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DEVICE FOR MACHINING NON-CIRCULAR GEARS

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Abstract: *If at first the non-circular wheels were treated as a hobby subject, their use now becomes ever larger. They are used in robotics, replacing cam mechanisms and lever mechanisms in the textile and agricultural industries.*

The paper presents a device used for the processing of non-circular gears, a device made according to my own design. For machining non-circular gears, it is necessary to make a toothed wheel on a CNC machine after which, with the designed device, it is possible to proceed to the processing of an unlimited number of wheels identical to the original wheel, which we will call the reference.

The device contains an operating rack that engages the reference wheel. The solid rack with the rack is mounted on the generator rack (tool). The two racks are fixed, with the indication that the tool performs both the main cutting movement and the intermittent radial feed motion.

The reference wheel and the semi-manufactured wheel move together (jointly) in engagement with the two racks. Taking into account the variable radius of the wheels (reference and green), the device is provided with a system of guides that allow the generation process to be carried out.

I appreciate that this device can be improved and adapted for machining non-circular toothed wheels with as many configurations as possible and with different gauges.

Keywords: *noncircular gear; gear manufacturing*

1. INTRODUCTION

The advantages of non-circular gears, as well as their great diversity and flexibility, are a serious alternative to replacing the classic mechanisms of obtaining variable gear ratios. Their kinematic and geometric complexity has limited the implementation of standardized algorithms for design but also for the adoption of performing teeth generation technologies.

The present paper provides an original solution for the construction of non-circular gears in large series production and mass by designing a specialized device for this purpose. For this, it is necessary to make a non-circular pattern wheel that is multiplied with this device. As such, the work is not subject to the design of non-circular gears.

The projected device allows to make the gears used in parallel axle gears with the spacing of fixed axles, obtained by rolling, with an evolving profile. Therefore, the non-circular wheels that can be made have an oval, elliptical and non-concave shape.

2. GENERAL CONSIDERATIONS REGARDING NON-CIRCULATING ROOTS

Non-circular gears justify their use through a wide range of advantages, such as:

Compact structure, rigidity, stability and high efficiency compared to cams or other mechanical transmission systems;

the possibility of making variable gear reports according to different motion laws, depending on their destination;

- may allow for a cyclical variation of movement, but non-cyclic variation laws may also be made by custom design;
- the use of a small number of kinematic elements to create a complex kinematics.

2.1 Types of non - circular gears

Considering the main characteristic of the non-circular gearing, namely the variation of the speed of the driven wheel, the following types of non-circular gears can be found: non-circular multithreaded toothed wheels where the driven wheel has different speeds; In this category also the eccentric circular wheels can enter.

Non-circular gears with continuous variable speed. They are most used, with a transmission ratio that varies according to a required law. In this category, logarithmic non-circular wheels can also be entered dividing (copying) the disc cutter, the module or a special profile with the cylindrical-front cutter, the same way or a special profile.

Figure 1. Logarithmic non-circular gears

- Rolling (rolling), with a worm gear module, comb knife or wheel knife.

The splitting process has the advantage of a low processing time and the disadvantage of a low precision, a feature that recommends them to operate at low peripheral speeds.

This is not a big impediment because the non-circular wheels are used in control mechanisms and work at low angular speeds.Non-circular concave shapes (e.g., logarithmic, concave complexes) can not be rolled.

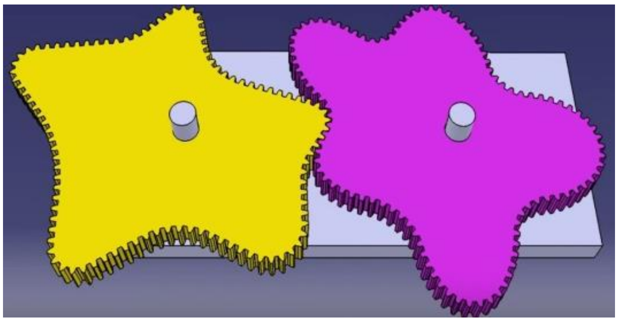

Figure 2. Non-circular wheels of complex shape

The advantage of the use of the rolling process is the advantage of the possibility of processing the tooth with an evolving tooth profile, a profile that gives precision in machining as well as economical machining processes.

3. PROJECTING THE NON-CROWN OVALE MODEL

From the start, we mention that we did not intend in this article to find a design algorithm for a non-circular wheel. It has been studied the possibility of making a wheel that can be used as a model for the projected device. For a quick and precise execution, a wheel made of four arches of sky, radius r18 and radius R78,033 as in the figure, equal two by two.

The adopted construction allows the evolving profile of module m=3 with an integer number of teeth on a circular arc of a certain radius, as in the figure. Highlights are for splitting cylinders.

We can see the shape of the different evolutionary profile on the two circular sectors of different division diameters.

The construction of the evolving profile used a program made in AutoLisp by the authors.

Generating the evolving profile for a non-circular wheel without concavities can be achieved by maintaining with the fixed axle of the wheel and displacement of the generator rack with the reference right tangential to the splitting right, as in Figs. 3 and 4 or maintaining the fixed generator rack and rotating the wheel with a variable distance from it to the tool, as was done in the design of the device.

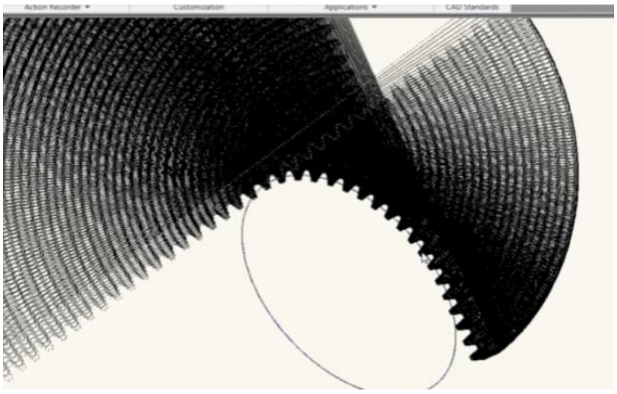

Figure 3. Generating Evolution

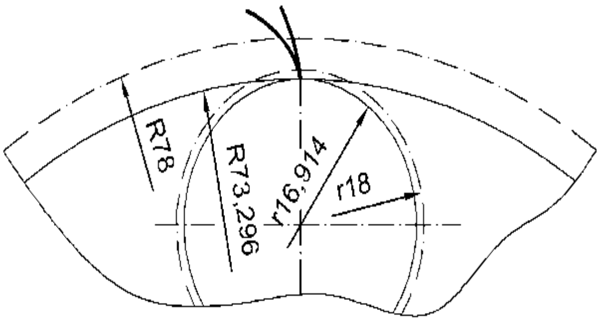

Figure 4. Different forms of evolution for different circles of the basic circle

The profile was generated in the engagement with a generating rack to take account of the shape of the evolutionary profile, different for different basic circles. In the picture, this phenomenon is noticed. It is noted that in the small toothed wheel sector, the foot ring is smaller than the base circle.

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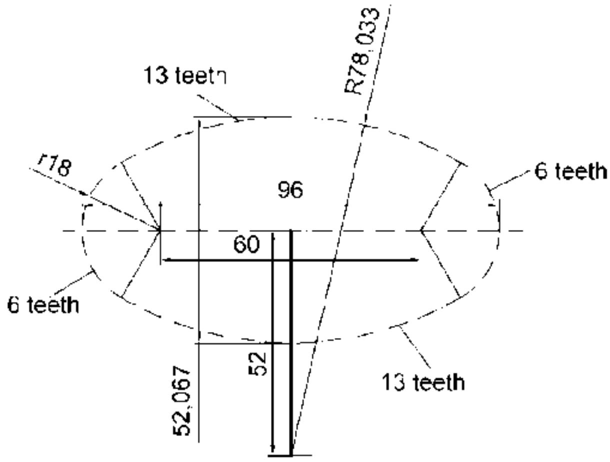

Figure 5. Geometrical elements for making the semifabrication of the metallic wheel

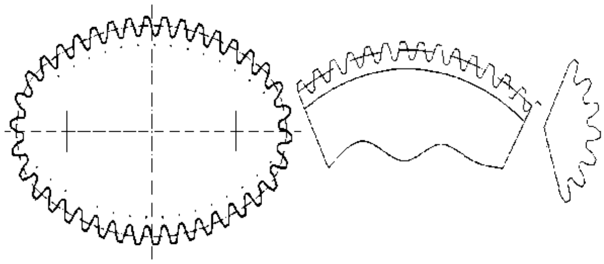

Figure 6. Gear sectors for making the model wheel

Between these two evolved circles must be extended with another curve, possibly with circular arcs.

4. PRESENTATION OF THE DEVICE

The component elements, sizes and subassemblies of the device are shown in the Figure 7.

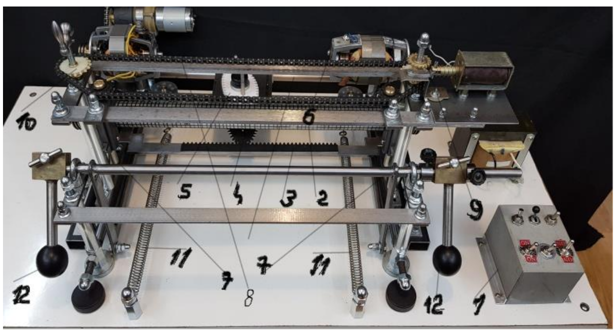

Figure 7. 1-bay, 2-blade tool, 3-rack reference, 4-wheel model,5-wheel gearing, 6-vertical feed mechanism, 7-transverse feed mechanism, for twin engagement; 8- longitudinal feed mechanism; 9-stroke mechanism for automatic vertical feed 10-manual vertical drop; 11- springs to keep in gear, 12-maneuvering handwheels

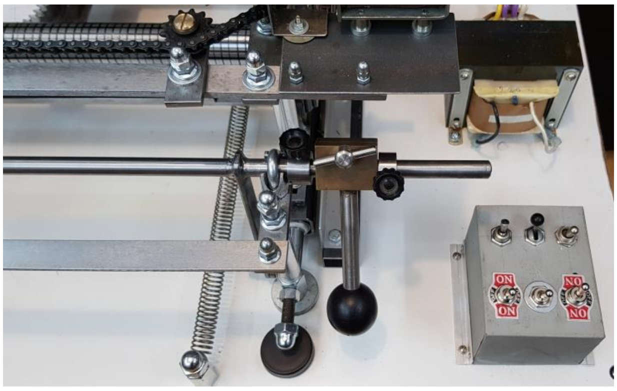

Figure 8. Command and power block

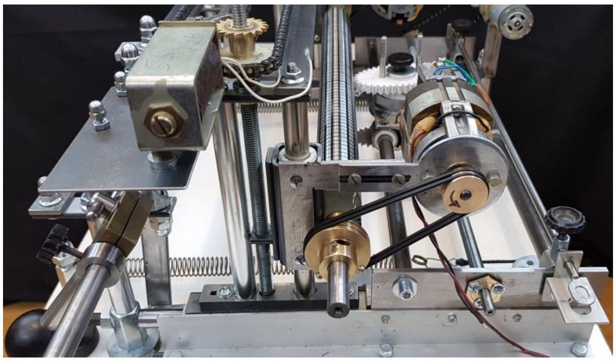

Figure 9. Mechanical transmission system for cutting tool operation

Figure 10. Mechanical transmission system for cutting tool operation

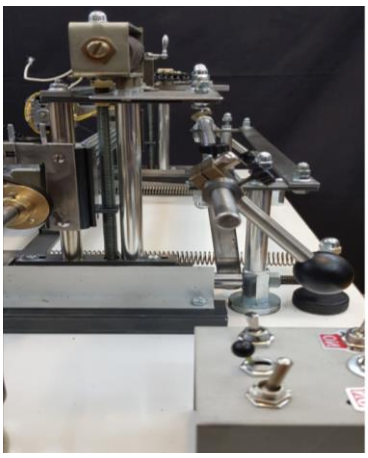

Figure 11. Screw mechanism for vertical vertical feed

5. DEVICE OPERATION

Device works on the principle of teething generation by rolling. It has the advantage that rack rails generate the profile of the tooth in accordance with the diameter of the basic circles of the different sectors of the semi-finished wheel.

The model wheel (4) was executed in order to achieve the longitudinal and transversal feed of the cermillary. This is monoblock or solidarized with the model wheel. The maintenance of the toothed wheel with the rack (3) is achieved by means of the springs (11) and the transverse feed shaft (7). The blade tool is a straight cutter with straight teeth with rack profile. The milling teeth are machined and detailed so that the cutting process performs a continuous movement of vertical movement during cutting and an intermittent radial feed motion for determining the depth of cutting at a passage.

After adjusting the depth of cut for a pass, the mechanical transmission system allows the rotating and displacement of the semi-finished wheel so that the cutting at the correct depth is achieved over the entire circumference.

This is carried out in a cyclical process performed with the automatic feed mechanism Fig. 11. The vertical drive mechanism of the cutting tool can be made manually or automatically and contains: a chain transmission required to move the scissors in a move on two vertical guides, without running the risk of locking by this inclination. The control and power block is shown in Fig. 8. Figure 9 is detailed with the cutting mechanism of the cutting tool.

6. CONCLUSION

The device allows the creation of a wheel or several wheels simultaneously having a model wheel in advance.

With this device, it is possible to make non-circular wheels without a device allowing the practical development of the theoretical evolution depending on the local curve radius of the model wheel and the semi-finished wheel.

The use of the device allows the making of non-circular toothed tooth profiles with hight roductivity.

Considering that the non-circular wheels are mainly used in control systems and that they are reduced in size, the device shown is suitable for such wheels, for large wheels it can be designed and redesigned according to the gauge of the wheel to be executed and the material it.

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