. Determine the necessary images (except the main view): local views, sections, cross-sections and remote elements.
4. Set the image on theA3 size paper with a screen.
5. Determine the ratio of the dimensions of the workpiece and the location of the images in the sketch.
6. Draw the center lines and the outer contours of the main view, while maintaining the proportions of the elements of the part (Fig. 6.23).

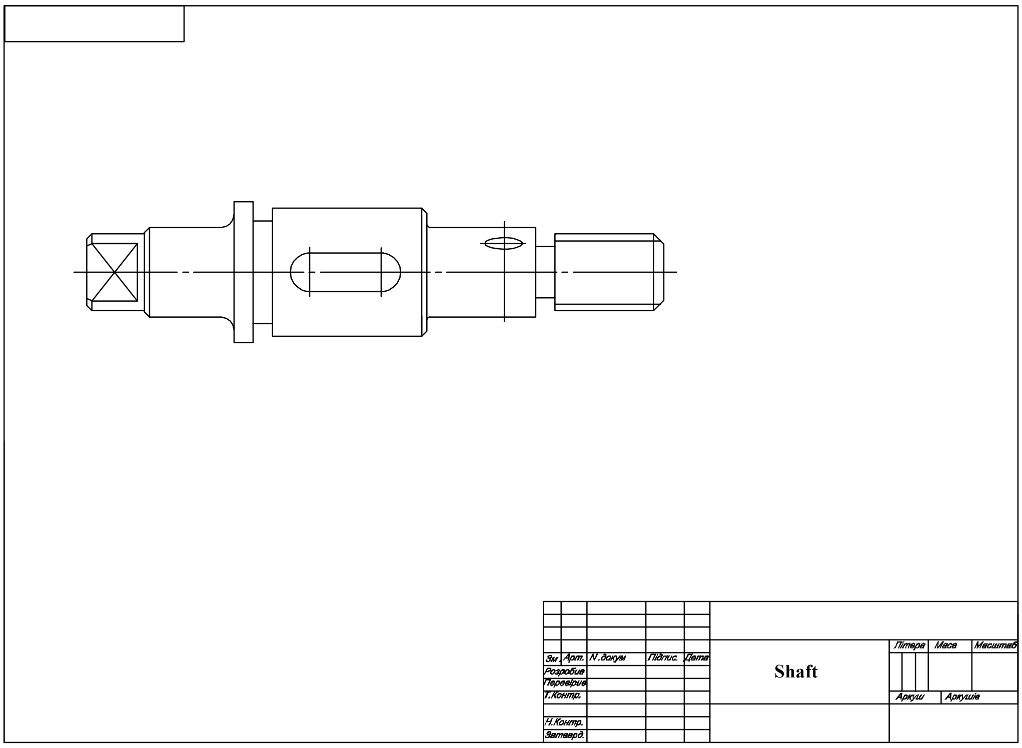


Fig. 6.23

7. Make sectional elevations, sections, local views and remote elements (Fig. 6.24).

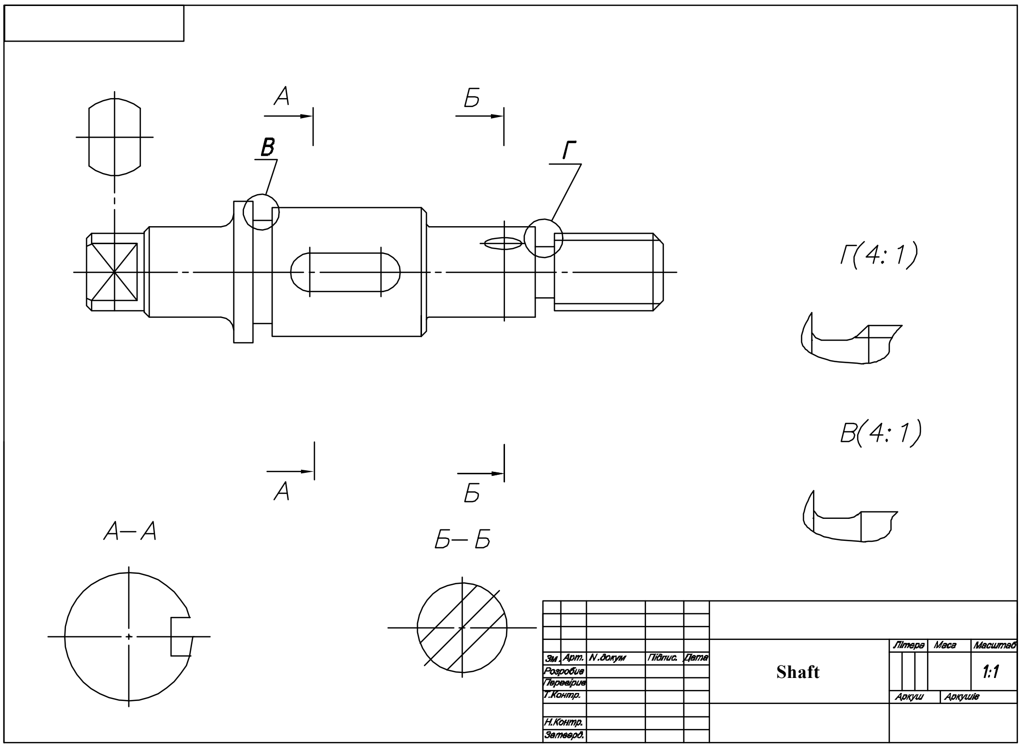


Fig. 6.24

8. Draw a sketch with a base line 1 mm thickness, hatch sectional elevations and sections (Fig. 6.25).

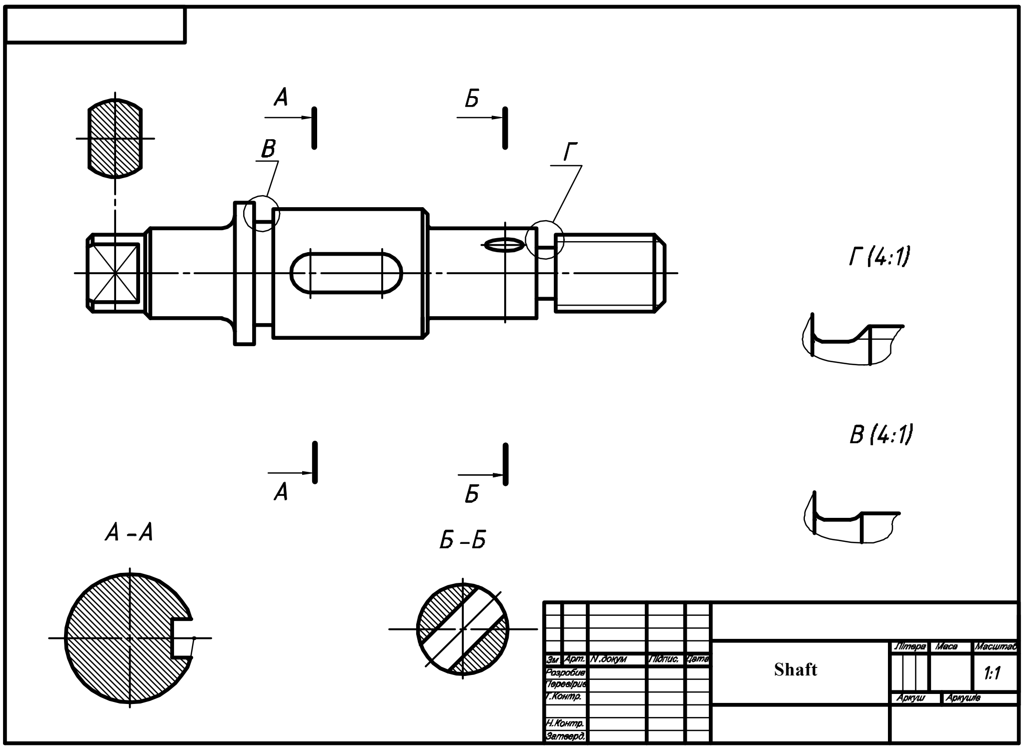


Fig. 6.25

9. Draw extension and dimension lines. The sizes are put from "bases" (end parts) no more than two sizes "chain". Measure the part and plot the dimensional numbers. Select the dimensions of the centre holes from table 6.1 (sample designation of Fig. 6.3), the dimensions of chamfers and fillets - from table 6.2, 6.3, keyseats - from table. 6.8, 6.9, 6.10, flats - from table 6.5 on p. 52, runouts for the output of the grinding wheel - from table. 6.6.

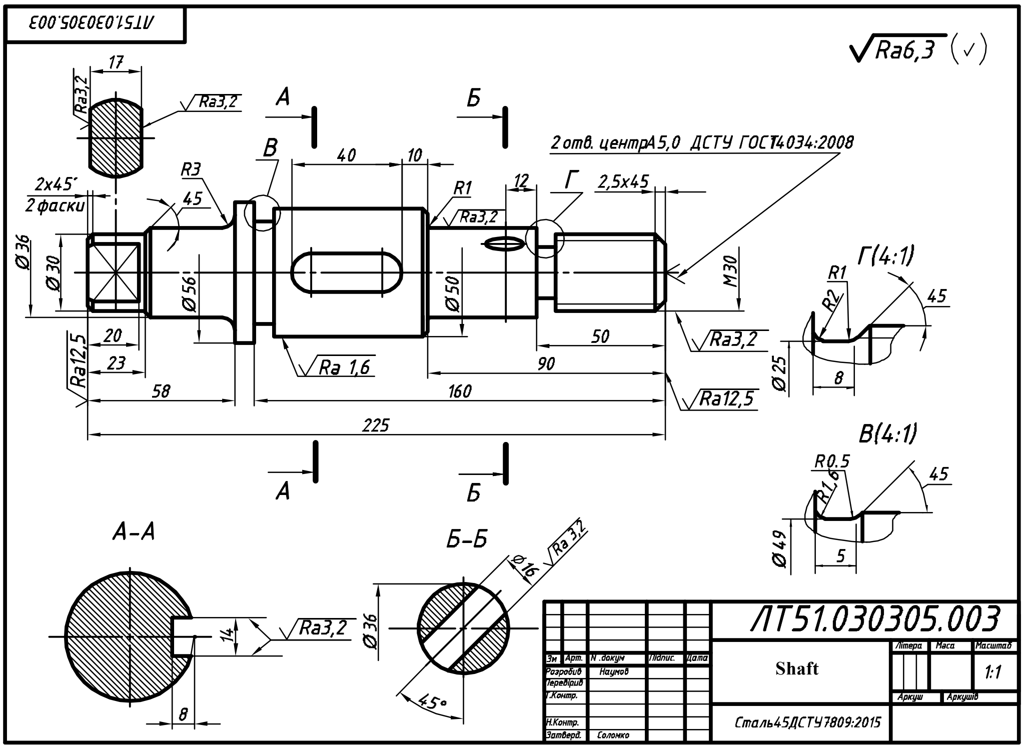


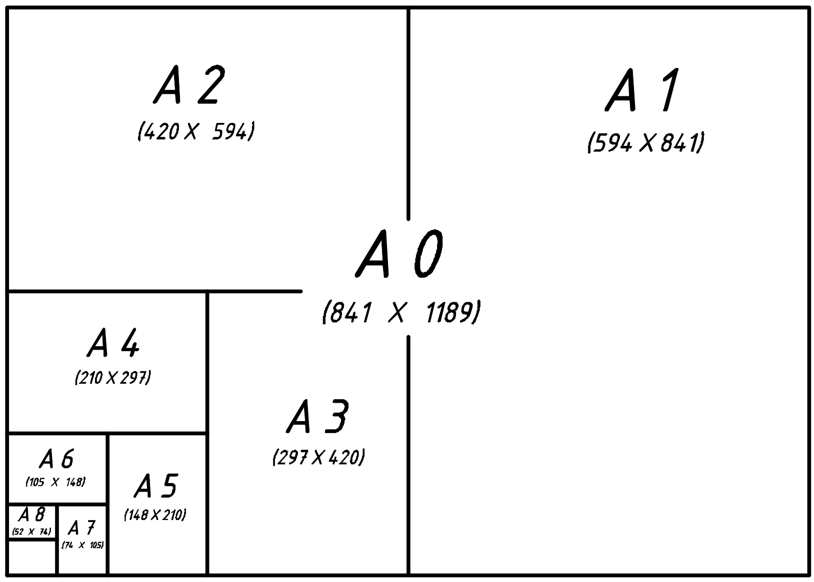
Fig. 6.26

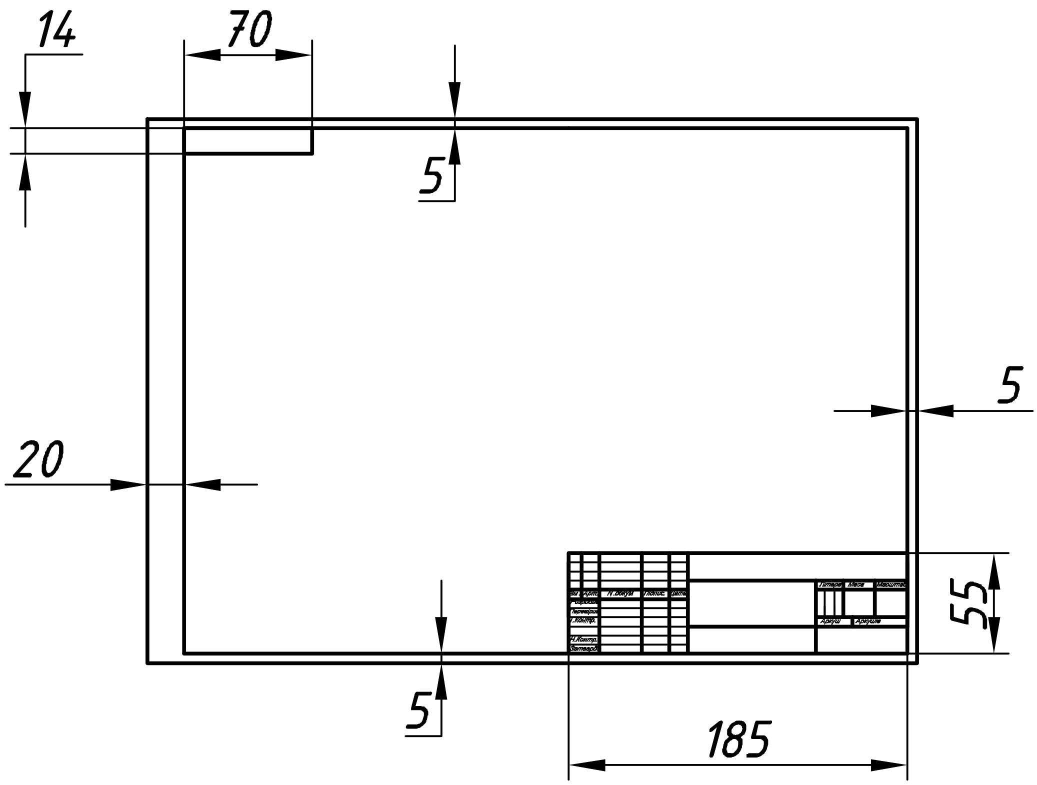
10. Determine the surface roughness and mark it on the sketch. Polished surfaces have a roughness of Ra 1.6; Ra 0.8. Other surfaces have a roughness of Ra 3.2; Ra 6.3; Ra 12.5.

11. Write down the technical requirements and fill in the main inscription.

Supplements

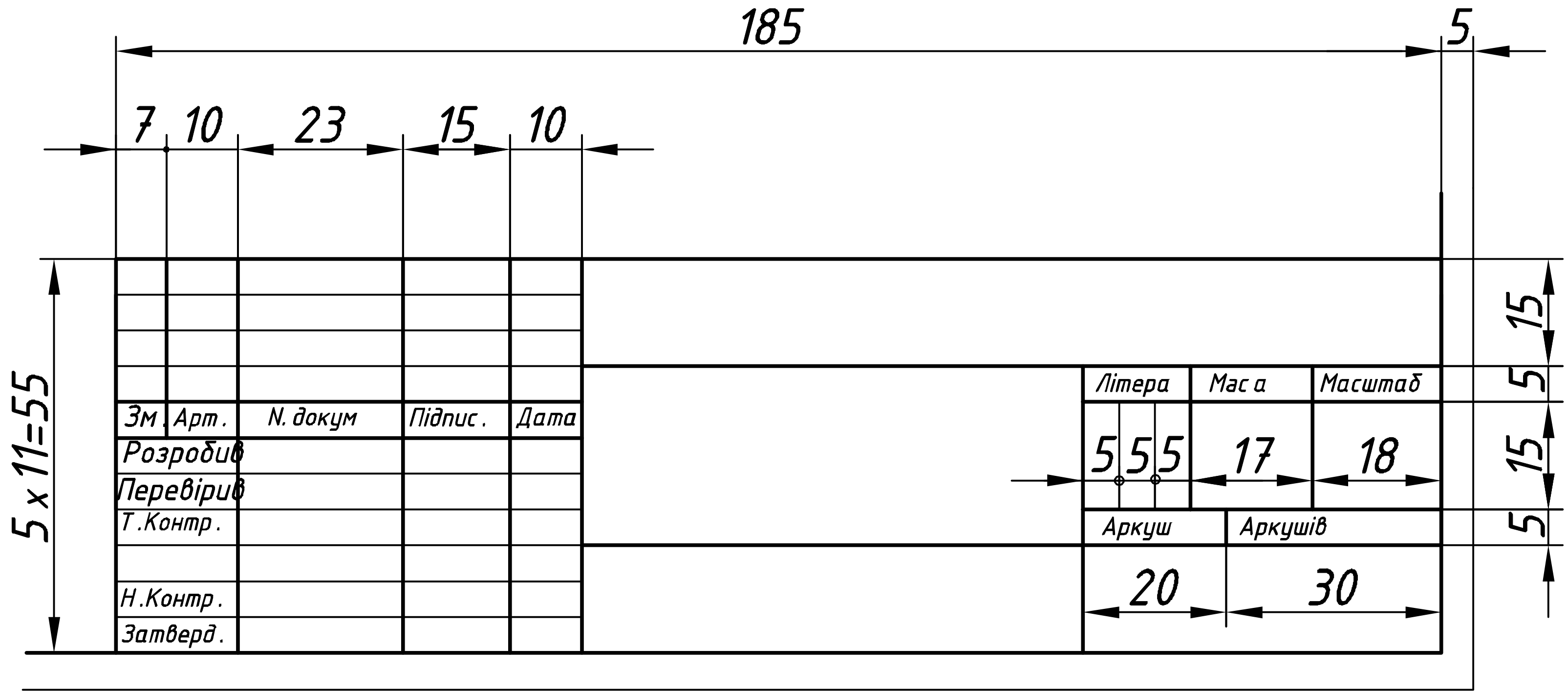
The main formats in the drawing



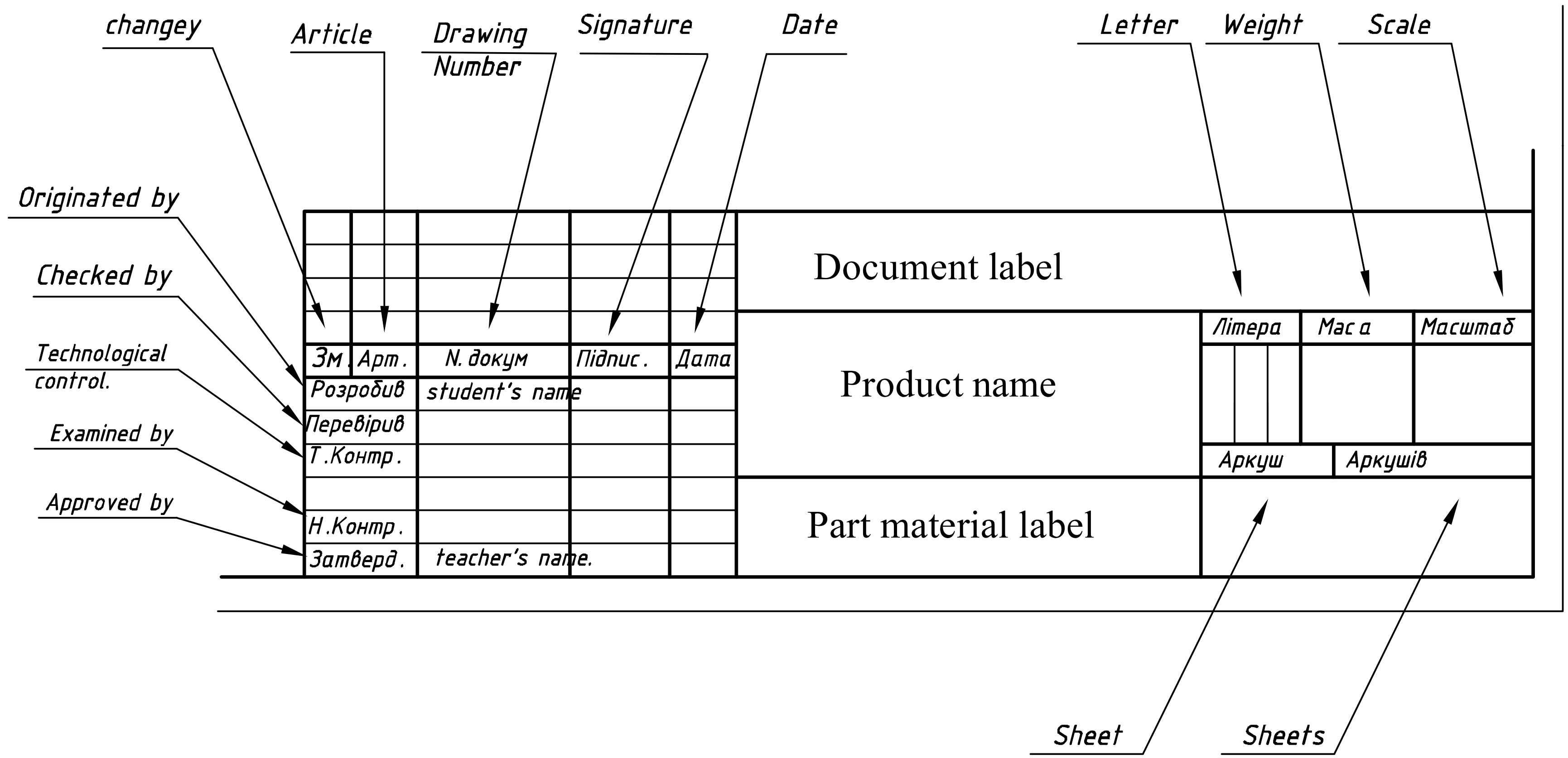


Supplement 1

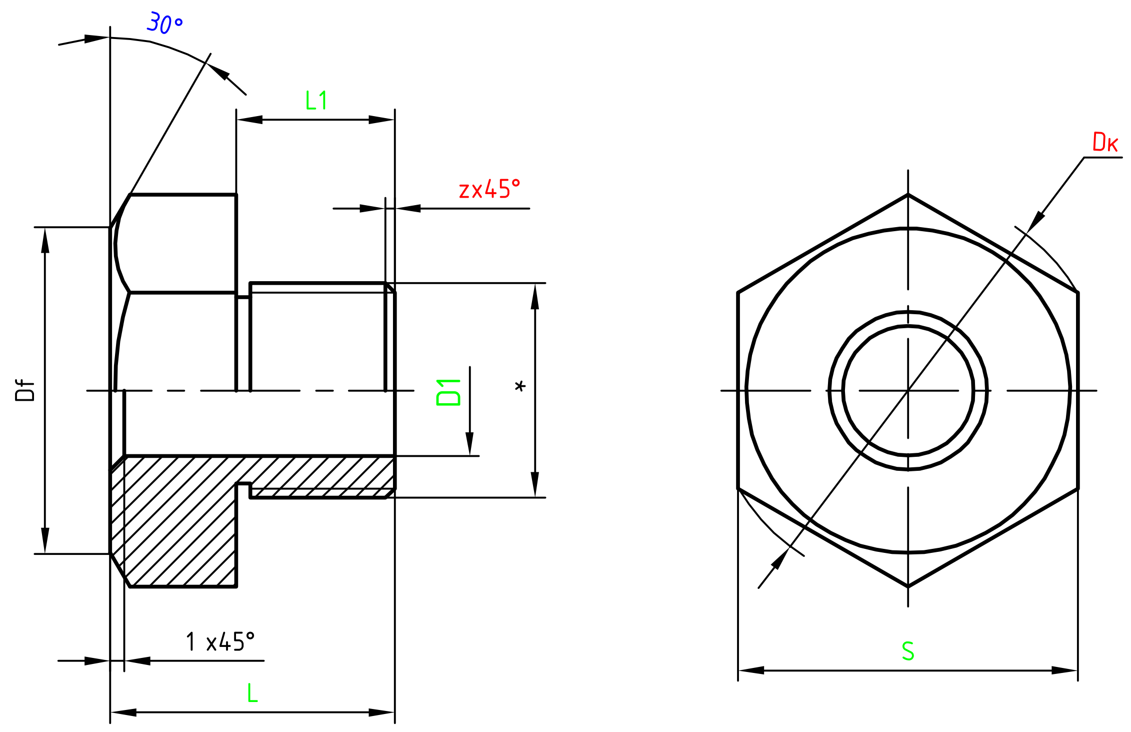
The main inscription



The main inscription



Tasks



№ var	L	L1	S	D1	* Thread mark
1	50	32	65	22	M36x2
3	55	36	70	20	M39x2
5	60	40	55	18	M30x1,5
7	65	44	60	20	M33x2
9	70	52	65	16	M36
11	50	30	60	18	M33x1,5
13	55	34	70	20	M39x1
15	60	42	65	14	M36x1,5
17	65	46	55	10	M27x2
19	70	54	70	18	M39
21	50	34	65	24	M39x1
23	55	38	60	18	M30x2
25	60	44	70	24	M42x2
27	65	48	65	20	M33x1,5
29	70	50	55	18	M30

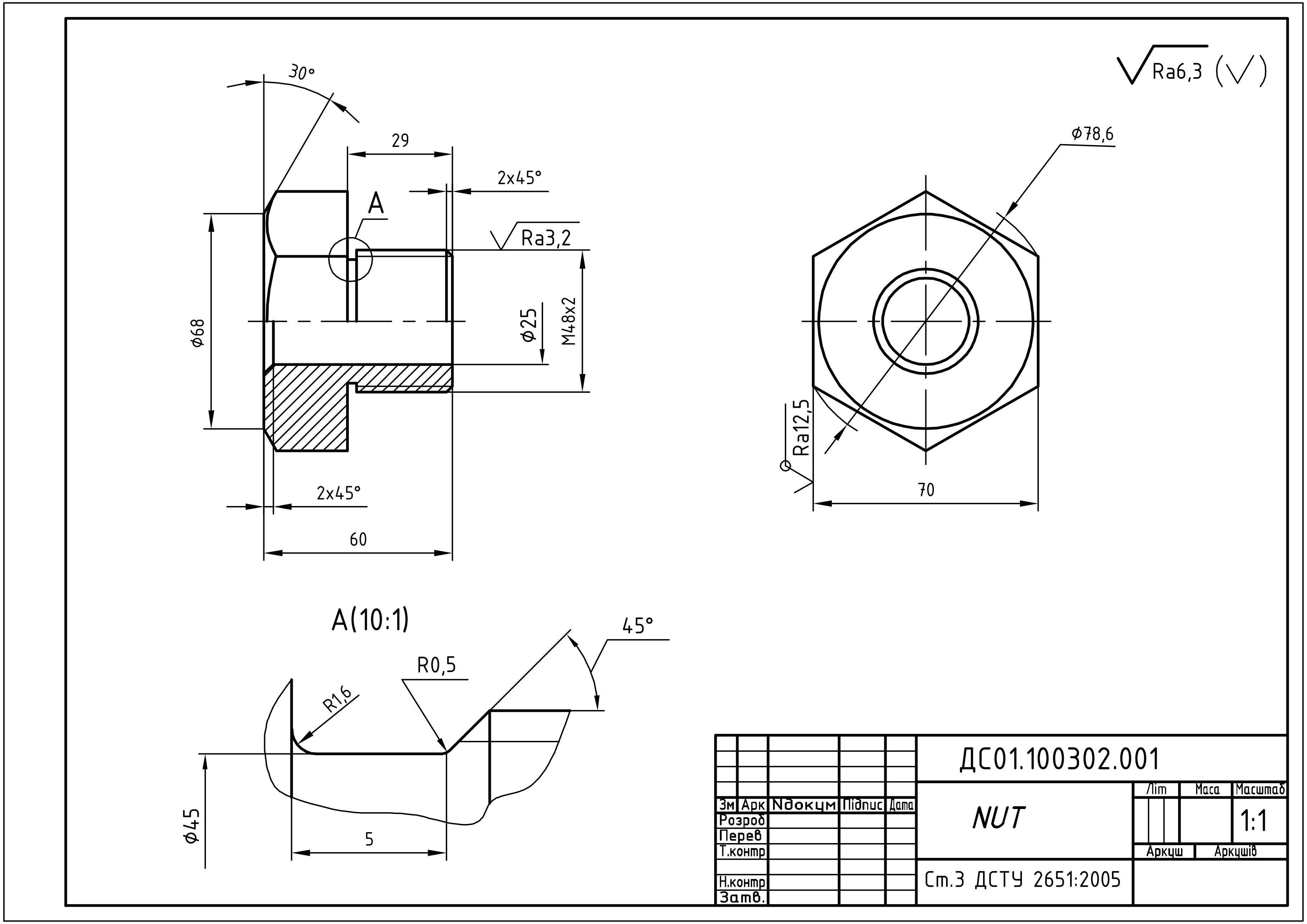
We take the sizes of green color from the table of tasks

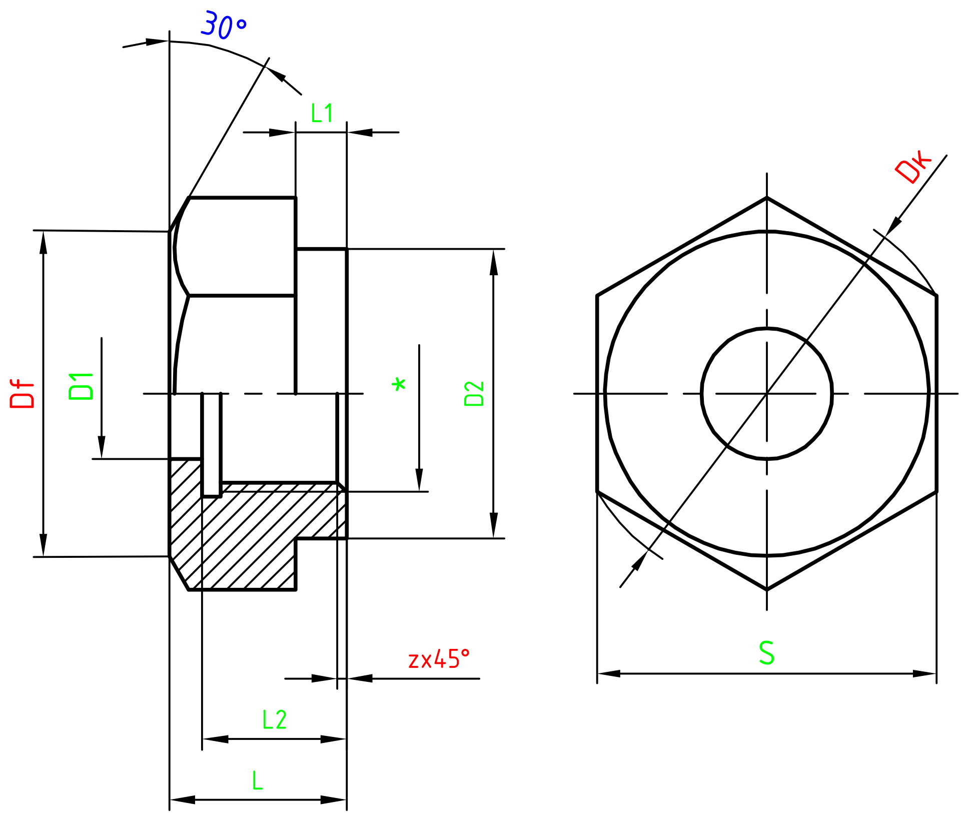
Dimensions of red – according to the reference tables

* – thread label from the task table

30 ° – the angular size of the chamfer, the same for everyone, Df=0,95S

Tasks for odd option numbers


Ra6,3 (√)
30°
29
2x45°
A
Ra3,2
⌀25
M48x2
⌀68
2x45°
60
⌀78,6
Ra12,5
70
A(10:1)
45°
R0,5
R1,6
⌀45
5
ДС01.100302.001
Зм Арк Nдокум Підпис Дата
Розроб
Перев
Т.контр
Н.контр
Затв.
NUT
Літ Маса Масштаб
1:1
Аркуш Аркушів
Ст.3 ДСТУ 2651:2005



№ var	L	L1	L2	S	D1	D2	* Thread mark
2	60	15	55	60	15	50	M36x1,5
4	55	12	45	65	20	60	M36
6	65	5	58	60	12	45	M27x2
8	50	8	45	70	18	50	M30x1,5
10	40	12	35	65	15	46	M33x2
12	50	10	46	60	18	48	M33x1,5
14	45	6	40	70	20	65	M42x2
16	60	12	55	65	12	45	M30
18	40	6	36	55	15	50	M36x2
20	55	5	42	70	18	58	M39
22	50	14	45	55	20	50	M33x1,5
24	45	8	40	65	18	60	M39x1
26	40	4	36	55	12	45	M30x2
28	60	12	55	70	20	60	M39x1
30	65	10	58	65	15	55	M39x2

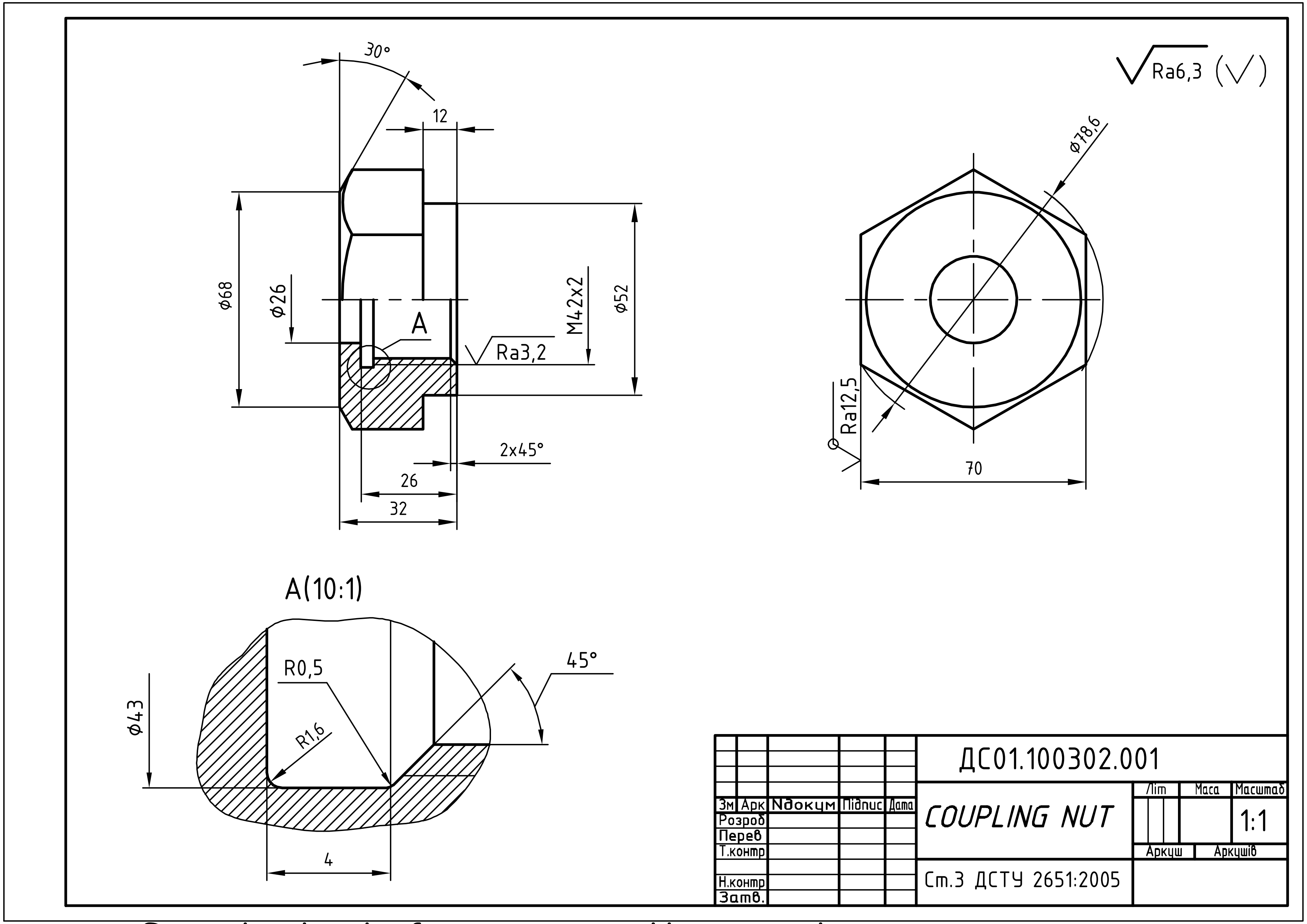
We take the sizes of green color from the table of tasks

Dimensions of red – according to the reference tables

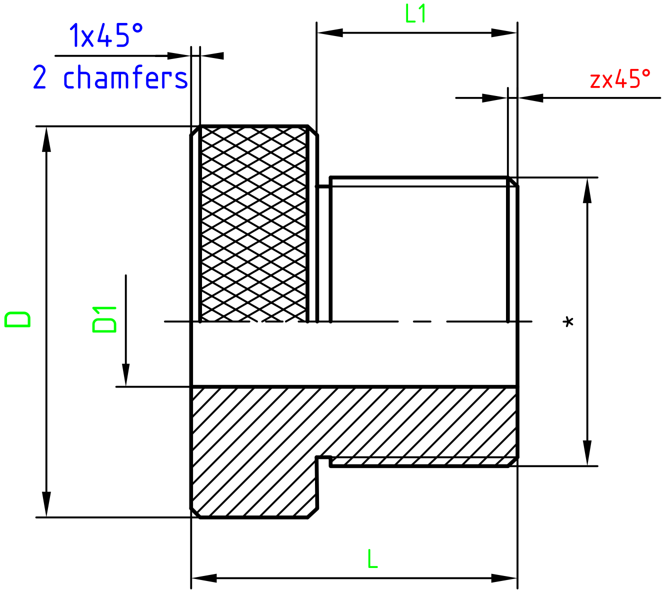
* – thread label from the task table

30 ° – the angular size of the chamfer, the same for everyone, Df=0,95S

Tasks for even option numbers



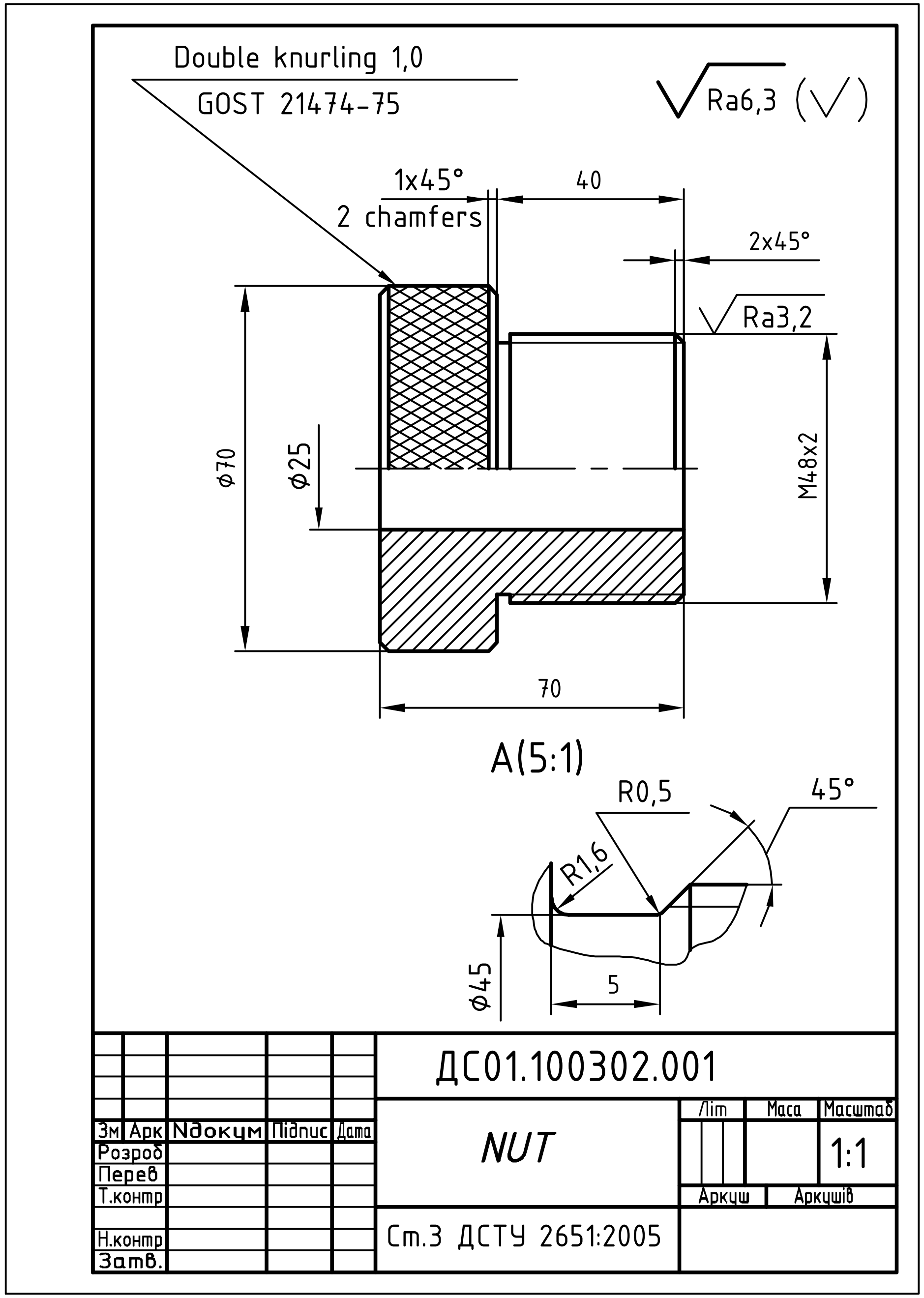
Sample task for even option numbers



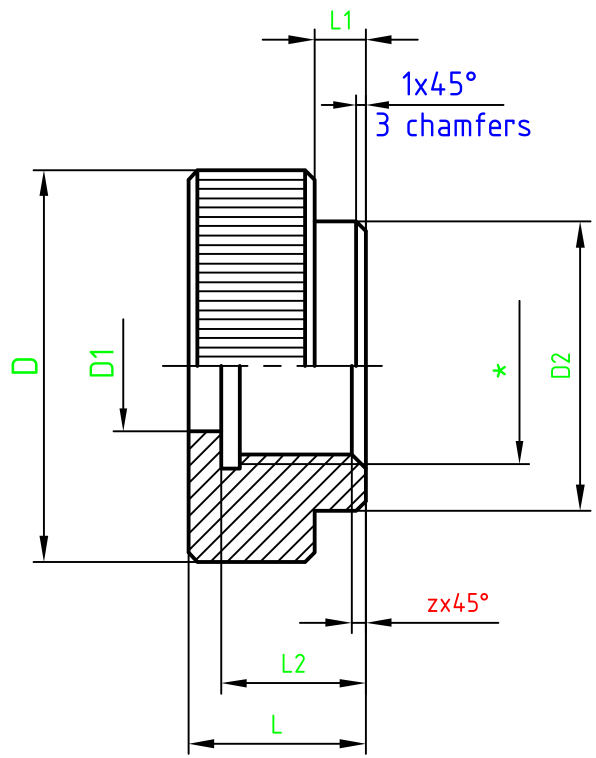
№ var	L	L1	D	D1	Thread mark *
1	50	30	65	22	M36x2
3	55	35	70	20	M39x2
5	60	40	55	18	M30x1,5
7	65	45	60	20	M33x2
9	70	50	65	16	M36
11	50	30	60	18	M33x1,5
13	55	35	70	20	M39x1
15	60	40	65	14	M36x1,5
17	65	45	55	10	M27x2
19	70	50	70	18	M39
21	50	30	65	24	M39x1
23	55	35	60	18	M30x2
25	60	40	70	24	M42x2
27	65	45	65	20	M33x1,5
29	70	50	55	18	M30

We take the sizes of green color from the table of tasks
Dimensions of red – according to the reference tables
* – thread label from the task table
1x45° – the angular size of the chamfer, the same for everyone

Tasks for even option numbers



Sample task for even option numbers



№ var	L	L1	L2	D	D1	D2	Thread mark *
1	50	20	45	60	15	45	M36x1,5
3	55	30	50	65	20	45	M36
5	60	40	55	60	12	35	M27x2
7	65	45	60	70	18	40	M30x1,5
9	70	50	65	65	15	40	M33x2
11	50	30	45	60	18	40	M33x1,5
13	55	35	50	70	20	50	M42x2
15	60	40	55	65	12	40	M30
17	65	45	60	55	15	42	M36x2
19	70	55	65	70	18	45	M39
21	50	30	45	55	20	42	M33x1,5
23	55	30	50	65	18	45	M39x1
25	60	45	55	55	12	40	M30x2
27	65	45	60	70	20	45	M39x1
29	70	50	65	65	15	45	M39x2

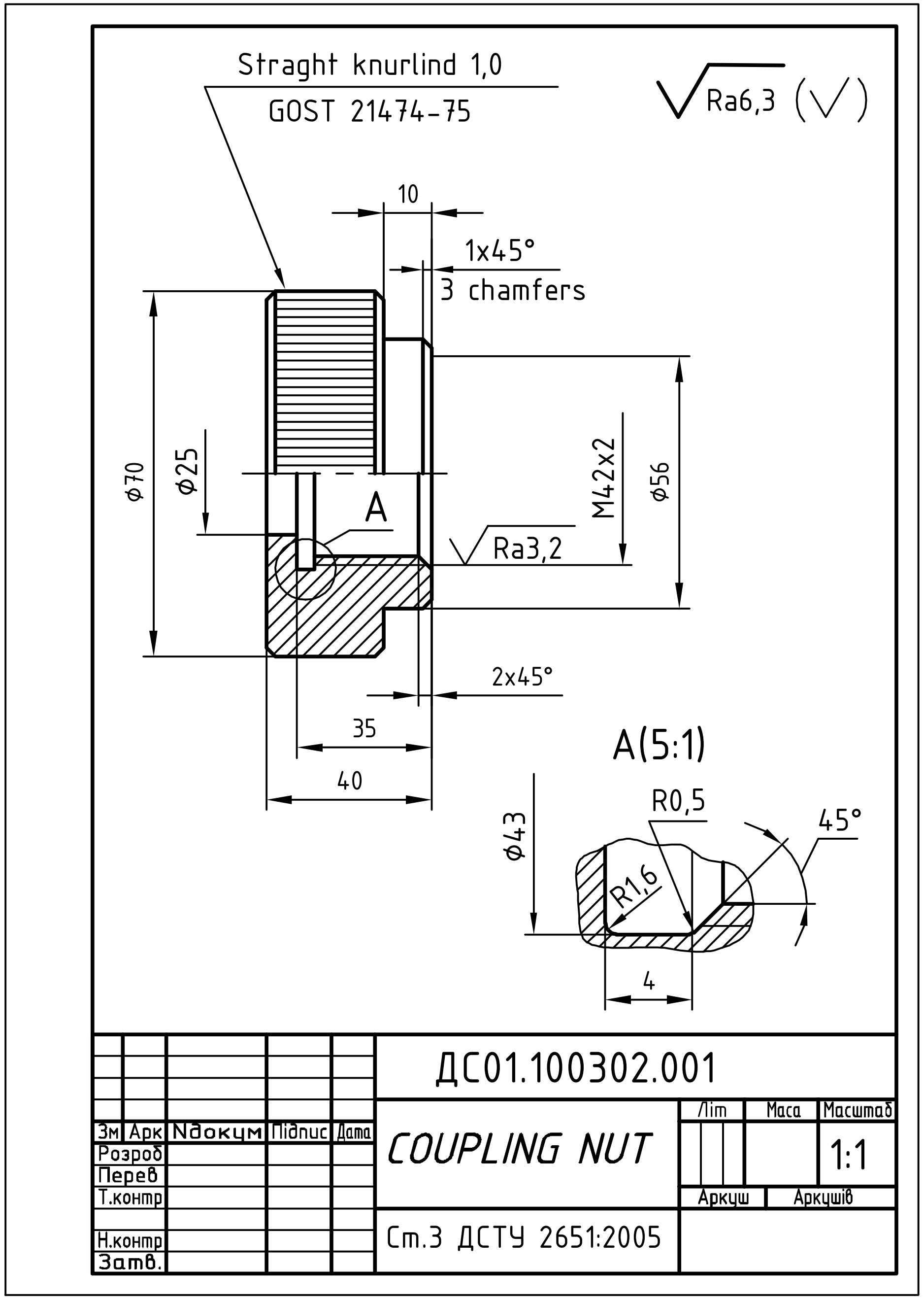
We take the sizes of green color from the table of tasks

Dimensions of red – according to the reference tables

* – thread label from the task table

1x45°– the angular size of the chamfer, the same for everyone

Tasks for odd option numbers

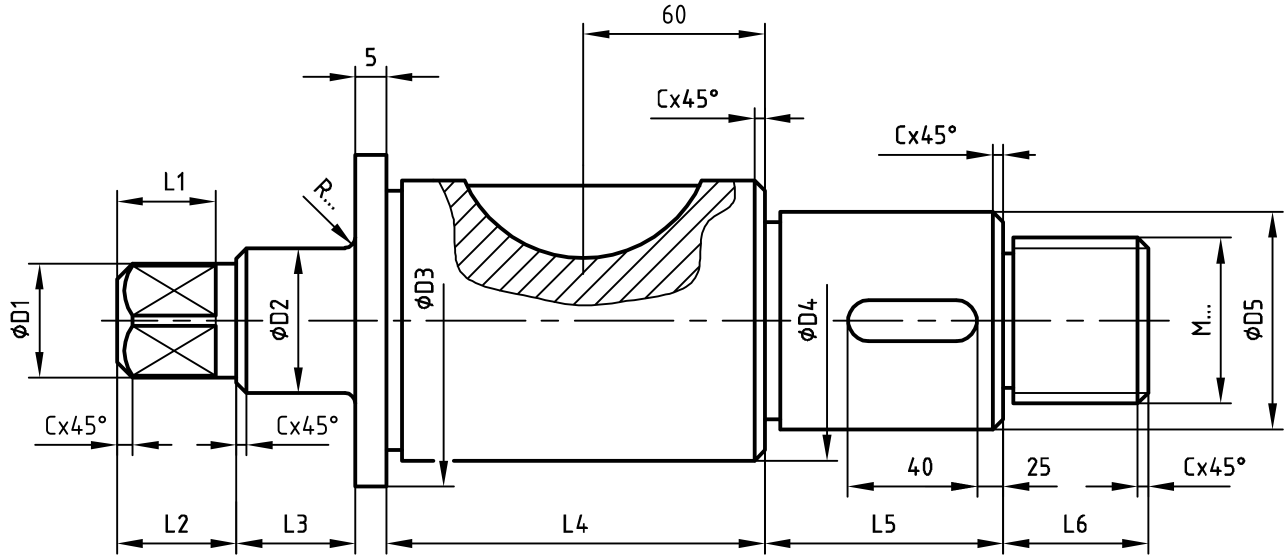


Sample task for odd option numbers

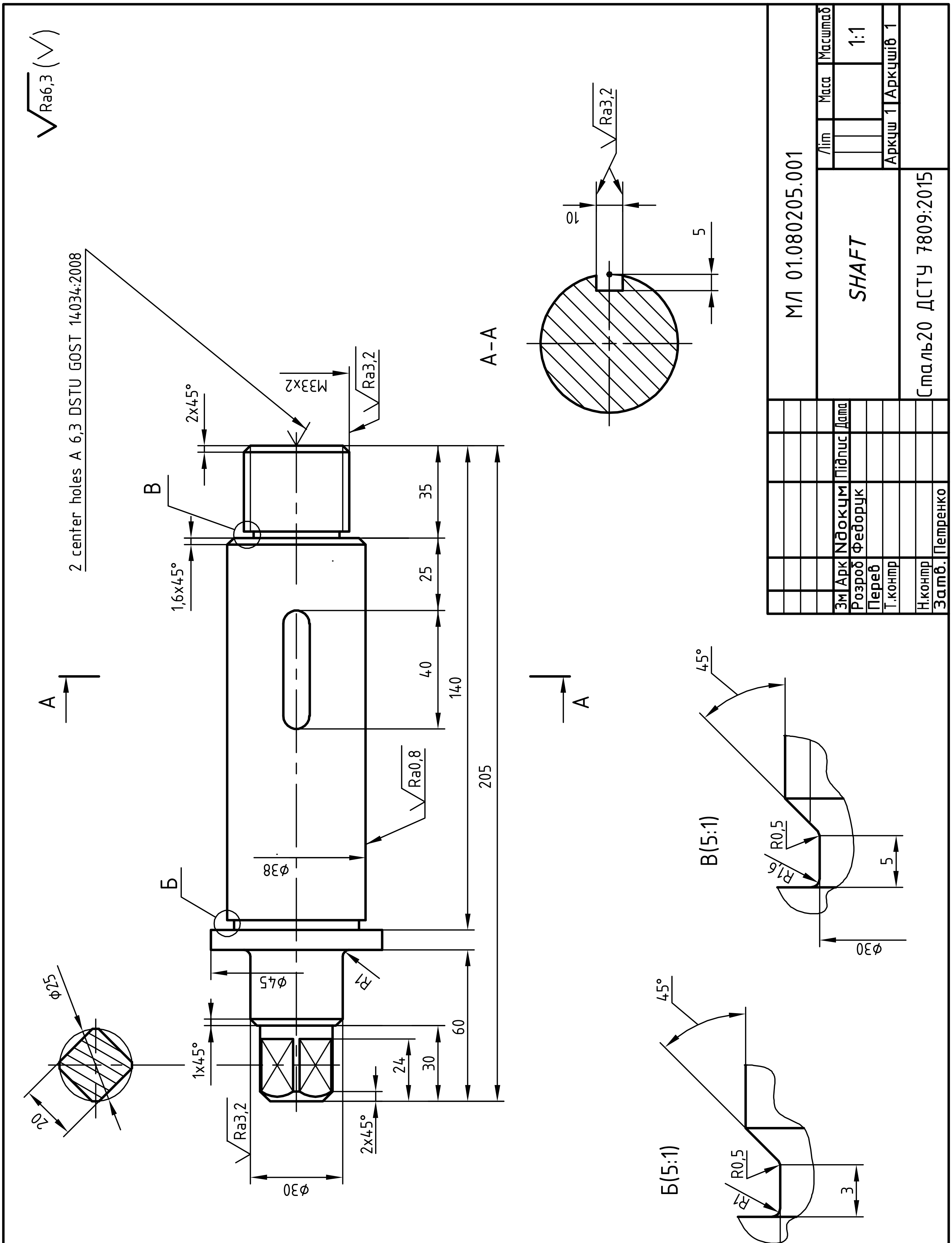
Working drawing of a "Shaft"-type workpiece

Task: to make the working drawing of a "shaft"-type workpiece according to the option (table 1).

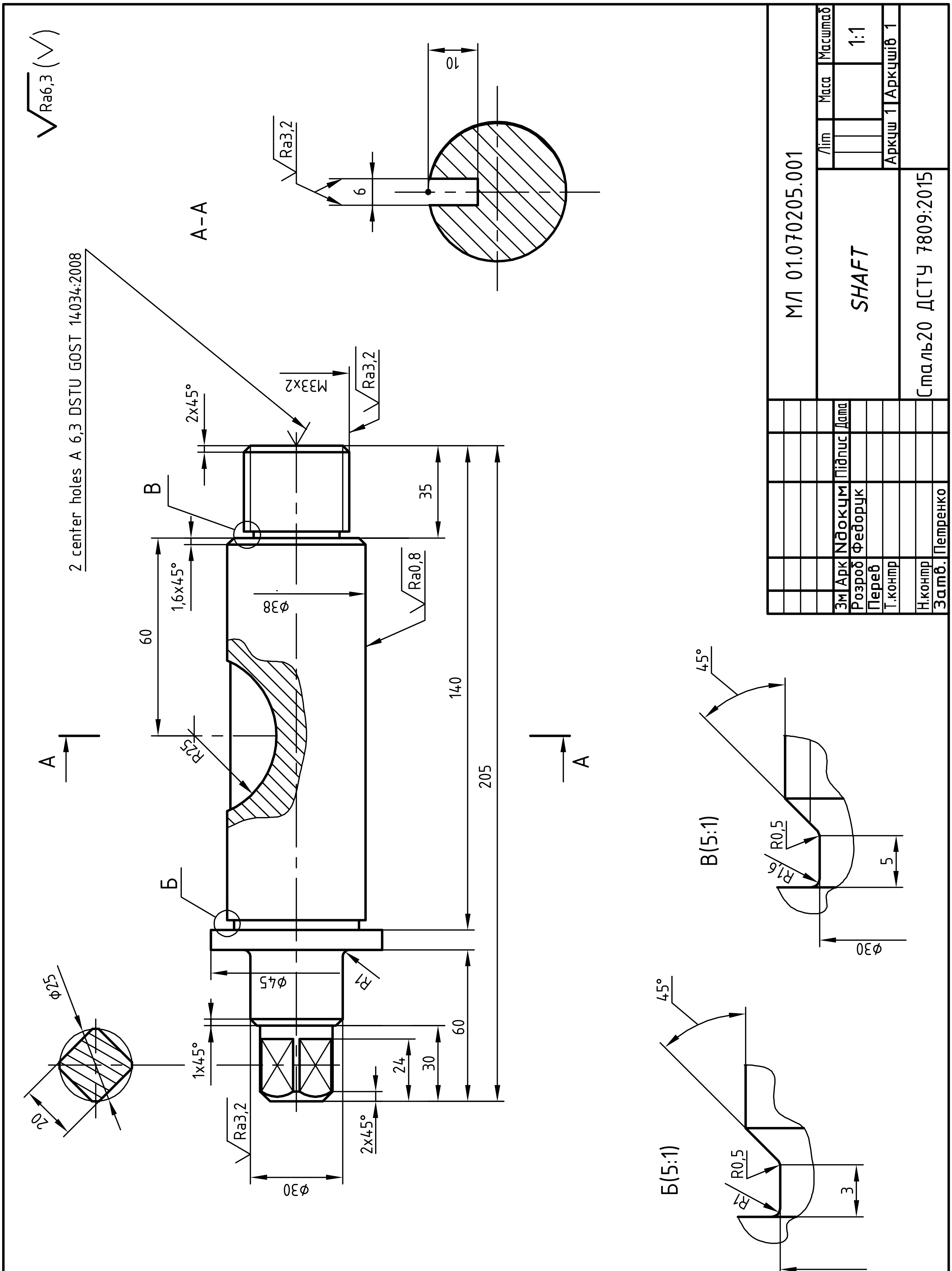
Scale 1: 1



№ вар	L1	L2	L3	L4	L5	L6	D1	D2	D3	D4	D5	M…
1	20	32	32	0	95	45	20	28	44	0	40	M20x2
2	23	35	34	95	0	42	22,4	30	42	38	0	M24x1
3	24	38	35	0	100	40	25	32	40	0	38	M27x2
4	26	40	38	100	0	38	28	34	42	36	0	M30
5	20	32	40	0	105	48	20	36	40	0	36	M24
6	23	35	42	105	0	46	22,4	28	42	38	0	M27
7	24	38	32	0	110	45	25	30	44	0	38	M33x2
8	26	40	34	110	0	50	28	32	42	36	0	M20
9	20	32	35	0	95	42	20	34	40	0	36	M30x1,5
10	23	35	38	95	0	45	22,4	36	42	38	0	M24x2
11	24	38	40	0	100	42	25	28	40	0	38	M24
12	26	40	42	100	0	40	28	30	42	36	0	M27x1,5
13	20	32	32	0	105	38	20	32	44	0	36	M20x1,5
14	23	35	34	105	0	48	22,4	34	42	35	0	M20x2
15	24	38	35	0	110	46	25	36	40	0	35	M27x1
16	26	40	38	110	0	45	28	28	42	36	0	M30x1,5
17	20	32	40	0	95	50	20	30	40	0	36	M24
18	23	35	42	95	0	42	22,4	32	42	38	0	M27
19	24	38	32	0	100	40	25	34	44	0	38	M20x1
20	26	40	34	100	0	38	28	36	42	36	0	M30x2

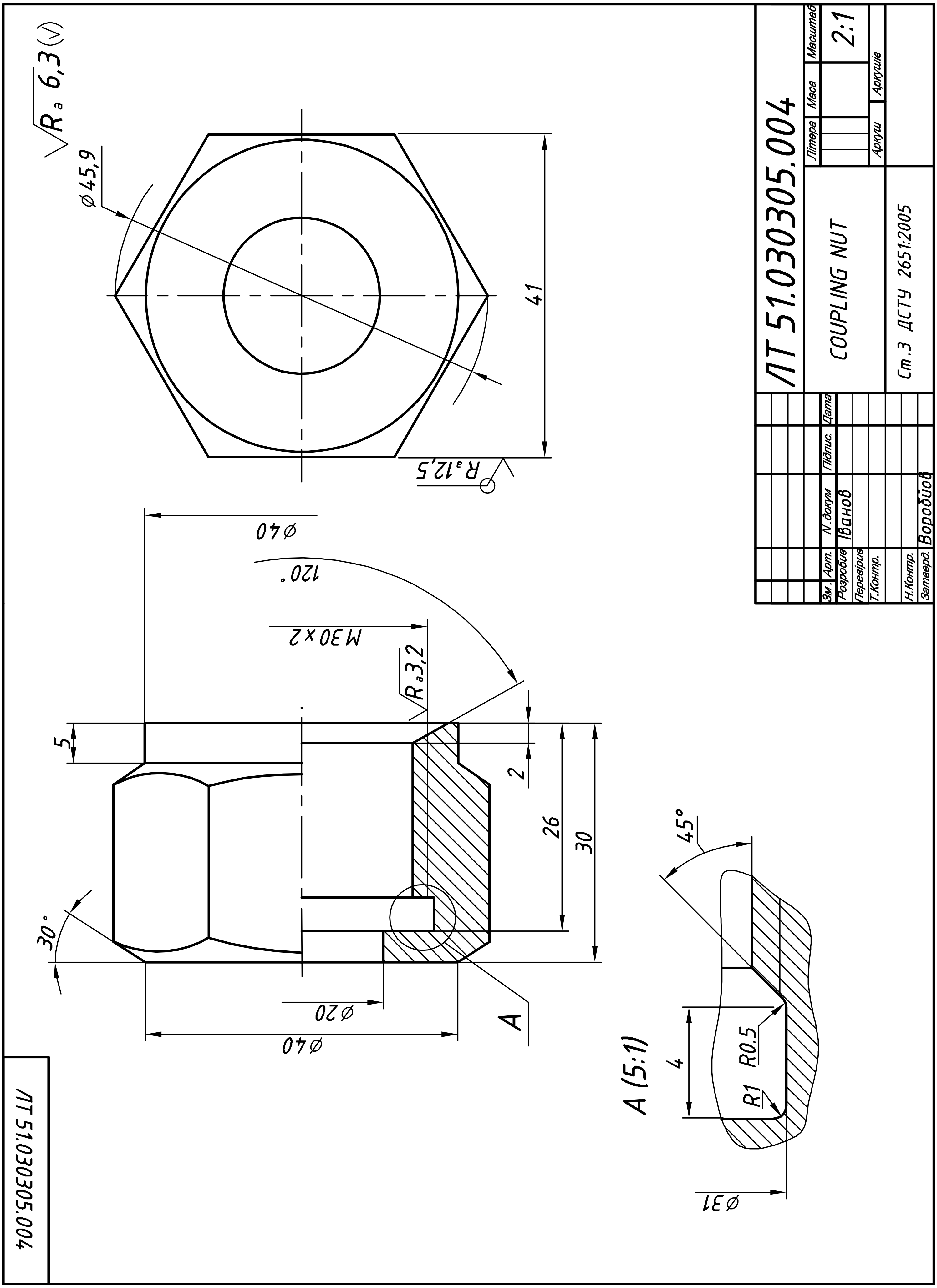


Odd option numbers

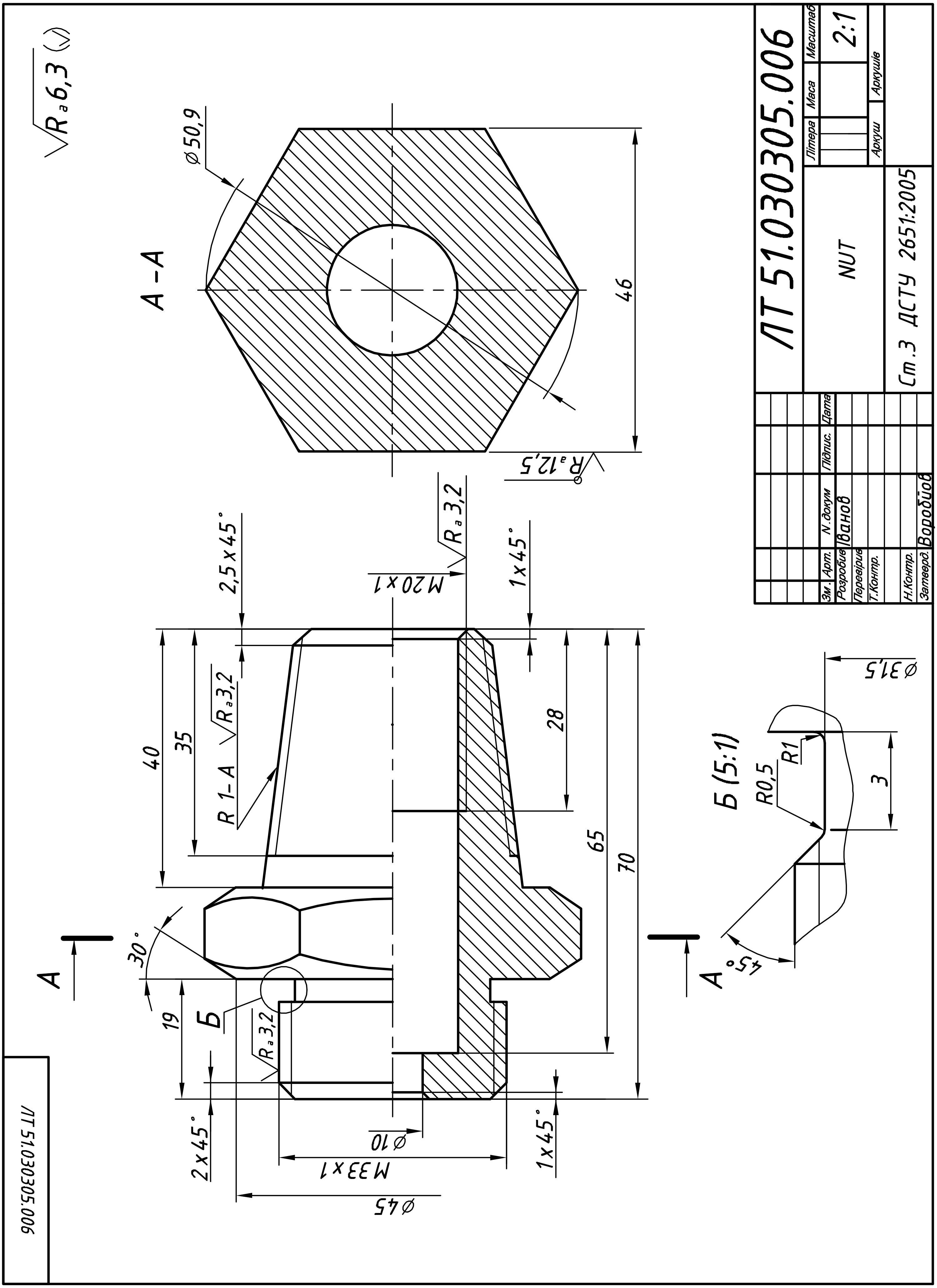


Even option numbers

Examples

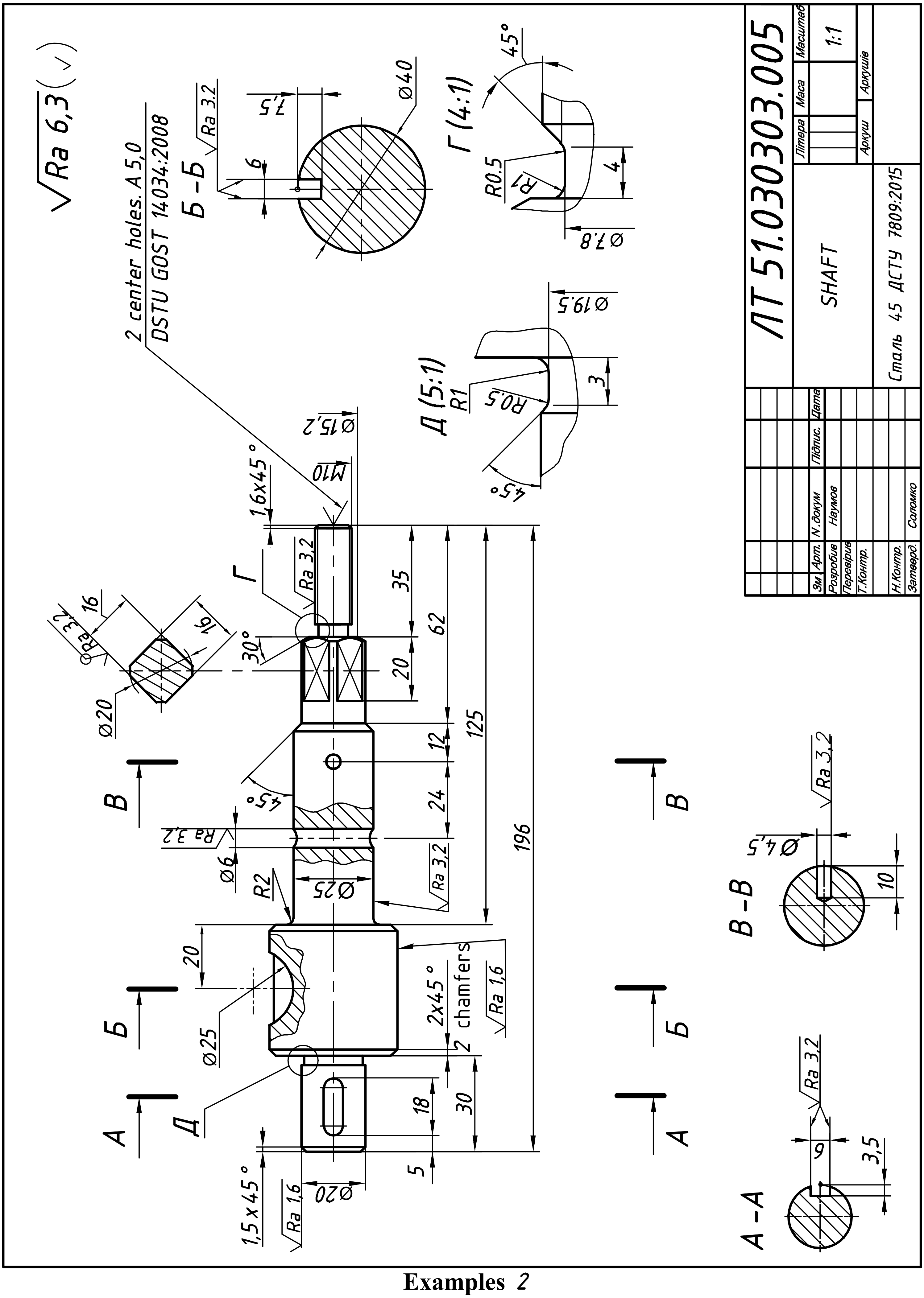

ЛТ 51.030305.004
COUPLING NUT
Ст.3 ДСТУ 2651:2005
Літера
Маса
Масштаб
2:1
Аркуш
Аркушів
Зм.
Арк.
N.докум
Підпис
Дата
Розробив
Іванов
Перевірив
Т.Контр.
Н.Контр.
Затверд.
Воробйов
Ra 6,3 (√)
Ra 12,5
Ra 3,2
Ø45,9
41
Ø40
120°
M30×2
5
2
26
30
30°
Ø20
A
A (5:1)
45°
4
R0.5
R1
Ø31
ЛТ 51.030305.004

Examples *1*

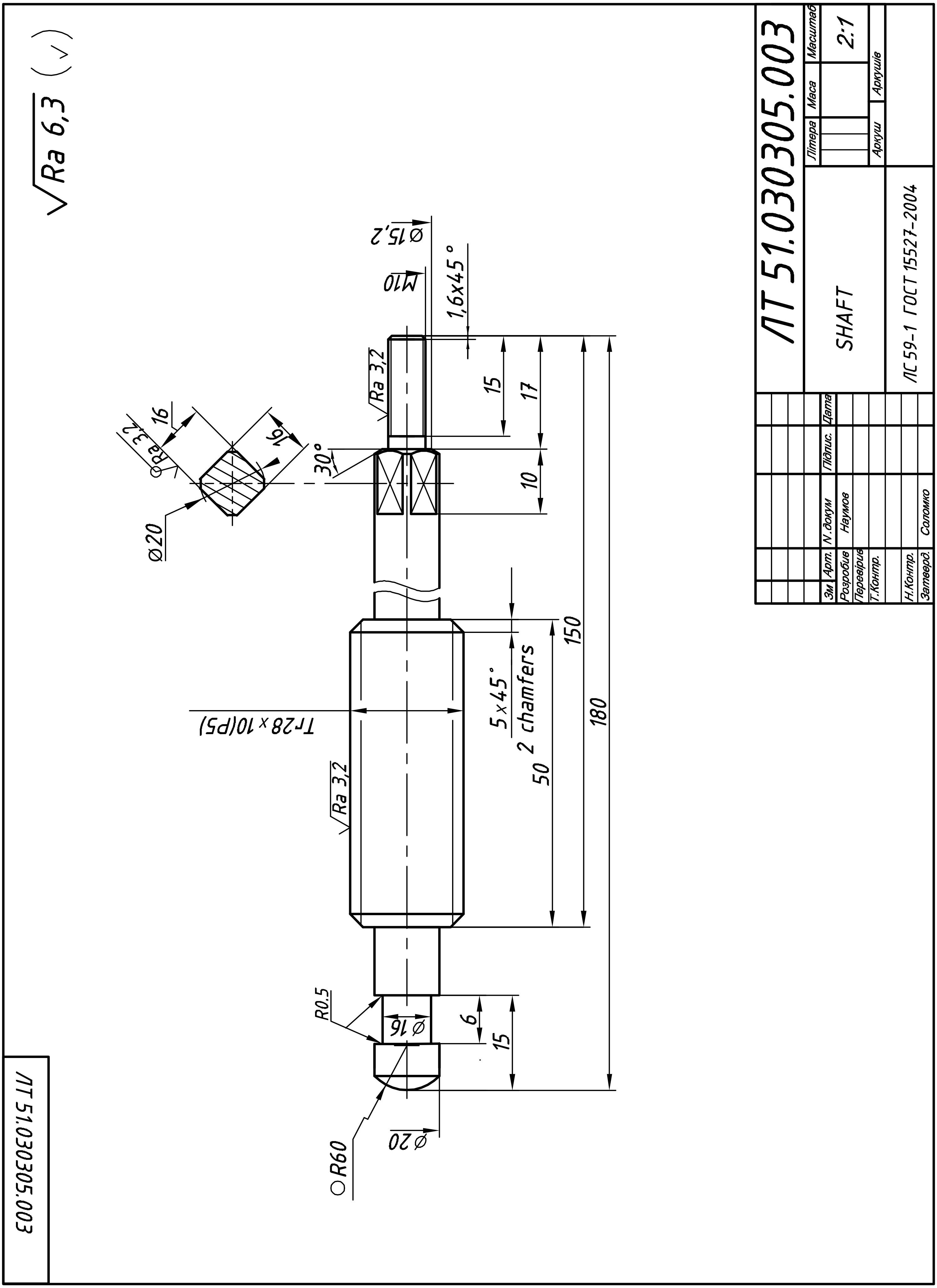


ЛТ 51.030305.006
NUT
Ст.3 ДСТУ 2651:2005
Літера
Маса
Масштаб
2:1
Аркуш
Аркушів
Зм.
Арк.
N. докум
Підпис
Дата
Розробив
Іванов
Перевірив
Т.Контр.
Н.Контр.
Затверд.
Воробйов
Ra 6,3 (√)
A–A
Ø50,9
46
Ra 12,5
Ra 3,2
M20x1
2,5x45°
1x45°
40
35
28
65
70
R 1–A
30°
19
Б
2x45°
1x45°
Ø10
M33x1
Ø45
A
Б (5:1)
R0,5
R1
3
Ø31,5
45°
ЛТ 51.030305.006

Examples *2*

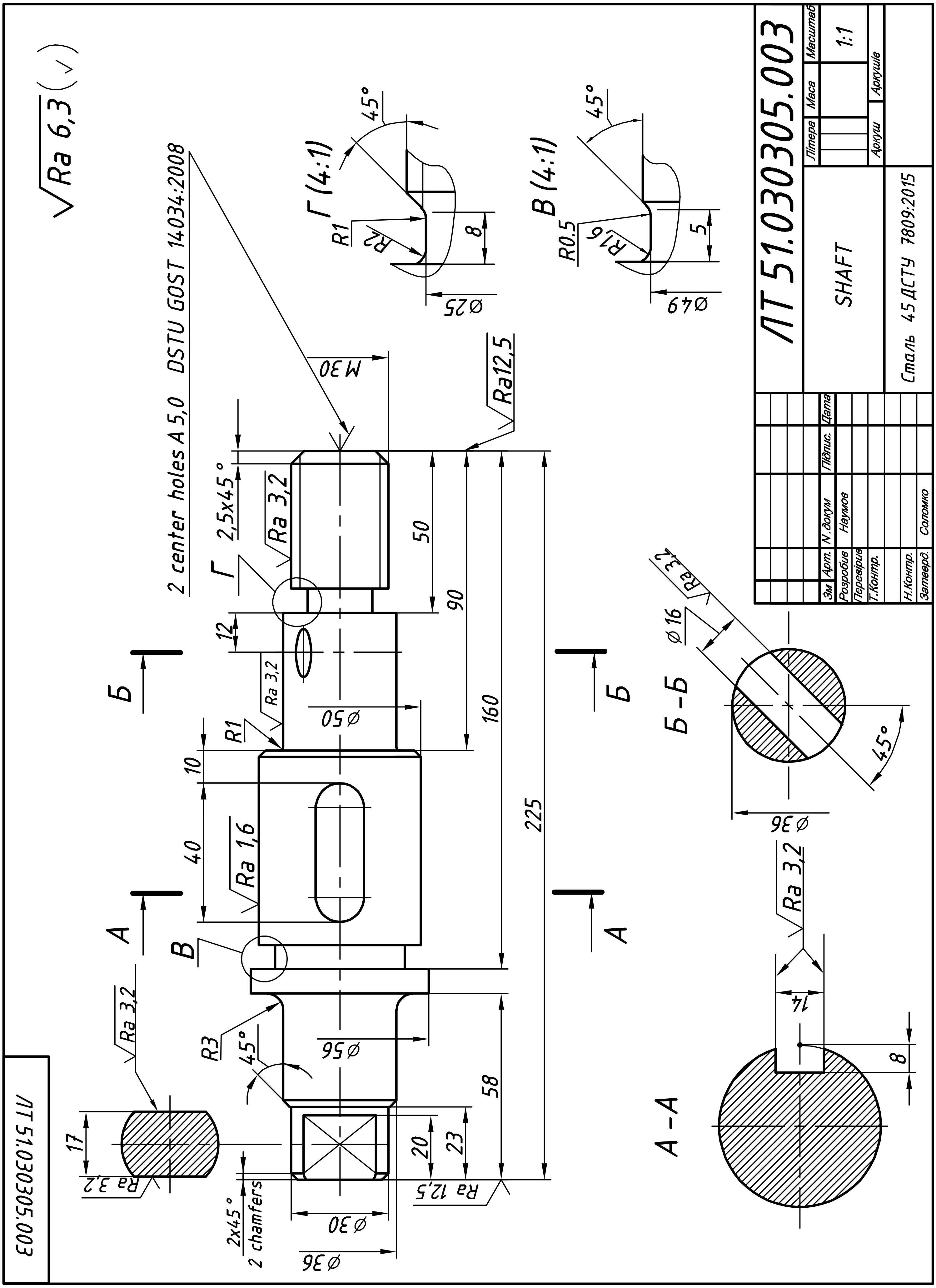

Ra 6,3 (√)
2 center holes. A 5,0
DSTU GOST 14034:2008
Б – Б
Г (4:1)
Д (5:1)
В – В
А – А
2x45° 2 chamfers
ЛТ 51.030303.005
SHAFT
Сталь 45 ДСТУ 7809:2015
Розробив Наумов
Затверд. Соломко

Examples *2*



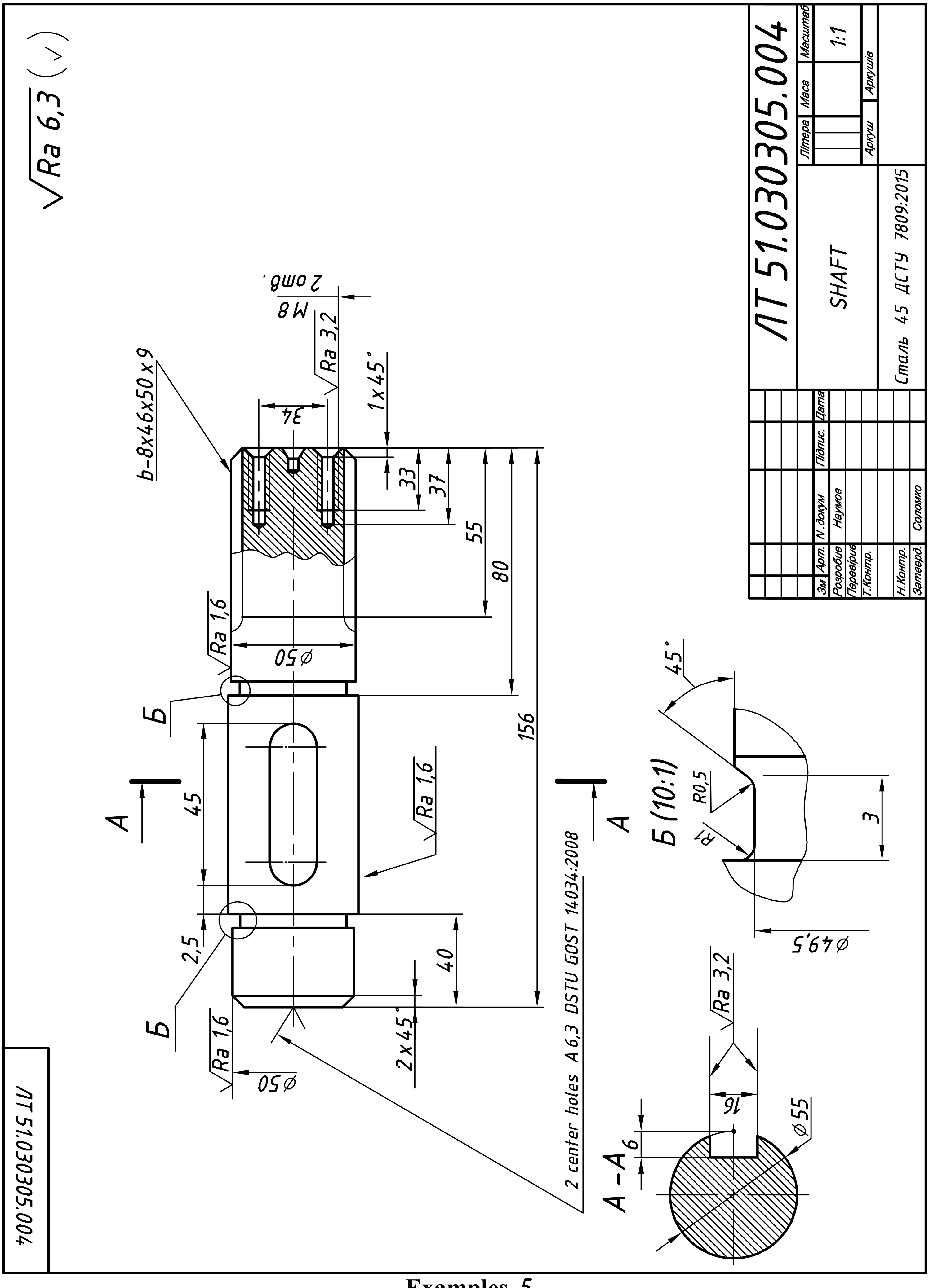
Ra 6,3
ЛТ 51.030305.003
SHAFT
ЛС 59-1 ГОСТ 15527-2004
Літера
Маса
Масштаб
2:1
Аркуш
Аркушів
Зм
Арт.
N. докум
Підпис
Дата
Розробив
Наумов
Перевірив
Т.Контр.
Н.Контр.
Затверд.
Соломко
Ø15,2
M10
1,6x45°
Ra 3,2
15
17
10
30°
16
Ø20
150
180
5x45°
2 chamfers
50
Tr28x10(P5)
R0.5
Ø16
6
R60

Examples *3*



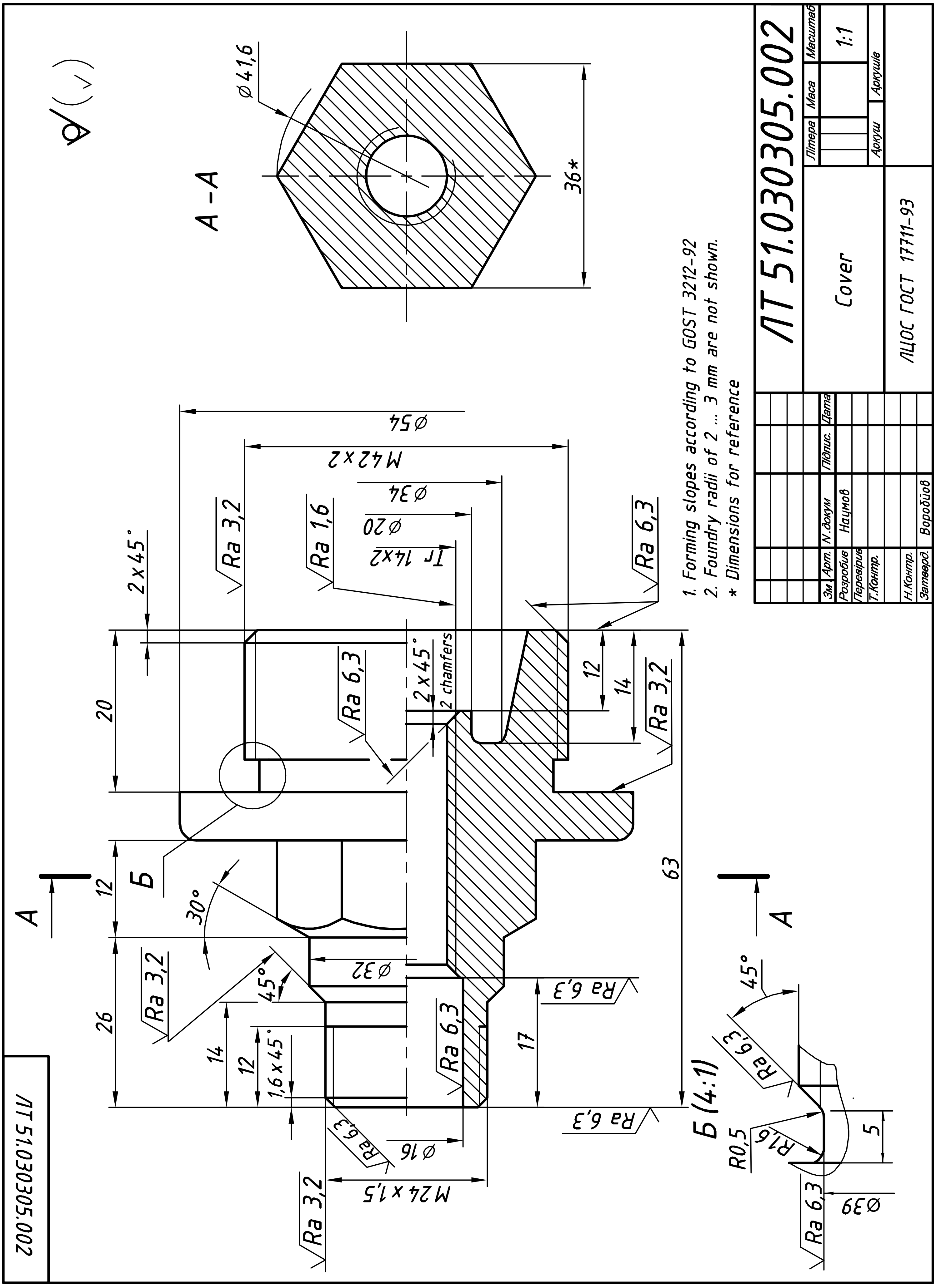
ЛТ 51.030305.003
SHAFT
Сталь 45 ДСТУ 7809:2015
Літера
Маса
Масштаб
1:1
Аркуш
Аркушів
Зм
Арк.
N.докум
Підпис
Дата
Розробив
Наумов
Перевірив
Т.Контр.
Н.Контр.
Затверд.
Соломко
Ra 6,3
2 center holes A 5,0 DSTU GOST 14034:2008
Г (4:1)
В (4:1)
Б–Б
А–А
2,5x45°
2x45° 2 chamfers
Ra 3,2
Ra 1,6
Ra12,5
Ra 12,5
M 30
⌀50
⌀56
⌀30
⌀36
⌀25
⌀49
⌀16
R1
R2
R3
R0.5
R1,6
45°
50
90
160
225
58
40
10
12
20
23
17
14
8
5
ЛТ 51.030305.003

Examples 4



Ra 6,3
b-8x46x50x9
M 8
2 отв.
Ra 3,2
1x45°
34
33
37
55
80
156
Ra 1,6
⌀50
Б
A
45
Ra 1,6
40
2,5
2x45°
Ra 1,6
⌀50
2 center holes A 6,3 DSTU GOST 14034:2008
Б (10:1)
45°
R0,5
R1
3
⌀49,5
A-A
Ra 3,2
16
6
⌀55
ЛТ 51.030305.004
SHAFT
Сталь 45 ДСТУ 7809:2015
Літера
Маса
Масштаб
1:1
Аркуш
Аркушів
Зм
Арт.
N. докум
Підпис.
Дата
Розробив
Наумов
Перевірив
Т.Контр.
Н.Контр.
Затверд.
Соломко
ЛТ 51.030305.004

Examples *5*



ЛТ 51.030305.002
Cover
ЛЦОС ГОСТ 17711-93
Літера
Маса
Масштаб
1:1
Аркуш
Аркушів
Зм
Арк.
N. докум
Підпис
Дата
Розробив
Наумов
Перевірив
Т.Контр.
Н.Контр.
Затверд.
Воробйов
1. Forming slopes according to GOST 3212-92
2. Foundry radii of 2 ... 3 mm are not shown.
* Dimensions for reference
A-A
Ø41,6
36*
Б
Б (4:1)
Ø54
M42x2
Ø34
Ø20
Tr 14x2
Ø32
Ø16
M24x1,5
Ø39
2x45°
2x45°
2 chamfers
1,6x45°
30°
45°
20
12
26
14
12
17
63
5
R0,5
Ra 3,2
Ra 1,6
Ra 6,3
R1,6

Examples *6*

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6. Методические указания и учебные задания по начертательной геометрии и инженерной графике для иностранных студентов факультета авиационных и космических систем [Текст]/ Укладачі: Г.А. Вірченко, Т.М. Надкернична, Г.І. Тимкович. - К.: НТУУ «КПІ», 2014. - 42 с.

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дисципліни для студентів хіміко-технологічного факультету, факультету медикобіологічної інженерії, факультету електроніки [Електронний ресурс]: навч. посіб.
для студ. спеціальності 161 «Хімічна технологія та інженерія», 151«Автоматизація та комп`ютерно інтегровані технології», 152 «Метрологія
та інформаційно-вимірювальна техніка», 163 «Біомедична інженерія»,
153 «Мікро- та наносистемна техніка», 171 «Електроніка»,
172 «Телекомунікації та радіотехніка»/ КПІ ім.. Ігоря Сікорського; укладачі:
А.Є.Ізволенська, Д.К. Луданов, Г.С. Подима. – Електронні текстові данні
(1 файл: 35 Мбайт).-Київ: КПІ ім. Ігоря Сікорського, 2018. – 94 с.

CONTENT

Educational edition

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ВОРОБЙОВ Олексій Миколайович
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ІНЖЕНЕРНА ГРАФІКА
РОБОЧІ КРЕСЛЕНИКИ ДЕТАЛЕЙ
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для самостійної роботи іноземних студентів англійською мовою

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