Web of Scholars: Multidimensional Research Journal (MRJ)
Volume: 01 Issue: 07 | 2022 ISNN: (2751-7543)
http://innosci.org

Analysis of Existing Configurations of Metal Cutting Machines with Parallel Kinematics

Shaozimova U. Kh., Mardonov U. T.
Associate professor at mechanical engineering department, Tashkent state technical university, Tashkent, Uzbekistan

Yoldashev E. A.
Master student at mechanical engineering department, Tashkent state technical university, Tashkent, Uzbekistan

Abstract: *In this paper, an analysis of existing configurations of metal cutting machines with parallel kinematics is given. Importance of the machine tools with parallel kinematic structure is also studied in the manuscript. All of the information given in the paper are the results of the literature review on this field.*

Keywords: *Cutting machines, kinematic structure, machine tool, and manufacturing.*

Introduction

Modern machine tool industry dictates the need to search for more advanced approaches to solving new problems, the emergence of which is due to the intensification of the cutting conditions of materials and the increased requirements for geometric accuracy and quality of the resulting surfaces of parts. The intensification of cutting conditions, in turn, is determined by the improvement of the layouts and designs of metal-cutting machine tools, the increase in the durability of the blade tool and the coatings applied to it, and the development of the theory of high-speed cutting.

Structures with parallel kinematics have attracted the active interest of machine tool manufacturing and research companies around the world over the past two decades [1]. Nowadays, mechanisms with a parallel structure are effectively used in a variety of areas, such as special machines for tire testing [2], telescope positioning systems, robots in the packaging industry [3, 4] and surgery, training simulators (Fig. 1), etc.

Figure 1. Radio telescope positioning system based on a "hexapod" type structure. 2 - Robot with a parallel kinematic structure of the "delta" type

Literature review

Research and development in the field of machine tools with parallel kinematics was carried out by such scientists as V. L. Afonin, V. V. Bushuev, S. S. Gutyrya, O.K. Akmaev, V.A. Glazunov, Y.A. Poduraev, Y.A. Mamaev, D. Staymer, Z. Pandilov and others [5, 6]. Work in this direction is being carried out by Comau (Italy), Okuma, Toyoda, Hitachi Seiki (Japan); Mikromat (Germany), Ibag and Mikron (Switzerland) Giddings & Lewis, Ingersoll (USA), Savelovsky Machine-Building Plant, Moscow State Technical University. Bauman, Moscow State Technical University "STANKIN", Institute of Mechanical Engineering named after A.A. Blagonravova, ENIMS (Russia), etc.

Machine tool structures can be divided into three types: sequential, parallel and hybrid kinematics. In this case, a hybrid structure is understood as a combination of a module with a parallel structure and one or more traditional modules with a serial structure [7].

Thus, a structure with three coupled drives and two independent drives is a hybrid structure [8], consisting of a module with parallel kinematics, which provides three degrees of freedom of the tool, and a traditional two-axis module, installed in series relative to each other. Figure 2 shows a machine with a hybrid structure of the Hexameh-1 model [9] manufactured by the Savelovsky Machine-Building Plant, which has a six-axis module of parallel kinematics of the "hexapod" type and a sequential module of the translational movement of the table.

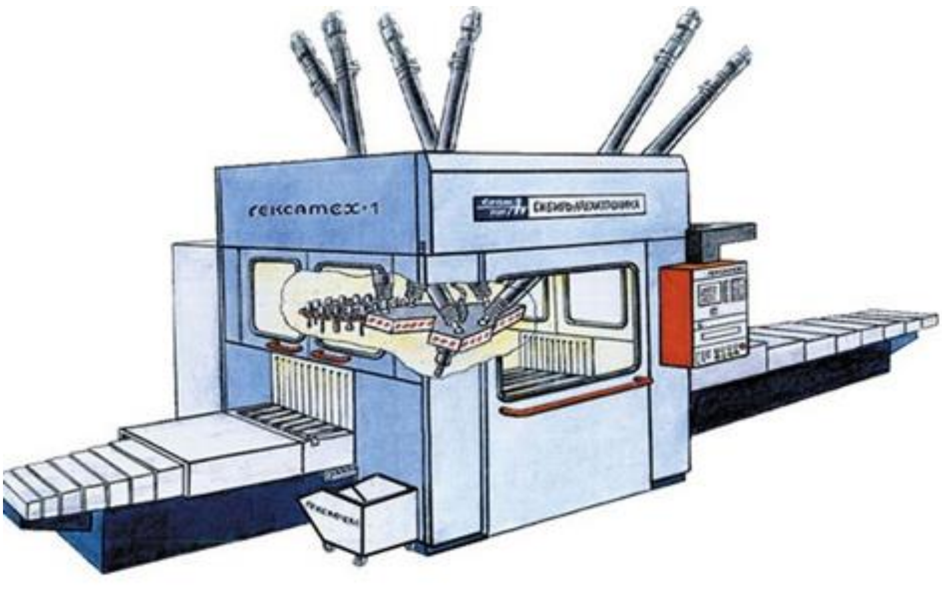

Figure 2. Machine "Geksameh-1" Savelovsky Machine-Building Plant

In Figure 3, as an example, a machine diagram with such a hybrid kinematic structure of the Tricept T805 model is shown [10]. It has in its structure three connected drives, forming a three-axis parallel module, and two separate (serial) modules, which are a two-axis milling head.

Figure 3. Tricept 805 Machine Structure Diagram

Structures (modules) of parallel kinematics consist of a different number of kinematic chains, each of which is a set of rods and hinges of various types, connected in a certain sequence. Chains can be divided according to the type of rods - into chains with rods of constant length, such as in the Index V100 machine [11] (Figure 4), and chains with variable length rods, such as in the OKUMA PM-600V machine (Figure 5) [12].

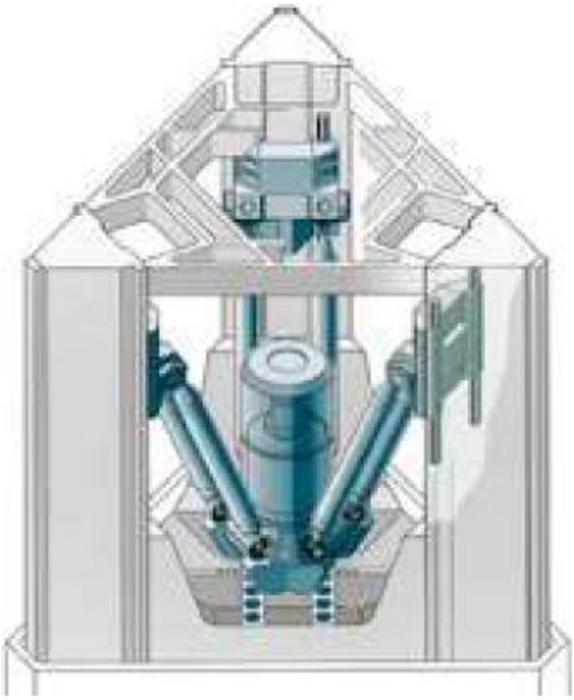

Figure 4. Parallel kinematic machine with constant length rods model INDEX V100

Figure 5. Machine with parallel kinematic structure using OKUMA PM-600V variable length rods

Nowadays, machines with a parallel structure have proven to be an effective solution to the problem of processing complex and large-sized parts [13], for example, such as body parts for the aviation industry (Figure 6).

Figure 6. Examples of using a machine with hybrid kinematics for processing large parts

Conclusion

Based on the sources studied, it can be concluded that there are potentially a large number of different variants of kinematic structures of the parallel type, only a few of which are given in this paper or mentioned in the literature. Considering all of the above, it seems appropriate to further search and study new configuration solutions for machine tools with parallel kinematic structures of increased torsional and axial rigidity, made on the basis of rods of constant length.

References

1. Stewart, D. A Platform with Six Degrees of Freedom // Proc. Institute of Mechanical Engr. – 1965. – Vol. 180. – P. 371-386.
2. Gough, V. E. Universal Tire Test Machine / Gough, V.E., Whitehall S.G. // Proceedings 9th Int. Technical Congress F.I.S.I.T.A. – 1962. – Vol. 117. – P. 117–135.
3. Nabat, V. Paptent US № 7735390 B25J17/0266/ 17.02.2005 / High-speed parallel robot with four degrees of freedom.
4. Patent US № 8134324 / 10.06.2008 // Parallel mechanism.

5. Afonin, V.L. Mexanizmi parallelnoy strukturi [Parallel Structure Mechanisms]. Kinematika i dinamika. – M: MGTU Stankin. 2005. – 185 s.
6. Enikeev, B.A. Sravnitelniy analiz jestkostnix xarakteristik stanka klassicheskoy komponovki i stanka s parallelnoy kinematikoy [Comparative analysis of the rigidity characteristics of a machine with a classical layout and a machine with parallel kinematics] / O.K. Akmaev, B.A. Enikeev, A.F. Yusupov // Mejvuzovskiy nauchniy sbornik «Sovremennie tendensii v texnologiyax metalloobrabotki i konstruksiyax metalloobrabativayuщix mashin i komplektuyuщix izdeliy». – 2014. – S. 135-140.
7. Enikeev, B.A. Povishenie effektivnosti konsevogo frezerovaniya na stanke s parallelnoy kinematicheskoy strukturoy [Improving the efficiency of end milling on a machine with a parallel kinematic structure], PhD dissertation thesis, 2020, Ufa, Russia. 144p
8. Kanaan, D. Kinematic Analysis of a Serial – Parallel Machine Tool: the VERNE machine / Kanaan D., Wenger P., Chablat D. // Mechanism and Machine Theory. – 2009. – Vol. 44, Issue 2. – P. 487 – 498.
9. Serkov, N.A. Rezultati eksperimentalnix issledovaniy mexanizma parallelnoy strukturi na primere stanka «GEKSAMEX-1» [The results of experimental studies of the parallel structure mechanism on the example of the machine "GEKSAMEX-1"] / N.A. Serkov, I.V. Vaynshteyn, A.A. Merzlyakov, R.O. Sirotkin // Vestnik nauchno-texnicheskogo razvitiya. – 2008. – № 5(9) – S. 67 – 88.
10. Tricept T805 product description (elektronniy resurs) URL: http://www.pkmtricept.com/productos/index.php?id=en&Nproduct=1240238098 (Data obraщeniya 06.07.2020).
11. Patent US № 6655247 / 01.12.1999 // Machine tool.
12. Pandilov, Z. Parallel kinematics machine tools: history, present, future / Pandilov Z., Rall K. // Mechanical Engineering - Scientific Journal. – 2006. – Vol. 25, №1. – P. 3 – 20.
13. Odilov, E., & Mardonov, U. (2021). Effect of Magnetic Field on the Properties of Flowing Lubricating Cooling Liquids used in Manufacturing Process. *International Journal on Orange Technologies*, *3*(12), 1-5.
14. Umarov, T. U., & Mardonov, U. T. (2020). General characteristic of technological lubricating cooling liquids in metal cutting process. *Int. J. Res. Adv. Eng. Technol*, *6*(2), 01-03.
15. Uriarte, L. Machine Tools for Large Parts / L. Uriarte, M. Zatarain, D. Axinte // CIRP Annals Manufacturing Technology. – 2013. – Vol. 62, Issue 2. – P. 731 – 750.
16. Umarov, E. O., & Mardonov, U. T. (2021). ETHODS FOR INCREASING THE WEAR RESISTANCE OF CUTTING TOOLS. In *Texnika i texnologii mashinostroeniya* (pp. 83-86).
17. Umarov, T. U., Mardonov, U. T., Khasanov, O. A., Ozodova, S. O., & Yusupov, B. D. (2020). Research of the variation of firmness of pointed drills by method of simulation modeling of process of wear. *International Journal of Psychosocial Rehabilitation*, *24*(4), 1885-1902.