Development of standard size pullers for bearings

Vasyl Rys

Lviv National Agrarian University, V.Velykoho Str. 1, 80381, Dubliany, Ukraine,
e-mail: rysvasyl@gmail.com

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Summary. Theoretical studies have justified the contact area of the pinchers of the puller with the bearing ring during dismantling, which made it possible to reduce its metal capacity without violating the functional properties. It is established that the rational form of the clutches of a puller is such that it is executed in the form of a segment of a circle.

Based on the dependence of the minimum value of the area of the contact of the puller's pincher with the bearing ring on the force of compression, the pullers are divided into four sizes according to the size of the contact area of the pinchers. With the four sizes of pullers provided by us, the first (the smallest) size of the puller allows the removal of bearings with a diameter of up to 40 mm, with a design effort of 38 kN, the second one - bearings with a diameter of 40 mm to 60 mm, with a design effort of 59 kN, and the third with bearings with a diameter of 60 mm to 90 mm for the design effort of 95 kN and the fourth (the largest) - bearings with a diameter of 90 mm to 100 mm, with a design effort of 104 kN.

The use of high-carbon alloy steels (60S2A steel) reduces contact area by 28%.

The design of the proposed puller is simple and reliable in operation. Using a puller of this design reduces the length of the process of disassembly of parts by 10 ... 20%.

Key words: puller, bearings, bearing units, contact area, standard size series.

INTRODUCTION

According to the results of the research, the expenses for repair and maintenance of the machine-tractor fleet of the agro-industrial complex make up 19% of its book value. A significant part of them falls on the replacement of worked parts, including roller bearings. The lifetime of agricultural machinery in most cases is 10 years or more, while most of the bearings are to be replaced several times during the service life of the machinery, with most seats being located in body parts and on shafts, which are important to keep as long as possible. That is, during the use of the machine, it may be necessary to disassemble its units several times in order to replace the bearings.

The main requirement for the operation of dismounting press compounds, in particular bearing units and bearings, is to keep them in working order. Knowing the permissible pressures that can occur in the details of the pullers during these operations and their location, the tool is selected.

During extortion of bearings it is very important not to damage the bearings itself, and its seats on the parts connected to it. Taking into account that the efforts of extortion of the connection is by 10-15% larger than the force of pressing and during operation, much of the rolling joints of the parts are deformed, their surfaces are corroded and damaged, such connections become stationary, so their disassembly becomes complicated [1, 2.21].

The correct extortion of the bearing is carried out with the transfer of the dismantling effort only on the ring, which is mounted with tension and in no case to the rolling bodies. Sometimes the bearings are disassembled to perform maintenance or repair of other parts of the mechanism - in this case, bearings are usually used repeatedly.

The essence of the problem is that during dismantling of parts connected to the tension, it is not always possible to use universal pullers due to the peculiarities of their design and the features of the units of machines that are being disassembled [3-7]. This is especially true in the processes of disassembling parts from deaf holes, parts installed at a considerable distance from the edges of the shafts, the dismantling of thin-walled parts and parts to which limited radial access and access to the end face of the captured surface. In the other many specific cases, it is inconvenient or impossible to use serial puller of known designs as it results in damage to or destruction of parts, and may also cause injury to performers [8, 9].

ANALYSIS OF RESEARCHES AND PUBLICATIONS

The conducted studies have shown that in each case, the use of pullers of the appropriate principle of action and design can be effective [8, 9, 11-17]. Our task in designing a puller is to ensure the transfer of the extrusion effort through the contact area of the bearing with the bearing ring. The main attention was paid to increasing the efficiency of the process of dismantling and mounting of bearing joints, improving working conditions, reducing the metal capacity of structures and expanding their functionality [10].

Based on the analysis of known structures of pullers [8, 9 ,11-17, 20], we can conclude that most of them have a special purpose for disassembling units with certain geometric parameters.

After analyzing the disadvantages of existing constructions of pullers, one can conclude that it is often necessary for a worker to hold a puller with one hand, and another to erect pullers for capturing the part to be removed. In this case, depending on the orientation of the puller in the space and the technical state of the pinchers, the latter can slip from the bearing, both during installation and after the creation of an effort in a mechanical screw or a hydraulic shaft rod.

The reliable fixing of the pinchers on the detachable part is ensured by the developed design of the puller provided in Figure 1 [10, 14, 21].

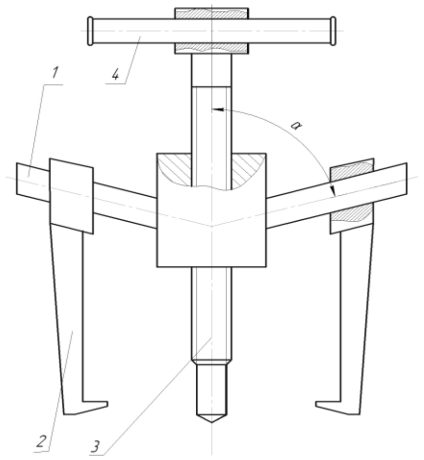

Fig. 1. General view of the puller: 1 - traverse; 2 - pinchers; 3 - power screw; 4 - lever

Puller for dismantling parts of the shaft set with tension operates as follows. Power screw 3 is centered on the end of the shaft (not shown in the figure), holding the traverse 1. Turning the screw in the right direction until the pinchers 2 do not come in contact with the detail (not shown in the figure) which is removed. Then, bring the pinchers 2 to contact them with the side surface of the detail. Then, with help of the lever 4 rotate the screw 3 to contact the pinchers 2 with an end surface of the detail and carry out the dismantling of the part, during which the pinchers are pressed against the side surface of the part and make the opening and jump off impossible.

Characteristic for the puller is that efforts of the claws fixation on the detail increases with the effort of dismantling and provides alignment of the power element of the puller with the axis of the shaft. The design of the proposed puller is simple and reliable in operation. Using a puller of this design reduces the length of the process of disassembly of parts by 10 ... 20%. [17]

THE PURPOSE OF THE RESEARCH

The purpose of the work is to develop a typical size of bearings removers on the basis of the dependence of the contact area of the claw of the puller with the bearing ring on the extrusion effort.

THE RESULTS OF RESEARCH

One of the problems that occur when disassembling the press connections is the slipping of the pinchers from the bearing ring. To eliminate this disadvantage strippers are equipped with additional elements, which in turn complicate their design and increase the mass, as well as create some inconvenience in use. The solution to this question is the justification of the contact area of the puller's pinchers, which will ensure that it does not slip from the bearing ring during its dismantling.

Let the area *A* of the contact of the pincher and bearing ring be in the shape of the circle sector shown in Figure 2. The area of the sector depends on the angles β and β_1. Provided that if the angle $\beta < \beta_1$ of the sector is restricted to Z_1, H_1, H_2, Z_2, if $\beta > \beta_1$, then the sector's area will be limited to Z_1, H_1, H, Z. The increase in the angle β can significantly increase the area of the sector.

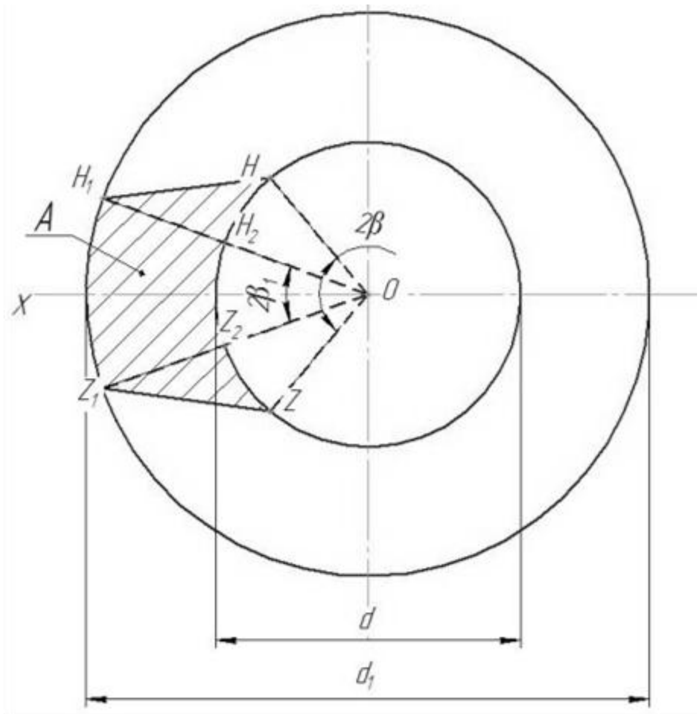

Fig. 2. The contact area of the claw and bearing rings

Determine the components of the total area:

a) the area of the circular sector OZ_1H_1:

$$A_1 = A_{OZ_1H_1} = \frac{\beta_1 d_1^2}{4},$$

where: d_1 - outer diameter of the inner ring of the bearing, mm;

b) the area of the circular sector OZ_2H_2:

$$A_2 = A_{OZ_2H_2} = \frac{\beta_1 d^2}{4},$$

where: d – diameter of the shaft on which the bearing is pressed, mm;

c) area of the triangle OH_1H:

$$A_3 = A_{OH_1H} = \frac{1}{2}\frac{d_1}{2}\frac{d}{2}\sin(\beta - \beta_1),$$

d) circular sector area OH_2H:

$$A_4 = A_{OH_2H} = \frac{\beta - \beta_1}{2}\frac{d^2}{4}.$$

The area of contact is found through the area A_1, A_2, A_3, A_4:

$$A = A_1 - A_2 + 2A_3 - 2A_4. \quad (1)$$

After substituting the expressions of the component areas, we obtain a formula for determining the contact area of the puller's pinchers with the inner ring of the bearing:

$$A = \frac{1}{4}\left(\beta_1(d_1^2 - d^2) + d_1 d \sin(\beta - \beta_1) - (\beta - \beta_1)d^2\right) \quad . \quad (2)$$

In the formulas above, the angles β and β_1 are defined radially.

Formula (2) is derived for the condition $\beta > \beta_1$, but it can be used without any changes and for $\beta_1 \geq \beta$.

In particular, for $\beta = \beta_1$, formula (2) is considerably simplified to the form:

$$A = \frac{\beta(d_1^2 - d^2)}{4}. \quad (3)$$

On the basis of theoretical calculations, the dependence of the contact area of the pincher with the bearing ring on the compression force, shown in Figure 3, was obtained. Calculations of the contact area of the puller's pinchers were made for bearings of different diameters and different sorts of steels.

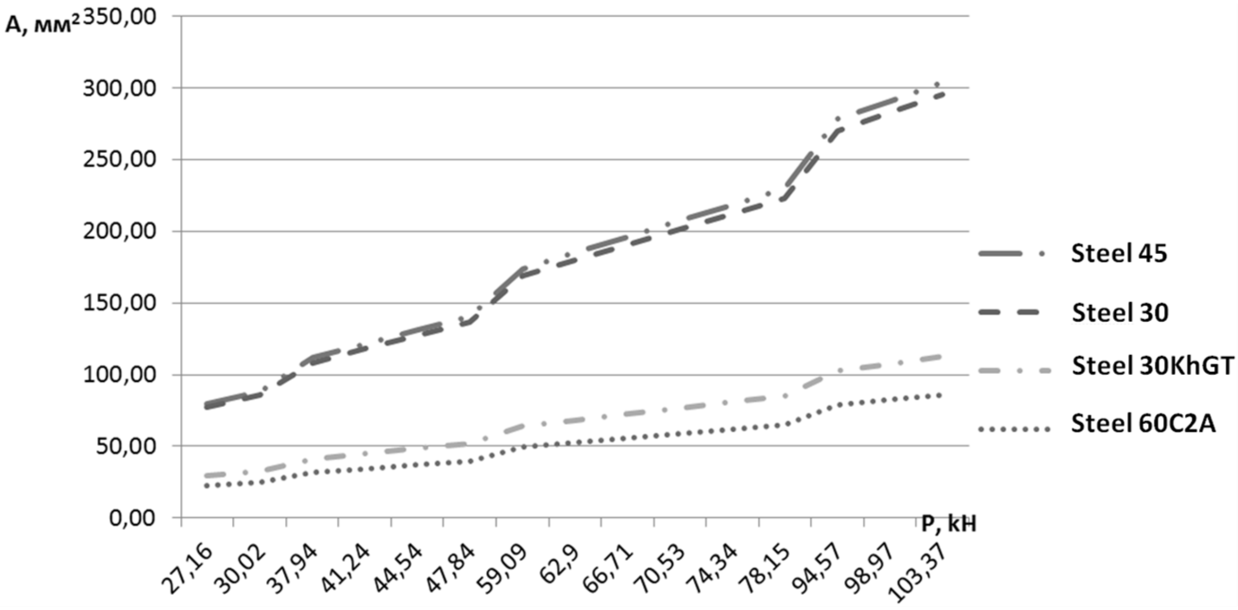

Fig. 3. Dependence of the contact area of the puller's pinchers with the inner ring of the bearing on the effort of extruding bearings with different internal diameter for different materials under the condition $\beta = \beta_1$

The analysis of the obtained dependence (Figure 3) shows that with the increase of the extortion force, the calculated area of contact of the pincher increases. This dependence allows you to divide pullers by four standard sizes by the contact area of the pincher. With the four sizes of removers provided by us, the first (the smallest) size of the puller allows the removal of bearings with a diameter of up to 40 mm, with a design effort of 38 kN, the second one - bearings with a diameter of 40 mm to 60 mm, with a design effort of 59 kN, the third with bearings with a diameter of 60 mm to 90 mm for the design effort of 95 kN and the fourth (the largest) - bearings with a diameter of 90 mm to 100 mm, with a design effort of 104 kN.

It is possible to reduce the contact area of the claw of the puller with the inner ring of the bearing due to the use of the material with the best strength characteristics. The use of high-carbon alloy steels reduces the contact area, in particular - for a diameter of 40 mm from 111.6 mm (steel 30) to 25.0 mm (steel 60C2A), respectively, the use of high carbon alloy steels (steel 60S2A) reduces the contact area by 28 %.

Having analyzed the dependence (Fig. 3), we see that as the bearing extortion force is increased, the contact area of the puller pincher with the inner ring of the bearing increases too. This leads to an increase in the metal content of the puller. However, the use of high carbon alloy steels reduces the contact area of the puller's pincher with the bearing ring and thereby reduces the metal capacity of the puller without affecting the functional properties.

CONCLUSIONS

1. Theoretical studies have grounded the area of contact of the claw of the puller with the bearing ring, which made it possible to reduce its metal capacity without violating the functional properties. It is established that the rational form of the claws of a puller is such that it is executed in the form of a segment of a circle.

2. The use of high-carbon alloy steels (60C2A steel) reduces contact area by 28%.

3. Based on the dependence of the minimum area of the contact of the pincher with the bearing ring on the extortion effort, the pullers are divided into four sizes according to the contact area of the pincher. With the four sizes of pullers provided by us, the first (the smallest) size of the puller allows the removal of bearings with a diameter of up to 40 mm, with a design effort of 38 kN, the second one - bearings with a diameter of 40 mm to 60 mm, with a design effort of 59 kN, the third with bearings with a diameter of 60 mm to 90 mm for the design effort of 95 kN and the fourth (the largest) - bearings with a diameter of 90 mm to 100 mm, with a design effort of 104 kN.

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РАЗРАБОТКА ТИПОРАЗМЕРНОГО РЯДА СЪЕМНИКОВ ПОДШИПНИКОВ

Василий Рыс

Аннотация. В работе теоретическими исследованиями обоснованно площадь контакта захвата съемника с кольцом подшипника во время демонтажа, что позволило уменьшить его металлоемкость не нарушив функциональных свойств. Установлено, что рациональной формой лапы съемника есть такая, которая выполнена в форме сегмента круга.

На основе зависимости минимальной величины площади контакта захвата съемника с кольцом подшипника от усилия выпрессовки съемники разделены на четыре типоразмера по величине площади контакта захватов. Из предложенных нами четырех типоразмеров съемников первый (самый маленький) размер съемника позволяет демонтировать подшипники диаметром до 40 мм за расчетным усилием 38 кН, второй - подшипники диаметром от 40 мм до 60 мм за расчетным усилием 59 кН, третий - подшипники диаметром от 60 мм до 90 мм по расчетному усилиям 95 кН и четвертый (самый большой) - подшипники диаметром от 90 мм до 100 мм за расчетным усилием 104 кН.

Использование высокоуглеродистых легированных сталей (сталь 60С2А) позволяет уменьшить площадь контакта на 28%.

Конструкция предложенного съемника является простой и надежной в работе. Использование съемника данной конструкции уменьшает продолжительность процесса демонтажа деталей на 10 ... 20%.

Ключевые слова: съемник, подшипники, подшипниковые узлы, площадь контакта, типоразмерный ряд.