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DETAIL DESIGN OF AIRFRAME PART

Laboratory Work Example

Самара

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Detail Design Of Airframe Part =Проектирование детали [Electronic resource]: Laboratory Work Example **/** The Ministry of Education and Science of the Russian Federation, Samara State Aerospace University; Compilers G.A. Reznichenko, A.A. Vyrypaev. - Electronic text and graphic data (2,7 Mb). - Samara, 2011. - 1 CD-ROM.

A method of executing laboratory works in accordance with the discipline of aircraft construction and design is described. A list of normative-technical documentation and reference materials that are needed for executing tasks, as well as examples of the work execution and preparation are offered.

The manual is intended for fourth - year students of the specialty 160201 “Airplane and Helicopter Construction” that study the discipline of aircraft construction and design and for the Masters programme «Designing, construction and CALS-technologies in Aeronautical Engineering» for education direction 160100.68 «Aeronautical Engineering».

Prepared by the Department of Aeronautical Engineering SSAU.

CONTENTS

1 THE EXEMPLARY REPORT OF THE LABORATORY WORK №1. ANALYZING A TASK. SKETCHING PROTOTYPES.

1.1 The task is to design the control crank and make the part drawing (Figure 1.1)

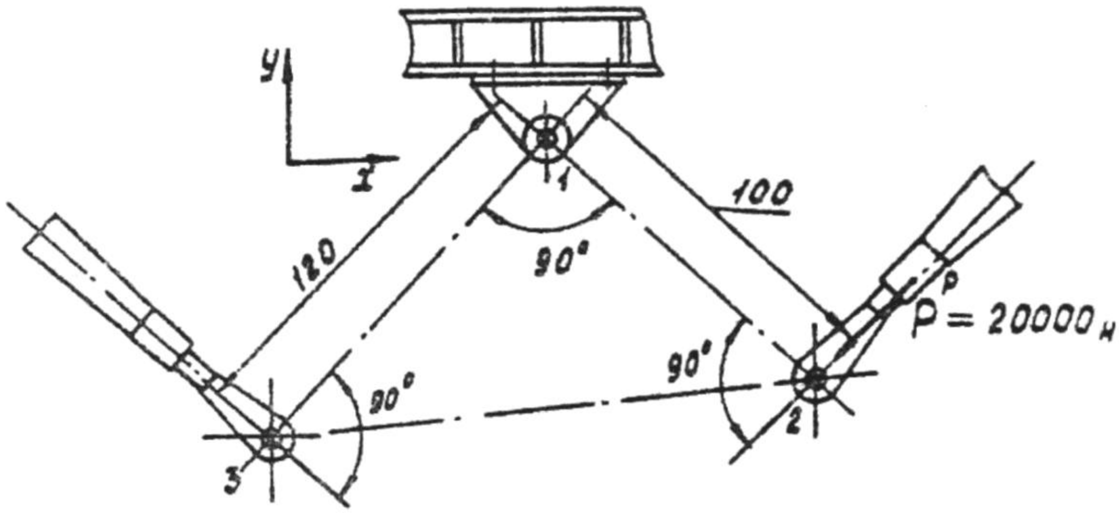


Figure 1.1 - The task of the laboratory work №1

1.2 The task analysis consists in defining the part function and work conditions and developing the part requirements.

It is necessary to design the control crank (Figure 1.1). The crank is fixed on the air-frame (the point 1). Control rods are led to the crank at the points 2 and 3. Force directions coincide with control rod axes.

The crank is designed to:

- change the control rode movement direction;
- change the value of the control rode stress;
- support the control rode linkage

The crank work conditions:

- the crank is located in the unpressurized compartment, the service access is troubled;
- the environment is the air, the work temperature is 60 to +50°C;

- there are no the crank deflection restrictions of neighboring elements.

Then the part requirements should be defined. These requirements are included in the requirements of the control rod that consists of the design crank:

- the minimum friction and backlash between joins of the part and control rods and the suspension bracket;
- excluding the possibility of jamming and seizure of joins in case of the maximum movements of the control rods and deformations of air-frame elements.

There are also additional requirements of the part:

- the minimum weight;
- the acceptable strength and rigidity:
- the crank life should be equal to the aircraft life;
- the process plan of manufacturing this part should provide the minimum explicit costs;
- the possibility of mounting the part without an additional adjustment of the control rod;
- only approved solutions should be used for defining the part shape and sections.

For the analysis we consider the cranks presented on the stand "Control parts and units" in the room of aircraft constructions and the crank of the stabilizer control unit of the aircraft MiG-17.

The sketches of the cranks that are similar to the design crank are shown in the Figure 1.2.

The crank I (Figure 1.2, *a*) is installed in the fin of the aircraft MIG - 17; it supports the control linkage and changes of the control rod directions. The part is made of the deformable aluminum alloy by the hot forming method.

At the points 2 and 3 the control rods are fixed in the crank eyes. Bearings are inserted in these eyes. The part thickness between the points 2 and 3 is defined by the bearing width. At the point 1 the part is fixed to the fin frame. This part of the crank has the form of a hub with two inserted spaced bearings. The hub that is supported by lateral ribs provides the steady position of the crank while acting forces of the part plane.

The part is manufacturable. Places under the bearings are machined. The part can be estimated as a beam with the rectangular cross-section.

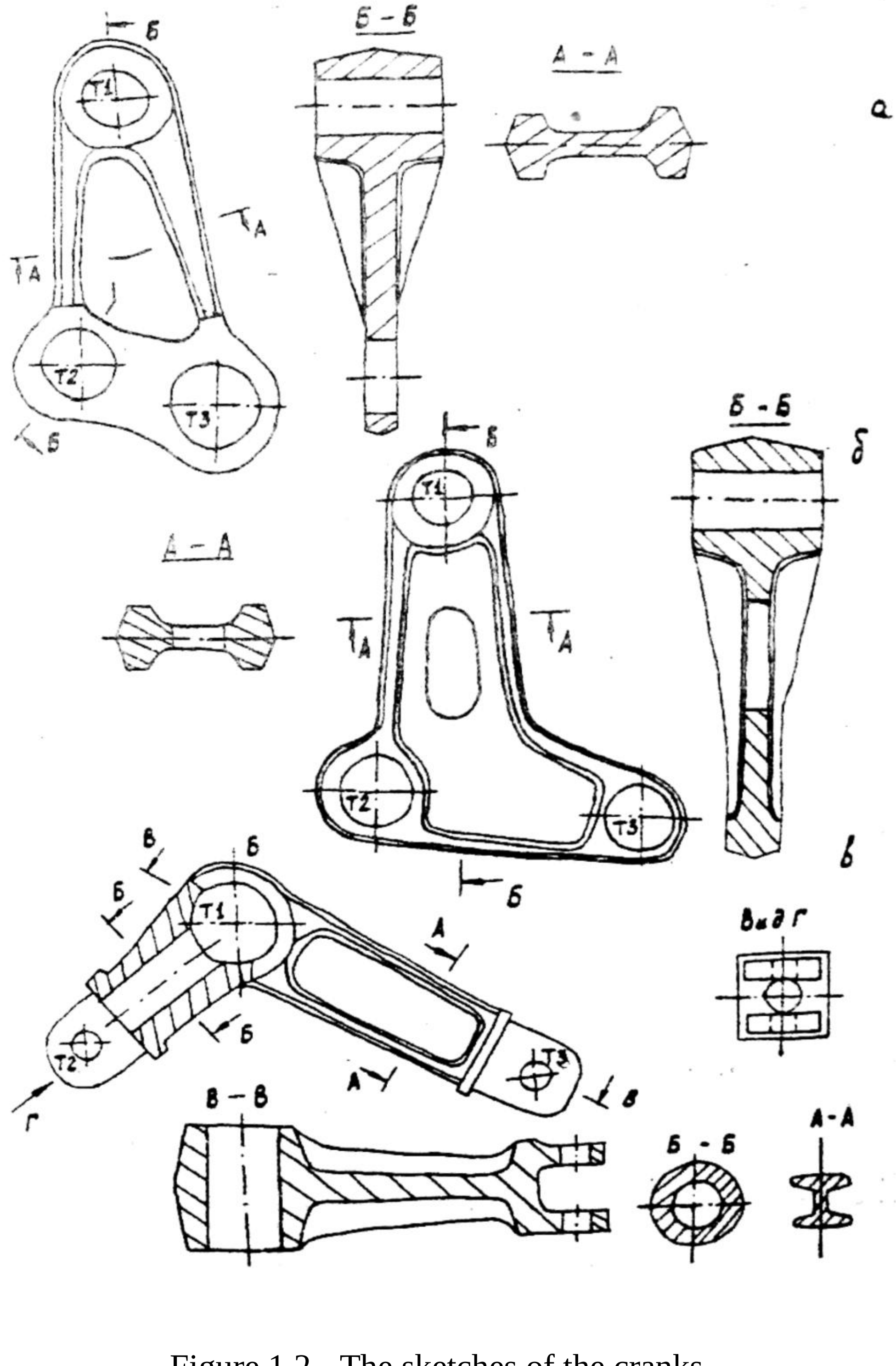


Figure 1.2 - The sketches of the cranks

The crank 2 (Figure 1.2, *c*) differs from the crank considered above by the planform. Each arm of the crank works as an I -beam. There is a hole in the crank body for lightening the part.

The crank 3 (Figure 1.2,*в*) is significantly different from the first two cranks by its implementation. It is made of the aluminum casting alloy by gravity die founding. In the junction with the rods the crank is made as a fork, the bearings are installed in the hub.

Both crank arms work as beams with the small constructional height. At that, one arm is made as an I -beam. Another has the tubular cross-section. This crank has more machining operations then the first two cranks.

2 THE EXEMPLARY REPORT OF THE LABORATORY WORK №2. CHOOSING NORMALS. CHOOSING THE DESIGN SCHEME AND DEFINING STRESSES OF THE PART ELEMENTS

2.1 Choosing normals. Ball bearings are set in joins between the part and rods and suspension brackets according to the requirement of the minimum friction and backlashes (the points 1, 2, 3 in the task).

Balancing the forces should be carried out for defining the stresses at the points 1, 2 and 3.

The equilibrium equation should be made relative to the point 1 for defining the force P_3:

$$P_2^p\, L_{12} = P_3^p L_{13}$$

$$\mathrm{P}_3^{\mathrm{p}} = \frac{\mathrm{P}_8^{\mathrm{p}} \cdot L_{12}}{L_{13}} = \frac{20000 \cdot 100}{120} \approx 16670$$

At the point 1 the stress is defined by projecting the forces P_1^p ,P_2^p и P_3^p ,H, on the axes X and Y. According to the task the angle between directions of the forces P_3^p and P_2^p and the axes X и Y is equal to 45^0 .

Taking into account that sin 45^0 = cos $45^0 \approx 0, 71$:

$$\mathbf{P_{12}^{p} = 0,71\,(P_2^p - P_3^p) = 0,71\,(20000 - 16670) = 2364},$$

$$\mathbf{P_{17}^{p} = 0,71\,(P^p + P^p) = 0,71\,(20000 + 16670) = 26036},$$

$$\mathbf{P_1^p = \sqrt{(P_{12}^p)^{\,2} + (P_{17}^p)^{\,2}} = \sqrt{2364^2 + 26036^2} = 26000}.$$

The results are shown in the Figure 2.1.

P_1 = 26000N; P_2 = 20000N; P_3 = 16670N.

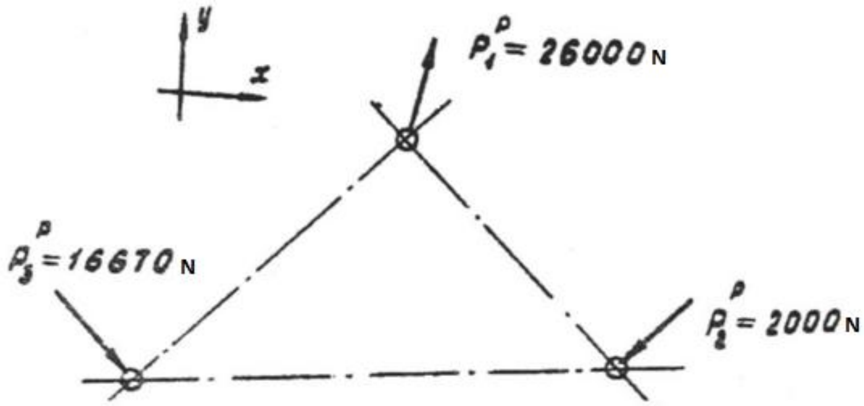


Figure 2.1 - Balancing the part

The bearings are selected by the static breaking loads at the points 1, 2, 3 [5]. An outer diameter of the bearing defines an inner diameter and thickness of the part eye.

At the point 1 two spaced bearings are set to ensure the efficiency of the control linkage work under acting unexpected loads of the part plane.

The dimensions of the chosen bearings are in the Table 1.

Table 1 - The dimensions of the chosen bearings

The point number	The bearing type	The static breaking load, N	The design load, N	η	d, mm	D, mm	в, mm
1	18	13000	13000	1,0	8	22	7
2	1007	20000	20000	1,0	7	22	7
3	1006	17000	16670	1,02	6	19	6

2.2 The sketches of the SLCS are shown in the Figure. 2.2.

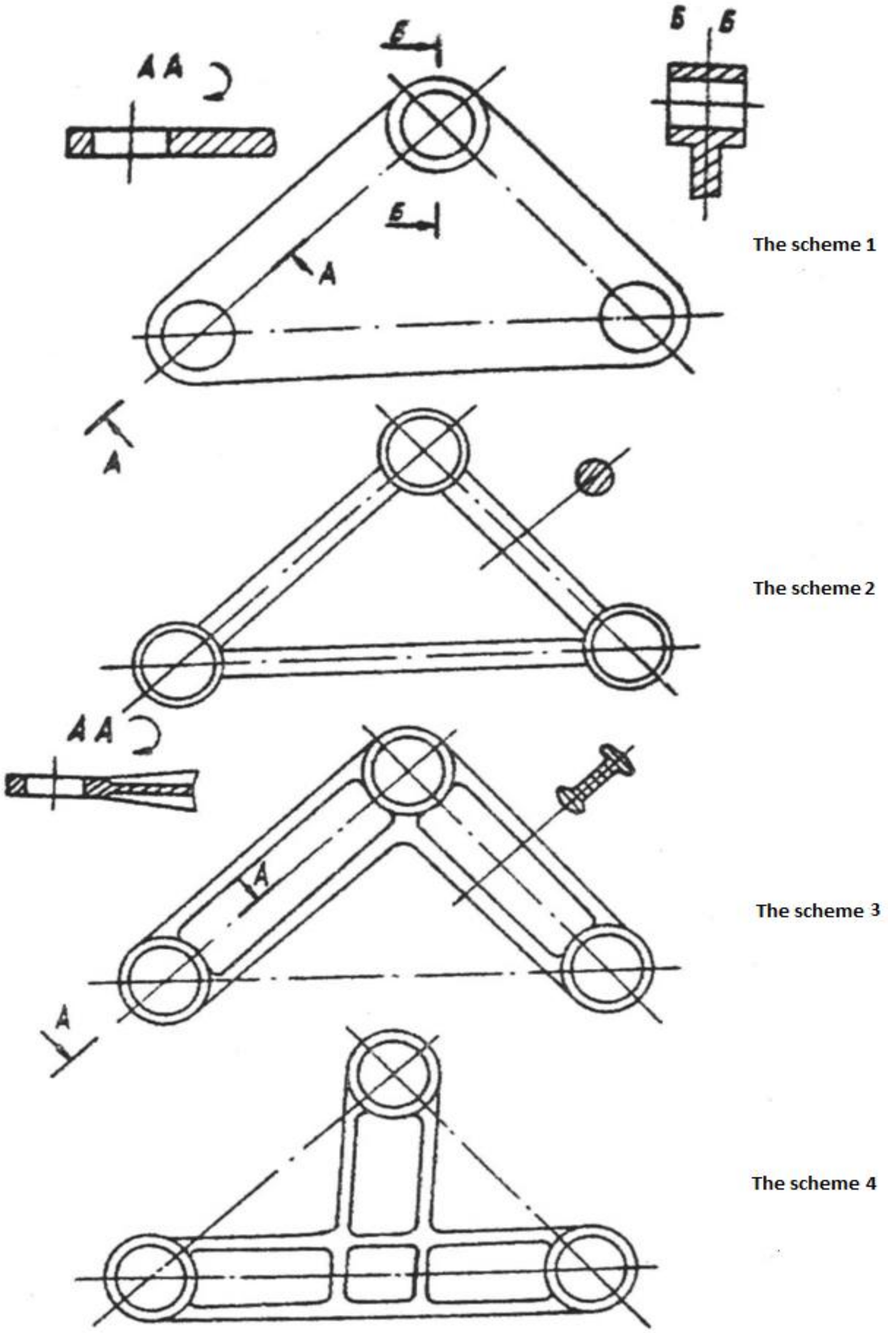


Figure 2.2 - The structural and load-carrying schemes of the part

The scheme 1

The crank is cut from the sheet with the thickness not less than 14 mm (it is the suggested width of the hub for two bearings at the point 1). All surfaces are milled according to the bearing thickness at the points 2 and 3.

The part is manufacturable, and the complex and expensive equipment is not required for the manufacture. This method is profitable only for single-piece manufacture. The design scheme of the part is a beam that has the rectangular cross-section. The part can be made of any material that allows machining operations.

The scheme 2

The crank is made as a three ring-eyes that are interconnected by rods. The whole part can be solid or welded from separate rings and rods. The welding will impose restrictions on the part material.

The part is less manufacturable. It can be made by pressing or founding. The junction between the eye and rod (stress concentration zones) requires the more accurate machining.

The design scheme of the part is three-rod truss that works on tension - compression. It is important to mention that the real part has the rigid rod connection in place of the hinge connection of the rods. Using the design truss model the part stresses can be correctly evaluated only for long rods; the influence of the embedment method on the long rods can be neglected.

The schemes 3 and 4

Both variants suppose manufacturing the crank by hot stamping and from the deformable aluminum alloy. The variants differ from each other by the planform and, accordingly, ways of transferring forces within the part.

The part is manufacturable. Their shapes are simple, and a small amount of machining is required after stamping the part. The design schemes of both parts are beams with the constant height. The element stresses are easily defined by formulas of the theory of beams.

The comparative evaluation of the part schemes shows:

– The scheme 1 has the "extra" material in the center of the part, so the requirement of minimum weight is not satisfied. The material usage ratio is low. The method of manufacturing the part does not satisfy the serial production;

– The scheme is less manufacturable. In addition, the selection of compressed rods sections with taking into account the buckling failure, obviously, requires a change in the section shape. And it is difficult to provide a long part life of the attaching points of rods and eyes. It also does not meet the technical requirements;

– The scheme 3 provides the longest way of transferring the forces between the control rods. The forces are transferred by bending the crank arms that have the small constructional heights. As you know, the bending method of transferring the forces is the most raw material intensive method. The crank of the scheme 3 will be the least rigid then all other considered cranks. The scheme 3 meets difficultly the technical requirements that concern the minimum weight and acceptable rigidity of the part;

– The scheme 4 also consists of beams; in comparison with the scheme 3 this scheme has the shortest way of transferring the forces between the rods. The main disadvantage of this scheme is the small constructional height of the crank arms.

The analysis of the schemes led to developing the scheme 5 that has no most of these disadvantages (Figure 2.3).

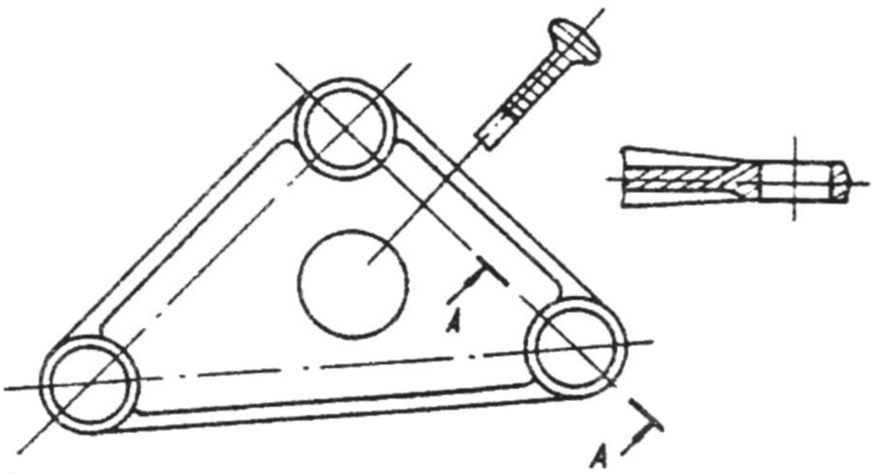


Figure 2.3 - The scheme 5

The scheme 5 is close to the truss scheme according to the method of transferring the forces.

At the same time the wall excludes the possibility of buckling the rods. The hole in the middle of the part removes the "extra" material. The forces between the rods are transferred by the shortest way. It is easy to provide the acceptable rigidity of the part.

The part can be made by the hot stamping.

2.3 Choosing the design scheme of the part. We choose the design scheme in the form of the beam with convergent belts for the selected scheme 5 (Figure 2.4).

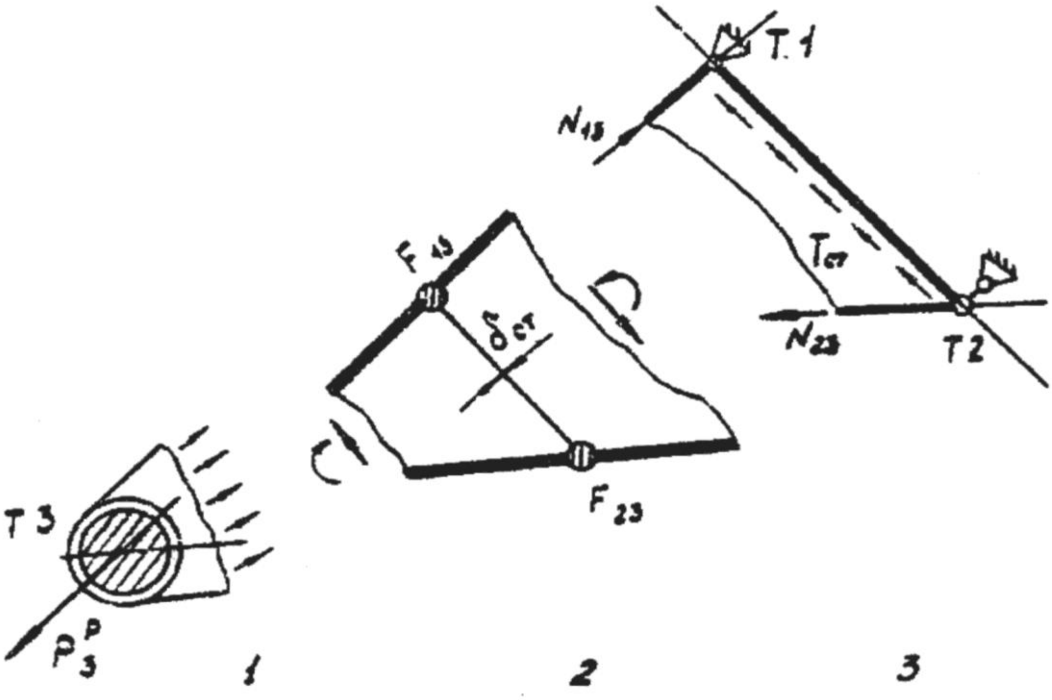


Figure 2.4 - The design scheme:

1 - The flat eye that is loaded through the rigid insert;
2 - The ideal I-beam with the variable lengthwise height H ;
3 - The support.

2.4. Defining the stresses of the part elements. Using the design scheme selected previously, the stresses of the crank wall and belts are defined by the formulas given in [2]. The initial data for calculations is shown in the Figure 2.5.

The stresses of the belts N13, N23, N12 and the wall T are defined by the formulas (4.1) (4.2) (4.3).

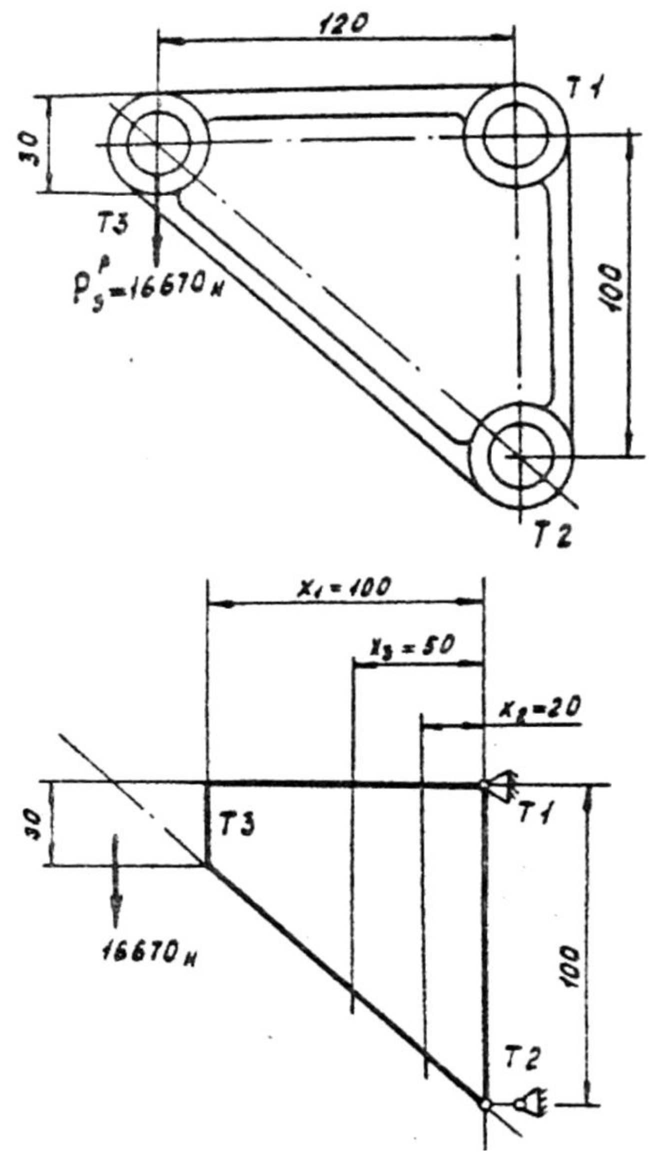


Figure 2.5 - The initial data for calculations

Symbols:

N_{13}^{3}, N - the stress of the rod 1 - 3 at the point 3;

N_{13}^{1},N - the stress of the rod 1 - 3 at the point 1;

N_{23}^{3},N_{23}^{2},N_{21}^{2},N_{21}^{1} - similarly to the previous symbols;

T^{3},N/mm – the shear flow of the wall at the point 3;

T^{0}, N/mm - the shear flow of the midsection;

x, mm - the distance to the design section;

α, β – the belt angles (α = 0^0; β = 37^0),

$$N_{13}^{3} = \frac{P^{P}(L_{13} - X_1)}{Cos\ a[L_{12} - X_1\ (tg\ a + tg\ \beta)]} = \frac{16670\ (120 - 100)}{1\ [100 - 100\ (0 + 0{,}841)]}$$
$$= 20968\ N;$$

$$N_{13}^{1} = \frac{16670\ (120 - 20)}{1\ [100 - 20\ (0 + 0{,}841)]} = 20041\ N.$$

Similarly, we obtain:

$$N_{23}{}^{3} = 27416 \text{ N};$$

$$N_{23}{}^{2} = 26198\ N.$$

$$N_{21}^{1} = P^{p}\left(1 - \frac{1}{L_{12}}\ tg\ a\right) = 16670\left(1 - \frac{1}{100} \cdot 0\right) = 16670\ N;$$

$$N_{12}^{2} = \frac{P^{P} L_{13}}{L_{12}}\ tg\ \beta = \frac{16670\ \cdot 120}{100}\ 0{,}841 = 16823\ N;$$

$$T^{3} = \frac{P^{p}}{L_{12} - x\ (tg\ a + tg\ \beta)} = \frac{16670}{100 - 100\ (0 + 0{,}841)} = 1048\ N/mm;$$

$$T^{0} = \frac{P^{p}}{L_{12}^{2}}\ [L_{12} - X_3\ (tg\ a + tg\ \beta)] = \frac{16670}{100^{2}}\ [100 - 50\ (0 + 0{,}841)]$$
$$= 96{,}6\ N/mm.$$

We decide that these stresses are constant and equal to the maximum value of the corresponding belt according to the fact, that the stresses of the root and tip belt parts are almost equal:

N_{13} = 20968 N; N_{23} = 27418 N; N_{12} = 16823 N.

It is easy to verify, that the shear flow T of the wall has the maximum value nearby the point 3:

$$T^3 = 1084 \text{ N/mm}, \; T^0 = 96{,}6 \text{ N/mm}.$$

3 THE EXEMPLARY REPORT OF THE LABORATORY WORK №3. DEFINING THE PART DIMENSIONS OF THE REQUIRED STRENGTH WITH TAKING INTO ACCOUNT THE MANUFACTURING FACTORS AND RESTRICTIONS

3.1 Choosing the material. The choice of the material is made according to characteristics of the material strength-to-weight ratio.

In accordance with the chosen design scheme the part works on bend. In [3] the criterion of the bend strength-to-weight ratio is equal to $\sigma^{2/3}/\rho$.

With regard to the fact, that the part is made by hot stamping, you should list the possible materials (use the recommendations [7]) and calculate their strength-to-weight ratios.

The material	σ_L, MPa	$[\sigma]^p$, MPa	ρ	$[\sigma]^{2/3}/\rho$
ЗОХГСА	1100	900	7,85	5,6
АК - 6	370	340	2,8	8,2
ОТ - 4	900	800	4,55	8,8
МАI4ТI	270	250	1,8	10,2

Where $[\sigma]^p$ is the failing stress, which is defined with taking into consideration the part work conditions and the material characteristics [8].

The magnesium alloy is more appropriate, because it provides the minimum weight of the part according to the table data. Its disadvantage is the weak rust-proof quality. The crank is placed in the tight open-type section, so it is difficult to check the antirust covering integrity of the part.

The titanium and aluminum alloys have the equal strength-to-weight ratio values. But the aluminum alloy is cheaper, and its machining is easier, so АК-6 should be chosen as the part material.

The heat treatment: hardening, and artificial tempering the part under the temperature 160° during 12 hours, $[\sigma]^p$ = 340 MPa.

3.2. Making calculations of the eyes parameters. These calculations are carried out in accordance with the recommendations given in [9].

The design conditions:

The material is АК-6, $[\sigma]^p = 340$MPa.

The failing stresses of the eyes:

$P_1^p = 26000$N;

$P_2^p = 20000$N;

$P_3^p = 16670$N;

The dimensions of the eye bearings, mm:

$D_1 = 22$, $\quad в_1 = 7$;

$D_2 = 22$, $\quad в_2 = 7$;

$D_3 = 19$, $\quad в_3 = 6$.

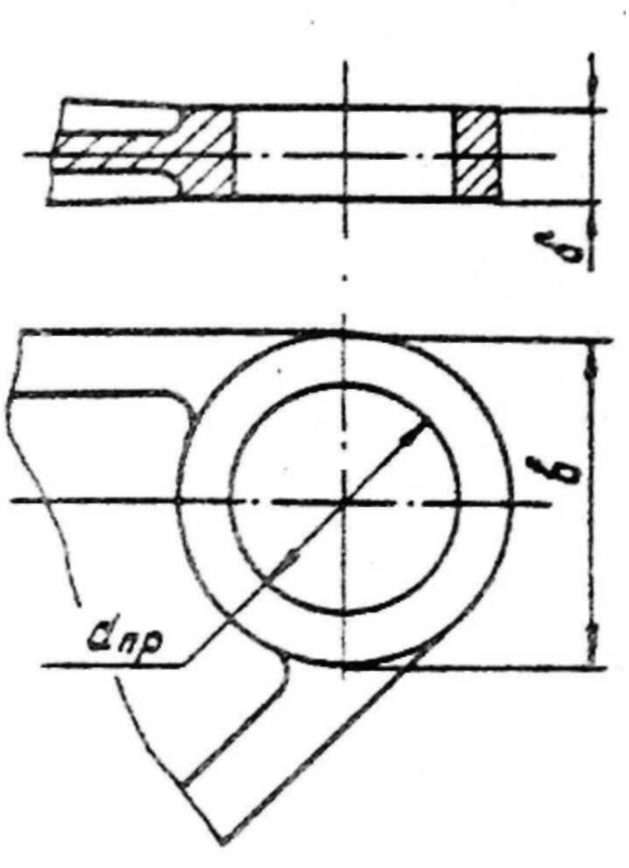


Figure 3.1 - The scheme of the eye at the point 2 and 3

1 The eye thickness, mm:

$$\delta = в_2 + 2a = 7 + 2x0{,}2 = 1{,}4 \ ,$$

where a - the bearing embedment allowance according to OCT 1.0384I-76, a=0,2 mm.

In accordance with ГОСТ 8032-84 δ is equal to7.5.

2 The eye width, mm:

$$в = \frac{P^p}{\delta\,[\sigma]^з} + d_{np} = \frac{20000}{7{,}5\ \cdot 340} + 22 = 29{,}8$$

where $d_{np} = D_2$.

$в$ is rounded up to 30 mm.

The minimum eye width is defined (mm) under the condition of the bearing insertion:

$$в_{min} = d_{np} + 2x_{min} = 22 + 2\text{x}4 = 30;$$

x_{min} = 4 мм (по ГОС1. 03841 - 76).

The eye width is equal to в = 30 mm.

The stress of the eye is defined (MPa):

$$\sigma^p = \frac{P^p}{\left(в - d_{np}\right)\delta} = \frac{20000}{(30-22)7{,}5} = 333{,}3\ ;$$

$$\eta = \frac{[\sigma]^p}{\sigma^p} = \frac{340}{333} = 1{,}02.$$

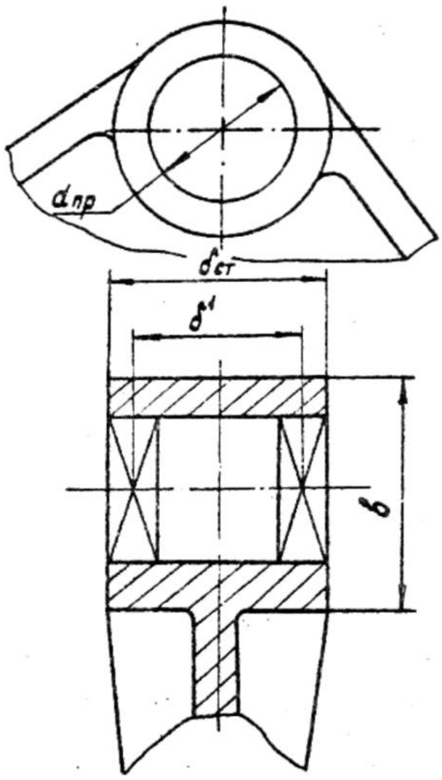


Figure 3.2 - The hub scheme (the point 1)

The eye dimensions at the point 3 are defined similarly to the previous calculations.

δ = 6,5 mm; $в$ = 27 mm; η = 1,06

The hub calculations (the point 1, Figure 3.2.):

1 The eye thickness. Two bearings are inserted in the hub, the distance between two bearings is:

δ = 18 mm, so

$\delta_{ст}$ = 25 mm (taking into account the bearing embedment).

2 The eye width, mm

$$в = \frac{P^p}{\delta[\sigma]^p} + d_{np} = \frac{26000}{25 \cdot 340} + 22 = 25{,}06.$$

Taking into account the condition of the bearing insertion:

$в_{min}$ = 30 mm, if d_{np} = 22 mm.

The width is accepted as $в$ = 30 mm.

The hub stress (MPa) is:

$$\sigma^p = \frac{P^p}{(в - d_{пр})\delta} = \frac{26000}{(30-22)25} = 130{,}2;$$

$$\eta = \frac{[\sigma]^p}{\sigma^p} = \frac{340}{130{,}2} = 2{,}61.$$

The dimensions of the eyes are plotted on the part sketch (Figure 3.3).

3.3 Calculating the part sections parameters of the required strength

The initial data:

The material АК – 6, $[\sigma]^p$ = 340 MPa.

The stresses of the belts:

N_{13} = 20968N,

N_{12} = 16823N,

N_{23} = 27418N.

The shear flow of the eyes T = 1048 N/mm,

T^0 of the part midsection = 96,6 Н/мм.

The areas of the belt cross-sections (мм$^{2)}$ are:

$$F_{13} = \frac{N_{13}}{[\sigma]^p} = \frac{20968}{340} = 61{,}7 \quad ,$$

$$F_{17} = 49{,}5 \quad ,$$

$$F_{23} = 80{,}6.$$

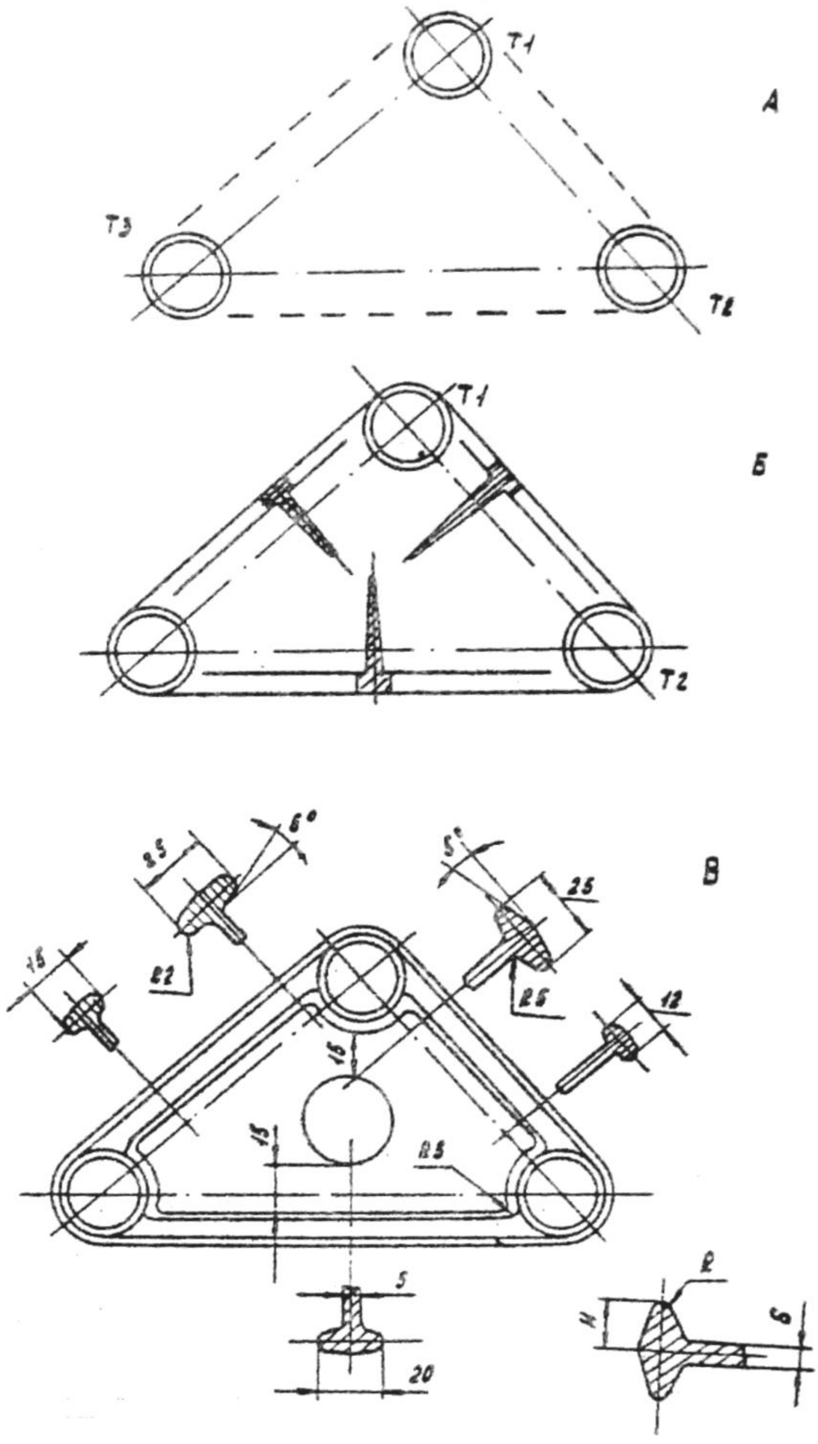


Figure 3.3 - The part configuration

The thickness of the eye wall (мм) is:

$$\delta = \frac{T^{3}}{[\tau]^{p}} = \frac{1048}{221} = 4{,}7\ ,$$

if $[\tau]^p$ = 0,65 $[\sigma]^p$ = 221.

The thickness of the eye wall in the centre δ^0 = 0,44 mm.

The dimensions of the wall and belts are plotted on the part sketch (Figure 3.3,*б*).

3.4 The modification of the sections with taking into account the manufacturing factors and restrictions. The part configuration that takes proper account of the hot stamping features is defined according to the recommendations [7].

1 Choosing the die parting line.

The part is symmetrical to the middle plane. The die parting line is straight, and it is generated by the intersection of the middle plane and the outer part profile (Figure 3.4)

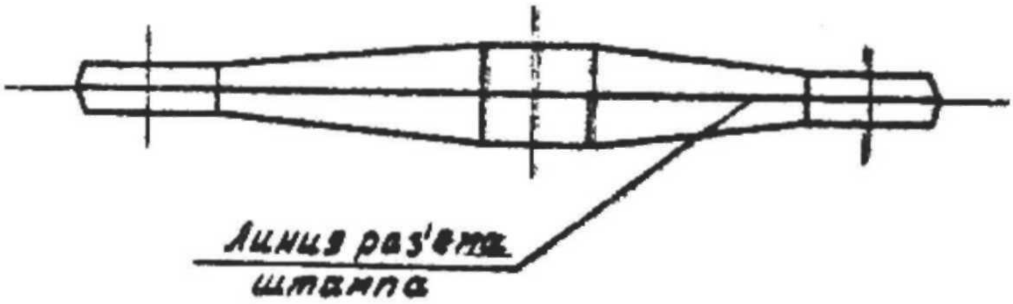


Figure 3.4 -The die parting line

2 Choosing the stamping angles

The belt 1 – 3

The belt height is variable.

The height at the point 3 is defined according to the belt area of the required strength.

F = 62 mm^2

Set up H =7,5mm; 2R = 4mm,

H - the rib height,

R - the radius при вершине ребра.

According to the Table 7,2 [7] the outer and inner angles are 5^0. At the point 1 the rib height is:

H =12,5mm (Table 7.2), the angle is 5^0.

The belt 1 -2

The belt height is variable.

At the point 2 F = 50 mm. Set up H = 6 mm. According to the Table. 7.2 the outer and inner angles are 5^0. At the point 3 the rib height (in accordance with the hub thickness) is equal to 12,5 mm, the angles are 5^0 .

The belt 2 - 3

The belt height is constant.

The belt area F = 81 mm. The rib height H = 10 mm and the thickness is constant, and the outer and inner angles are 5^0.

3 The calculations of the part wall thickness

The minimum acceptable wall thickness is defined according to the part projection area (Table 7.7 [7]).

If $F_{дет.}$ = 60 cm, the minimum thickness S = 2 mm.

The wall thickness of the required strength is 4,7 mm that quickly decreases to the part centre up to 0,5 mm.

Let us assume that the wall thickness is constant along the part and equal to 5 mm.

In the part centre the hole is made for lightening the part, the minimum distance between the rib and the hole edge should be no less then 15 mm (The total wall height of each section should be no less 30 mm).

4 The radiuses of conjugations and переходов are defined according to the Table 7.15 [7] (Figure 3.3, *B*).

The radius of conjugation between the rib and the wall R = 5 mm.

The radius of переходов (at the interfaces between the rib and the eye) R=5 mm.

5 The limit deviations of the dimensions between the unmachined surfaces are defined by the 4th degree of finish:

The vertical dimensions: +0,5 - 0,3 mm (Table 7.20) [7].

The horizontal dimensions: +0,6 - 0,3 mm (Table 7.22).

The limit deviations of the radiuses закруглений: +2,0 - 1,0 mm (Table 7.24).

The part sections should be modified under the condition of the strength (Figure 3.3, *Б*) with taking into account the manufacturing factors and restrictions (Figure 3.3, *В*).

The antirust covering should be chosen according to the work conditions and material of the part [12]: the sulphuric acid anodizing process with filling the oxide film by the bichromate; should be done and , no later than within 24 hours the covering АЛГ- 1 with the hot drying process should be done.

4 THE EXEMPLARY REPORT OF THE LABORATORY WORK №4.MAKING THE PART DRAWING

4.1. The execution of the part drawings. The part drawing is shown in the Figure 4.1.

4.2. Техническое описание of the designed part. The control crank is designed to transfer the control force and support the control rods of an aircraft. It is located in the in the tight open-type section of an aircraft fuselage.

It is made of the deformable aluminum alloy АК - 4 by the hot stamping method with the following mechanical operations of the eyes and the places of inserting ball bearings.

The antirust covering of the part does not require the control during the operation life of the part. In case of the mechanical failure of the covering it is necessary to cover the fault location by the lacquer coating.

BIBLIOGRAPHY

1. Шульженко, М.Н. Конструкция самолетов [Текст]: [учеб. для авиац. вузов] / М. Н. Шульженко. - 3-е изд., перераб. и доп. - М.: Машиностроение, 1971. - 415 с.

2. Проектирование конструкций самолетов [Текст]: [учебник для студентов вузов, обучающихся по специальности «Самолетостроение»]/Е.С. Войт, А.И. Ендогур, З.А. Мелик-Саркисян, И.М. Алявдин. – М.: Машиностроение, 1987. – 416 с.

3. Гиммельфарб, А.Л. Основы конструирования в самолетостроении [Текст]: Учеб. пособие для высш. авиац. учеб. заведений / А. Л. Гиммельфарб. - 2-е изд., перераб. и доп. - М. : Машиностроение, 1980. - 367 с.

4. Вильчек М.И. Проектирование узлов силовых конструкций летательных аппаратов [Текст]. – Куйбышев: КуАИ, 1985 – 64 с.

5. Зайцев, А.М., Коросташевский, Р.В. Авиационные подшипники качения [Текст] / Под ред. Р.В. Коросташевского; М.: Оборонгиз, 1963. – 340 с.

6. Крепёжные нормали : Сб. стандартов. М.: Минавиапром СССР, 1970.

7. Рекомендации по технологичности самолетных конструкций [Текст] (второе издание) / Под общим руководством и редакцией докт. техн. наук, проф. В.В. Бойцова; М.: Оборонгиз, 1963.

8. Справочник по авиационным материалам (ВИАМ). М.: Машиностроение, 1964

9. Основы конструирования в самолетостроении [Текст] : метод. указания к лаб.-практ. работам / Самар. авиац. ин-т им. С. П. Королева ; [сост. В. Н. Майнсков]. - Самара : [б. и.], 1992. - 56 с.

10. Майнсков, В.Н. Технические требования на чертежах [Текст]: метод. указания. – Куйбышев: КуАИ, 1982.- 30 с.

11. Резниченко, Г.А. Система обозначения чертежей в самолетостроении [Текст]: метод. указания. – Куйбышев: КуАИ, 1981.

12. Производственная инструкция ПИ-3620. Защитные покрытия изделий. 4-е издание. М.: Минавиапром СССР, 1979.

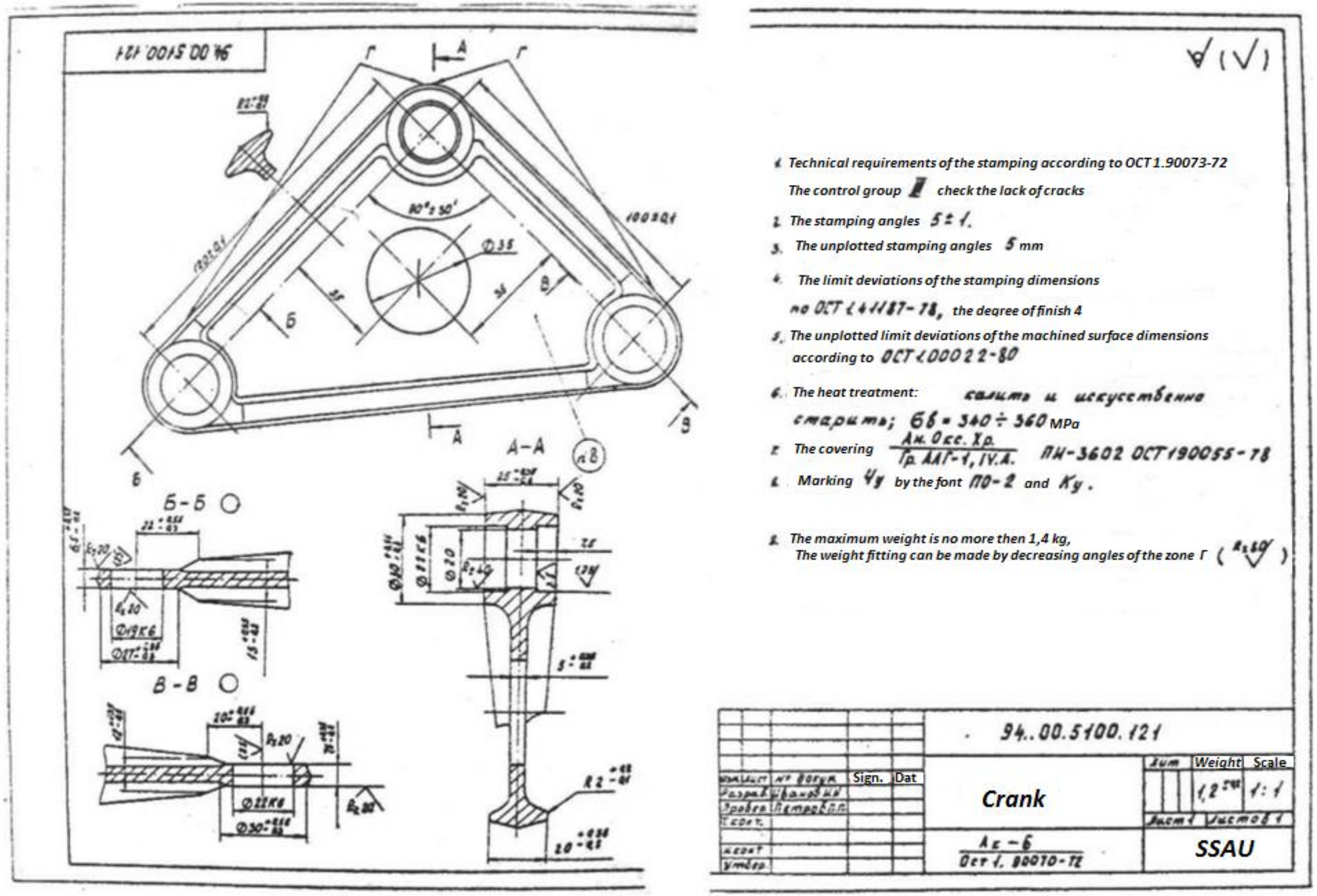
13. Детали крепежные.: Сб. стандартов. М.: Минавиапром СССР, 1987.

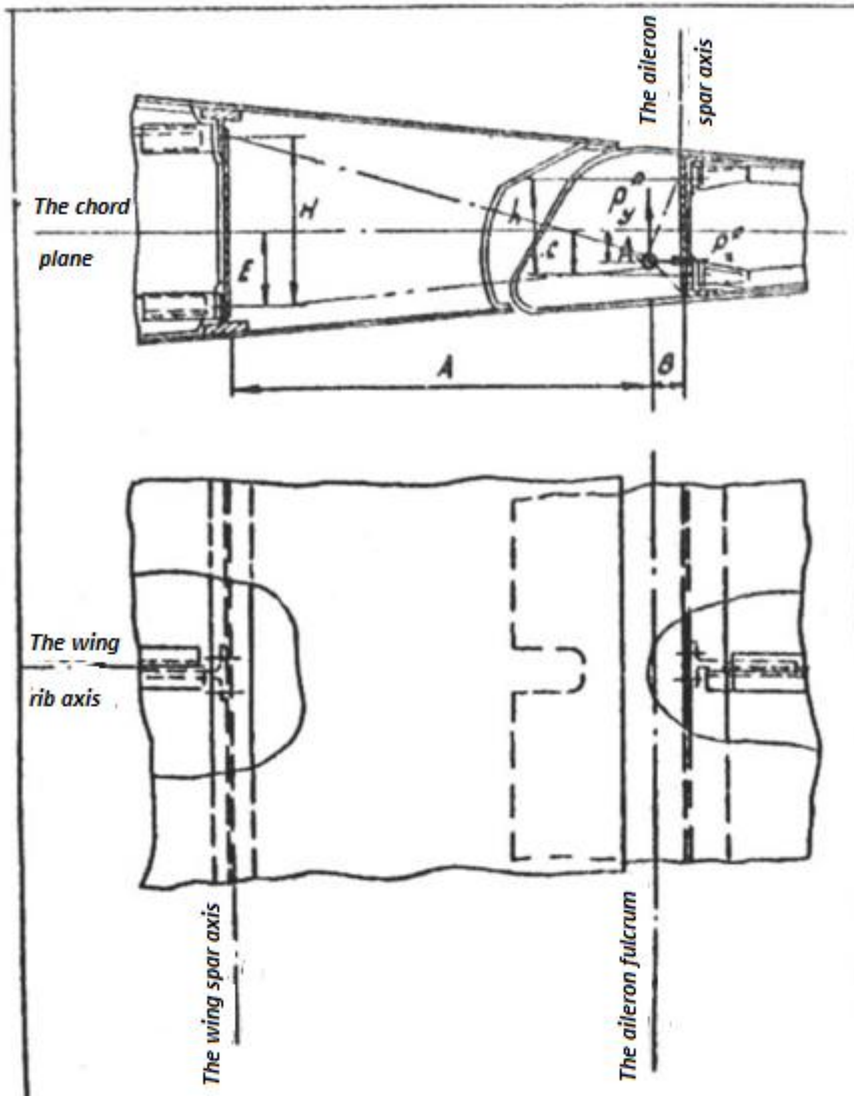
14. ГОСТ 13682-80. Минимальные размеры мест под гаечные ключи. Введён с 01.07.81.

15. ГОСТ 2.316-68. Правила нанесения на чертежах надписей, технических требований и таблиц. Введён с 01.01.71.

16. Резниченко Г.А. Проектирование детали [Текст]: методические указания к лабораторным работам / В.А. Вырыпаев, Г.А. Резниченко; Самар. гос. аэрокосм. ун-т им. С. П. Королева. – Самара, 2012.

4.1 The part drawing



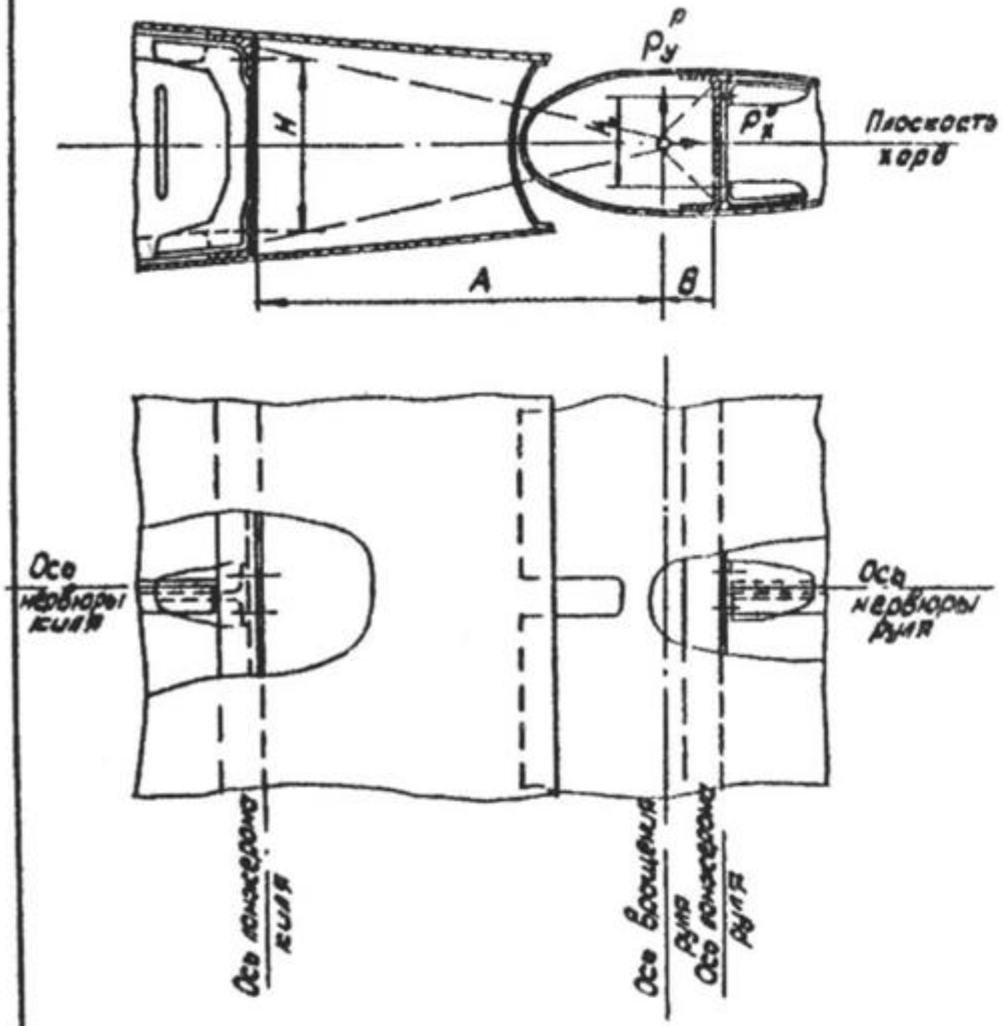


The Task Пк,Пэ

The aileron hinge bracket

№	A	B	C	Δ	E	H	h	P_x^p	P_y^p
I.	280	I00	40	30	50	I10	I00	I000	I200
2.	290	I10	60	50	80	2I0	I90	I200	2000
3.	300	I20	50	40	70	I80	I60	I300	I500
4.	3I0	I00	30	20	40	I20	I00	I I00	I800
5.	320	80	50	40	60	I50	I35	I500	2500
6.	330	90	35	30	45	I30	I I0	I800	3000
7.	340	I00	50	40	60	I40	I20	I700	2500
8.	350	70	60	50	70	200	I80	I600	2000
9.	360	II5	50	40	60	I60	I40	I500	3000
I0.	370	75	65	50	75	220	200	2000	4000
II.	380	85	60	50	70	I70	I60	I800	3500
I2.	390	95	55	40	70	2I0	I90	I600	3000
I3.	400	I25	40	30	50	I30	I I0	I I00	2500

The task Iст,Iр

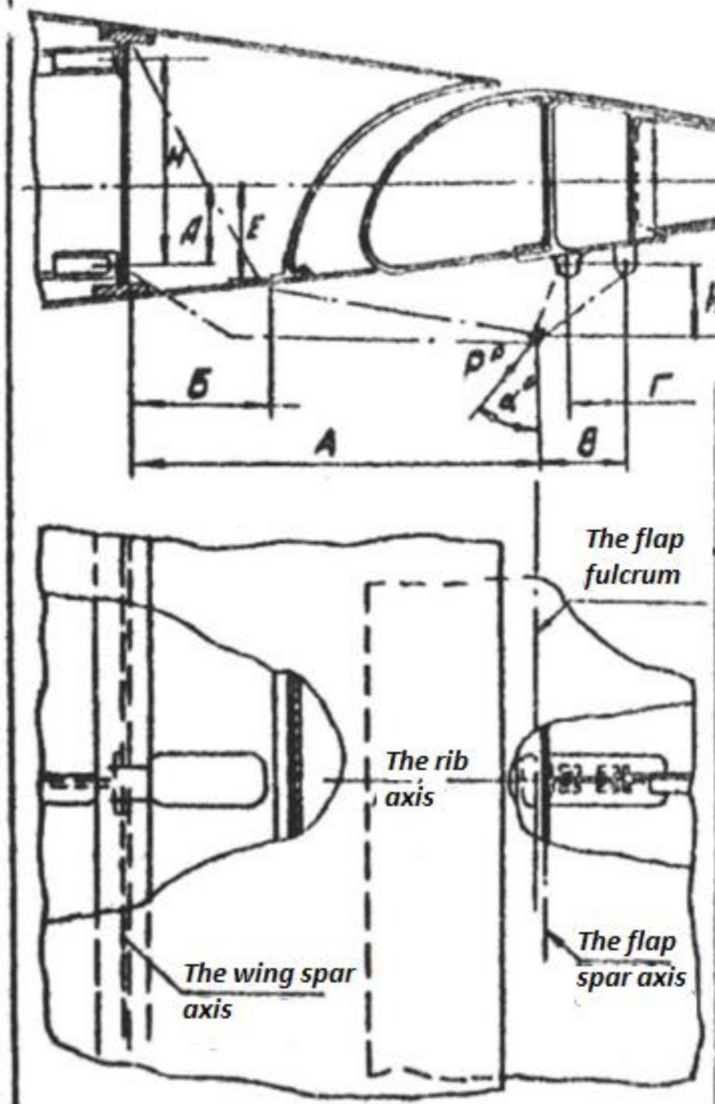


The stabilizer hinge bracket

№	A	B	H	h	P_y^p	P_x^p
I	I50	80	I70	I00	2000	II00
2	I60	90	I30	90	4000	I800
3	I70	70	I00	80	3500	I600
4	I80	I00	200	I60	2500	I400
5	I90	70	I20	I00	4000	2I00
6	200	80	I50	I20	3500	I900
7	2I0	90	II0	70	2000	I200
8	230	70	I40	I20	2500	I500
9	250	80	I90	I30	2500	I800
I0	270	90	I20	II0	3000	2000
II	290	I00	220	I30	2000	800
I2	300	70	I60	II0	3000	I700
I3	320	80	220	I50	3000	2000
I4	340	90	I40	I00	3500	I600
I5	360	I00	250	I80	2500	I000

The Task **Шк, Шэ**

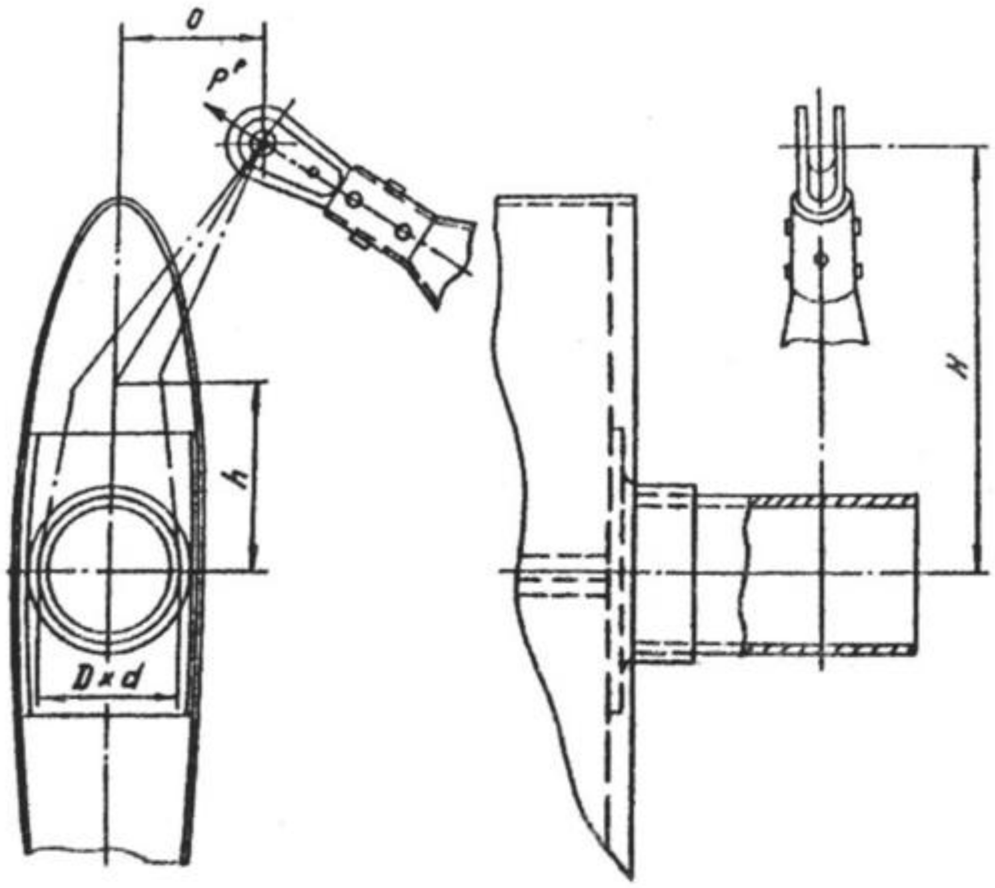
The flap hinge bracket



№	A	Б	H	Δ	E	ρ°	α°	B	Г	K	h
I	250	I00	I50	50	70	3000	45	I00	60	I40	80
2	270	II0	I60	50	70	3500	60	I05	60	I45	85
3	290	II5	I70	60	80	2800	50	II0	70	I50	90
4	300	I20	I80	60	80	4000	40	II5	70	I55	95
5	3I0	I30	I90	70	90	4300	70	I20	80	I60	80
6	330	I40	200	70	90	5000	50	I25	80	I65	85
7	350	I50	2I0	80	I00	3200	45	I20	90	I70	I00
8	370	I60	220	80	I00	3000	60	II5	90	I80	95
9	390	I70	230	90	II0	4000	40	I25	I00	I90	90
I0	400	I80	240	90	II0	3500	60	I30	I00	200	II0

The task IУ

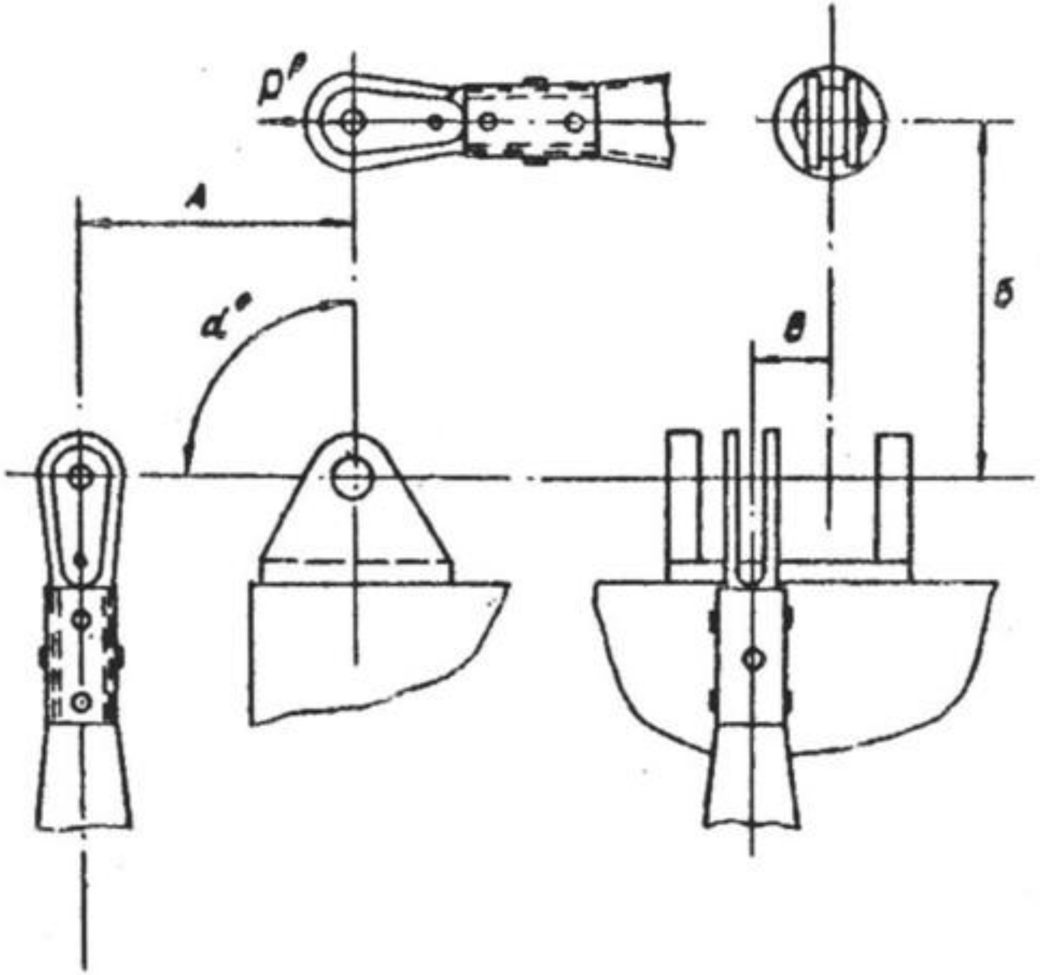
управления рулем



№	a	H	h	D×d	P°
I	30	I80	60	50x48	700
2	40	I90	80	55x52	I200
3	80	200	I00	60x57	I200
4	50	2I0	80	65x62	I800
5	0	220	I20	70x66	I800
6	I00	230	I00	75x7I	I800
7	70	240	80	85x8I	I600
8	0	260	I20	90x85	I400
9	50	280	II0	95x90	I200
I0	I00	300	I20	I00x94	I000

The Task У

The control crank



Nº	A	б	в	α°	ρ°
I	I20	I80	0	90	I500
2	I30	200	0	I00	I600
3	I40	220	0	60	2000
4	I50	2I0	50	45	I800
5	I60	250	0	I20	I500
6	I20	220	0	70	I700
7	I30	I50	70	90	I800
8	I40	I60	I00	60	2000
9	I50	I80	0	45	I800
I0	I60	I80	80	0	I600
II	I40	I00	50	90	2I00
I2	I30	II0	I00	0	2000