METHOD AND NEW DEVICE FOR ELLIPSOID WORM GEAR MANUFACTURING ON THE TURNING

PÁY Gábor László, *College of Nyíregyháza, Nyíregyháza Hungary,gaborp@nyf.hu*
RAVAI NAGY Sándor, *North University of Baia Mare, Baia Mare Romania, rnsandor@ubm.ro, rnsandor@yahoo.com*

Abstract: The internal worm gear pairs are special ones, which are composed by a helical worm and an internal teeth worm wheel. The base of these researches is a patent for internal teeth gears manufacturing by a helical worm hob. The geometrical and kinematics problems were so great and this idea was abandoned. In the case of internal worm gear pairs, when the internal teeth worm wheel are manufactured by a worm hob with same geometrical parameters like the helical worm the manufacturing not represent a difficult problem.

The paper presents a new manufacturing method, by turning, which is better then by hobbing, because in this case we can achieve any module and basic diameter without problems. The method is lower, but is economically and more simple.

Key words: *ellipsoid worm, surface generating, turning device,*

1. INTRODUCTION

The internal worm gear pairs are special ones, which are composed by a helical worm and an internal teeth worm wheel. The classic type of these gears is the perpendicular axis one (figure 1.), but the axis can be under every angle between 0 and 90 degree (figure 2.).

In first step we manufactured these gears with worm hob, but in this case we can manufactured only one module and we need two special device, an arm device (figure 3.) and a multi-cutter device (figure 4.).

The disadvantages missed this method, in present we search for a new ellipsoid worm manufacturing method. In this case also we need special devices but it is a universal device for all modules and wheelbase. In this case we manufacturing with only one turning tool and the productivity is lower but the devices are more simple and cheaper.

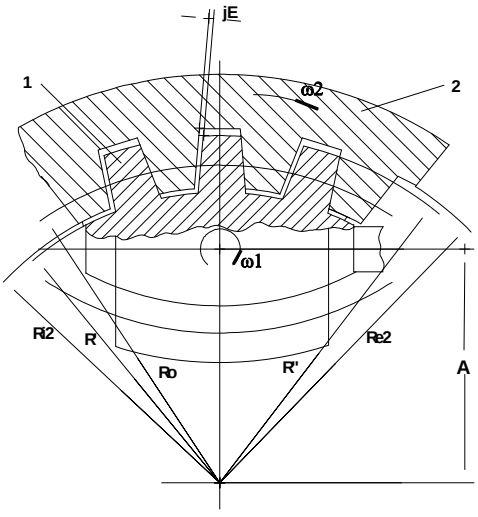

Figure 1. Perpendicular-axes internal worm gearing

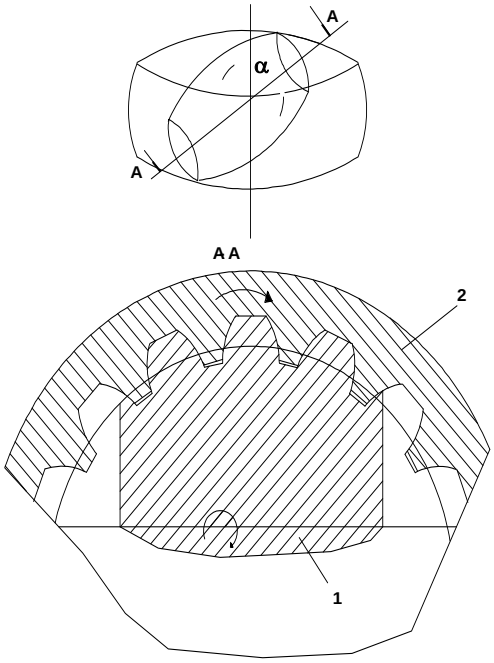

Figure 2. Internal worm gearing with any axes

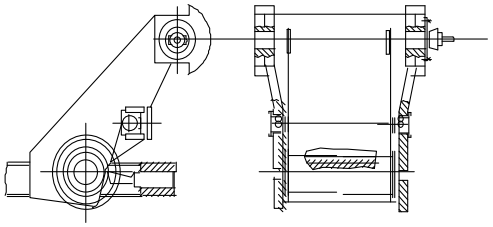

Figure 3. Arm device for manufacturing by hobbing

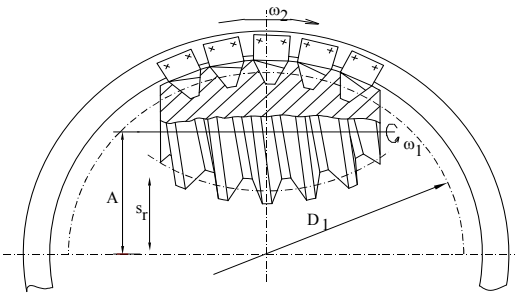

Figure 4. Multi-cutter device

2. THE NEW MANUFACTURING METHOD BY TURNING

The worm manufacturing begins from one semi-manufactured product, which is approach to the final engine part.

The manufacturing technology depend to the worm design, worm whit bore or worm whit shaft (figure 5.). The monoblock worm has some advantages, don't need fixing the worm to the shaft, by this it is spare space for the bearing and for the length of worm but it need a forging process and heat treatment. This construction its better for the strain as worm with bore who it is one additional element, key or flute.

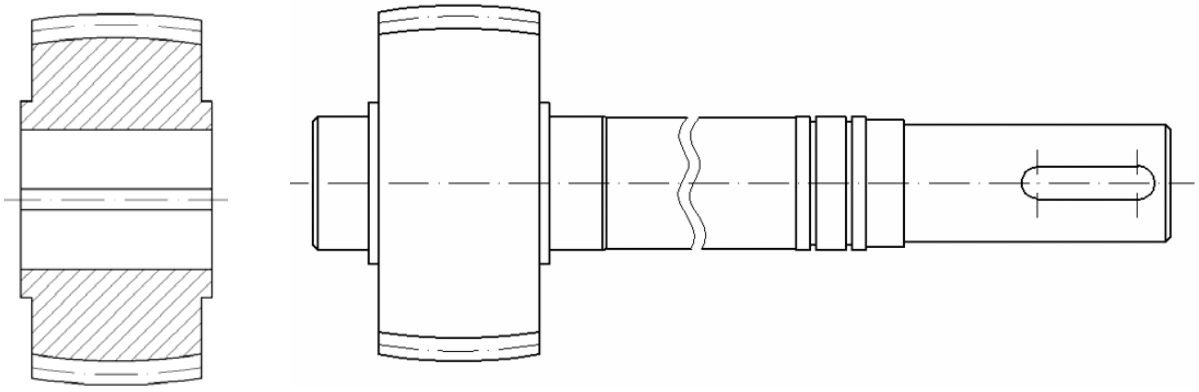

Figure 5. Ellipsoid worm gear with bore and shaft

When manufacturing worm with bore it is excess cutting process for generate the contact surface between the worm and his shaft.

This is a precision manufacturing for provide the coaxiality between the elements. Using the centering holes it is provide the same basis for all the cutting process.

The ellipsoidal surface on the shaft it is manufactured whit the same device (figures 6-9.), which is use for the worm, using feeds that provide necessaries surface quality. For the rough- and finish turning at worm it is use the same device and machine tool but different cutting regime and tools. With rough turning remove the most part of tooling-allowance and whit finish turning and adequate turning-tool generating the final worm surface.

In the standpoint of manufacturing technology, an ellipsoid worm and a cylindrical worm manufacturing is similar. The difference is: the tool path is a line for the cylindrical worm in the contrary with the ellipsoid worm when the path is an arc. The cutting tool is rotated radial on this arc. (figure 6.)

We know the tools trajectory and we designed a turning device for manufacturing worm with different pass (p), module (m), diameter ratio (q), and transmission. The new device is designed for the turning whit cod name SNA560.

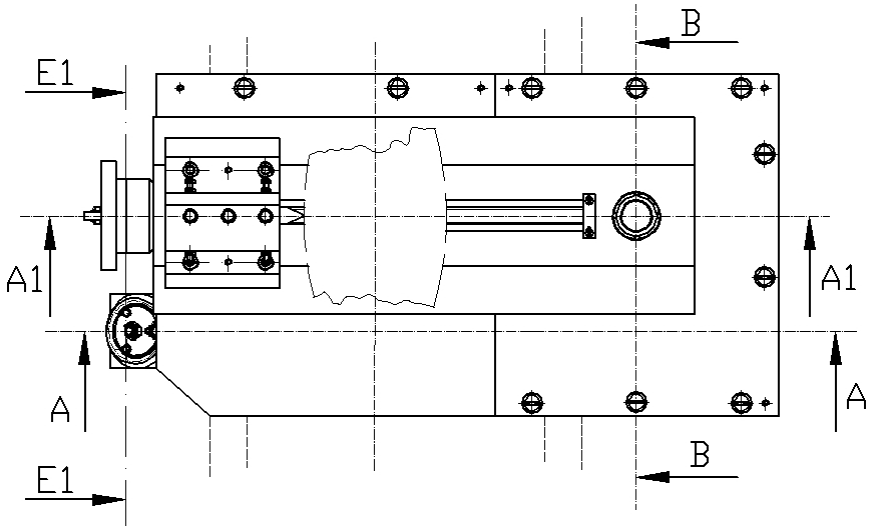

Figure 6.

The following movements made a device for the ellipsoid worm manufacturing:

- In horizontal plan perform the tool whit w2 angular speed, but it be must exist the following relation:

$$u = \frac{\omega_1}{n \cdot \omega_2},$$

where: ω_1-the worm angular speed

ω_2-the worm wheel angular speed

n-the number of worm begins

"s_t" is the tool lead.

Besides the ellipsoid worm manufacturing movements the device have one perpendicular move on the main axis of turning, for the inner wheelbase fixing. This auxiliary move guarantied the device universality, that is, for worm pairs whit different wheelbase we use the same device for manufacturing.

For manufacturing we need closed cinematic chain between worm and turning tool. The device is drive with the turning lead box.

With the "1" base plat fixing the device on the turning which base plat for the first time we assembling on the longitudinal guide of the turning. On this same base plat fixing the elements of bevel gearing. In this way fixed device has a perpendicular displacement of the turning main axe, this movement control the ellipsoid worm pair wheelbase provide.

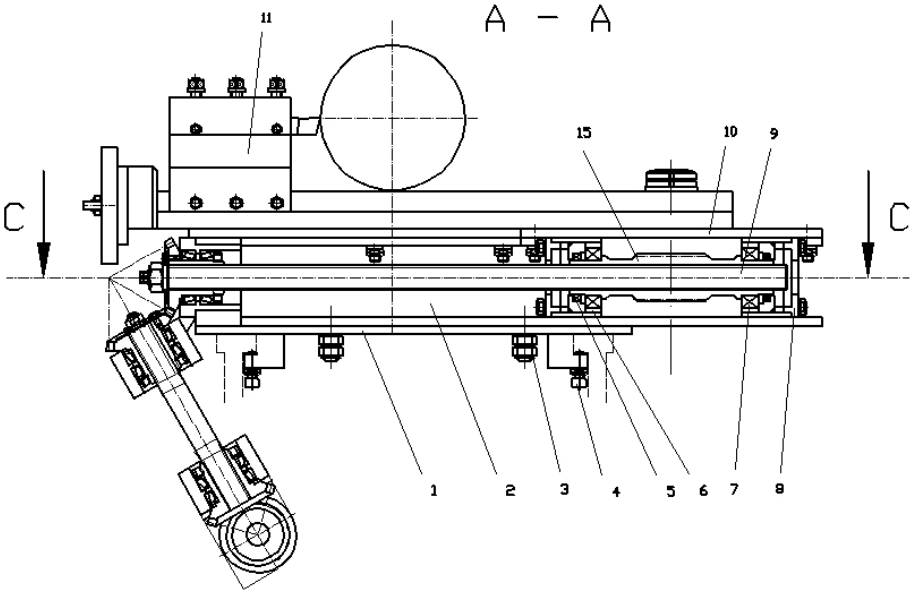

Figure 7.

The base element of the device it is a "14" worm gear in the horizontal plane, which axis must be coincide whit the ellipsoid worm gear theoretical axis for what we manufacturing the ellipsoid worm. The "14" worm gear gearing whit the "15" cylindrical worm (whit inside spline) what is drive by the bevel gears and crossing (through) by "9"

splined shaft. We need the splined shaft between cylindrical worm “15” and bevel gear because the device it used for variable inner wheelbase.

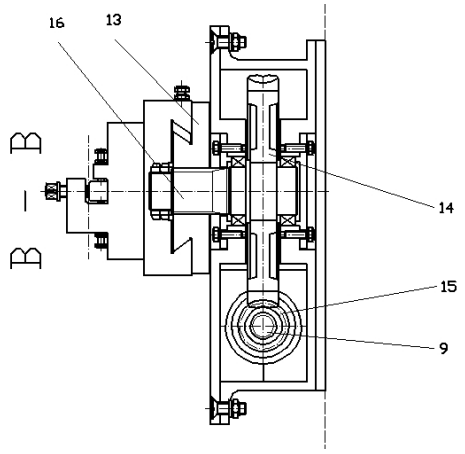

Figure 8.

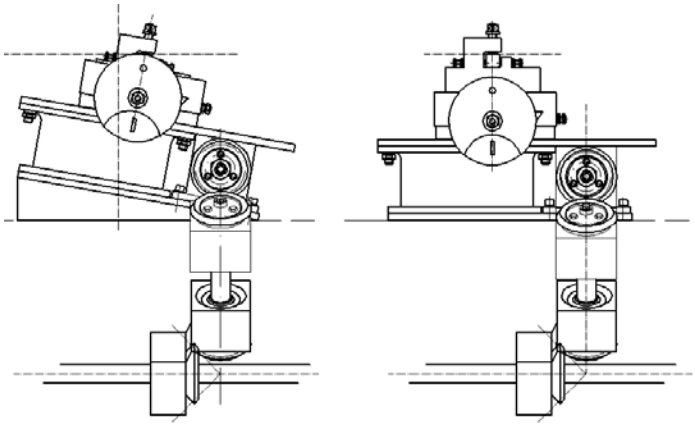

Figure 9.

The “14” worm gear is fixed on the “16” axe what drive the “13” turning plate. On this turning plate it is a radial guide for the cutter holder (tool-post). After each pass of the tool the cutter holder is lead whit the cutting depth.

3. CONCLUSION

This new manufacturing method is more simple then the used method by hobbing. The special devices are simple and universal. We can manufacture with the same tool different ellipsoid worm gears. Also, we can achieve the correspond worm wheel, with different wheelbase. In other hand, in this case we use lathe machine tool, in the precedent case we have use toothing hob machine what is a complex machine tool.

Finally, this new method open new possibilities on the manufacture of this new type of worm gear pair, also the possibilities for use this gear pair.

4. BIBLIOGRAPHY

[1] Cioban, H. – *Contribuţii la studierea angrenajului melc butoi – roată melcată cu dantură interioară şi a unor factori tribologici asupra comportării acestuia*. Teza de Doctorat, Cluj – Napoca, 1999, Coordonator Prof. univ. dr. ing. Pay Eugen.

[2] Elekes, C., *Scule pentru melci şi roţi melcate*, Editura Litera, Bucureşti, 1985.

[3] Litvin,F.L. - *Theory of Gearing*, U.S. Government Printing Office, Washington D.C., 1989.

[4] Pálffy, K., Prezenszky, T., Csibi, V., Antal, B., Gyenge, Cs., *Fogazott alkatrészek tervezése, szerszámai és gyártása*, Editura Gloria, Cluj Napoca, 1999.

[5] Pay, E. - *Asupra execuţiei frezei elipsoidale*, În Lucrările Conferinţei a II-a "Creaţia Tehnică şi Fiabilitatea în Construcţia de Maşini", Vol. Maşini - Unelte, Scule şi Dispozitive, Iaşi, 1980, pp. 223-227.

[6] Pay, E. - *Reductor melcat cu melc interior*, Brevet de invenţie nr. 90521, 1986, Bucureşti, România.

[7] Pay, E., Vijdeliuc, M., Sziklai, V. - *Freză pentru prelucrarea melcului butoi*. Brevet de invenţie nr. 103382, 1987, Bucureşti, România.

[8] Pay, E., Páy, G., Cioban, H. - *Study Regarding the Internal Worm Gearings and Their Simulation Using the CAD System*. Journal of Intelligent Mechatronics, Design and Production, vol.I., no. 4/1995, september, 1995, Ankara, Turkey, pp. 204 – 211.

[9] Pay, E., Cioban, H., Páy, G. - *Internal Worm Gearings Modelling*, Vîsokie Tehnologii, INTERPARTNER 95, Harkiv, HGPU, Alushta, Ukrajna, 1995, pp. 99-105.

[10] Pay, E., Páy, G., Cioban, H. – 2001, *Internal Worm Gear Pairs*, Conferinţa Internaţională SYROM 2001, Bucureşti, Vol. III., pp. 345 – 350.

[11] Páy, G., *Belsõ csigás hajtások*.(Angrenaje melcate cu melc interior). Teză de doctorat, Miskolc, 2001.

[12] Páy, G., Năsui, V. – 2000, *Internal worm gearing elements processing by classical machine – tools*, A XIII-a Conferinţã Internaţionalã de Maşini Unelte, ICMaS 2000, Bucureşti, 15-17 oct. 2000, In: Tehnologii, Calitate, Maşini, Materiale, Editura Tehnică, Vol. 40, pp. 101 - 106.

[13] Ravai Nagy, S., *Studiul angrenajelor melcate cu melc interior şi tehnologie de execuţie pentru melcul butoi.* Proiect de Diploma, Baia Mare, 2002.

[13] Ştefiu, M. - *Dispozitive de prelucrare şi control. Construcţie şi exploatare*, Editura Didactică şi Pedagogică, Bucureşti, 1998.

[14] Tache, V., ş.a. - *Construcţia şi exploatarea dispozitivelor*, Editura Didactică şi Pedagogică, Bucureşti, 1982.

[16] *** *Cartea maşinii SNA 560*, Întreprinderea de maşini unelte Arad, 1989.