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STRUCTURAL IMPROVEMENT OF THE CARRIAGE ASSEMBLY IN THE MODERNIZATION OF THE NF-630 MILLING MACHINE INTO THE NF-1200 MODEL

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Abstract. This article analyzes the structural and technological solutions implemented during the modernization of the NF-630 milling machine into the NF-1200 model. The main focus of the study is on the redesign of the carriage assembly, which plays an important role in improving the movement accuracy of the working table, increasing the load-carrying capacity, and expanding the machining area. Since the existing structural capabilities of the NF-630 machine were not sufficient for machining large-sized parts, its table-carriage system was modernized in accordance with the technical requirements of the NF-1200 model. According to the passport data of the NF-1200 milling machine, it is designed to perform milling, drilling, boring, and threading operations on housing-type and base-type parts made of ferrous and non-ferrous metals, as well as some plastic materials. As a result of the modernization, the working table surface was increased to 1200 × 500 mm, while the maximum dimensions of the workpiece reached 1200 × 500 × 500 mm. In addition, the machine became capable of machining workpieces weighing up to 800 kg, and travel distances of 1000 mm, 450 mm, and 500 mm along the X, Y, and Z axes, respectively, were provided. In this study, the technological efficiency of the modernization solutions was evaluated based on carriage drawings, structural elements, and passport data.

Keywords: NF-630, NF-1200, milling machine, modernization, carriage, table-carriage system, CNC machine, structural improvement, machining accuracy.

Annotatsiya. Ushbu maqolada NF-630 frezer dastgohini NF-1200 modeliga modernizatsiya qilish jarayonida amalga oshirilgan konstruktiv va texnologik yechimlar tahlil qilinadi. Tadqiqotning asosiy e'tibori karetka uzelini qayta loyihalashga qaratilgan bo'lib, ushbu uzel ishchi stolning harakatlanish aniqligini oshirish, yuk ko'tarish qobiliyatini kuchaytirish va ishlov berish zonasini

kengaytirishda muhim ahamiyatga ega. NF-630 dastgohining mavjud konstruktiv imkoniyatlari yirik o‘lchamli detallarni qayta ishlash uchun yetarli bo‘lmaganligi sababli, uning “stol–karetka” tizimi NF-1200 modelining texnik talablariga muvofiq modernizatsiya qilindi. NF-1200 frezer dastgohining pasport ma’lumotlariga ko‘ra, u qora va rangli metallar, shuningdek ayrim plastmassa materiallardan tayyorlangan korpusli va bazaviy detallarni frezerlash, parmalash, teshik kengaytirish hamda rezba ochish operatsiyalarini bajarishga mo‘ljallangan. Modernizatsiya natijasida ishchi stol yuzasi 1200 × 500 mm gacha oshirildi, ishlov beriladigan zagotovkaning maksimal o‘lchamlari esa 1200 × 500 × 500 mm ga yetkazildi. Bundan tashqari, dastgoh 800 kg gacha bo‘lgan zagotovkalarni qayta ishlash imkoniyatiga ega bo‘ldi hamda X, Y va Z o‘qlari bo‘yicha mos ravishda 1000 mm, 450 mm va 500 mm harakatlanish masofalari ta’minlandi. Ushbu tadqiqotda modernizatsiya yechimlarining texnologik samaradorligi karetka chizmalari, konstruktiv elementlar va pasport ma’lumotlari asosida baholandi.

Kalit so‘zlar: NF-630, NF-1200, frezer dastgohi, modernizatsiya, karetka, stol–karetka tizimi, CNC dastgoh, konstruktiv takomillashtirish, ishlov berish aniqligi.

Аннотация. В данной статье анализируются конструктивные и технологические решения, реализованные в процессе модернизации фрезерного станка НФ-630 в модель НФ-1200. Основное внимание в исследовании уделено перепроектированию узла каретки, который играет важную роль в повышении точности перемещения рабочего стола, увеличении грузоподъёмности и расширении зоны обработки. Поскольку существующие конструктивные возможности станка НФ-630 были недостаточны для обработки крупногабаритных деталей, его система «стол–каретка» была модернизирована в соответствии с техническими требованиями модели НФ-1200. Согласно паспортным данным фрезерного станка НФ-1200, он предназначен для выполнения операций фрезерования, сверления, растачивания и нарезания резьбы на корпусных и базовых деталях, изготовленных из чёрных и цветных металлов, а также некоторых видов пластмасс. В результате модернизации рабочая поверхность стола была увеличена до 1200 × 500 мм, а максимальные габариты обрабатываемой заготовки достигли 1200 × 500 × 500 мм. Кроме того, станок получил возможность обрабатывать заготовки массой до 800 кг, при этом были обеспечены перемещения по осям X, Y и Z соответственно на 1000 мм, 450 мм и 500 мм. В исследовании технологическая эффективность модернизационных решений оценивалась на основе чертежей каретки, конструктивных элементов и паспортных данных.

ISSN 3030-3907

Ключевые слова: НФ-630, НФ-1200, фрезерный станок, модернизация, каретка, система «стол–каретка», станок с ЧПУ, конструктивное совершенствование, точность обработки.

INTRODUCTION.

Increasing production efficiency in the machine-building industry and machining large-sized and complex-shaped parts with high accuracy require the use of modern technological equipment. In particular, during milling, drilling, boring, and threading operations on housing-type and base-type parts, the working area of the machine, the load-carrying capacity of the table, and the accuracy and rigidity of the carriage movement are of great importance.

In practice, completely replacing existing machine tools with new ones is not always economically feasible. Therefore, expanding the technological capabilities of existing equipment through modernization is considered an urgent issue for manufacturing enterprises. This study examines the process of adapting the NF-630 milling machine to the NF-1200 model, with particular attention to the structural improvement of the carriage assembly.[1]

The NF-1200 machine is designed for complex mechanical machining of parts made of ferrous and non-ferrous metals under small- and medium-scale production conditions. In this machine, the main motion is performed by the spindle, while feed motions are carried out along the X, Y, and Z coordinate axes. The table moves along the X-axis, the carriage-table system moves along the Y-axis, and the spindle head moves along the Z-axis. The NF-1200 milling machine modernized on the basis of the NF-630 milling machine was selected as the research object. The general structural view of the machine is shown in Figure 1.

ISSN 3030-3907

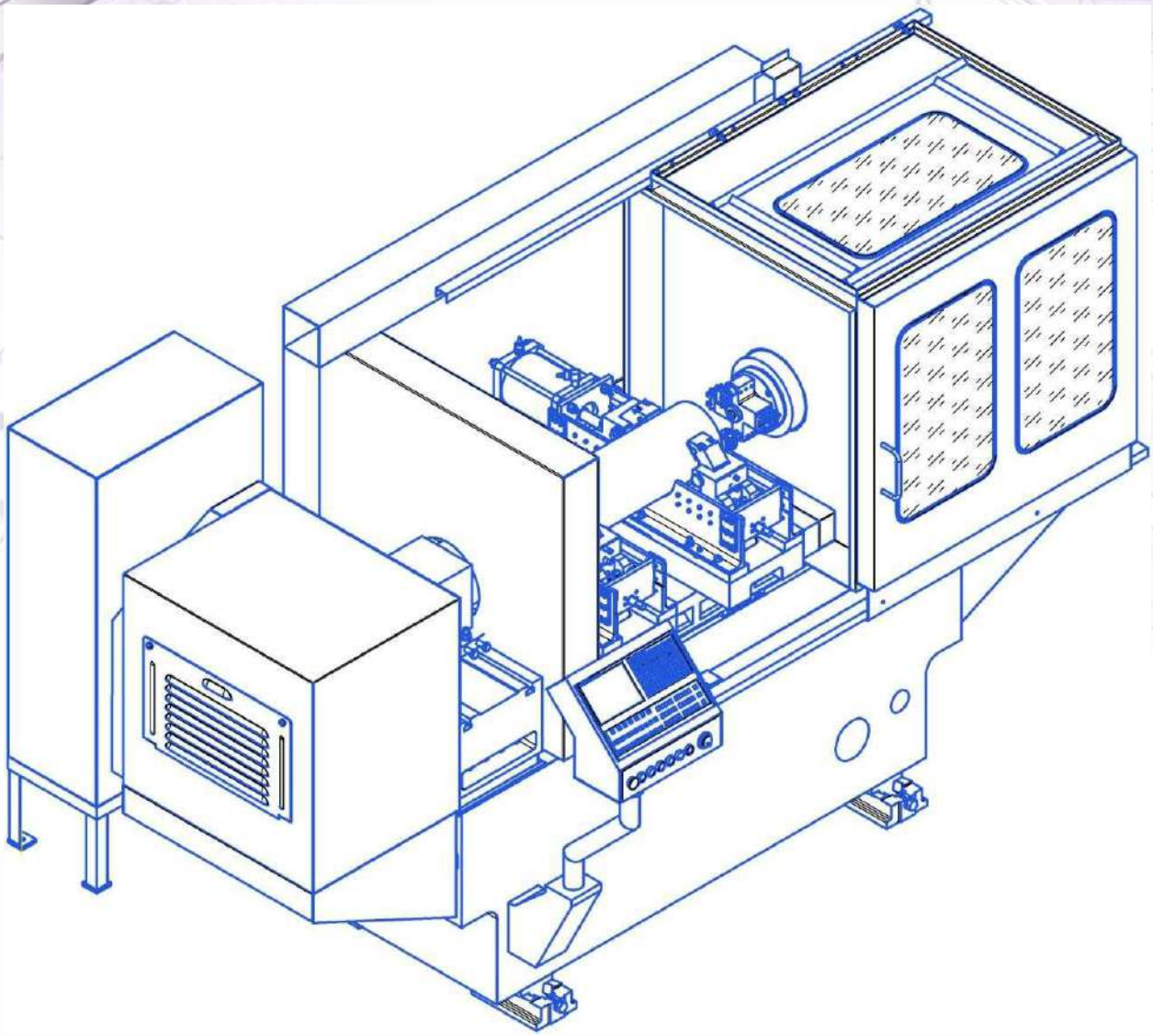


Figure 1. General view of the NF-1200 milling machine

2.Research Object and Necessity of Modernization

The research object was selected as the structure of the NF-630 milling machine modernized into the NF-1200 model. The main reason for modernization was that the working area and table-carriage system of the existing NF-630 machine were limited for machining large-sized parts. Therefore, the carriage, which is one of the main moving assemblies of the machine, was redesigned.[2]

The existing carriage structure of the NF-630 machine had limitations in terms of working area and load-carrying capacity when machining large-sized parts. The structural view of this carriage assembly is shown in Figure 2.

ISSN 3030-3907

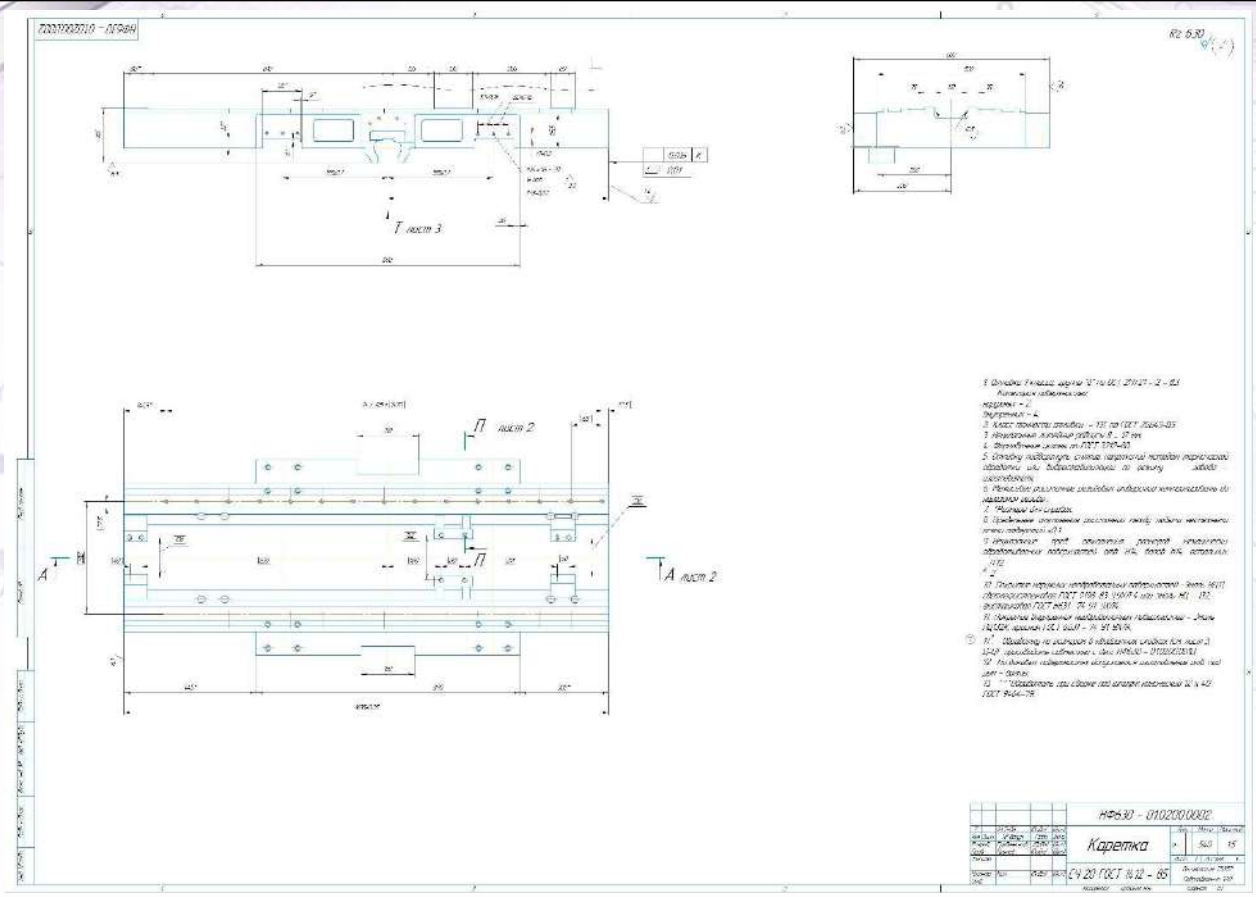


Figure 2. Working drawing of the carriage assembly of the NF-630 milling machine

The carriage is one of the main structural elements of the machine, supporting the table and moving it along the Y-axis. The geometric accuracy, rigidity, and arrangement of the guide surfaces of this assembly directly affect the final accuracy of the machined part. In the NF-1200 model, the carriage performs the following functions:

- it serves as a support for mounting the table and moving it along the X-axis;
- it moves the table-carriage system along the Y-axis;
- it receives the loads generated by the weight of the workpiece;
- it ensures movement accuracy and structural rigidity;
- it provides coordinate motion together with the ball screw pair and linear guideways.

According to the passport data of the NF-1200 machine, the carriage is made as a cast component. The table moves along the X-axis through the guideways located on the carriage, while the carriage itself moves along the Y-axis on the guideways mounted on the machine base.

3.MATERIALS AND METHODS

The study was carried out based on the following materials:

1. the operating manual of the NF-1200 milling machine;
2. working drawings of the NF-1200 carriage component;

ISSN 3030-3907

3. the general view of the NF-630 machine modernized into the NF-1200 model;
4. structural analysis of the table-carriage system;
5. comparative evaluation of the main technical parameters.

During the analysis, the main technical characteristics of the machine, carriage geometry, arrangement of guide elements, mounting holes, T-slots, and motion transmission elements were examined. In the carriage design, the increase in working table dimensions, the growth of applied loads, and the requirements for maintaining movement accuracy were taken into account.

The main technical parameters of the NF-1200 machine are given below:

Parameter	Value
Working table size	1200 × 500 mm
Maximum dimensions of the workpiece	1200 × 500 × 500 mm
Maximum workpiece weight	800 kg
Travel along the X-axis	1000 mm
Travel along the Y-axis	450 mm
Travel along the Z-axis	500 mm
Feed rate range	1–4000 mm/min
Positioning accuracy	0.02 mm
Positioning stability	0.01 mm
Spindle speed range	80–3550 rpm
Maximum torque	500 N·m
Machine weight	7000 kg

These parameters indicate that the NF-1200 model is adapted for machining larger-sized parts.

4.Structural Improvement of the Carriage Assembly

One of the most important structural solutions implemented during the modernization process was the redesign of the carriage assembly in accordance with the requirements of the NF-1200 model. As can be seen from the drawings, the new carriage was designed to operate with a longer and wider working table, and its guide surfaces, mounting holes, and support zones were rearranged accordingly. During the modernization process, the carriage assembly was redesigned to meet the technical requirements of the NF-1200 model.[3] In the new carriage design, the support base, guide surfaces, and fastening elements were improved. The working drawing of the modernized carriage assembly is shown in Figure 3.

ISSN 3030-3907

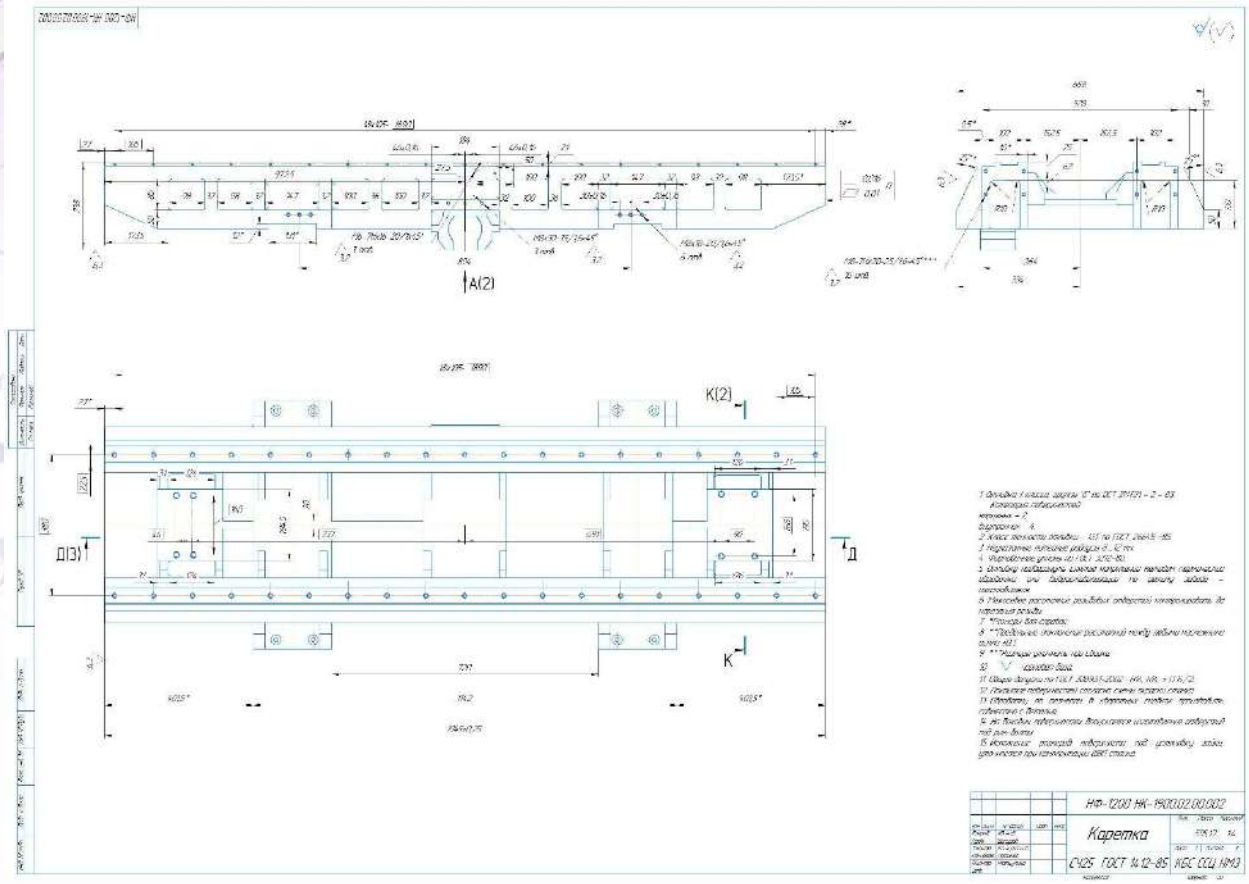


Figure 3. Working drawing of the modernized carriage assembly adapted to the NF-1200 model

Compared with the NF-630 carriage design, the following changes were made in the NF-1200 carriage assembly:

1. **The carriage length and support base were increased.** This makes it possible to stably support the working table with a length of 1200 mm.

2. **The guide surfaces were strengthened.** To ensure the movement accuracy between the table and the carriage during the machining of heavy workpieces, the arrangement of the linear guideways was optimized.

3. **The number and arrangement of mounting holes were redesigned.** This ensures reliable fastening of the carriage to the machine base and helps reduce vibrations during the machining process.

4. **Structural rigidity was increased.** The enlarged cast body and support surfaces of the carriage help reduce deformation under load.

5. **The travel capability along the Y-axis was expanded.** According to the passport data of the NF-1200 machine, the maximum travel of the carriage-table system along the Y-axis is 450 mm.

The working drawings of the carriage component show that the modernization was not limited only to increasing the dimensions. Movement accuracy, ease of assembly, and operational reliability were also taken into account.[4]

ISSN 3030-3907

5. RESULTS AND DISCUSSION.

As a result of modernizing the NF-630 machine into the NF-1200 model, the technological capabilities of the machine were significantly expanded. The most important result was the increase in the working table surface to 1200 × 500 mm and the creation of the possibility to machine workpieces with dimensions of 1200 × 500 × 500 mm. This made the machine suitable for machining large housing-type and base-type parts.

The redesign of the carriage assembly provided the following technological advantages:

- the possibility of placing large-sized workpieces was increased;
- the required support rigidity for machining workpieces weighing up to 800 kg was ensured;
- the accuracy of coordinate movement along the X and Y axes was improved;
- the overall stability of the table-carriage system was increased;
- the field of application of the machine in production was expanded;
- economic efficiency was achieved by using the existing NF-630 base.

According to the passport data of the NF-1200 machine, the positioning accuracy is 0.02 mm, while the positioning stability is 0.01 mm. These indicators show that the modernized table-carriage system can operate with sufficient accuracy.[5]

In addition, the machine has a feed rate range from 1 to 4000 mm/min along the X, Y, and Z axes. This makes it possible to perform various technological operations, including rough milling, semi-finishing, and final finishing.

CONCLUSION.

The modernization of the NF-630 milling machine into the NF-1200 model is one of the effective ways to expand the technological capabilities of existing production equipment. The results of the study show that the most important structural change in the modernization process is related to the carriage assembly. This assembly plays a key role in increasing the working table size, improving the load-carrying capacity, and ensuring the accuracy of coordinate movement.

As a result of the modernization, the machine became capable of machining workpieces with dimensions of 1200 × 500 × 500 mm and weighing up to 800 kg. Travel distances of 1000 mm, 450 mm, and 500 mm along the X, Y, and Z axes, respectively, were provided. This increases the practical importance of the NF-1200 model for machining housing-type, base-type, and large machine-building parts.

In general, the modernization of the NF-630 machine into the NF-1200 model is a technically, technologically, and economically reasonable solution. It

ISSN 3030-3907

contributes to the efficient use of the existing production base, reduces the cost of purchasing new equipment, and expands production capabilities.

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