A STUDY OF ENCLOSED CYLINDRICAL AND BEVEL GEAR REDUCERS

Abduxakim Nigmatovich Abdullayev
Tashkent State Pedagogical University, Department of "Technological Education Methodology",assistant professor,Tashkent city.
https://doi.org/10.5281/zenodo.10730416

ANNOTATION: Students should be able to draw sketches and use them in models, along with having theoretical information about reducers, their function, structure, and types.

KEY WORDS: reducer, machine, wheel, multipliers, transmission, multi-speed reducers, shafts, torque, electric motor, bevel gears, Light and medium load, Slewing gears.

RESULTS:

1. By inspecting the reducer from the outside and using the drawing given in Figure 4.1, the names and structure of its external parts are studied.
2. The hardener parts are released, and the reducer cover is separated from its base.
3. Get acquainted with the mutual location and structure of the parts and assembly units located in the base.
4. The overall dimensions and connecting dimensions of the reducer (Figure 4.1, a, b) are measured and recorded in table 1 of the report sheet (*sample).
5. Full details of the gear reducer are given (Table 1). In this case, the shape of the wheels (cylindrical, conical), the location of the teeth in them (straight, oblique, chevron) and the number of steps (one, two, three, etc.) are indicated in the type of transmission. For example, "cylindrical spur gear, one-stage transmission" The direction of the teeth of the wheels (right bevel, left bevel, chevron, straight) is determined by the location of the teeth relative to the wheel axis. The angle of inclination of the teeth - β to find , the wheels are rotated once by placing a sheet of clean, tracing paper between the adjacent teeth. The slope of the tracks on the papers and the width of the wheel rim b_w is measured.
6. The kinematic diagram of the reducer (Fig. 4.1, a, b) is drawn and directly measured dimensions are shown in it:

b_w – width of gears, mm;
B – width of bearings, mm;
δ - the distance between the hub of the edge wheels and the wall of the reducer body, mm;
Δ - distance between side wheels, mm;
a_w , a_{wc}- interaxial distance of fast and slow steps, mm.

7. After removing the driving, intermediate and driving shafts, the number of teeth of the wheels located on them is counted.
8. Solving the intermediate shaft, using the directly determined dimensions, the remaining main dimensions of the reducer are calculated using the given formulas.
9. The results of the work are recorded in the report table

Table 1
Kinematic history of the reducer

T / p	Reducer Extensions	Dimensions symbol	Calculation formulas	A fast step		A slow step	
				Shestemya	The wheel	Shestemya	The wheel
1	Type of reducer gears	-	-				
2	The direction of the teeth of the wheels (right, left, chevron)	-	-				
3	Angle of inclination of the teeth, degrees	β	-				
4	The width of the teeth of the wheels, mm	b_W	-				
5	The number of teeth on the wheels	Z	-				
6	Distance between centers, mm	a_W	-				
7	Transmission ratio	U	$U_T = Z_1/Z_2$ $U_C = Z_4/Z_3$				
8	The module of engagement on the side of the wheels, mm	m_t	$m_{tT} = 20W_T / Z_1 + Z_2$ $m_{tc} = 20W_c / Z_4 + Z_3$				
9	Moderate flexural modulus, mm	m_n	$m_{nT} = m_{tT} * \cos B_T$ $m_{nc} = m_{tc} \cos B_T$				
10	Wheel diameter, mm	D	$d_1 = m_{nt} * Z_1 / \cos B_T$ $d_2 = m_{nt} * Z_2 / \cos B_T$ $d_3 = m_{nC} * Z_3 / \cos B_T$ $d_4 = m_{nC} * Z_4 / \cos B_T$				

DISCUSSION:

A reducer is a mechanism designed to reduce the speed of the rotational movement from the power source of the machine to its working part and is made up of gear or worm gears located in a separate box (body). A distinctive feature of reducers is the reduction of motion, that is, the number of transmissions in them $U \geq 1$ will be This property of the reducer is widely used in the design of machines and mechanisms. For example, the so-called gearbox reducers of cars work on this basis. It is known that when starting a car, the torque on the wheels must be greater than the torque during normal flat motion, and on the contrary, after the car has reached a certain speed, the torque on the wheel shafts does not need to be as large as before in order to continue the movement. Therefore, the rotation frequency of the drive shaft is gradually increased by means of a reducer. Such mechanisms are called multipliers or accelerators. They always have a transmission number $U<1$ will be Reducers differ from each other in the location of their shafts, size, number of transmissions and structure. According to the arrangement of the reducer shafts in space, they are horizontal and vertical. According to

the number of steps, the reducers can be single (Fig. 1 a, Fig. 2 a, Fig. 2 v), two (Fig. 1 b,v) and multi-step. Multi-stage reducers are used when the number of revolutions of the first shaft and the last shaft are very different from each other. According to the type of transmission, the reducers are cylindrical (Fig. 1 a), conical (Fig. 2 a), worm (Fig. 2 c) and mixed , i.e. cylindrical-conical (Fig. 2 b), cylindrical-worm types. Cylindrical gear reducers are the most widely used in industry, their structure and preparation are simple, and their durability is high. A typical transmission number $U \leq 6{,}3$ бўлганда бир поғонали, $U \leq 40$ two-speed reducers are used, and in cases where U ≤ 400 points, three-speed.

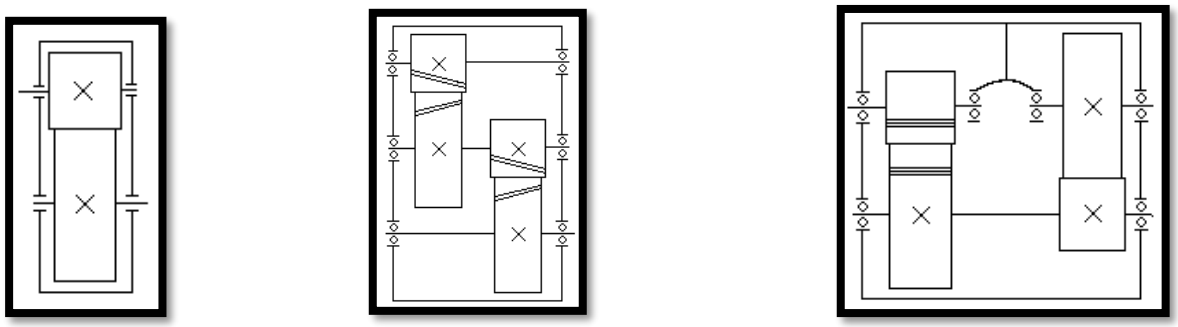
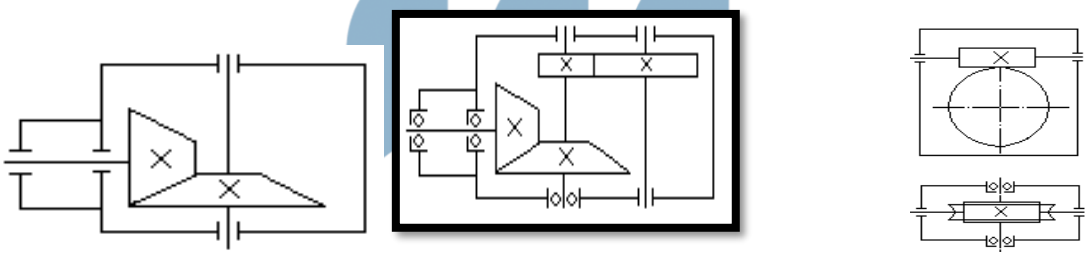


Figure 1.a) b) c)



Picture 2. a) b) c)

The weight and external dimensions of reducers mainly depend on how the value of the transmission number is distributed over the transmission steps. In this case, the indicators of reducers with the same diameters of the driving wheels are higher, because it is easy to lubricate the teeth of such reducers. Since the loading of the first stage in reducers is relatively small, it is recommended to make the value of the transmission number larger than that of the second stage in order to ensure the same diameters of the driving wheels. and the value of the coefficient psba is greater in the second stage. The most used two-stage reducers are the ones with wheels located in a row (Fig. 1 b,v). The structure of these reducers is simple, but the symmetrical location of the wheels relative to the supports causes uneven distribution of the load along the length of the teeth. As a result, the working conditions of the wheels and supports deteriorate. In order to eliminate this situation, gear reducers are used, where the wheels are located symmetrically with respect to the supports. In order to reduce the length of the gear reducer, it is recommended to use axle reducers (Fig. 1 c). The main disadvantage of such reducers is that some shaft supports are placed inside the reducer. First, it is structurally inconvenient, and secondly, it makes it difficult to control the position of the supports. If the number of transmissions $U \leq 6$, If the shaft connected to the electric motor in 3 parts and the shafts that transmit the movement to the working part are located in a mutually perpendicular position, bevel gear reducers (Fig. 2 a) are used. If the number of transmissions of reducers with mutually vertical shafts is required, multi-stage reducers consisting of

conical and cylindrical wheels are used. is used (Fig. 2 b). In this case, it is recommended to place the part of the reducer consisting of conical wheels on the first step.

If the transmission consisting of a worm and a worm wheel, whose axles intersect, is placed in a special housing, it is called a worm gear reducer (Fig. 2 c). The advantage of such reducers is to provide a large number of transmissions in a single-stage transmission, which can be up to U=500 for kinematic transmissions, and U=8...120 for power transmissions. The hardness of the shafts used in reducers is brought to NV 270...300 by thermal treatment. . Shafts with a diameter of up to 80 mm are made of 45 grade steel materials, shafts with a diameter of 80...125 mm are made of 45XTs; It is recommended to make 40XN4 35XM brand steel materials. Rolling bearings are mainly used as supports of shafts. Roller bearings are used in the shaft supports of reducers working with light and medium loads. Gear wheels of reducers must be lubricated. For this, oil is poured into the lower part of the reducer, called the crankcase. The oil level is 2h for high-speed spur gears (where h is the tooth height). 1/.3 of the drive wheel radius should be immersed in oil for the slow-rotating gear. To ensure this, 0.4...0.7 liters of oil is poured into normal reducers for each kW of power. In bevel gears, the axes are located at an angle to each other, and these angles are often ∑=90° will be equal. This type of gears is difficult to prepare compared to cylindrical gears, special machines are used for cutting the wheel teeth, in which the wheel teeth can be straight, inclined, circular (Fig. 3 a, b, c). When the speed of the transmission is up to 2-3 m/s, it is recommended to use straight gears, and when it is higher, it is recommended to use inclined and circular gears, in which the operation of the transmission will be smooth and noiseless. In conical transmissions, the magnitude of the force directed along the axis of the shaft, the uneven distribution of the forces acting on the teeth during engagement as a result, the generation of additional dynamic forces is the main disadvantage of this type of transmission.However, it is often necessary to use cross shafts in machines, so bevel gears are widely used despite the above

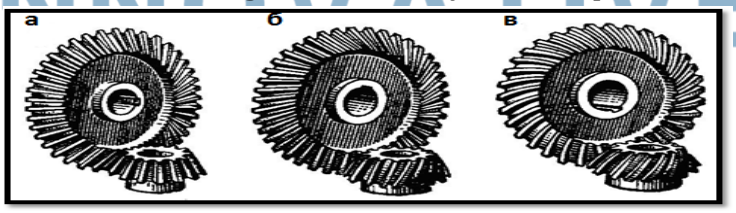


Figure 3

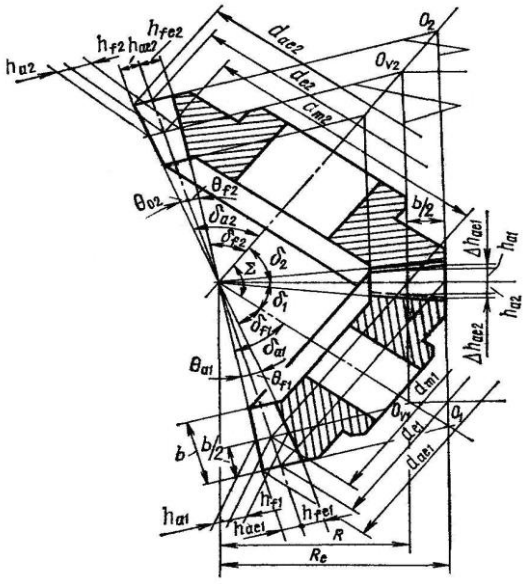
The angle of inclination of the wheel teeth is for spur gears β=35°, for tangential gears, it is recommended to take 20...30°. The greater the angle value, the smoother and smoother the transmission works (however, the value of the longitudinal force also increases). The geometric dimensions of bevel gears. friction gears are defined as: $u = \frac{\omega_1}{\omega_2} = \frac{n_1}{n_2} = \frac{z_2}{z_1}$. When the angle between the axes of the shafts is 90°, the number of transmissions expressed by the initial cone angle is as follows (Fig. 4). $u = tg\delta_2 = ctg\delta_1$ In general, the value of the number of transmissions for bevel gears with straight teeth is 2...3, for circular gears u_{max}=6,3 It is recommended to get up to. When determining the geometric dimensions of gear wheels, the module determined by the surface (width) of the tooth is used as the calculation module, where me for spur gear wheels is mte for circular gear wheels, and these values are not

rounded according to the standard. In these gears, like cylindrical gears, the basic geometric dimensions are expressed using initial or dividing cone dimensions

$$d_e = m_{te} z, \qquad m_{te} = m_m \frac{R_e}{R_e - 0{,}5 b_\omega}, \qquad R_e = \frac{d_{e1}}{2\sin\delta_1} = \frac{d_{e2}}{2\sin\delta_2}$$

.

here:R_e - the length of the cone maker; de - the dimensions of the circle of the wheel; tte is the module determined by the surface of the wheel tooth; tm is the modulus determined by the mean diameter. In general, for bevel gears with spur and spur gears $z_k > z_{min}=17$ should be, in which it is ensured that the base of the tooth is not sheared in the process of cutting the wheel tooth with a tool.Purpose of the work: Reducers are a device consisting of a set of gears, which serve to reduce the rotational speed and increase the torque. Two-stage cylindrical reducers are the most 4-p common in mechanical engineering

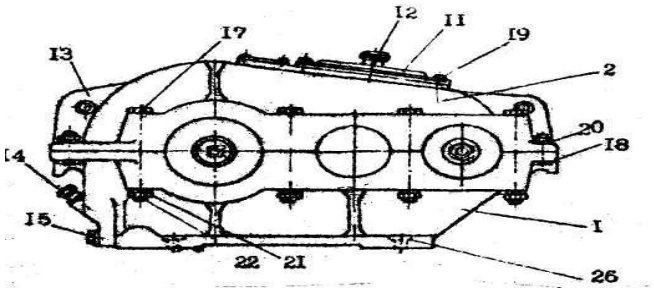


(Fig. 4.1 a,b).

Laboratory equipment: two-stage reducer model (in shear), posters, diagrams, set of keys, hammer, scale ruler, barbell circle, barbell gauge, universal protractor, tooth marking paint, etc.

The essence of work: Reducers can be single or multi-stage. The number of stages is selected depending on the degree of reduction of the angular speed, that is, the transmission ratio. If the transmission ratio i < 6,3 if there is one step, 6,3 < i < 40 when - two-step, i > 40 when it is - it is recommended to use three- and multi-stage reducers. The shafts of the steps in the reducer can be parallel or parallel, and the wheels can be symmetrical or vertical with respect to the supports. But from the point of view of load distribution along the length of the shafts, serial shaft reducers with high-speed or slow-speed stages are considered to be better.

The main parts of the reducer can be familiarized with the example of a two-stage reducer given in Figure 5:



4.1 - picture. Kinematic history of two-stage spur gear reducers.

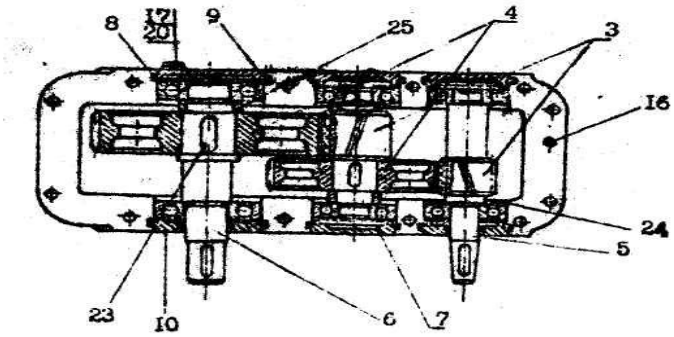


Figure 5. Two-stage reducer. 1 - the base of the reducer body, 2 - the cover of the reducer body, 3 - gears, 4 - wheels, 5 - drive shaft, 6 - drive shaft, 7 - intermediate shaft, 8 - rolling supports, 9 - closed cover of supports, 10 - open support cover, 11 - inspection window cover, 12 - air extractor, 13 - lugs, 14 - oil indicator, 15 - oil drain plug, 16 - nails without a cap, 17, 18, 19 - fastening bolts, 20, 21 - strap rings, 22 screws, 23 - washers, 24 - oil-absorbing rings, 25 - support rings (bushes), 26 - holes for foundation bolts. The base of the reducer body 1 and the cover 2 together form a closed volume and protect the parts inside it from dust. In addition, the base of the reducer body receives the loads that fall on the shafts and supports. The rotary gears 3 and the wheel 4 are fixed to the shafts 5, 6 and 7 with the help of pins 23. To limit their longitudinal position on the shafts, stud bushings (bushings) 25 are used. The shafts 5, 6, 7 of the reducer body rest on the base 1 through rolling supports (bearings) 8. Oil-absorbing rings 24 are installed on the bearings so that the oil inside the reducer does not pass through. The longitudinal position of the bearings is limited by means of caps 9 and 10, which fit into slots in the gearbox body. In this case, if the shaft does not come out of the reducer, closed covers 9 are placed, and if it comes out - open covers 10. Covers 9 and 10 are fastened to the body of the reducer with the help of bolts 17 and belt rings 20. There is an observation window in the cover of the reducer to control the engagement of gear wheels and pour oil into it during the work of the reducer. The window is closed with cover 11. An air vent 12 is fixed on the cover 11 so that the pressure inside the reducer does not increase too much. Lugs 13 are used to lift or move the reducer. For this, holes are made in the ears. A special oil indicator 14 is used to check the oil level poured into the reducer. Oil drain plug 15 is used to drain excess or contaminated oil. Ensure that the reducer body cover 2 and the base 1 are mutually compatible for them, there are 16 nails without caps, which are inserted into special holes in them. Covers 2 and 1 are fixed to each other with long 17 and short 18 bolts, as well as screws 22 and strap rings 21. In order to fasten the reducer to the base, holes 26 are opened on its base.

References:

1. Abdullayev, A. (2023). METHODS OF PROBLEM SOLVING IN THEORETICAL MECHANICS COURSES. International Bulletin of Applied Science and Technology, 3(9), 282-287.
2. Abdullayev, AN (2023). Pedagogical Description of the Formation of Professional Competence in Students of a Higher Education Institution . Vol. 4 No. 2 (2023): AJSHR March 9, 2023 . American journal ajshr , "Global Research Network LLC" ISSN: 2690-9626 (online), Published by "Global Research Network LLC" under Volume: 4 Issue: 2 in Feb-2023 https://globalresearchnetwork .us/ index.php / ajshr
3. Abdullayev, AN (2023). Methodology of problem solving in technical mechanics classes. Scientific electronic magazine "Science and Education". Volume 4 Issue 4 https://drive.google.com/file/d/1GJzuiTGK_lTj7HReL8Pl6 yMqytgpgj1/view?usp=share_link . ISSN 2181-0842 . APRIL 2023 . 684-688
4. Abdullayev.A.N "Pedagogical Description of the Formation of Professional Competence in Students of a Higher Education Institution" AMERICAN JOURNALAJSHR, "Global Research Network LLC. Vol. 4 No. 2 (2023): AJSHR March 9, 2023. ISSN: 2690-9626 (online), Published by "Global Research Network LLC" under Volume: 4 Issue: 2 in Feb-2023 https://globalresearchnetwork.us/index.php/ajshr
5. Abdullayev.A.N "Maxsus fanlarni o`qitishning professional ta`lim tizimidagi ahamiyati" Analytical Journal of Education and Development. Volume: 03 Issue: 05 May- 2023 ISSN: 2181-2624 www.sciencebox.uz 145-147 pades

INNOVATIVE ACADEMY