14 MARCH 1980 (FOUO 1/80) 1 OF 2

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JPRS L/8975

14 March 1980

USSR Report

CONSTRUCTION AND EQUIPMENT

(FOUO 1/80)

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CONSTRUCTION

PROBLEMS IN THE PLANNING AND STIMULATION OF CAPITAL CONSTRUCTION

Moscow VOPROSY EKONOMIKI in Russian No 12, 1979 pp 3-11

[Article by Academician T. Khachaturov]

[Text] The decree of the CPSU Central Committee and USSR Council of Ministers "On Improving Planning and Intensifying the Impact of the Economic Mechanism on Increasing the Effectiveness of Production and Improving the Quality of the Work" contains a system of measures for the improvement of planning, capital construction and cost accounting. These measures are an outgrowth of the stage of developed socialism in which the volume of production is significantly increased, its technological level becomes more complex, and the interdependence of various branches and enterprises is enhanced. All this makes new and higher demands on the management of the national economy, on the improvement of the economic mechanism, on planning, and on cost accounting.

With each passing year, higher demands are made on capital construction, the effectiveness of which determines the growth of production potential and prospects for the development of the country's economy. The decree assigns a significant place to the improvement of capital construction. Particularly important is the fact that the decree views such improvement as part of the interconnected system of measures encompassing planning, construction and cost accounting and envisaging the implementation of uniform principles: higher effectiveness and quality, orientation toward five-year periods and longer periods, proportionality in economic growth, increased interest and responsibility of managers and performers for the attainment of high end results

The decree defines the periodicity and procedure for compiling long-range and one-year plans of our country's economic and social development. The USSR Academy of Sciences, the State Committee for Science and Technology and The USSR State Committee for Construction Affairs are instructed to draft a 20-year comprehensive program of scientific and technical progress adjusted for five-year periods every five years. This ensures the continuity of planning. The USSR State Planning Committee together with USSR ministries and departments and the councils of ministers of union republics are charged with the responsibility of drafting the Basic Directions of Socioeconomic Development of the USSR for 10 Years by Five-Year Periods based on long-range socioeconomic tasks articulated by the party and the Comprehensive Program for Scientific and Technical Progress. The decree also makes provision for ensuring the continuity of planning by making amendments in the Basic Directions every five years. Accordingly, the USSR State Planning Committee will elaborate control figures for the forthcoming five-year plan, broken down by year, and will convey them to ministries and departments of the USSR, to councils of ministers of union republics and beyond to associations, enterprises and organizations that must draft five-year plans with due regard to counter-plans and social competition commitments. The USSR State Planning Committee uses these draft plans to draft a balanced state five-year plan.

Thus the decree clearly defines the system of national economic planning; for the first time establishes planning horizons for 20, 10, 5 years and for one year; formulates particular features of the plans for these periods; and defines the procedure for drafting these plans. Five-year plans compiled on the basis of a system of scientifically substantiated technico-economic norms become the principal form of planning of economic and social development.

The planning of construction and the enhancement of the effectiveness of capital investments occupy an important place in the system of planning of the economic and social development of the USSR. The role of capital construction in the development of the socialist economy is exceedingly great. The country's national wealth (not counting land and timber) is presently evaluated at more than two trillion rubles. The value of USSR fixed capital is in excess of 1.5 trillion rubles. This vast wealth was created by the labor of the Soviet people. The overall volume of capital investments in the Ninth Five-Year Plan and in four years of the Tenth Five-Year Plan alone amounted to almost one trillion rubles. Considering the fact that the national economy's fixed capital is roughly 30 times greater than in the initial years following the revolution, it is obvious that most of the Soviet people's possessions were created and accumulated during the years of Soviet power. Moreover, this is not passive property but is production potential, i. e., is the prerequisite and basis of the further growth of production and of the entire economy as a whole.

But the results of capital investments could be still greater. Analysis and calculations show that shortcomings in capital construction have impeded its development and have been the reason for the incomplete return on the vast sums invested in it. These shortcomings have been repeatedly pointed out at pargy congresses and at plenums of the CPSU Central Committee.

At the October (1976) Plenum of the CPSU Central Committee, L. I. Brezhnev, focusing attention on several key problems, stated that "capital construction is one such problem and possibly the central problem... The orientation of the five-year plan is toward lowering the volume of incomplete construction, toward reducing the time and cost of construction and installation work, and toward the more rapid reconstruction of existing capacities." In a speech at the November (1978) Plenum of the CPSU Central Committee, L. I. Brezhnev criticized the situation in capital construction. "We have not yet succeeded in halting the process of scattering capital investments over numerous construction projects. The volume of incomplete construction is on the rise. Uninstalled equipment costing several billions of rubles lies idle in the warehouse. This point has been discussed more than once. But it is not evident that the USSR State Planning Committee, clients, and builders feel a sense of responsibility for freezing capital investments, equipment and materials."

The share of incomplete construction has systematically increased in recent years. Vis-a-vis the annual volume of capital investment, it increased from 69 percent in 1965 to 75 percent in 1975 and 85 percent in 1978. The volume of incomplete construction is particularly great in the case of productive projects. Thus, in the power industry in 1978 it was 127 percent of the annual volume of capital investment; in the coal industry -- 140 percent; in ferrous metallurgy -- 131 percent; and in chemistry and petrochemistry -- 173 percent.

The excessive volume of incomplete capital construction immobilizes almost two times more resources than are required for the activation of a year's projects. The construction time of various projects is normed according to type and capacity. These norms cannot be called understated: they frequently significantly exceed the actual construction time of analagous projects in the USA and Japan. However, analysis of the data on numerous completed projects shows that only a few of them have been put into operation on schedule, while the majority of them were activated with a greater or lesser lag time.

The disruption of the schedule for the activation of new capacities not only lowers the effectiveness of the construction process proper, but also has a negative impact on the economy as a whole. After all, the output that is supposed to be forthcoming from newly activated capacities is distributed beforehand in supply plans and capital is allocated for it; the shortfall in output from non-activated capacities complicates the normal operation of the capital-holding enterprise and frustrates their plans, which is reflected in the economic activity of client enterprises.

One of the major reasons for the delay in construction time is the scattering of capital investments among an excessively large number of construction projects. The party and the government have repeatedly indicated the need to halt the scattering of capital and to concentrate capital investments primarily on decisive, priority projects. Measures have been repeatedly taken to review and reduce the number of construction projects. However, the proper results are not obtained when nonreturnable state budget financing is the source of the capital investments and when the proper stability of the plans is not attained. Clients see their goal to lie in proving the need to include the projects they need in the plan. They use various, sometimes improper approaches to this end. For example, the estimated cost of proposed projects is understated whereas the actual overrun is later discovered to be 1.5-2 times or even higher. New projects are included in the title list under the pretext that the necessary volume of production would be impossible without them. New construction, not listed in the plan as such, is sometimes carried out under the guise of reconstruction.

In order to halt the scattering of capital investments, the CPSU Central Committee and the USSR Council of Ministers have directed the USSR State Planning Committee, USSR ministries and departments, and councils of ministers of union republics to elaborate measures to accelerate the activation of production capacities at construction projects already in progress and to bring about a sharp reduction in the number of new construction projects so as to bring the volume of incomplete construction down to the established norms in the next few years.

The decree's pronouncement on increasing the importance of the five-year plan and on ensuring its stability is very important. Considering the duration of production time, this pronouncement plays a special part where capital construction is concerned. The stability of the five-year plan permits the confident planning of the work of construction organization with an eye to commissioning the project on or ahead of schedule and the planning of the work of the customers for new products, for whom the time of receipt will be thoroughly realistic. Naturally the stability of the five-year plan of capital construction with targets broken down by year presupposes the elimination or at any rate the maximum reduction of all manner of corrections and revisions that undermine the stability and efficacy of the plans.

The stable five-year plan must be balanced with resources of materials, technological and power generating equipment, with labor and financial resources, and with the capacities of construction and installation organizations. To date, insufficient proportionality has been one of the reasons for prolonging construction time and for increasing construction costs.

The untimely supply of construction materials and components, the incomplete delivery of equipment "piecemeal," and the occasionally poor quality of equipment greatly hinder the work of builders, disrupt its planned character, and decelerate the activation of completed construction projects. Interruptions in the delivery of materials sometimes compel builders to use more expensive and higher quality materials -- metal, cement, slabs -- where lower quality materials could be used and vice versa. All this leads to the overexpenditure of materials. Incomplete deliveries, the low quality and shortage of materials and equipment cause idle time and extend construction time and the time of installation, debugging and development of capacities. Interruptions in the supplying of construction are also reflected in the wages of construction workers and necessitate their transfer to other construction projects thereby disrupting the fulfillment of the plan still further.

The "Basic Directions of Development of the USSR National Economy Between 1976 and 1980" adopted by the Twenty-fifth Congress of the CPSU call for raising the role and responsibility of enterprises of machine building ministries in securing complete deliveries, of the installer, and in bringing the equipment manufactured by them up to rated capacity. These tasks also confront organizations in the material-technical supply system.

The new decree indicates a higher measure of responsibility on the part of suppliers for the nonfulfillment of delivery plans, which will be taken into account in the evaluation of their economic performance. Sanctions must be invoked for the violation of delivery contracts. In order to facilitate the delivery of complete equipment packages, the decree envisages the use of credit: bank credit is offered to the general supplier of equipment prior to the expiration of the planned date for completing the delivery of the entire equipment package or for its installation. When the planned period expires, the crediting continues but higher interest is charged for the use of the loan.

Lag in construction work and interruptions in the delivery and installation of equipment packages result in the formation of large equipment inventories in the warehouses. At the same time, millions of square meters of production space are vacant. The implementation of measures indicated in the decree will make it possible to eliminate these disproportions.

The coordination of the construction volume planned for every construction organization with its capacities is an important condition to striking a balance. To this end, it is necessary first and foremost to determine the capacities of each construction organization. The decree envisages the compilation of 'passports' for each production association or enterprise in 1979 and 1980 and their subsequent updating. The passports must contain data on the availability and use of production capacities, on the organizational and technical level and other technico-economic indicators required for drafting five-year and one-year plans. Such passports on construction organizations will provide the complete picture of the capacity of each of them.

Accordingly, it is essential to plan the work volume for a five-year and one-year period based on the decree's pronouncement that plans must be compiled on the basis of economic and engineering calculations. At the same time, we must not permit the establishment of plan targets for subordinate construction organizations solely on the basis of the existing dynamics of the corresponding indicators, i. e., on the basis of the "status quo."

The decree's pronouncement that existing production and new construction must be planned as a single whole holds great significance for securing the proportionality of capital construction plans. In this regard, the five-year plans will allocate capital investments for the development of branches of material production to perform the planned volume of production and services. This ensures the creation of new capacities in branches of material production in a volume necessary for the solution of problems posed in the five-year plans and envisages an increase in the volume of production in particular in accordance with the requirements of construction proper.

The decree obligates USSR ministries and agencies and councils of ministers of union republics to draw up balances and make calculations of the use of production capacities and fixed capital as part of the drafts of five-year plans and also to draw up summary plans of reconstruction and technical retooling of existing enterprises inter alia at the expense of the production development fund. The compilation of such balances will make it possible to elicit reserves of production capacities and to provide a technico-economic substantiation of the reconstruction of existing enterprises for which there is a real need.

The use of the production development fund for the reconstruction of enterprises was frequently impeded by this fund's lack of the appropriate material resources and the lack of the necessary capacities. Now, according to the decree, the plans must give top priority to the allocation of material resources and equipment to associations and enterprises for reconstruction and technical retooling and must also assign limits to capital investments, to construction-installation and contractor-performed work. This ensures the use of the development fund for the needs of capital construction in the interest of reconstruction and technical retooling and will thereby bring one of the economic incentives for increasing the effectiveness of production into play.

The existence of balances of production capacities and plans for the reconstruction of existing enterprises provides a real opportunity for placing new construction in a framework corresponding to the real needs of the national economy. The decree envisages the allocation of funds for the construction of new enterprises and for the expansion of existing enterprises only if the requirement for given output cannot be provided through the reconstruction and technical retooling of existing enterprises. This will make it possible to limit new construction that is extensive, to concentrate capital investments on a lesser number of projects, to place major emphasis on the use of new equipment, on increasing the effectiveness of production, and on its intensification.

The decree charges the USSR State Committee for Construction Affairs with responsibility for pursuing a unified technical policy in construction, for improving planning estimates, for improving the quality of project-planning, for preparing measures to reduce construction costs, for improving city planning norms, and for improving the architectural appearance of population centers.

The USSR State Planning Committee will ratify five-year plans for project-planning and surveying operations and the performers of these operations. In order to attain greater maneuverability, the plans and estimates will be only for the first stage of an enterprise when construction takes longer than two years. But the project will be based on the master plan of development of the enterprise. Subsequent stages will be designed concurrently with the construction of the first stage.

The new system of indicators for evaluating the work of construction workers is of great importance. Up until now, their work has been evaluated on the basis of the fulfillment of the capital investment plan, i. e., essentially on the basis of the expenditure of capital. This has determined the size of the wage fund and the material incentive fund. Capital investment plans were fulfilled, resources were "assimilated," but the activation [of capacities] lagged significantly behind the plan (by 20-30 or more percent for certain branches). The orientation toward gross indicators has led to an increase in the interest of construction organizations in the use of costlier materials and components and in their redistribution, to the division of projects into "profitable" and "unprofitable" projects, and finally to all manner of exaggeration of report data.

The decree specifies a list of indicators that are ratified in the five-year and one-year plans assigned to construction ministries and construction-installation organizations. The principal indicator among them is the activation of production capacities and projects, i. e., the final product of construction. The list of indicators also includes: the volume of commercial construction output with a breakdown of general volume by client; the growth of labor productivity; the maximum number of workers and employees; profit (for individual organizations -- reduction of the prime cost of construction and installation work); targets for the introduction of new technology; and the volume of delivery of materials, machinery, mechanisms, and other resources required for the fulfillment of the plan.

The evaluation of the economic activity of construction and installation organizations and their economic stimulation will be based on the results of the fulfillment of targets, on the activation of production capacities and projects, on the volume of commercial output of the construction industry, and on the growth of the productivity of labor and profit. This creates new stimuli in the work of construction and installation organizations and leads to the abandonment of the orientation toward the "assimilation of capital" and the notorious "gross." The most important indicator is the commissioning of completed projects. At the same time, the fewer material resources and the less manpower expended, the greater will the profit of an organization be. Thus, the higher the evaluation of its performance, the higher will the economic incentive funds be.

The introduction of the new system of evaluation calls for the transition to the practice of settl`ng accounts between clients and contractors for entirely completed enterprises, for individual complexes, for capacities ready to produce goods and render services on the basis of the estimated cost of commercial construction output already in the year 1969. Such a procedure is analagous to the payment procedure used in industry and in other branches of material production (where money is paid after the product is produced and received) and stimulates the speediest conclusion of construction projects. Advance payments by clients to contractors for the purpose of defraying the expenses of the latter are forbidden until the project is completed. These expenses are defrayed by bank credits pending the deadline for commissioning a given construction project from the clients' disposable funds. Subsequent credit is granted if necessary, but at a higher interest rate. This will encourage the commissioning of projects on schedule or ahead of schedule. It is proposed that accounts between clients and project-planning and surveying organizations be settled in similar fashion. Payment is made for projects that are entirely completed and accepted by the client: the expenses of project-planning organization prior to the commissioning of completed projects are defrayed by their working capital and by bank credit also on the basis of the clients' disposable funds in connection with the settlement of accounts without intermediate payments. All this will have a stimulating influence on project-planning organizations and will compel them to complete project plans of higher quality on schedule.

Credit will also play a greater part in connection with the fact that the decree envisages the expedience for individual branches to finance construction projects from credit granted by the USSR All-Union Bank for Financing Capital Investments [Stroybank SSSR] to construction and installation contractors in the full sum of construction costs in accordance with the estimate accepted by the contractor and the agreement to turn the project over to the client in completely ready-to-use form.

At the present time it is essential to enhance the role of long-term credits in the financing of capital construction -- at least, to double its share in the next few years. The use of credit increases the responsibility of both contractors and clients. Unlike budget financing, credit must be repaid. When credit is used, it is necessary to substantiate the expedience of expenditures and to secure their effectiveness.

In order to ensure the lack of interruption in capital construction plans and to increase the responsibility of clients and contractors for the activation of capacities and projects on schedule, the decree envisages the elaboration and ratification of lists of enterprises undergoing reconstruction or slated for reconstruction in five-year plans and the compilation of title lists of construction projects. They must become a stable planning document that is binding for clients and contractors; for planning, finance, bank and supply agencies; for suppliers of equipment and components not only for a year but for the entire period of construction. The one-year capital construction plans will include only construction projects for which project-planning and estimate documentation and blueprints for a year of work are available by the first of July of the preceding year. Ministries producing technological and power equipment must receive orders for the delivery of equipment for the entire period of construction, and must receive orders for at least two years for the delivery of metal structural components.

A number of measures are envisaged for the expansion of work on the technical retooling and reconstruction of existing enterprises. They include the right of managers of production associations and enterprises to ratify title lists for the technical retooling of enterprises irrespective of the overall estimated cost of the work in accordance with their established limits on capital investments and construction-installation work and material stocks. Managers are also entitled to establish bonuses for personnel meeting targets for the technical retooling of existing enterprises and to raise wages in construction-installation organizations in whose plan the volume of work on technical retooling and reconstruction of existing enterprises is 50 percent or more.

The All-Union State Bank for Financing Capital Investments (Stroybank) and the USSR State Bank (Gosbank) are instructed to finance state capital investments in productive construction projects continuously on the basis of title lists for the entire period of construction within the sums ratified in the estimate. It is permitted to grant clients credit to pay for major technological and power equipment of domestic manufacture for productive facilities before the equipment is installed and to continue to grant credit upon the expiration of the equipment installation deadline but for a higher interest rate. This procedure creates the stability of financing of construction projects. The same procedure is also extended to the settlement of accounts for the delivery of equipment packages. In such a case, the client pays the general supplier in full for the delivered and installed equipment package. The general supplier receives bank credit pending the delivery and installation of the entire equipment package. Credit continues after the deadline but the interest rate is higher.

The decree calls for higher bonuses for the timely activation of production capacities and facilities in the average amount of up to three percent of the estimated cost of construction and installation work performed.

According to regulations on awarding bonuses for putting completed projects into operation (regulations ratified by the USSR State Committee for Labor and Social Problems, the USSR State Committee for Construction Affairs, and the All-Union Central Council of Trade Unions), bonuses are paid with regard to the quality of the work for the activation of projects on schedule: bonuses are increased by 10 percent for a rating of "excellent"; there is no increase in bonuses for a rating of "good"; and bonuses are reduced by 20 percent for a rating of "satisfactory." When the activation time is reduced by at least 30 percent, the total bonus is raised by 50 percent; when the activation time is reduced by 20 percent, the bonus is raised by 25 percent; and when the activation time is reduced by 10 percent, the bonus is raised by 10 percent. When a project is put into operation ahead of schedule, the general contractor receives from the client 50 percent of the projected profit for the reduced period of construction but not more than 0.5 percent of the estimated cost of construction-installation work for each month of reduction in construction time. These funds are channeled into the economic incentive fund of organizations involved in the construction. Provision is made for the distribution of the profit realized by the general contractor between subcontractors, project-planning and other organizations responsible for the reduction of construction time and for the development of production. This profit is used for sociocultural measures and housing construction and for the payment of bonuses to managerial, engineering-technical personnel, and employees and to workers and brigade leaders who have distinguished themselves in the amount of up to 1, 1.5, 2, and 3 times their salaries or basic wage scales.

The Eleventh Five-Year Plan calls for making the transition to the planning of labor productivity in construction-installation organizations on the basis of normative net output or another indicator that reflects changes in labor inputs more precisely. The wage fund will be planned on the basis of rubles' worth of commodity output on the basis of the indicator that is used for the planning of labor productivity. The USSR State Committee for Construction Affairs in conjunction with the construction ministries must prepare the norms and estimates base to this end. The transition to the settlement of accounts on the basis of net output is also envisaged in industry.

Construction ministries of the USSR and councils of ministries of union republics are instructed to implement measures to improve the management of capital construction and to adopt a two-three element system of management between 1979 and 1981. These measures hold great importance for construction: the present system of construction management is complex and unwieldy. It includes four and even five elements and the simplification of the system of management will increase the effectiveness of construction.

Cost accounting principles will undergo further development in construction-installation organizations as well as in production associations and at enterprises. Cost accounting is based on five-year plan targets and on long-term economic norms that guarantee an increase in resources that are left at the disposal of cost-accounting organizations depending on improvements in the final results of their activity coupled with a simultaneous increase in deductions paid into the state budget. Provision is made for the evaluation of the results of economic activity to fulfill product delivery plans (including construction output) in accordance with contracts, to increase labor productivity, to improve product quality, and to increase profits. Economic incentive funds will be formed on the basis of stable norms: the higher the profits, the larger the incentive funds.

Ministries and agencies establish a unified fund for the development of science and technology for the compensation of expenditures associated with the elaboration and development of new types of products and technological processes, with the improvement of product quality, and with higher expenditures during the first years of production of new products. This innovation holds great significance for industry and will also be a stimulus to the introduction of new technology in construction as well.

The pronouncement regarding the elaboration and implementation of measures for the broad development of the brigade form of organization of labor, considering the fact that is must become basic in the Eleventh Five-Year Plan, is especially important for the organization of labor and wages. Collectives (councils) of brigades are authorized to determine the size of bonuses and wages on the basis of the actual contribution of each brigade member to the general results and other types of material encouragement. All this emphasizes the significance of the development of the brigade contract method and of other progressive forms of labor in construction. The successful use of this method and these forms depends in larger measure on the rhythmic operation of the entire construction-installation organization and, in particular, on the lack of interruption in supply.

The decree should be the basis for the elaboration of normative acts on the implementation of measures indicated in the decree, including measures in capital construction (some of them have already been ratified and published).

The decree of the CPSU Central Committee and the USSR Council of Ministers opens up broad opportunities before all workers in the construction industry complex to raise the level of all work, to eliminate existing shortcomings, to increase the effectiveness of construction production and labor productivity, and to accelerate scientific and technical progress in construction and in the entire national economy.

5013
CSO: 1821

METALWORKING EQUIPMENT

UDC 658.512.6:658.52.011.56:621.9.06-529

OPTIMIZING AUTOMATED MACHINE-TOOL SECTIONS

Moscow STANKI I INSTRUMENT in Russian No 5, 1979 pp 3-5

[Article by M. Kh. Blekherman: "Optimization of Equipment Load of Automated Sections Consisting of Machine Tools with Individual Control Panels"]

[Text] The creation of comprehensively automated sections of machine tools with individual control panels (ChPU) controlled by computer is a promising trend for increasing labor productivity and efficiency of utilization of equipment in small-serial and unitary production. In this article are described the principles of equipment load optimization in the system of on-line industrial planning (SOPP) for automated sections of machine tools with ChPU for treatment of parts such as solids of rotation (type ASV sections). The SOPP was elaborated at ENIMS (Experimental Scientific Research Institute of Metal-Cutting Machine Tools) and was realized on the M-6000 electronic computer (with 32 kbyte working storage and one floppy disk file). The first phase of the system (SOPP-1) has been in industrial operation since 1977 at the ASV-20 section (Stankokonstruktsiya plant of ENIMS); the second phase of the system (SOPP-2) is being put into operation at the ASV-21 section (Sasovsk Plant of Automated Lines).

Machine tools with ChPU (as compared to all-purpose machine tools of the same technological designation) have high productivity and cost, and therefore the maximum intensification of their load is so important. Several theoretically new possibilities in this direction have been revealed by comprehensive automation of production in type ASV sections because of the presence in the section of a control computer, unified transport and storage system (TNS), automated systems of technological preparation of production (TPP) and the SOPP. Within the SOPP, intensification of loads of machine tools with ChPU is achieved by reducing down time for technical organization and preparation and finishing time.

Aspects Of The Planning Object And Interaction With The Planned Production Control Division (PDO) Or Automated Production Control System (ASUP)

Type ASV sections are designed to accomplish lathe, milling and drilling operations in the manufacture of parts of the solids of rotation type and consist of several technical machine tool groups (TGS). Each TGS combines machine tools of the same model and modification, designed to perform identical technological operations. Within a TGS, all machine tools are completely interchangeable. For example, the ASV-21 section consists of three TGS: lathe (six model 1725MF3's), drill-milling machines (three models MA2235MF4's) and a centering-milling machine (model MR021F4). The SOPP is adjusted to a specific equipment make-up according to tables. Up to 30 machine tools of different TGS can be simulatneously connected to the SOPP.

Let us examine the ASV-20 to illustrate several characteristics of the ASV type section load. The average size of a start-up run (in 1978 figures) is 19 items: 52 percent of the run contains no more than five parts per item. The average treatment time per run in a single control program (UP) for lathe operations is T_{up} = 8.5 minutes. The annual inventory of rotary parts comprises more than 1200 items. An average of 50-60 items are simultaneously being produced.

Therefore, the ASV type section is a multi-item small-serial production line with short treatment cycle. Typical features of such production (because of the diversity and complexity of industrial connections) are: 1) raising the requirement for efficiency and coordination of activities of all section and plant services; 2) the large number of unpredictable deviations from production schedule, leading to equipment down time for organizational and technical reasons.

Some of these deviations (retraining of production because of design changes of treated articles or tretment technology; untimely delivery of billets, fittings and cutter; delay in performance of subcontracted work) are typical for most small-serial productions; some deviations (errors in UP, need to retrain UP for significant deviations in billet dimensions) are specific to equipment with ChPU. The breakdown of equipment also leads to unpredictable deviations from the section's work schedule. Elimination of causes of unpredictable deviations requires the performance of a set of measures aimed at improving short-term planning, improvement of preparation of production and enhancement of equipment reliability.

In addition to coordinating section service work, section stability in the fact of unpredictable deviations from the production schedule is of primary importance (i.e., distribution of resources and planning conditions so that equipment down time for organizational and technical reasons due to random deviations is at a minimum).

Work planning of automated sections of the ASV type is done at two levels: the level of long-term (monthly, biweekly) volume planning of section work as a whole, done by the PDO or ASUP within the entire plant; and the level of short-term (shift, half-shift) planning of work of specific units of equipment and section services, done by the SOPP. This organization of planning is governed by the fact that within the ASUP it is almost impossible to consider on-going changes in the manufacturing situation typical of small-serial production in a thorough and efficient manner.

Intervention of PDO or ASUP in the work of SOPP is only permitted when the monthly production program is corrected or the initial orders are changed.

Shortening Equipment Down Time for Organizational and Technical Causes

The basic means of shortening equipment down time for organizational and technical causes within the section SOPP have been determined from operating experience of automated sections.

1. Comprehensive solution of production control problems. In ordinary production lines, the load of machine tools is planned on the basis of technological routing. Work planning of automated sections is done in SOPP on the basis of a comprehensive examination of the entire manufacturing cycle of the order path through the section [1]. The manufacturing cycle of order path consists of two stages (see table): preparation of production (opening the order and listing parts, UP, fittings and cutter) and the execution of the order per se (from start-up of the listed order to sealing of the order and shipping the ready product to the customer). The first stage in the manufacturing cycle is standard for all orders, while the second stage is automatically shaped on the basis of the technological route. The technological route, UP and standard and adjustment data for each UP (so-called UP tags) are elaborated in the TPP system and are transmitted to the section via punched tape.

The manufacturing cycle contains the following operation groups: 1) metal working operations carried out in the section (with breakdown according to installation of parts); 2) subcontract operations after which the parts must be returned for further treatment in the shop; 3) TPP operations; 4) receipt of fittings and cutters stored outside the section; 4) technical monitoring operations; 6) dispatcher operations.

TPP operation is planned once in the SOPP (with first start-up of a given item). With repeated start-ups, the SOPP automatically considers this operation to be executed (except for cases of change in billet size or treatment technology). Operations of billet delivery and subcontract work are included in the manufacturing cycle of order path in the section to organize a closed accounting system that identifies possible disturbances in section work rhythm caused by disruption in billet delivery time and subcontract performance. In the SOPP, the performance of these operations is not planned, only monitored.

Thus, the entire manufacturing cycle of order routing is reduced to the performance of a preset sequence of operations. A shift from the technological path to the manufacturing cycle of order routing enables us to plan the work not only of machine tools within SOPP, but also TPP services, technical monitoring, cutters and dispatcher work. In addition, Manufacturing Cycle of Order Transit in Section of the ASV type (Formalized Example)

Cycle stages	Groups of operations
preparation of production	opening of order in the section receipt of billets technological preparation of production
execution of order	loading in TNS preliminary lathing, first unit* prelminary lathing, second unit* technical monitoring forwarded for subcontracting subcontracted heat treatment* loading in TNS final lathing, first unit* final lathing, second unit* drilling-milling work, first unit* technical monitoring sealing order and shipping ready product to customer

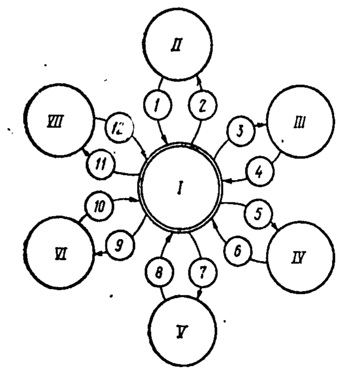
*Operations appearing on the technological path of an item elaborated in the TPP system

based on data contained in UP labels, the SOPP plans the operations of the cutter service for cutter alignment and fitting out. The SOPP interaction chart is illustrated in the figure.

Metal working operations are automatically standardized in SOPP based on the values of T_{up} and T_v (manual auxiliary time) contained in the UP labels.

An important role in reducing equipment down time for organizational and technical causes is played by on-line reporting to section and plant services on the current status of production. In this connection, SOPP (in addition to output of reports) on request of the appropriate services displays reference data (disruption of deliveries of billets, current work load, etc).

2. Increasing Efficiency of Control Reactions. If there is a significant number of deivations from the production schedule, it is necessary to achieve maximum speed of feedback, i.e., to reduce the time interval between the moment of change in the manufacturing situation and the change in the appropriate planned assignment. This requirment is most fully satisfied by the conditions of continuous (dynamic) planning in which the next line item of the planned assignment is determined and is reported to the working area only after receipt of data on the performance or non-performance of the preceeding assignment line item.



Interaction of SOPP with Plant and Section Subdivisions and Services:
I--SOPP; II--PDO or ASUP; III--TPP service; IV--technical montiroing; V--section chief; VII-cutter service; VII--dispatcher service; 1--section manufacturing program, additions and corrections to program, change in initial data on orders (run size, time, etc.); 2--reports, data on current status of production (current status or orders, volume of insurance reserves, shortage in order parts list); 3--assignments for technological preparation of rpoduction and UP error corrections, data on current status of technological data bank; 4--technological routing and labeling of UP prepared according to assignments; 5--assignments for conduct of technical monitoring operations; 6--data on results of operations of technical monitoring; 7--assignments for machine tools of section, data on current status of production, reports; 8--data on results of execution of assignments for machine tools, removal of residue at end of half shift and status of work areas; 9--assignments for receipt of cutter and fittings, assignments for alignment of cutter and fittings; 10--data on receipt of cutter and fittings; 11--assignments for dispatcher operations (loading in TNS, sending out for subcontract work and sealing orders); 12--data on results of dispatcher operations, data on receipt of billets and half-finished products (from subcontractors).

The choice of the current line item of the assignment is done on the basis of the entire set of data stored in the system at the time of inquiry. But realization of these conditions is complicated by several organizational and technical problems. In this context, when SOPP programming instructions are developed, it is provided that the system can operate under both continuous and session planning conditions.

The most natural interval of planning is the half shift (planning sessions are done between shifts and during the lunch break). Planned assignments for the next half shift are elaborated on the basis of information on the status of production at the end of the preeceeding half shift. Data during the half shift are stored on paper, usually the planned assignment blanks. Information is put into the SOPP at the start of the planing session. Only data on changes in the current status of orders and equipment are put in; the bulk of the data is stored on the floppy disk. The SOPP is serviced by one operator per shift.

The need for highly efficient data processing in continuous and half shift planning required the creation of a special system of information processing [2]. Input and monitoring of data for the preceeding half shift, correction of data banks, calculations and print out of planned assignments for the next half shift take no more than 30 minutes in all. As operating experience with the ASV-20 shows, conditions of half shift planning provide, in most cases, the necessary efficiency of readjustment and adaptation of production in conformity with current manufacturing conditions. According to the nature of production, SOPP can be aligned to conditions of shift and daily planing.

3. Localization of deviations from the production schedule. In addition to introducing on-line feedback, SOPP stability is also increased by using additional constraints which localize the consequences of random deviations. The essence of these constraints consists in a distribution of resources so that the performance of the planned assignment at one work site in a given planning interval (half shift) is independent of the performance or lack thereof at other work sites.

Thus, the planned assignment for a machine tool only contains orders (or parts of orders) which are completely ready for execution of operations of the appropriate TGS at the time of planning. During the interval of planning, parts can not be moved from machine tool to machine tool, even if the machine tools are completely interchangeable. This guarantees local indepedendence of machine tool loads, i.e., the operation of one machine tool does not affect (during the planning interval) the operation of other machine tools. If the order is placed in several containers, these constraints are related only to each part in its individual container, not to the entire order.

Localization of discrepancies can be used only with small planning intervals and ensures more stable and efficient machine loads.

4. Increase in the Number of Degrees of Freedom in Solving Optimization Problems. One of the basic constraints in solving optimization problems of equipment loading is the planned periods of order output. If the planned periods are uniformly distributed throughout the month, under conditions of multi-item production the criterion of minimization of disruption of these periods is very rigid and almost unambiguously determines the sequence of order processing on the machine tools [3]. By establishing the sequence of treatment in this way, it may involve the inefficient use of equipment and significant down time for organizational and technical reasons.

Analysis of multi-item small-scale production shows that in most cases, the required accuracy of observance of planned periods of order delivery does not exceed two or three days. Thus in the SOPP, all orders are grouped according to three priorities of fulfillment ("normal", "urgent", "emergency"); this permitted a shift from a more than 20-level system (according to the number of working days/month) of priorities to a three-level system.

Within the level, all orders are considered equally urgent. The priority level is designated upon opening of the order and be changed on-line by technical and engineering workers of the section and plant during completion of the order (not only the entire order, but also each part placed in a separate container). Fulfillment of an order of lower priority is permitted only after fulfillment of all orders of high priorities.

To equalize random deivations from the production schedule and optimize macine tool load in the ASV-type section, insurance work reserves are envisaged for each TGS (for 2-3 shifts). Data on current volume of insurance work reserves are automatically prepared in the SOPP. In addition, insurance work reserves are introduced into each half-shift assignment per machine tool.

Reduction of Preparation and Finishing Time (T_{p-z})

One basic obstacle to efficient use of machine tools with ChPU in small-scale and unitary production is the relative large portion of T_{p-z} in overall resources of machine tool time. The relative significance of T_{p-z} is reduced in SOPP by minimizing re-adjustments of machine tools.

Under conditions of small-scale production, machine tool load is usually planned by operations (without dividing into installations). At the same time, re-installations within an operation in some instances are related to significant re-adjustment of the machine tool. The presence of unified TGS of the section, which ensures efficient feed of items to any work position, permits a shift from planning of operation fulfillment to planning of installation fulfillment. The planning unit of the SOPP is fulfillment of one UP (i.e., one installation) for a part of an order situated in a single container. Therefore, SOPP permits fulfillment of two installations in one operation with a discontinuity in time at various machine tool positions.

The sequence of planning units for each machine tool (planned assignment per machine tool) is established using the type optimization method [4], which represents a modification of the method of group treatment in short-term planning and is designed for the high intensity of unpredictable deviations from production schedule.

The type optimization method is high speed: calculation of the half-shift assignment for TGS of four machine tools (with order portfolio of 100 planning units) takes about 2.5 minutes.

Introduction of SOPP in the ASV-20 section reduced to almost 1/2 the down time of equipment for organizational and technical causes and to almost 1/2 the machine tool adjustment time.

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APPROVED FOR RELEASE: 2007/02/08: CIA-RDP82-00850R000200060016-6

METALWORKING EQUIPMENT

UDC 621.9.06-112+[658.527:621.9.06-52]

STANDARDIZED SUBASSEMBLIES OF MACHINE TOOLS

Moscow STANKI I INSTRUMENT in Russian No 5, 1979 pp 14-17

[Article by L. S. Bron: "Unified Range of Standardized Subassemblies of Modular Machine Tools and Automated Lines"]

[Text] Automated lines (AL) and modular machine tools (AS) are the most productive equipment for multiple arbor mechanical treatment of chassis parts under conditions of large-scale and mass production. A distinctive feature of AL and AS is that they are composed of separate standardized (normalized) subassemblies and parts, which reduces periods of planning and manufacture, reduces cost and raises the quality of this equipment.

In the Minstankoprom system, modular machine tools (using normalized subassemblies in their manufacture) have been manufactured since the early 1950s by the Moscow Machine Tool Construction Pant imeni Sergo Ordzhonikidze (according to designs of Moscow Special Design Bureau of Automated Lines and Modular Machine Tools, the Minsk Plant of Automated Lines (according to designs of Minsk Special Design Bureau of Automated Lines) and the Kharkov Plant of Modular Machine Tools (according to designs of the Kharkov Speicl Design Bureau of Modular Machine Tools). Individual normalized subassemblies were manufactured by the Glukhovskiy Plant of Modular Subassemblies (according to designs of Kharkov Special Design Bureau of Modular Machine Tools), Gomel'skiy Plant of Machine Tool Subassemblies (according to designs of Minsk Special Design Brueau of Automated Lines), the Moscow Stankoagregat Plant, and the Moscow Plant of Special Machine Tools Spetsstanok (according to designs of the Moscow Special Design Bureau of Automated Lines and Modular Machine Tools).

Subassemblies manufactured according to the designs of the three enumerated special design bureaus were normalized only for the corresponding manufacturer; consequently it was not possible to arrange their centralized production for use in machine tool designs and automated lines manufactured by other plants.

With the growth of machinery of large-scale and mass production (automobiles, tractors, agricultural machinery, etc.), the need increased for metal cutting equipment to manufacture the most complex chassis parts of

Table 1

Item	type sizes	Item	type sizes	% change in type sizes	Increased technical level of subassemblies and their AS and AL
--	--	power packs, small for AS	3	--	possible creation of AS for high-productivity and precision treatment of openings Ø1.5-12 mm and small surfaces
power packs, automatic	3	power packs with radial cam actuator	2	-33	30-40% increased rigidity of tail spindle, 20-40% increased tail spindle stroke, 10-20% possible increase in rate of rapid extraction
power packs, multi-spindle, automatic & manual (with hydraulic feed)	32	--	--		1.8 increase in number of power tables in stroke length (with overall reduction in number of type sizes of power packs) permits reduced size and weight of machine tools. Average 25% increase in table rigidity, 20-50% increase in rate of rapid stroke. Design of tables provides possibility of manufacturing classes of precision P & V
power tables, manual (with hydraulic feed)	14	power tables, straight-line for AS (with hydraulic feed)	25	-19	
power tables, automatic (with electromechanical feed)	12	power tables, straight-line for AS (with electromechanical feed)	22		
angle stops	6	angle stops	8	+33	using unified range stops increases rigidity of attachment of arbor housings by 10-15% because of increased flange size. Facilitates projection of arbor housings (since rotary drive can be directly attached to rear plate of housing
chucks, drill	3	chucks, drill	3	+14	design of chucks and drives (in contrast to replaceables) are standardized. Use of chucks expands technical resources of machines and lines.
chucks, reamer	5	chucks, reamer	5		
chucks, milling, w/o tail spindle	5	chucks, milling, w/o tail spindle	7		
chucks, milling, w/ tail spindle	6	chucks, milling w/tail spindle	7		
chucks, recess-reaming	5	chucks, recess-reaming	6		
heads, recess-reaming, hydraulic	3	--		--	
housings, arbor	56	housings, arbor	22	-60	complete standardization of deisngs. 1.5 times increase in rigidity. Increased precision and improved technical effectiveness due to shift to clear reaming of bearing holes

Table 1 (continued)

Item	type sizes	Item	type sizes	% change in type sizes	Increased technical level of subassemblies and their AS and AL
tables, index, rotary, hydraulic (design of Moscow Special Design Bureau of AL & AS)	2	tables, index, rotary, hydraulic (design of Moscow Special Design Bureau of AL & AS) mounted with dual locks	3	-22	increased precision and stability of division by 30%, 2-3 times increase in retention time of initial precision, increased rigidity of tables and easy of assembly of machine tools (because of use of mounted design)
tables, index, rotary, electromechanical (Minsk Special Design Bureau of Automated Lines)	3	-	-		
tables, index, rotary, electromechanical (Kharkov Special Design Bureau of AS)	4	tables, index electromechanical (Kharkov Special Design Bureau)	4		increased stablity of indexing and increased time of retention of initial precision
base frame parts	62	base frame parts	54	-13	30% increase in rigidity, improved conditions of chip removal (for horizontal beds and bases)

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these machines. In the machine-tool manufacturing industry, several new plants were drawn into production of modular machine tools and automated lines; this made it necessary to elaborate a unified range (for all designers and manfuacturers) of standadized subassemblies for modular machine tools and automated lines and to arrange centralized production.

In the creation of a unified range of standardized subassemblies, the following goals were set: 1) further development of modular methods of machine tools and automated lines to expand technical resources and increase the number of possible combinations using the minimum list of subassemblies; 2) refinement of parameters of several subassemblies to conform to recommendations of CMEA and ISO; 3) increase precision and performance of subassemblies; improve designs based on operating experience of functional subassemblies (including increased rigidity and precision, rate of rapid movement, etc.); 4) expansion of possible fields of application of modular machine tools and automated lines by including subassemblies of small modular machine tools in the unified range.

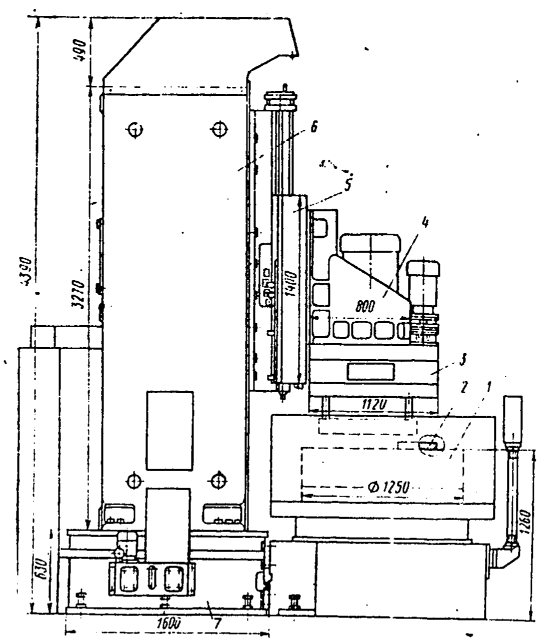

Figure 1. Vertical multi-arbor multi-position AS: 1--rotating table; 2--work; 3--arbor housing; 4--stop brackets; 5--moving platform of power table; 6--pedestal; 7--base support.

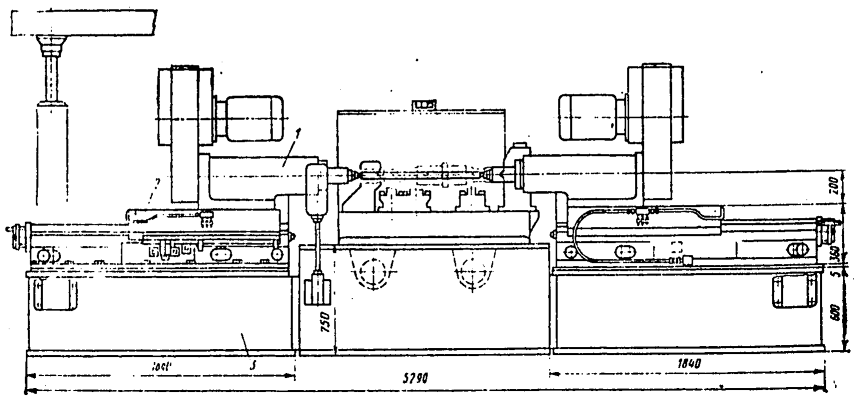

Figure 2. Horizontal bilateral drill AS: 1) drill chuck; 2) power table; 3) side base.

Table 2

parameters affecting AS productivity	improved parameters of subassemblies of unified range (average based on applicability of subassemblies), %	relative significance of increased productivity, %	possible increase in machine-tool productivity, %
increased rate of rapid travel of power packs	40	15	6
increased dimensions of arbor housings (and accordingly, average number of arbors) set on bracket, whose size corresponds to size of power table	70	32	10
inccreased conditions of cutting because of increased rigidity of arbor housings, chucks, power and index rotation tables and frame parts	70	33	11
increased output of electric rotary drive of arbor housings and chucks	45	20	9

When the unified range of standardized subassemblies is incorporated, the overall number of moduluar machine tools (including 25 type sizes of new subassemblies for small machine tools) is reduced by about 40 percent (including arbor housings, about 60 percent).

The following are used as power packs in the unified range: small manual hydraulic tail-spindle heads (size 01-04) with hydraulic drive 0.12-1.1 kW; automated radial cam tail spindle heads (sizes 03 and 05), output 0.6-3 kW; tables, power (sizes 1-7) of normal, increased and high precision (with hydraulic and electromechanical feed); chucks, reaming, drilling and milling (without tail spindles), output 1.5-30 kW; chucks, recess-reaming and milling (with tail spindle), output 15-30 kW.

Work rotating subassemblies for the unified range include: mounted rotary index tables (Ø200-320 mm) of high precision with hydraulic drive; rotary index tables (Ø400-800 mm) of normal and increased precision with electromechanical drive; mounted rotary index tables (Ø800-1600 mm) of normal and increased precision with hydraulic drive.

The unified range envisaged the use of support frames (for modular machine tools planned by all special design bureaus) including: frame for small modular machine tool; frame parts (including base and pedestal) for modular machine tool with radial cam heads; frame parts (cast and welded) for AS and A1 composed of power tables.

For the possible use of computer technology in composing orders for unified range subassemblies, a classifier was elaborated in conformity with which the code of each subassembly consists of 6 characters.

The first character (letter U) is the index of the unified system of standardized subassemblies. The second character is a letter belonging to the developer of the technical specifications: A--ENIMS; D--Odessa Special Design Bureau ARS; E--Minsk Special Design Bureau of Automated Lines; N--Moscow Special Design Bureau of AL and AS; Kh--Kharkov Special Design Bureau of AS. The third character is a figure belonging to the subassembly group: 1--frame, base parts; 2--drives and mechanisms of installation; 3--arbor subassemblies; 4--main drive subassemblies, feed and adjustment units, etc. The fourth character is a figure belong to the subassembly group; the fifth symbol is a figure belong to the subassembly type size.

ENIMS developed state standards (over 20) governing basic dimensions and norms of precision of standardized subassemblies of the unified range, which ensures high quality of manufacture of these subassemblies by all plants according to standardized technical conditions.

The use of unified range standardized subassemblies of AS and Al instead of the previously used normalized subassemblies yields the following advantages: 1) the overall number of type sizes of subassemblies is greatly reduced and the technical level of subassemblies and their AS and AL is increased (Table 1); 2) productivity of AS can be raised by 36 percent (Table 2); 3) subassemblies of unified range are fitted with improved electrical and hydraulic control, as well as systems of lubrication, removal of cuttings, etc.

Figures 1 and 2 illustrate typical arrangements of AS (design of Moscow Special Design Bureau of AL and AS) of different purposes, built on the basis of standardized subassemblies of the unified range.

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METALWORKING EQUIPMENT

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NEW LINE OF SPINDLE BOXES ELABORATED

Moscow STANKI I INSTRUMENT in Russian No 5, 1979 pp 17-19

[Article by G. I. Gorelik, V. B. Genin and Zh. E. Tartakovskiy: "Spindle Boxes"]

[Text] The Moscow Special Design Bureau of AL and AS and the Minsk Special Deisgn Bureau of Automated Lines elaborated a range of single-spindle boxes of varied technological designation in which they use uniform design solutions and a large number of identical elements. The composition of the range includes boring chucks in seven sizes, recess-boring chucks in five sizes, drill chucks in three sizes and milling chucks in five sizes.

Boring chucks of the UYe411 type are designed for reaming holes without the use of jig bushings and may be of normal and increased precision.

Chucks of normal precision are used in nonferrous reaming of holes of all classes of precision, in semifinished reaming of holes of the third class of precision and in finished reaming of holes of the fourth or lower classes of precision. Additional requirements are not imposed on the form of holes in these classes, as a rule, and hole axis deviation of 0.1 millimeter is permitted within 300 millimeters of length.

Chucks of increased precision are used in semifinished reaming of holes of the first and second classes of precision and in finished reaming of holes of the second and third classes of precision with a tolerable error of shape of reamed holes no more than half the diameter tolerance and tolerable error of hole axis position not to exceed 0.05 mm over a length of 300 millimeters.

The reaming chuck type UYe411 is shown in Figure 1. In the housing (5), the arbor (3) is mounted on bearings. Axial forces are absorbed by the thrust bearing (6). Provisional clearance of the bearings is controlled by nuts(2) and (4) and expansion rings (1) and (7). The basic technical data of reaming chucks of type UYe411 are shown below.

If it is necessary to face end surfaces and scroll grooves in apertures, the recessing-reaming chucks composed of standardized reaming chucks (cf. Figure 1) are used containing type UN428 faceplate and type UN474 cross feeder. Basic technical data of recessing-reaming chucks are shown below.

UYe411 Reaming chucks

Size	1	2	3	4	5	6	7
Diameter of arbor in front support, mm	40	60	80	100	130	160	200
Front end of arbor (GOST 12595-72)	3	4	5	6	8	11	15
Permissible axial force, kgs	160	250	400	630	1000	1600	2500
Largest diameter of reamed aperture, mm	100	125	160	200	250	320	400

Recessing-Reaming Chucks

Size	3	4	5	6	7
Diameter of arbor in front support, mm	80	100	130	160	200
Diameter of faceplate, mm	250	320	400	500	630
Longest travel of carriage, mm	50	60	80	100	125
Highest rate of arbor rotation, rpm	650	550	550	500	400
Cross feed, mm/min	17-450	11-450	11-450	7-400	7-400
Rate of rapid extraction of carriage, m/min	5	4.5	4.5	4.5	4.5
Greatest force of feed in carriage, kgs	125	200	320	500	800
Permissible bending moment of cutting forces with respect to carriage force, kgs•m	10	20	40	80	160
Rated pressure in hydraulic system, kgs/cm^2	20	20	30	30	50

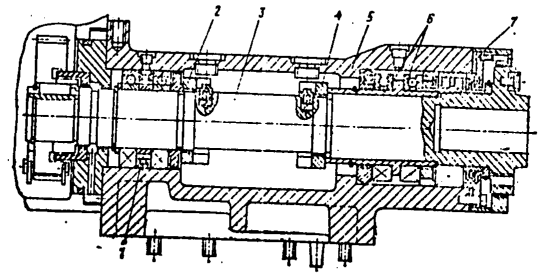

Figure 1. Type UYe411 Reaming Chuck

The arbor (9) of chuck (Figure 2) is rotated by an electric motor through the main drive (7). A faceplate (10) along whose guides the carriage (12) travels in a radial direction is attached to the arbor flange. Carriage movement is accomplished through a rack transmission by a pull rod (8) which is actuated by a hydraulic cylinder (2) of the cross feeding mechanism.

The rack cut into the front end of the pull rod is engaged with the two wheels (11) which in turn are engaged with the two racks (23) and (24), attached to the carriage. This coupled rack transmission is necessary for selection of clearance in the feed mechanism by moving the rack (23) with screws (22) along rack (24). To guarantee precision the forward position of the carriage (with diameter tolerance of less than 0.5 millimeter) has a control screw (14) which, in forward carriage position, touches the detent (13).

The cross feed mechanism contains a bearing block 915) intended for connecting the pull rod (8), which rotates with the arbor, to the stationary rod (3) of the hydraulic cylinder (2). The initial position of the rod and carriage are set by detent (17) on which rests the nut (1) attached to the rod. With a diameter tolerance of more than 0.5 millimeter, the working stroke of the rod and carriage are controlled by the detent (16) on which the nut (1) rests.

To monitor the end positions of the carriage, contactless end breakers (4) and (21) are used. When the hydraulic cylinder rod moves, pin(5) rotates a roller (18) past lever (6), together with which the detents (19) and (20) rotate, interacting with the end breakers. If necesary, the recessing-reaming chucks can be used to sequentially ream holes and face ends. Reamers are attached to the faceplate along with the carriage.

In all cases, the power table on which the recessing-reaming chuck is mounted must approach the fixed detent at a slow speed. If it is also necessary to ream a hole in addition to recessing faces, the power table must approach the fixed detent in working feed. In this case, the table is controlled by the hydraulic feed panel. If only an end is to be reamed, the table is controlled by the guide hydraulic distributor, and to reduce the rate of approach to the fixed detent, a travelling throttle may be used.

Figure 3 shows a standard hydraulic control circuit for a recessing-reaming chuck. After stopping the power table (on the fixed detent), electromagnet E1 of the three-position guide distributor (5) is switched on. Oil from the high pressure pump passes through the filter (8), reducing valve (7) and flow regulator (9) into the right cavity of the hydraulic cylinder (2) of the cross feeder. The cylinder piston moves left performing the working feed of the carriage. From the left cavity of the cylinder (2) the oil pours into the tank throug the pressure valves (3) and (6). The reduction valve (7) is designed to reduce pressure in the cylinder (2).

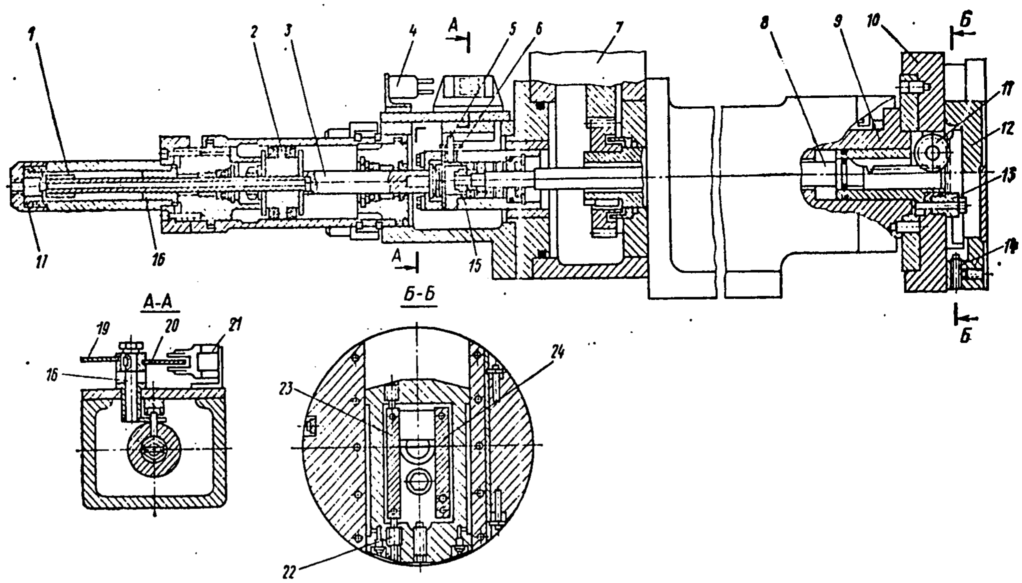

Figure 2. Recessing-Reaming Chuck.

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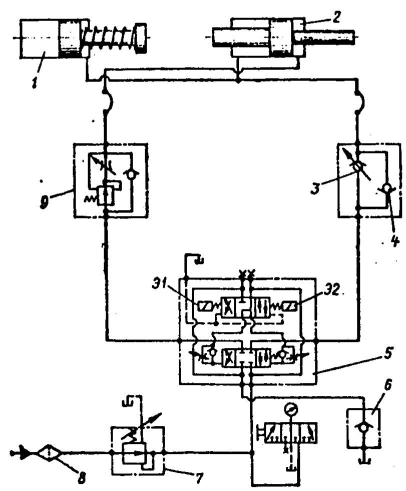


Figure 3. Standard Hydraulic Control Circuit of Recessing and Reaming Chuck.

When recessing the front end of a part, the carriage returns to its initial position after the power table arrives at its initial position: this ensures minimum cycle time because carriage return in this case can be combined with release of the work. In recessing the rear end of work, the carriage returns to initial position before the extraction of the power table.

To return the carriage to initial position, electromagnet E1 is disconnected and electromagnet E2 is switched on. Oil enters the left cavity of the cylinder (2) through the reverse valve (4); from the right cavity of the cylinder, oil pours into the tank through the reverse valve of the flow regulator (9) and pressure valve (6). Oil is also fed into the cavity of the lubrication plunger pump (1).

If necessary to drill single openings of large diameter, type UYe412 drill chucks are used which are similar to reaming chucks shown in Figure 1. The difference is that the leading end of the arbor has a hole for installation of the mandrel tail spindle with a bar cutter (similar to the arbors of multi-arbor boxes), and in the front support of the of the arbor instead of the two-row roller bearing are placed two radial thrust ball bearings. On the sides of the front part of the housing of the drill chuck there are bars for attachment of the conductor plate. The basic technical data of type UYe412 drill chucks are shown below.

Size	2	3	4
Arbor diameter in front support, mm	60	70	85
Hole diameter in arbor (GOST 13876-76), mm	28;36	36;48	48;60
Permissible axial force, kgs	1000	1500	2000
Largest hole Ø, mm (steel):	25	32	40
(cast iron):	32	40	50

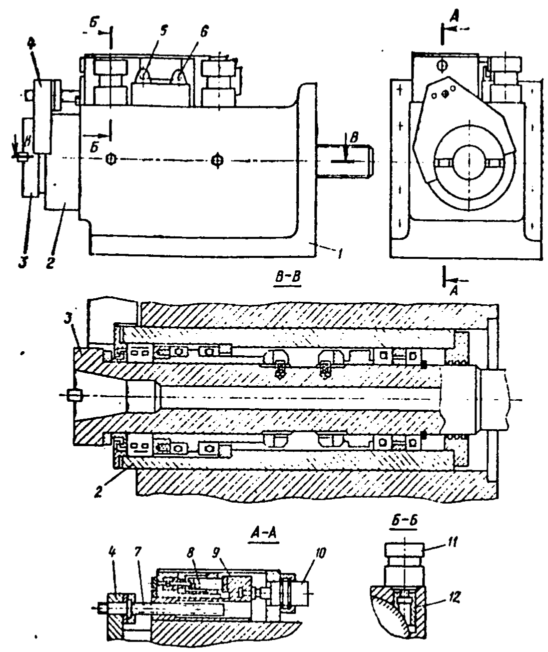
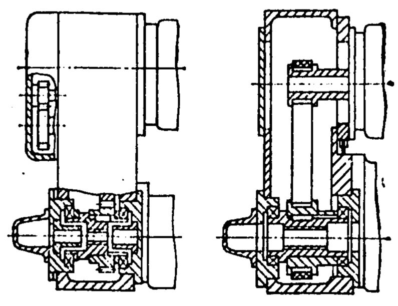


Figure 4. Milling Chuck type UYe413 with Tail Spindle Break-Away.

Milling chucks type UYe413 are mainly designed for facing work made of ferrous and nonferrous metals. The milling chucks can be set horizontally, on an incline and vertically on moving or stationary elements or machine tools; feed motion can be imparted to the work or to the milling chuck itself. The milling cutter is set to treatment size by an adjusting motion of the tail spindle.

Standardized milling chucks of type UYe413 are manufactured in two kinds: with and without tail spindle break-away. The former ones are used when the cutter does not have to be withdrawn from the work surface during the machine cycle. The basic technical data of UYe413 milling chucks are cited below.



a) б)

Figure 5. Spindle box rotary drives:
a) type UYe465 drive; b) type UYe464 drive.

Size	3	4	5	6	7
Arbor diameter in front support, mm	60	80	100	130	160
O.D. flange of arbor (GOST 836-72), mm	88;882	101.600; 128.570	128.570; 152.400	152.440; 221.440	221.440; 335.0
Largest milling diameter, mm	200	250	400	500	630
Adjustment movement of tail spindle, mm	50	50	100	100	100

Figure 4 shows the milling chuck with tail spindle break-away. The housing (1) has a base plane for attachment of the chuck to the machine tool and a shaft plane for installation of the arbor rotary drive. In the housing opening (1) is set the cylindrical tail spindle (2) with the arbor (3) mounted on bearings. Clearances in the bearings are controlled the same way as in reaming chucks (see Figure 1). A connecting link (4) is attached to the tail spindle which is connected to the adjustment mechanism. This mechanism is made in the form of an adjustment screw (7) which interacts with a slide block (9).

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Extraction (break-away) of the tail spindle is accomplished by a hydraulic cylinder (10) connected via a slide block (9), screw (7) and connecting link (4) to the tail spindle (2). When the slide block moves to the right, the tail spindle is extracted 10 millimeters. When it moves in the opposite direction, the tail spindle is brought up to the detent of the variable caliber slide block (8) designed to replace the milling ccutter without adjustment.

The clamping and release of the tail spindle are accomplished when the slide block (12) is moved by the hydraulic cylinder (11). The forward position of the tail spindle is monitored by the contactless end breaker (5); the rear position--by the end breaker (6). In milling chucks without tail spindle break-away, the hydraulic cylinders (10) and (11) are replaced by screws with manual rotary drive. The bearings, tail spindle and trail spindle movement mechanism are lubricated when the chuck is assembled with plastic lubricant TsIATIM 203.

When installed on cross tables which both feed the work and perform cross extraction of the chuck from the work, milling cutters without tail spindles can be used. These chucks differ from reaming chucks (see Figure 1) only in the design of the front end of the arbor, made in conformity with GOST 836-72. The basic technical data of milling chucks correspond to the data of reamers.

In the event that the direction of feed is parallel to the support plane of the milling chuck, the latter is set at the angle of the milling cutter and is locked in this position by conical pins. If the direction of feed is perpendicular to the support plane of the milling chuck, the necessary angle of inclination is assured by scraping the work coupled with the chuck or the housing the chuck itself.

To rotate the arbors of chucks of normal and increased precision, standardized drives of two types are used: type UYe465 with cylindrical geared transmissions (Figure 5a) and type UYe464 with gear-and-belt transmissions (Figure 5b). Drives with gear-and-belt transmissions are used primarily when a high rate of rotation is necessary, e.g., in work made of aluminum alloys. Below are cited the basic technical data of rotary drives of reaming, recessing-reaming, drilling and milling chucks (numerator for UYe465, denominator for UYe464 drives).

Size	1	2	3	4	5	6	7
Maximum motor power, kW	-/0.55	1.5/1.5	4/4	5.5/7.5	11/11	18.5/18.5	30/-
Maximum torque, kgs•m	-/0.5	25/1.5	50/4	90/9	180/16	360/31	710/-
Output shaft rpm	-	71-1180	45-900	25-900	20-850	16-710	12-450
	770-4100	630-4130	550-3110	410-2550	330-1900	290-780	-

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CSO: 1821

METALWORKING EQUIPMENT

UDC 621.9.06.112-229.31-182.5

POWER AND ROTARY INDEX TABLES WITH HYDRAULIC DRIVE

Moscow STANKI I INSTRUMENT in Russian No 5, 1979 pp 19-22

[Article by V. B. Genin and Zh. E. Tartakovskiy]

[Text] Power tables are among the basic subassemblies which determine the make-up of modular machine tools, both discrete ones and those appearing as part of automated lines (AL). Multiple spindle boxes, milling, reaming, revolving and other chucks are mounted on power tables. High productivity multiple position machine tools with rotary index tables hold a significant place among modular machine tools. On each of these maachine tools a number of sequential operations is performed, making it equivalent to a section of automated line.

The Moscow Special Design Bureau of Automated Lines and Machine Tools elaborated power tables of type UN451 and rotating index tables of type UN205 with hydraulic drive, whose production has been assimilated by the Moscow Plant of Special Machine Tools Spetstanko. These tables are used by all plants which product modular machine tools of medium and large dimensions.

The basic technical specifications of power tables of type UN451 are cited below. The basic dimensions of power table correpond to GOST 21038-75 and recommendations of ISO and CMEA, and precision norms correspond to GOST 16461-77.

Size	1	2	3	4	5	6	7
Platform width, mm	200	250	320	400	500	630	800
Greatest feed force (hydraulic pressure 50 kgs/cm^2), kgs	630	1000	1600	2500	4000	6300	10,000
Smallest feed, mm/min	50	32	20	12.5	8	5	4
Recommended rate of rapid travel, m/min	11	9	8	7.5	6.5	5.5	4.5
Longest stroke, mm:							
horizontal	400	630	630	1000	1000	1250	1250
vertical	400	630	630	630	630	1000	1000

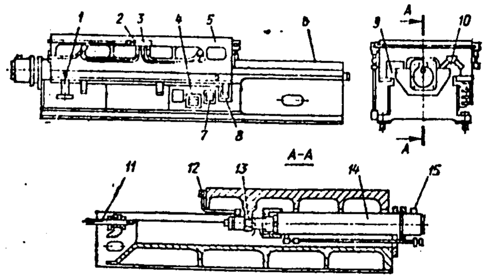

Figure 1. Type UN451 Power Table.

Note: When the special hydraulic drive is used, the rate of rapid extraction may be 50-80 percent higher.

The UN451 power table with hydraulic feed drive is shown in Figure 1. The platform (5) of the table travels along the plate (6) with rectangular (9) and prismatic (10) guides. The use of the prismatic guide, although it led to some increase in labor intensiveness of manufacture of the plate (compared to a plate having two rectangular guides), did make it possible to completely eliminate gaps in the guides and avoid the use of a control wedge.

The non-rectilinearity of table motion is no more than 16-25 microns (according to the stroke length) for table of normal precision and no more than 10-16 microns for tables of increased precision.*

The hydraulic feed drive of the power table contains a hydraulic cylinder (14) set in the plate (6), a pump with electric motor and hydraulic panel mounted on the free-standing hydraulic tank. Electromagnets which move the slide valves of the hydraulic panels switch on and off during the table travel on command from contactless end breakers (4), (7) and (8). The latter are arranged on the plate and cycle in reaction to detents (1) set on the platform (5). The number of end breakers and detents is determined by the operating cycle of the power table.

In the front part of the plate (6) is set a screw (rigid detent) (11) which enables one to control the forward position of the platform. The hydraulic cylinder (14) is attached to the plate (6) and the plunger (14) to the platform. This method of attachment ensures possible disassembly of the hydraulic cylinder without taking down the power table. Furthermore, thermal deformations of the hydraulic cylinder are not transmitted to the power table. Valves (12) and (15) are designed to release air from the hydraulic cylinder.

*This relates also to power tables with electromechanical feed drive (see article of R. G. Chaadayev and G. I. Gorelik "Power tables with electromechanical feed drive", published in this issue of the journal.

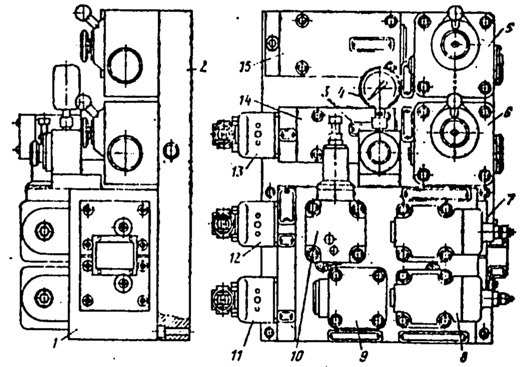

Figure 2. Hydraulic feed panel: 1) hydraulic distributor guide unit; 2) plate; 3) type 3M22-S320 distributor; 4) type 60Mt-1-100 NVS manometer; 5) type PG77-1 throttle; 6) flow regulator type 2PG55-1 (for hydraulic panels of first modification); 7 and 8) safety valves type APG52-24 of feed pumps and rapid travel pumps, respectively; 9) reverse valve type PG51-14; 10) pressure vale type PG52-24; 11, 12, 13) control distributors type 55BPG73-11; 14) feed selection valve; 15) hydraulic seal.

The power table guides are lubricated automatically from a central system. Oil is fed from the lubrication station through a flexible hose to the collector (3) attached to the table platform. The collector is connected by meters (2) to the lubrication points (amounts ranging from 0.2 to 0.6 cubic centimeters according to table size).

Oil flow control entering the hydraulic cylinder cavity of the power table is accomplished with the aid of a type UN74 hydraulic feed panel. Hydraulic panels of models UN7416 and UN7414 are designed to control power tables oeprating in a cycle with one working feed. Hydraulic panels UN7426 and UN7427 are designed to control power table operating in a cycle with two working feeds. The total consumption of oil for the first and third models is up to 50, and for the second and fourth models is up to 80 liters per minute.

Each hydraulic panel has two modifications, differing in type of flow regulator. In hydraulic panels of the first modification, a type 2PG55-1 flow regulator is used which during operating feed changes the pressure in the system according to the load on the power table. The hydraulic panels of the second modification have a type PG55-2 flow regulator which during operating feed maintains a constant pressure in the system regardless of the load on the power table. All hydraulic panels are similar in design and their parts are highly standardized.

Feed hydraulic panels (Figure 2) consist of a set of general hydraulic apparatus and special devices with clamps making possible rapid replacement of any part. Special elements of the hydraulic panels are the plate (2), hydraulic distributor guide unit (1), hydraulic seal (15) and feed selection valve (14).

Elements of the hydraulic panel are set on the plate (2), through which pass the connecting channels. On the rear of the plate are apertures to which are connected the pipes designed for connection of the hydraulic panel to the hydraulic cylinder, pump and tank. The hydraulic panel is attached on the vertical guard of the hydraulic deivce station with four screws.

A primary difference in the hydraulic circuit of the type UN74 hydraulic panels and the earlier models 5U42 is the incorporation of a hydraulic seal (variable check valve) between the hydraulic distributors of the panel and the forward cavity of the feed cylinder. The hydraulic seal isolates the hydraulic distributor and thereby eliminates the effect of internal leaks on the intensity of working feed.

Because of the presence of a hydraulic seal, and the sealing of the cylinder piston with V-shaped rubber sealing rings (instead of the earlier cast iron piston rings), fluctuations in working feed do not exceed 5 percent for maximally possible changes in load and temperature.

Research done by the Moscow Special Design Bureau of Automated Lines and Machine Tools showed that the spread from the selection point of the power table from rapid approach to working feed at rapid stroke (see technical description) does not exceed 2 millimeters. Instability of power table platform position when stopped on the rigid detent (with constant alignment of the safety valve) does not exceed 0.02 millimeters.

To assure repeated intermediate extractions of the power travel during working feed (when drilling deep holes), an additional control device is installed which contains two end breakers and a moving working feed detent. This mechanism is placed on the right side of the power table; on the left side of the stable are placed another two end breakers, one of which is switched on when the table platform is in initial position, and another at a point to which the table travels during intermediate extraction. The end breakers of the additional control device determine the selection point of the table from rapid approach to working feed and the extreme forward position of the table (end of treatment).

The basic technical specifications of rotating index tables type UN205 are cited below. Their basic dimensions correspond to GOST 22439-77 and precision norms correspond to GOST 16460-77.

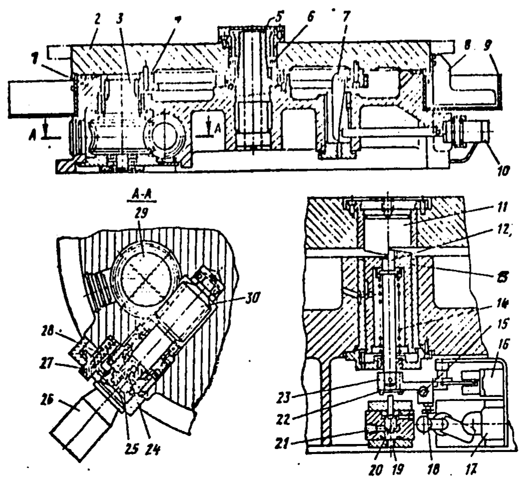

Figure 3. Rotary index table type UN205

Table model	UN2056	UN2057	UN2058
Faceplate diameter,mm	800;900	1000;1120	1250;1400
Number of positions	2-6;8-10	2-6;8-10	2-6;8-10
Rotation time to one position (seconds, not more than) for tables with number of positions:			
2-5:	5.5	6	7.5
6-12:	3.5	3.7	4
Precision of positioning (angle seconds) for tables:			
normal precision	14	12	8
increased precision	8	8	5
Tolerable torque on faceplate from cutting forces, kgs•meter:			
clockwise	600	800	1100
counterclockwise	800	1000	1300
Tolerable radial force applied 200 mm above faceplate end, kgs	4000	6300	10,000
Greatest weight of jigs and work set on table, kg	2000	3000	4000

On the housing (1)(Figure 3) of the rotating index table is set a faceplate (2) and within it are arranged the rotary drive, locking mechanisms and

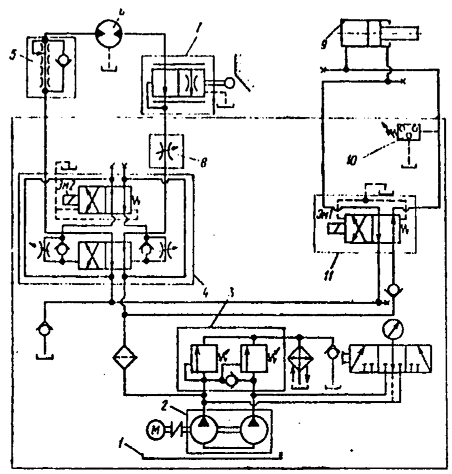

Figure 4. Theoretical hydraulic circuit of rotating index table

faceplate clamp. The faceplate (2) rotates around an axle (5) on a precision double roller bearing (6) with conical opening. The axle (5) has a central opening for pipes feeding oil to the device set on the faceplate.

The table's hydraulic drive includes a hydraulic motor (26) which rotates the faceplate, hydraulic cylinders (10) for clamping the faceplate, a traveling throttle (20), and a pump with electric motor and control hydraulics placed on a separate hydraulic station.

The rotating table operates in the following cycle: release of the faceplate and hydraulic relief, rotation of faceplate with braking at end of stroke, reversal of faceplate and securing to lock, clamping of faceplate.

The faceplate is released when the hydraulic cylinder pistons are retracted (10). The clamps (7), in reaction to the force of gravity, rotate around their axes and release the faceplate. Simultaneously, oil is fed under pressure from the central lubrication station into grooves on the annular housing guide to ensure separation of the faceplate from the guide and create an oil layer between them to reduce torque required to rotate the faceplate and to prevent guide wear.

The instruction to rotate the faceplate is given by the pressure relay mounted in the guide relief system. The faceplate is rotated by a hydraulic motor (26) via a flexible coupling (24), worm gear (30), worm wheel (29), geared wheel (3) and (4). When approaching the next position, the detent)11_ fixed to the faceplate drops a locking pin (13). The rod (12), whose cleat faces the lever (23) set inside the locking pin, clamps the slide block of the traveling throttle (20).

At first, the inclined grooves of the slide block located on its bottom smoothly reduce oil feed from the hydraulic motor. When they are completely closed, the upper groves are opened. Then the lower grooves are completely overlapped and the oil emerging from the hydraulic motor only passes through the upper grooves. The slide block is automatically dropped to the extreme bottom position. The flow rate of oil through the upper grooves of the slide block (2.5-3.5 liters/minute) assures the necessary retardation of rotation (smooth retardation) of the faceplate prior to reversal.

When the locking pin (13) is dropped, the screw (18) switches on the end breaker (17) which then prepares the instruction for reversal of the hydraulic motor (26). When the detent (11), as the faceplate continues to rotate, releases the locking pin (13), the latter is lifted in reaction to a spring (14). The end breaker (17) shuts off and relays the signal for the hydraulic motor (26) to reverse. Oil begins to enter through aperture (19), and the slide block of the traveling throttle (20) is lifted, releasing the passage of oil to the hydraulic motor through aperture (21).

At the end of the reversal cycle, the detent (11) rotates a cleat (12) overcoming the force of the spring (not shown in Figure 3). The screw (15) acts on the end breaker (16). The latter switches on a time relay whose delay is adequate to stabilize the clamping force of the working surfaces of the detent (11) and lock (13). When the time relay cycles, hydraulic relief of the faceplate is shut off and it is clamped. The clamping of the faceplate and the indexing cycle end with the cycling of the clamping pressure relay which enables the rapid approach of the power packs.

In a rotary table, it is possible for manual rotation of the faceplate during adjustment. The manual rotation drive consists of a spring-loaded shaft-wheel (27) with hexagonal aperture for the key and a wheel (25) set on the shaft of the hydraulic motor (26). When the spring is compressed (28), the shaft-wheel (27) is engaged with the wheel (25), which permits the faceplate to be rotated.

The cavity (9) is designed for collecting shavings and lubricating fluid which, using scraper (8) attached to the faceplate, are removed along an inclined pan into a separate chip drum.

Figure 4 shows the theoretical hydraulic circuit of the rotating index table. In the hydraulic tank (1) is set a dual pump (2) of type 5G12-23A with feed of 5/25 liter/minute. The pump is controlled by the distributing hydraulic panel (3) of type MPG53-14. The hydraulic motor (6) is controlled by the guide hydraulic distributor (4) of type 5U4321 with Em2 electromagnet.

When the Em2 electromagnet is switched on, oil enters through the check valve of the stabilizer (5) into the left cavity of the hydraulic motor (6) and the faceplate is rotated. The rate of rotation is adjusted by the throttle (8) set at the outlet of the hydraulic motor. At the end of rotation, before reversing, the faceplate is braked by the traveling throttle (7).

When the electromagnet Em2 is shut off, oil is directed to the right cavity of the hydraulic motor (6); this reverses the faceplate. The rate of reversal is determined by the stabilizer (5) placed at the outlet of the hydraulic motor. The stabilizer contains a several successive diaphragms, whose number may be changed according to the diameter of the faceplet and moment of inertia of jigs and work set on the faceplate.

In the locked position, the faceplate is clamped by hydraulic cylinders (9) controlled by the guide hydraulic distributor (11) with electromagnet Eml. The end of faceplate clamping cycle is monitored by the pressure relay (10).

Hydrostatic relief of the faceplate is accomplished from the lubrication station which also services the centralized lubrication system of the guide opwer tables and working surfaces of jibgs of the modular machine tool, which contains a rotating indexing table. For hydrostatic relief of the faceplate it is necessary to have much less pressure than for operation of the lubrication system; thus the lubrication system has a reducing vavle which lowers pressure to 3-6 kgs/cm^2, which is monitored by the pressure relay.

The oil flowing out of the guide ring into the inner cavity of the table housing is used to lubricate the geared and worm transmissions. Oil returns to the lubricating station by gravity flow thorugh a mesh filter with magnetic separator. The dual roller bearing of the central axle is lubricated by a plastic lubricant when the rotating table is assembled.

A basic advantage of rotating index tables of this design, as compared with earlier type 5U28, is the increased precision of indexing assured by design measures and by stabilization of the force of clamping of the detents to the lock because of the constant rate of reversal. Rotating index tables make it possible to put together modular machine tools with vertical power tables on which the spindle box is mounted. In some cases it is advantageous to put together modular machine tools with several power packs arranged radially. Each pack treats work arranged at one work position. In this case, especially when treating large work pieces, it becomes necessary to use rotating index tables with a faceplate of more than 1400 millimeters in diameter.

The Moscow Special Design Bureau of Automated Lines and Machine Tools elaborated a design for rotating type of table UN206 with a faceplate of 1600 millimeter (model UN2064) and 2000 millimeter (model UN2065) diameter faceplate, whose production is being assimilated by the Moscow Plant of Special Machine Tools Spetstanok.

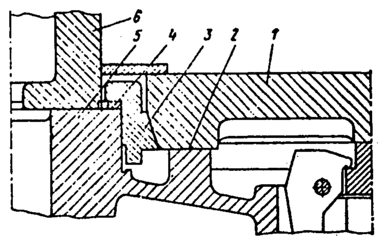

Figure 5. Type UN206 Rotating Index Table

Type UN206 tables have the same kinematic circuit as type UN205 tables. Almost all parts of the rotary drive, locking mechanisms and faceplate clamp are identical in both tables. The difference is that tables of type UN206 have a second annular guide (2) (Figure 5) and large conical slip bearing (3) diameter (in UN205 tables, a standard roller bearing is used). The clearance between the bearing (3) and the faceplate (1) is selected by polishing expansion pieces (4).

During hydrostatic relief, the faceplate is raised above the guides and a gap is created between the faceplate and the bearing (3); this reduces the force necessary to rotate the faceplate. The large bearing permits the central column (6) to be set on the housing (5). It is possible to put together machine tools in which are used vertical power packs placed at the edges of a central column, in addition to radial arrangements of power packs.

Conclusions

1. Type UN451 power tables have the following merits: increased operating reliability due to the use of contactless end breakers; increased reparability of tables due to possible disassembly of hydraulic cylinders without taking down the power table and hydraulic feeder drive because of modular arrangement of hydraulic control panel to ensure easy change of any component requiring repair; lack of thermal deformations in heating oil in the hydraulic system because the hydraulic feed cylinder is attached to the rear face of the guide plate; increased height of power tables in conformity with ISO recommendations, i.e., increased rigidity; increased precision of tables (rectilinearity of motion) with simultaneous elimination of the need for periodic regulation of clearances in the guides using wedges; 5-6 fold increase in feed stability.

2. Type UN205 rotating index tables have high precision of indexing; wear of surfaces affecting indexing precision is almost non-existent.

3. Type UN206 rotating index tables expand technological resources of modular machine tools; they permit assembly of machine tools with radial and vertical power pack arrangements in various combinations.

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UDC 621.9.06-112.229.31

POWER TABLES WITH ELECTROMECHANICAL FEEDER DRIVE

Moscow STANKI I INSTRUMENT in Russian No 5, 1979 pp 22-25

[Article by R. G. Chaadayev and G. I. Gorelik]

[Text] Power tables with electrochemical feeder drive have been elaborated by the Minsk Special Design Bureau of Automated Lines. Their production has been assimilated by the Spetstanok Moscow Plant of Special Machine Tools and the Glukhov Plant of Modular Units. The adopted series contains six type sizes of power tables.

In modular machine tools and automated lines it is possible to simultaneously use power tables with hydraulic and electromechanical feed drive; they have therefore been made interchangeable in conformity with GOST 21038-75. In the design of power tables with electromechanical driver, it is possible to use spherical helical rollers.

Power tables are standardized units designed for moving a cutter or work at a working rate of feed and rapid stroke. Motors and clamping jigs holding work can be set on the tables.

Figure 1 shows an overall arrangement of power tables with electromechanical feed driver; the dimensions are shown in the table. The power table (1) (see Figure 1) together with the electromechanical feeder (3) and control detents (2) is an automatic unit.

The basic characteristics of power tables types UYe4532-UYe4537 with feeders UY4722-UYe4727 and control detents models UYe9531 or UYe9532 are shown below.

The parameters of the power table, which is a basic standardized unit in modular machine tools, must ensure performance of various technological operations with peak productivity. For this purpose, it is possible to produce stable values of working feeds within wide limits, various cycles of table platform movement, adequate rate of rapid stroke, high geometric precision of motion and reliability.

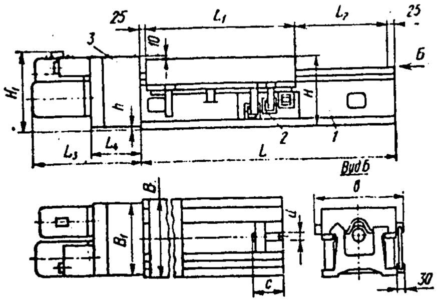

Figure 1. Basic dimensions of power tables with electromechanical feeder drive

Тип стола	Модель	Присоединительные размеры, мм												
		B	B_1	H	H_1	L	L_1	L_2	L_3	L_4	h	c	d	n
УЕ4532	02, 12, 22, 32 03, 13, 23, 33	250	260	250	297	800 950	500	250 400	457	220	315	130	M24×1,5	1
УЕ4533	02, 12, 22, 32 03, 13, 23, 33 04, 14, 24, 34	320	300	280	290	930 1080 1310	630	250 400 630	457	220	380	130	M30×1,5	2
УЕ4534	02, 12, 22, 32 03, 13, 23, 33 04, 14; 24, 34	400	400	320	330	1100 1250 1480	800	250 400 630	576	270	460	165	M33×1,5	2
УЕ4535	02, 12, 22, 32 03, 13, 23, 33 04, 14, 24, 34 05, 15, 25, 35	500	450	360	370	1300 1450 1680 2050	1000	250 400 630 1000	576	270	560	160	M36×1,5	2
УЕ4536	02, 12, 22, 32 03, 13, 23, 33 04, 14, 24, 34 05, 15, 25, 35	630	540	400	410	1700 1930 2300 2550	1250	400 630 1000 1250	630	290	690	200	M39×1,5	2
УЕ4537	02, 12, 22, 32 03, 13, 23, 33 04, 14, 24, 34 05, 15, 25, 35	800	560	450	460	1850 2080 2450 2700	1400	400 630 1000 1850	635	295	860	200	M48×1,5	2

Both power tables of the range and their feeder drives have been constructed according to a single design scheme.

The lead screw (1)(Figure 2) is set in the housing (4) on four radial ball bearings. Axial loads on the screw are absorbed by thrust bearings which are retracted by a nut (10). A geared wheel (2) is placed in cantilevered fashion on the lead screw and the former engages the output wheel of the feeder drive.

Table type	UYe4532	UYe4533	UYe4534	UYe4535	UYe 4536	UYe4537
Guide width, mm	250	320	400	500	630	800
Maximum feed force, kgs	1000	1600	2500	4000	6300	10,000
Maximum output of feeder drive electric motor, kW	1.5	3	5.5	11	18.5	30
Working feed, mm/min	22.2-850	20.9-1020	9.1-810	8.4-700	7.5-845	7.3-815
Working feeds per cycle	1	1	1;2	1;2	1;2	1;2
Rate of rapid stroke, m/min	7	7	6	6	5	5
Feeder motor:						
type:	4AA5684U3		DPT22-4-C2		4AKh80A4U3	
output, kW:	0.18		0.55		1.1	
rpms:	1370		1400		1400	
Fast stroke motor:						
type:	DPT22-2-C2		4AKh80V4U3		4A100S4U3	
output, kW:	0.75		1.5		3	
rpms:	2850		1400		1425	
Table travel, mm:	250;400	250;400; 630	250;400; 630	250;400; 630;1000	400;630; 1000;1250	400;630; 1000; 1250
Length of table with feed drive and control detents, mm	1260;1410	1390;1540; 1770	1680;1830; 2060	1880;2020; 1160;1630;	2330;2560; 1930;3180;	2485;2715; 3085;3335
Weight, kg	245;262	388;423; 468	630;665; 725	910;945; 1010;1105	1412;1530; 1613;1778	2002;2113; 2880;2408

Note. To ensure two working feeds, the electric motor for working feed is replaced by a two-speed one of the same size.

The lead nut (6) is rigidly attached to the rear recess of the platform (7) of the table by pins (5) and screws. When the lead screw rotates, the platform travels along the guide plate (9). On the housing (4) is mounted a ring (3) which serves as a centering flange for the feed drive. With long table travel and consequently, long travel of the lead screw, bronze bushings (8) are placed in the intermediate ribs of the platform; these limit overhang of the cantilevered end of the screw. On the lead rig of the platform there is a steel abutment which, in the event of the need for precision stopping of the platform in forward motion, rests on the rigid detent screw. The lead screw is advanced coaxially with the lead nut by means of expansion pieces (11). After testing coaxial alignment, the housing (4) is attached to the guide plate (9) with two cylindrical pins (12).

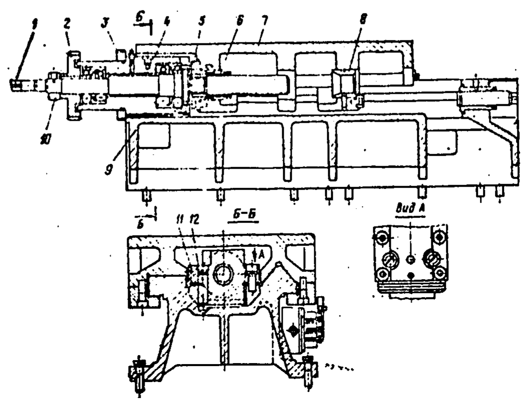

Figure 2. Power table with electromechanical feed drive.

The base parts of the table with electromechanical feed drive have one plane and one prismatic guide, identical in size, shape and position with the guides of base parts of power tables with hydraulic feed drive.

The feed drive of the power table is attached to the rear end of the guide plate, while centering it in ring (3). It is a reducer with cylindrical gears with two electric motors, one of which moves the table platform at working feed, while the other is for rapid stroke.

The electric motor (5) (Figure 2) of working feed transmits movement via six pairs of gears (situated in shafts VIII-IV) to a spline bushing seated on point bearings on shaft III. On it is installated an electromagnetic coupling whose outer discs are engaged with a strap (1) rigidly fastened to the shaft III. When the electromagnetic coupling is switched on, the bushing rotates the shaft III and then through the gear pair rotates shaft II with the output drive gear. The guide screw (shaft I), being rotated by the motor, moves the platform at working feed velocity, adjusted to the external size by replaceable gears (6) positioned under the cover. To replace them, it is not necessary to take down the drive. The range of control of working feeds adjusted by these gears equals 8.

In the feed drive, the gears (3) and (4) installed during assembly are replaceable. They determine the modification of the drive in terms of feed velocity. Each drive has three modifications of feed velocity: 01--low feed; 02--average feed; 03--high feed. Practice of planning and debugging modular machine tools has shown that in most cases the adjustment of necessary working feed velocity by replaceable gears totally justifies itself.

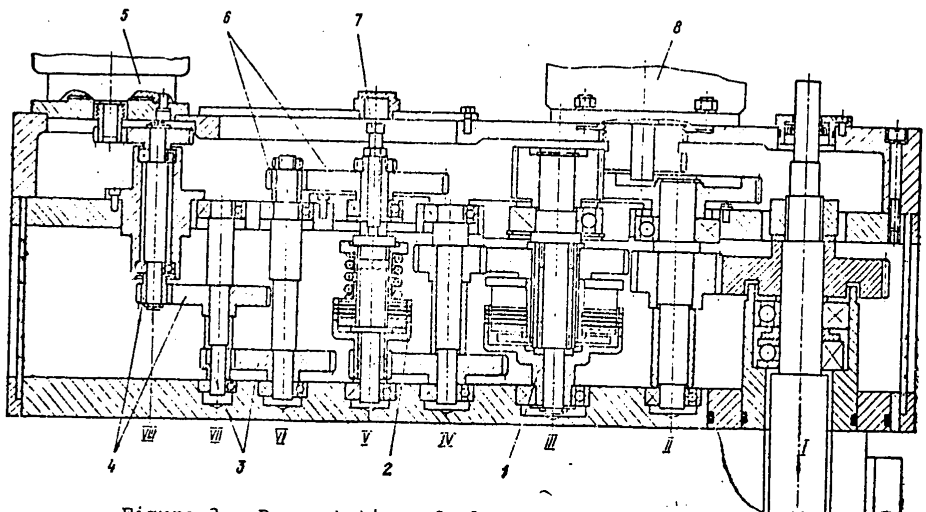

Figure 3. Presentation of electromechanical drive for power table feed.

On shaft V of the feed drive is placed a friction safety clutch (2) to adjust the amount of feeding force on the guide screw, permitting the power table to operate at the rigid detent. The momentum imparted by the clutch is regulated, if necessary, by screw (7) placed under the replaceable gear cover.

From the rapid stroke electric motor (8), motion is transmitted to the table platform via a gear pair, shaft II, output drive gear and guide screw. The direction of platform motion is changed by reversing the electric motor (8) when the electromagnetic coupling is disconnected. The latter is switched on after switching off the electric motor (8) so that the kinematic circuit of working feed damps the inertia of the flywheel masses of the electric motor rotor and the rapid stroke circuit.

In the operating cycle of tables of types UYe4534-UYe4537, it is possible to accomplish two feeds. In this case, instead of a one-speed electric motor of working feeds, a two-speed motor is used; the second feed is 1/2 the first. When the feed rate must be double or it is necessary to have several working reeds in a cycle, a d.c. electric motor or hydraulic motor (in the latter case a special reducing gear is required) is placed in the drive instead of an asynchronous working feed electric motor.

Control detents (2) (see Figure 1) have a standard design for all tables in the series. By controlling the table stroke, they assure the required operating cycle of the latter. Spacing cams of the detents with aluminum blades enter into slits of the contactless end breakers type BVK, fixed solidly, when the table is in motion. Commands go from the BVK to the machine tool's electric cabinet, and thence to the motors and clutch of the feed drive.

The following operating cycles of tables are most commonly used: a cycle with one working feed (rapid approach--working feed-rapid extraction); a cyclie with two working feeds (rapid approach--first working feed--second working feed--rapid extraction). In the first case, three BVKs are used, in the second case--four. In both cases work can be done with a delay at the rigid detent and the backstroke of the table to the extreme rear position (position of cutter replacement). In more complex cycles of table operation (with intermediate extractions in deep drilling, with travel, etc.) it is necessary to install additional traveling selectors or special control detents.

The electrical equipment is completely assembled on the power table. Leads run from the control detents, electric motors, electromagnetic coupling down into a box with plug connector attached to the feed drive. When assembling or disassembling the table on the machine tool, it is only necessary to disconnect or pull out the plug connector without disturbing electrical connections.

The table guides and the screw-nut pair are force lubricated from the lubrication station. With a pressure pulse every 15-30 minutes (according to the length of the table's work cycle), dosers feeds a specific amount of oil into the lubrication points. The feed drive is lubricated by spraying. The bearing unit of the guide screw is filled with plastic lubricant.

Power table types UYe4532-UYe4537 with feed drive models UYe4722-UYe4727 are planned on the basis of operating experience of series UM power tables. Prototypes of power tables with electromechanical drives of the unified range of standard subassemblies were manufactured and tested at the Minsk Plant of Automated Lines. In the tests they checked out the basic precision parameters of the tables: selection from rapid stroke to working feed, ending working feed with cycling of the traveling selector, stop at the rigid detent. These data confirmed that the power tables of types UYe4532-UYe4537 completely satisfy the modern requirements of modular machine tool construction.

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METALWORKING EQUIPMENT

UDC 621.9.06-112-229.2:62-233.1

MULTI-SPINDLE BOXES OF UNIFIED SERIES UNYE-3100

Moscow STANKI I INSTRUMENT in Russian No 5, 1979 pp 25-27

[Article by V. M. Lobusev, Ye. S. Tukayev and A. Ya. Frenkel']

[Text] In modular machine tools and automated lines, multi-arbor boxes are widely used to perform operations of drilling, countersinking, scrolling, reaming, rolling, routing and thread cutting.

Each modular machine tool is planned to treat a specific piece of work; thus the number of arbors, their rate of rotation and intercenter distances beteen them, as well as the diameters and types of cutters, is virtually unlimited. This is a substantial hindrance to the creation of a completely unified spindle box.

The problem is resolved by using unified elements and subassemblies, from which it is possible to put together spindle boxes for treatment of various pieces of work. The basic unified elements of multi-arbor boxs are related to housing parts, arbors, intermediate shafts, gears, drives, electric brakes, thread cutting tail spindles and lubrication devices.

Based on analysis of the design of spindle boxes of domestic production and operating experience, as well as a study of the experience of several foreign companies by the Minsk Special Design Bureau of Automated Lines, unified elements of spindle boxes series UNYe3100 was developed.

Spindle boxes of a unified series (Figure 1) have significant advantages over earlier units of similar purpose. The precision of output parameters of the arbors in assembly (radial play and mutual parallelism) is 35 percent high on the average. This was achieved by making tolerances stricter on the manfuacture of arbors, housings and detent flanges; by the use of radial ball bearings of the fifth class of precision set into clear openings of the housing (which permits fine reaming from one side without rebasing the housing); and by elimination of the thread as a tie component of the ball bearings.

The use of double bll bearings assures greater durability of support of the arbor and doubles its rigidity. Because of a change in design of the housing, the rear plate and the front cover, the rigidity of the spindle box was increased by a factor of 1.4-1.6 with an increase in weight of 20 percent.

Mechanical treatment of all external surfaces of housing parts permits thread cutting tail spindles, conductor plates, lunettes and other auxiliary components to be installed without using special casting and improves the outward appearance of the item. The spindle box is symmetric on two axes and can be rotated 90°; this makes it possible to select its optimum size and improve the overall arrangement of the machine tool.

The use of variable arbor projections makes it possible to reduce to one tenth the number of variable bushings (mandrels), whose durability is 1/3 to 1/5 of that of the arbor. The fitting diameters for the cutter meet international standards.

Electric couplings in the drives eliminate the effect of assembly accuracy of the electric motor on the precision parameters of the spindle box; because of the absence of radial and axial loads on the electric motor shaft, the service life of the latter is increased.

Unification of components of spindle boxes makes it possible to have cooperation between the manufacturing plants, increase technical and economic effectivness of the manufacture of parts in large lots, facilitates the operation and repair at user plants; this is very important for such high productivity equipment as modular machine tools and automated lines.

The system of component unification of the spindle box permits a reudction in planning labor intensivess with a signficant improvement of quality because of the use of computers; they perform geometric and power calculations of the design, sketch the overall appearance, print out the accompanying technical specifications and produce punched tape for machine tools with ChPU which treat housing parts of the spindle boxes.

Technical Specifications

Number of arbors	1-80
Maximum arbor projection	80-260
Diameter of fitting openings in arbors for variable bushings (mandrels), mm	14;16;20; 25; 26; 28; 36; 44; 48; 60; 80
Arbor rpm	10-3000
Size of box (wihout arbor), mm:	
thickness L	375-395
breadth B	400-1600
height	360-1250
Maximum box weight, kg	2800
Motor output, kW	1.1-30

There are two modifications of the boxes--horizontal and vertical, which have different lubrication systems. The series UNYe-3100 contains 23 type sizes of spindle boxes with dimensions from 360 x 400 up to 1250 x 1250 millimeters (GOST 22586-77) and thickness of 375 millimeters. If it is necessary to attach conductor plates, lunettes, etc. to the front end of the spindle box, instead of the front cover 90 millimeters thick is placed a more rigid rear plate 110 millimeters thick. In this case, the thickness of the spindle box is 395 millimeters.

The size of the spindle box is mainly determined by the position of arbors and the minimum distance from the arbor to the side wall of the housing, necesary to install the gears and arbor supports.

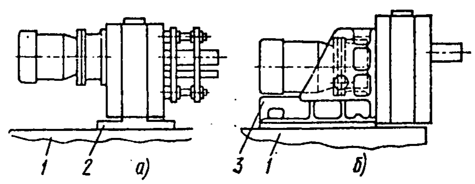

Figure 2. Installation of spindle box on power table: a) using gasket plate; b) using detent bracket.

Spindle boxes of series UNYe-3100 are mounted (Figure 2) on standardized power table s(1) and attached with either a detent bracket (3) or directly to the table using a gasket plate (2).

The size of the detent bracket (GOST 22585-77) corresponds to the size of the power table. But if needed, a smaller detent bracket can be installed on the power table. Below are cited the data of applicability of spindle boxes as a function of the type sizes of the power table and detent brackets.

Type size of power table (detent bracket)	2	3	4	5	6	7
Size of spindle box (HXB), mm:						
minimum	360x400	360x400	450x500	500x630	630x800	800x1000
maximum	400x500	500x800	630x1000	800x1250	1000x 1600	1250x 1250
Number of type sizes of spindle boxes mounted on power table	2	6	9	12	12	9

The maximum number of type sizes of spindle boxes can be installed on tables of type sizes 5 and 6 used most commonly.

The applicability is determined on the basis of requirements of maximum rigity of the spindle box/detent bracket system in order to eliminate overturning momentum (which occurs in reaction to the weight of the spindle box) and total bending moment (which occurs in reaction to axial cutting loads), which have a negative effect on table operation.

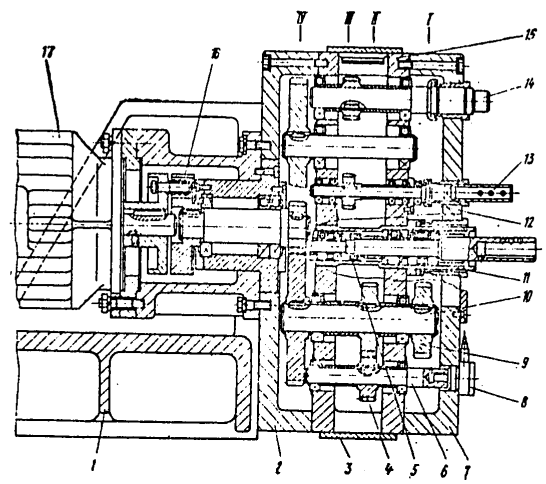

Figure 3. Drilling spindle box.

Figure 3 depicts a standard drilling spindle box of series UNYe-3100. The set of cast parts of the spindle box of each type size includes a rear plate (2), by means of which the box is attached to the connecting flange of the detent bracket (1); a housing (15) which carries supports of the arbors and intermediate shafts; a front cover (7) which serves as a reservoir for lubricating vertical spindle boxes and a cover (3) which seals the assembly windows of the housing.

In the box housing are mounted the arbors (13), intermediate shafts (10), drive shaft (6) of the pump and a shaft (14) for manual rotation of the arbors. With large projections or diameters, the arbors are mounted in bushings (11).

The blade pump (8) lubricator is mounted on the front cover (with piping outside the housing) or in the housing under the front cover (with piping inside the housing). In the latter case, in the front covers of large boxes a window is cut (covered by a special cover) which makes it possible to change the lubricant pump without taking apart the heavy front cover.

The arbors and intermediate shafts are locked in the axial direction by stoppers and expansion rings. The arbors are mounted on radial ball

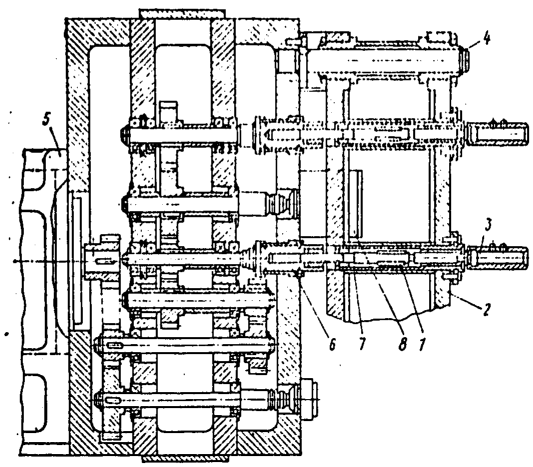

Figure 4. Thread cutting spindle box.

bearings (5). The thrust bearing (12) absorbs axial loads. The intermediate shafts are mounted on radial ball bearings.

Rotation is transmitted from the electric motor (17) to the arbor through an elastic coupling (16). The required rate of rotation of arbors is assured by a system of gears (4) mounted in four rows (I, II, III and IV). The gears (9) (row I) placed under the front cover can serve as replaceable gears if it is necessary to change the rate of arbor rotation.

Each spindle box has a sealed circulation lubricating system consisting of a pump, inlet and pressurized pipelines, oil distributor, discharge tube and chute. The reservoir is the housing of the spindle box.
Oil is gravity fed from the chut into the gears of rows II and III.

In contrast to spindle boxes, the vertical model has a chuteless lubrication system and all the oil flow from the oil distributor is directed to row IV of the gears, whence by gravity it flows to the other gears and bearings.

In the lubrication system of thread utting spindle boxes, a reversable type pump and oil distributor with exterior oil tap to the electromagnetic brake coupling is mounted; the oil is gravity fed back to the spindle box. The cover of the oil distributor is made of a transparent organic class which makes it possible to use the oil distributor as an indicator of operation of the lubrication system. The folloiwng oils are used for lubrication: I-30A, I-40A, I-50A (GOST 20799-75).

Standardized spindles have two diameters series of fitting holes for the variable bushings (mandrels) in conformity with GOST 13876-76 and a variable projection.

An element which determines the minimally permissible intercenter distance between the arbors (see table) is the radial ball bearing. The thickness of the baffle in the housing wall between the two bearings must be at least three millimeters. When planning a spindle box it is necessary to consider the number of openings and their juxtaposition as well as the minimally permissible thickness of walls so that total axial force on the housing is not critical.

When working under conditions of abundant cooling of the cutter, the spindle boxes require protection against the entry of cutting fluids. Protection is provided by contact or contactless labyrinth gaskets, screening or cut-off by compressed air.

In spindle boxes of series UNYe-3100, gear wheels of the sixth (at circular velocities over 6 meters per second) and seventh degree of precision with polished teeth are used. The width of the gear hub is constant and equals 40 millimeters, the width of the gear rim depends on the modulus. Thus a gear with modulo 2 and 2.5 millimeters has a rim width of 25 millimeters; with modulo 3, 4 and 5 millimeters--a rim width of 32 millimeters. The minimum number of teeth is 17, the maximum 80.

In the design of the spindle box it is possible to build in several auxiliary mechanisms: to monitor torque on the arbor (to protect the cutter against breakage), to adjust and lock the arbor in a desired position, to increase or reduce feed of individual (as a rule one or two) arbors with respect to feed of the entire spindle box.

Individual unified elements of the spindle boxes of series UNYe-3100 can be used successfully in planning drives of reaming chucks of original design.

Thread cutting spindle boxes are a modification of drilling spindle boxes. The constant working feed per rotation of the screw tap is achieved by using individual copying nuts for each thread cutter.
The thread cutting spindle boxes can be stationary; such horizontal boxes are mounted, as a rule, on side platform beds, while vertical models are mounted on bases.

The thread cutting box (Figure 4), in contrast to the drilling one, has an attachment (2) with thread cutting tail spindles (7) mounted on the front cover of the box on rods (4); a mechanism (8) which controls the thread cutting cycle and is mounted on the front cover, rear plate or side wall of the housing; and an electric brake (5) with electromagnetic coupling.

After being rotated by the shaft (6), the arbor (3) travels along the copying nut (1) which has the spacing of the thread to be cut. A spring (not shown in Figure 4) compensates for misalignment of spacing (within manufacturer's tolerances) of the copying nut and screw tap.

Spindle boxes of the unified series UNYe-3100 manufactured by the Stankoagregat Plant (Moscow) and delivered by cooperation of several machine tool construction plants, have been awarded the State Seal of Quality.

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APPROVED FOR RELEASE: 2007/02/08: CIA-RDP82-00850R000200060016-6

METALWORKING EQUIPMENT

HISTORY OF FIVE-YEAR PLANS FOR MACHINE TOOL AND TOOL BUILDING

Moscow STANKI I INSTRUMENT in Russian No 6, Jun 79 pp 1-3

[Article: "The Victorious Path of Our Five-Year Plans"]

[Text] At the end of April 1979, the 50th Anniversary of the approval of the First Five-Year Plan for Development of the National Economy of the USSR by the 16th Conference of the All-Union Communist Party of Bolsheviks, and in May, approval of the Fifth All-Union Congress of the Soviets.

In the resolution of the Central Committee of the CPSU "On the 50th Anniversary of the First Five-Year Plan for Development of the National Economy of the USSR" the magnitude and significance of the socialist five-year plans with which the enormous achievements of our country have been continuously connected in all branches of economic and cultural development, are clearly revealed and analyzed.

Fifty years ago, the heroic struggle of the Soviet peoples for implementation of the First Five-Year Plan, which played a prominent role in the realization of Lenin's Program for the building of socialism in the Soviet Union, developed in the direction of the Communist Party.

The realization of the First Five-Year Plan insured the creation of a strong material base for the building of the socialist society. The successful execution of the First Five-Year Plan dashed the hopes of the imperialist reaction to see the Soviet Union fail economically.

The outstanding historical significance of the First Five-Year Plan also consists in the fact that it was the beginning of the application of five-year assignments in the basic form of economic planning, and it converted them to the large organizing and nobilizing force of the building of communism, in the matter of proving the superiority of socialist methods of economic management over capitalist methods.

Successively carrying out the five-year plans for the development of the national economy, the Soviet people, under the leadership of the Communist Party, insured unheard-of rates of economic and social conversion and the growth of power of our country.

In the three incomplete prewar five-year plans our people completed the feat of industrialization of the country and collectivization of agriculture, it insured its defensive capacity, providing a strong, material-technical base for our victory in World War II. The epogee of the postwar restoration and development of the national economy augmented this feat.

The scales of the construction increased especially in the phase of making the transition to the developed socialism and under the conditions of developed socialism. A powerful economic and scientific-technical potential for mature socialism was created in the country. The volume of industrial production in the Soviet Union presently exceeds the 1928 level by 128 times.

The core of the economic policy of the CPSU is insurance of a stable, balanced development of heavy industry -- the foundation of the economy. In 1978 the production of means of production in industry (group A) had increased by 272 times by comparison with 1928.

Thanks to the planned use of the advantages of the socialist economic system in the USSR, historically unheard-of rates of development of industrial production were achieved. In the last 10 years the volume of industrial production in the USSR was doubled. At the same time Great Britain required 29 years to double its production, the Federal Republic of Germany, 18 years, France 17 years, and the United States 16 years.

On the eve of the first five-year planning period, the country had 24 million scattered peasant businesses equipped with a primitive inventory. At the present time the agriculture of the USSR is a large, mechanized production facility in which the processes of specialization and concentration based on intereconomic cooperation and agroindustrial integration are taking place actively.

The first five-year planning period opened up the broadest space for realization of the cultural revolution. Today complete middle education of the youth is realized. Every fourth scientific worker and every third doctor on our planet are citizens of the Soviet Union. A Soviet man was the first in the world to penetrate outer space.

The Soviet five-year planning periods are also plans for the social progress of our country. They serve in the achievement of the highest goal of the socialist social production -- the most complete satisfaction of the material and spiritual needs of the people. Using the advantages of the centralized planning, the socialist society eliminated unemployment in the First Five-Year Plan while tens of millions of workers in capitalist countries are continuing to suffer from unemployment.

From five-year period to five-year period, the actual income of the population, the payments and advantages from the social funds, the retail commodity turnover of the state and cooperative trade are growing; national education and public health are developing continuously, the living and working conditions of the Soviet people are improving. One of the most important social problems -- the housing problem -- is being solved successfully. In the country about 110 million square meters of living space are put into operation every year; 11 million citizens have been moved to new apartments or they are improving their own housing conditions. The apartment charge has remained unchanged for a half century.

An important and ever-increasing role in the standard of living of the Soviet people is being played by the social consumer funds. The payments from these funds amounted to 105.5 billion rubles in 1978 as opposed to 90.1 billion rubles in 1975. At the present time the Soviet Union occupies first place in the world with respect to support of the population with medical personnel. Last year 51 million people took rests at the sanatorium and health resort facilities, rest houses and tourist bases.

The Communist Party, developing and realizing the Leninist plan of industrialization and development of heavy industry, solidly and consistently has followed a course to the creation of a powerful base for Soviet multibranch machine building. The 14th Congress of the All-Union Communist Party of Bolsheviks adopted exceptionally important resolutions in December 1925 defining the general development of Soviet machine building industry. In accordance with the goals stated at the Congress, the USSR was to be converted from the country which imported machines and equipment to a country that produces them in an amount which would permit us not to depend on the capitalist world economy.

During the years of the First Five-Year Plan, the mean annual growth rates of gross production with respect to industry as a whole were 19.2%; with respect to machine building and metal working the rates were 41.3%. Branches of machine building which have not existed before arose in the country. These included tractor building, automobile construction, machine tool building, agricultural, chemical, mining and metallurgical machine building, and the aviation industry.

The process of the growth of the capacities of Soviet machine building continued at accelerated rates also in the Second Five-Year planning period. The gross production of the branch increased by 2.8 times during these years.

The first years of work by the Third Five-Year Plan noticeably advanced machine building. Its production increased by almost 1.8 times in 1940 as opposed to 1937. The Soviet machine building advanced to first place in Europe and to second in the world. The far-sightedness of the policy of the Communist Party played an exceptional role in the preparation of our industry for the conditions of war time. The high level of development of machine building during the years of the first five-year planning periods made it possible quickly to assimilate and persistently build up the production of materiel and ammunition.

In accordance with the requirements of the national economy, even in the subsequent five-year periods machine building developed and is developing at leading rates. The fixed industrial-production capital of machine building and metal working at the beginning of the Tenth Five-Year Plan amounted to more than 25% of the value of the capital of the entire country. In solving the problems stated by the 25th Congress of the CPSU with respect to the growth of the productivity of labor in the national economy, improvement of the efficiency of social production and acceleration of scientific and technical progress, the role of machine building will persistently increase.

The development of the machine tool building and tool industry is organically connected with the development of Soviet machine building in accordance with the five-year plans. From the First Five-Year Plan to the present time the scientific and technical progress in machine tool building has been determined by the development of machine building production, improvement of the metal working processes, raising of the technical level of machine building production.

The collectives of the enterprises and organizations of the machine tool building and tool industry, widely celebrating the 50th Anniversary of the First Five-Year Plan for Development of the National Economy of the USSR, are simultaneously celebrating the 50th Anniversary of the creation of Soviet machine tool building as an independent branch. In June 1929 the Council of Labor and Defense of the USSR decided to organize the State Trust for Medium Machine Tool Building, which established the beginning of the formation and development of the specialized production of metal cutting machine tools.

The Communist Party and the Soviet Government have given a great deal of attention to the development of machine tool building, the design and construction of machine tool building and plants, and the training of specialists. For the training of the designers, technologists and researchers, the Moscow Machine Tool and Tool Institute was created, the machine tool building departments were organized under the MVTU imeni N. E. Bauman and the Leningrad Polytechnical Institute imeni M. I. Kalinin.

In 1933, the Experimental Scientific Research Institute of Metal Cutting Machines (ENIMS) was built. The ENIMS has priority in the creation of theoretically new processes and equipment; all phases of technical progress of Soviet machine tool building are connected with its activity.

During the years of the First Five-Year Plan, the Moscow Machine Tool Building Plant imeni Sergo Ordzhonikidze, the Gor'kiy Milling Machine Plant, the Moscow Kalibr Tool Plant, Moscow Frezer Cutting Tool Plant imeni M. I. Kalinin were introduced into operation.

During the years of the Second and Third Five-Year Plans, machine tool building proceeded with the assimilation and production of special and specialized machine tools required by the developing branches of machine building. During this period, the Khar'kov Machine Tool Building Plant imeni S. V. Kosior, the Kiev Automatic Machine Tool Plant imeni M. Gor'kiy, the Saratov Plant for Heavy Gear Cutting Machines, and so on went into operation. In 1939 the Kramatorsk Heavy Machine Tool Building Plant imeni V. Ya. Chubar' was put into operation.

In the prewar period of development of Soviet machine tool building, the types and sizes of all forms of universal machine tools were expanded, and the production of special machine tools was assimilated. The production of large machine tools and the first unit machines was started. The unit machines served as the basis for the subsequent creation of automatic machine tool lines.

Beginning with the first year of World War II, machine tool building was converted to the filling of the orders of the military industry and the production of machine tools for the defense branches. During the war years large machine tool building enterprises were organized on the basis of the plants evacuated to the eastern regions of the country, and the new plants were also built.

In the Fifth Five-Year Plan, the production of large, heavy and unique machine tools developed. The production of vertical lathes for machining products with diameters to 16,000 mm, gear-milling machines with machining diameter to 5,000 mm, screw-cutting lathes with machining diameter to 4000 mm and spacing between centers to 30,000 mm, and so on was mastered. This period was also characterized by the development of the production of automatic lines.

The creation of complex automated production of automobile pistons was a great technical achievement. Another important step in the technical development was the work with respect to creating the complex automated shop at the GPZ-1 for the production of ballbearings and roller bearings with a total number of 1.5 million per year. All the machining operations, the monitoring, assembly, anticorrosion treatment and packing operations were automated.

During the postwar years the large machine tool building centers were created in the RSFSR, the Ukrainian SSR, the Belorussian SSR, the Georgian SSR, the Lithuanian SSR, the Armenian SSR. At the present time the Soviet machine tool and tool industry includes specialized enterprises for the production of metal cutting machines, automatic and semiautomatic lines for machine building, forging and pressing and casting equipment and also equipment for the woodworking industry. The branch also includes plants for the production of metal working tools, abrasive and diamond tools.

In 3 years of the Tenth Five-Year Plan, 707,000 metal cutting machines and 161,700 forging and pressing machines were built. In the overall production of metal working equipment, the proportion of forging and pressing machines is increasing. This corresponds to the trend in the development of machine building technology. Thus, in 1978 the proportion was 19% as opposed to 15.6% in 1965.

The most characteristic feature of scientific and technical progress in the field of creating new types of machines, machine tools and equipment (along with increasing their productivity, precision and reliability) is a higher level of automation of control of the basic mechanisms, the production processes and quality of manufacture. The types and sizes of automated equipment are growing from year to year. In this respect, a broad transition to the creation and the production of metal working equipment with digital programmed control is characteristic. Thus, in 1978, 7300 machine tools with digital programmed control were manufactured as opposed to 1588 in 1970.

During the 1970-1978 period, the national economy also included more than 40,000 machine tools with digital programmed control, among which the proportion of multiple-tool machine tools with devices for automatic tool changing is increasing. The rates of production of machine tools with digital programmed control will also increase in subsequent years. Machine tools with small electronic digital programmed control systems are finding broad application. Operations are continuing with respect to the creation of complexes of high-output metal-working equipment controlled from computers.

Beginning with the problems stated for machine building by the 25th Congress of the CPSU in the area of increasing the productivity of labor and increasing the production efficiency, the collectives of the enterprises and organizations of our branch must work still more purposefully on creating a broad nomenclature of the most improved, automated equipment. By the end of the current five-year period, it will be necessary to increase the production of automatic and semiautomatic lines by 1.7 times, special and unit machines by approximately 1.5 times, forging and pressing automatic machines and presses with feed and receiving mechanisms by 2 times by comparison with 1975. It is also necessary to expand the output of forging and pressing and casting machines with programmed control.

In the area of casting machine building, new sets of machines have been built for special methods of casting and for automated flask and flaskless forming lines, lines for manufacturing cores, machines for the preparation and distribution of mixes based on new binders, and so on.

Important technical problems are being solved by the branch with respect to the production equipment for the woodworking industry. By the end of the five-year planning period, the production of woodworking equipment will increase by more than 1.5 times by comparison with 1975. In this case the proportion of automated equipment in the overall production volume will be 31% in 1980 as opposed to 14.2% in 1975.

Important goals have been set in the Tenth Five-Year Plan for the enterprises and organizations of the tool industry. Tool production is expanding with the application of natural and synthetic diamonds and other superhard materials and alloys; a large nomenclature of high-precision tools, tools for automatic lines and for machine tools with digital programmed control have been assimilated. The production of tools with nonresharpenable hard-alloy tips is to be increased by 3.8 times by the end of the five-year period by comparison with 1975. Its proportion in the overall production of hard-alloy tools will increase to 44-45% in 1980 as opposed to 15.6% in 1975. The production of cutting tools from superhard synthetic materials is developing at high rates. The production of tools from tungsten-free hard alloys and mineral ceramics has been organized. The improvement of the quality of the tools is one of the most important goals of specialized tool plants.

In the tool industry, the production of abrasive and diamond tools has great specific weight. The abrasives industry is producing a broad nomenclature of abrasive tools, including elbore tools. Abrasive tools using bakelite binder for power stripping will increase the productivity of the machining by almost 3 times. The production of tools based on ceramic binder for precision thread and gear grinding and for high-speed grinding has been assimilated. The production of cutting tools based on cubic boron nitride is increasing, which will provide a savings of hard alloy.

A significant increase in the production of new and improved types of abrasive tools is the main goal of the remaining two years of the five-year period. The proportion of basic tools in the tool production will be 26.9% in 1980 as opposed to 3.1% in 1975. The production of abrasive tools made of elbore will more than double.

The prodigy of the last five-year planning periods is the branch for the production of diamond tools. At the present time almost all forms of diamond tools known in world practice are being produced in the USSR. The Soviet Union has become a large exporter of tools made from synthetic and other superhard materials. The production of diamond tools had increased by 8 times in 1975 by comparison with 1965, and during the Tenth Five-Year Plan it has increased another 1.8 times. The production of diamond tools in the Soviet Union is distinguished by a high level of concentration and specialization. In recent years, the production of monocrystalline and polycrystalline diamonds has increased significantly.

The planning system for the socialist method of production has made it possible in the shortest possible time to achieve high levels of development of Soviet machine tool and tool industry. The five-year plans have at each stage of economic development of our country determined the goals of the branch; they have insured concentration of material and financial resources for their solution.

The collectives of the enterprises and organizations of the Ministry of the Machine Tool Industry are celebrating the 50th Anniversary of the Machine Tool and Tool Industry with great achievements in the fulfillment of the goals stated by the 25th Congress of the CPSU.

The production workers, engineering and technical workers and office workers of the branch have widely developed socialist competition under the motto of "All new reserves for economic growth into action." The workers in the machine tool and tool industry will celebrate the 50th Anniversary of the First Five-Year Plan of Development of the National Economy of the USSR which played a prominent role in the realization of the Lenin program for the building of communism in the Soviet Union, by fulfillment of the socialist obligations adopted for 1979.

10845
CSO: 1821

METALWORKING EQUIPMENT

UDC 621.9.06-529-183.2:681.586

ANGULAR COORDINATE GAUGE FOR DIGITALLY-PROGRAMMED MACHINE TOOLS

Moscow STANKI I INSTRUMENT in Russian No 6, Jun 79 pp 22-23

[Article by G. A. Lebedev, L. Ye. Kraytman, A. M. Tuv: "Angular Coordinate Gauge for Heavy Machine Tools With Digital Programmed Control and Digital Display"]

[Text] Among the large number of designs of feedback sensors for angular measurements, the most widespread are the selsyns, rotary transformers, reductosins (redusins), inductive converters, circular inductosins, and so on [1-3]. However, their use in the assemblies of heavy and unique machine tools is complicated for the following reasons. When joining the sensor to the axis of rotation of the assembly, an additional error arises (reaching 15" [4]) as a result of noncoaxialness and eccentricity. In addition, building in the sensors in areas which are difficult of access inside the rotating assembly complicates its installation, operation and maintenance.

These deficiencies can be eliminated if the sensor is made in the form of a device which permits measurement of the linear displacements of the assembly with respect to the arc of a large-radius circle (the measurement precision is higher, the larger this radius), and it is a structural part of the assembly.

On the basis of the rectilinear contactless transmitting selsyn of the PBSD type used in the machine tools with digital programmed control produced by the Novosibirsk Tyazhstankogidropress Plant imeni A. I. Yefremov, experimental and experimental-industrial models of angular contactless transmitting selsyns were developed, manufactured and tested. This sensor (Fig 1, a) has a gear scale 1 executed in the form of a ring (or a part of a ring) and fastened to the rotary assembly, and a stationary magnetic circle 2 with poles. The phase and output windings are arranged in a defined sequence of the poles.

The phase A windings are located at the poles Π_A and are opposite-series connected. The phases B and C windings are located correspondingly on the poles Π_B and Π_C, and they are joined analogously. In order to receive a large signal and decrease the error caused by inaccuracy of manufacturing the scale and the magnetic circle, the number of pairs of the poles for each phase will increase by comparison with the minimum number equal to two.

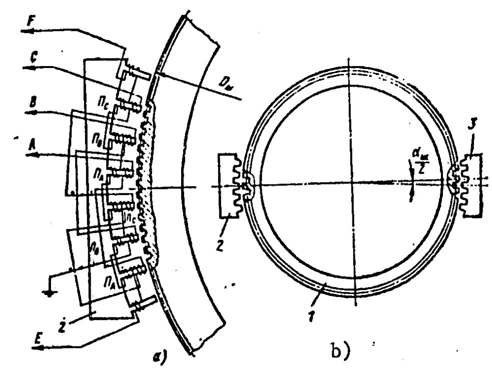


Figure 1. Schematic diagram of a gauge (a) and diagram of the installation of magnetic circuits for the compensation of errors caused by beating of the scale (b)

When an alternating current is fed to the winding EF in the phase windings there is an emf induced which on shifting the scale with respect to the magnetic circuit varies in accordance with a law which is close to sinusoidal. On shifting the toothed scale by an amount that is a multiple of one angular step of it, the voltage in each phase varies by complete period, that is, by 360 electric degrees. The shift between phases is 120 electric degrees which corresponds to displacement of the scale by 1/3 of a step. This gauge, similar to the ordinary selsyn can operate both in the transformer mode and in the phased mode (in the latter case the windings A, B and C are fed by a triple-phase voltage, and the voltage phase in the EF winding is a function of the scale position).

The angular pitch α_M of the poles of the magnetic circuit of the sensor and the angular pitch α_p of the scale teeth are related to each other by the relation $\alpha_M = \alpha_p (2qn \mp 1)/(2q)$, where q is the number of phases of the sensor; n=1,2,3... is the structural coefficient.

The angular pitch of the scale is determined from the condition that the discreteness of the digital display is 0.001° (3.6") and that the digital programmed control unit Razmer 2M divides the period of the output signal of the sensor by 200. Beginning with this, $\alpha_p = 3.6'' \cdot 200 = 12'$, and the number of teeth $z_p = 360°/12' = 1800$. For the experimental model of the sensor (n=2, q=3) $\alpha_M = 26'$.

The angular scale is a toothed rim of diameter D_p cut by the modular cutting tool (m=1.25 mm). The effect of the errors in manufacturing the teeth and the oscillation of the scale and also the deviations of its shape from circular on the accuracy of reading the coordinates can be significantly decreased if the magnetic circuit 3 (see Fig 1, b) is placed diametrically opposite to the magnetic circuit 2, and their output windings are connected in opposite series.

In order to decrease the intrapitch error of the sensor, the magnetic circuit 3 is shifted with respect to magnetic circuit 2 by half the angular pitch in the scale, that is, by 180 electric degrees. In this case the basic harmonics of the intrapitch error with corresponding inclusion of the output windings are mutually compensated. For more complete error compensation it is possible to place several pairs of magnetic circuits around the scale, joining their output windings.

This design has the following advantages: 1) high precision of measuring the rotation of the assemblies of the heavy machine tools; 2) the possibility of using digital programmed control units applied on heavy machine tools for programming the rotation of the assembly; 3) convenience of the installation and operation and maintenance of the sensor. All of this permits broad application of the sensor in heavy machine tool building: on the slewing tables, vertical lathes and also rotating stocks, the planing and milling slides of the combined and specialized longitudinal-machining machine tools.

When testing (Fig 2) the experimental model of the sensor for reading the angles of rotation, the modules of the digital display type F5071 and Razmer 2M-1104 were used. The error of the sensor was estimated in the scale pitch interval (12') by a glass optical rule using the OMS-6 microscope where the displacement by one micron on the scale of the rule corresponded to rotation of the tooth scale by 0.189". The discreteness unit of the module F5071 (on switching it to the "Diametr" regime) corresponded to rotation by 0.36", and the unit of discreteness of the Razmer 2M-1104, rotation by 3.6".

The intrapitch error of the sensor when combining the output windings of two diametrically oppositely arranged magnetic circuits was on the average 4-5," that is, it was commensurate with the discreteness of the digital programmed control unit.

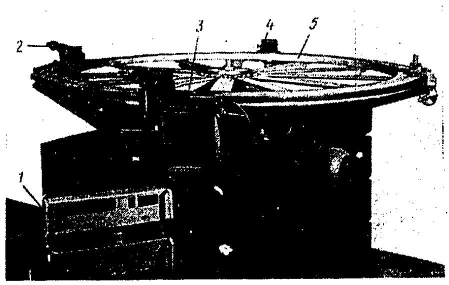
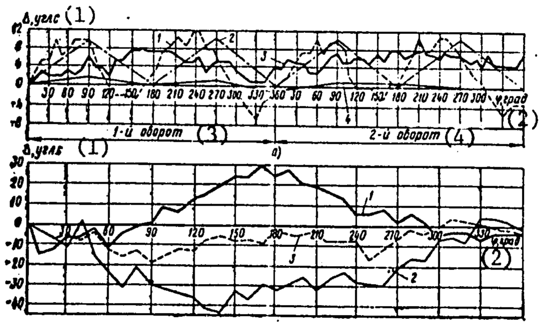


Figure 2. Device for testing and experimental model of a sensor: 1 -- digital display module type F5071; 2 -- reading microscope with scale division 1 micron; 3 -- magnetic circuit; 4 -- optical rule; 5 -- toothed scale



b)

Figure 3. Accumulated error Δ of the sensor with respect to the angle ϕ of rotation of the toothed scale: a -- for testing of an experimental model of the sensor on a bench; b -- when testing the experimental-industrial model of the sensor on the model NS-3 rotary table

Key:

1. Δ, angular seconds
2. degrees
3. 1st rotation
4. 2d rotation

In order to determine the accumulated scale error, a theodolite with scale division of 1" was installed coaxially with it on a rod 800 mm high; the mark was fastened to the opposite wall of the shop at a distance of 20 m from the theodolite. The toothed scale was rotated manually, noting the angle of rotation every 10° with respect to the digital display module. At the indicated points the angle of rotation was monitored using the theodolite, and after every 90°, also using optical rules and OMS-6 microscopes.

The accumulated error Δ (Fig 3, a) was determined on connection of both two and four magnetic circuits. It was established that for two connected magnetic circuits the accumulated error was 10" for measurements with a range of 90° (curve 2) and 17" for measurements with a range of 10° (curve 1). On connection of four magnetic circuits, the accumulated error could be decreased to 2-3" for measurements with a range of 90° (curve 4) and to 8" for measurements with a range of 10° (curve 3). It is also necessary to consider that the instability of the measurements using the theodolite is 5-6".

The experimental-industrial model of the sensor was developed considering installation of it on the model NS-3 rotary table which was equipped with the "Razmer 2M-1104" digital display. The latter made it possible to realize preliminary selection and automatic positioning both with respect to the displacement coordinate of the slides and with respect to the angular coordinate.

Technical Specifications of the Table

Dimensions of the operating surface, mm	3600x3600
Greatest displacement of the slides, mm	2000
Rates of displacement of the slides with respect to the bed (continuous regulation), mm/min	13-1360
Rate of rotation of the rotary section, deg/min	2.5-169
Discreteness of the digital display:	
displacement of the slides, mm	0.01
rotation of table, deg	0.001
Lift capacity, kg-force	50 000
Overall dimensions (lengthXwidthXheight), mm	5700x4250x1200
Weight, kg	36 000

The parameters of the experimental-industrial model of the sensor are as follows: D_p=3600 mm; z_p=1800; m=2 mm; α_M=14'. The structural design for the attachment of the sensor provided for the maintenance of constant currents between the scale and the magnetic circuit independently of the beat of the scale.

During tests on the first four tables sensors were installed with two magnetic circuits arranged diametrically opposite. Their series-counter connected output windings are connected to the channel for exact reading of the Razmer 2M-1104 device; the selsyns of the type B2RG multibit sensor, the output gear of which with z=20 teeth was engaged with the toothed rim of the scale were connected to the remaining channels. This method of connection is explained by the fact that in contrast to the digital display module type F5071, which is a cyclically absolute system and outputs complete information about the displacement of the object on connection of only one precision sensor to it, the Razmer 2M-1104 device is among the absolute systems and requires installation of a multibit sensor.

The accuracy of the rotation of the table and the emergence of it at the given coordinate was determined using a theodolite installed on a mandrel with respect to the center of the table. In order to check the stability and the error in the pitch interval of the scale, in addition to the theodolite, a clock type display was used with scale division of 0.01 mm in contact with a support located on the edge of the table at a distance of 2000 mm from the center; a displacement by 0.01 mm with respect to the display corresponded to rotation of the table by 1".

In order to check the stability of the development of the preliminary selection on the panel, the same coordinate was selected a multiple number of times to which the table was fit automatically. The dispersion of the readings with respect to the display did not exceed 0.02 mm in this case, which corresponds to half the value of the discreteness.

Giving the displacements with an interval of 72", the pitch angle of the scale (12') was passed through 3 times; the maximum accumulated error in this interval was 11". The error for a complete rotation of the table was determined (with an interval of 10°) with connection of both each magnetic circuit individually to the system and the combined windings of two magnetic circuits. As is obvious from Fig 3, b, the errors from the individually connected magnetic circuits (curves 1 and 2 respectively) did not coincide with respect to sign (for the magnetic circuits are arranged diametrically opposite); the maximum error is ~46". This error is commensurate with the component caused by beating of the scale (e=0.45 mm) and it is equal to $\Delta_p = 4e/D_p = 52''$. For jointly connected magnetic circuits the maximum error is 17" (curve 3). Thus, the installation of two diametrically opposite magnetic circuits with corresponding connection of their windings to a significant degree decreased the error component caused by eccentricity of the scale. The installation of four magnetic circuits at an angle of 90° also compensates the error components caused by deviation of the shape of the scale from a circle.

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10845
CSO: 1821

METALWORKING EQUIPMENT

UDC 621.914.4:061.4(437)

EXHIBIT OF SPECIALIZED MACHINE TOOLS FROM SOCIALIST COUNTRIES

Moscow STANKI I INSTRUMENT in Russian No 6, Jun 79 pp 34-36

[Article by O. I. Aver'yanov: "Machine Tools of the Drilling-Milling-Boring Group at the First Specialized Exposition of Metal-Cutting Machine Tools and Forging and Pressing Equipment From Socialist Countries"]

[Text] During the period from 8 to 16 November 1978, in Brno (Czechoslovakia) the First Specialized Exposition of Metal Cutting Machine Tools and Forging and Pressing Equipment from Socialist Countries was organized (the People's Republic of Bulgaria, the Hungarian People's Republic, German Democratic Republic, Polish People's Republic, the USSR, Czechoslovakia and Yugoslavia were represented). At the exposition, 140 units of equipment were shown, among which about 25% represented machine tools of the drilling-milling-boring group with manual control and with digital programmed control.

In the proposed article, a study is made of the most interesting machine tools of this group reflecting the trends in the development of world machine tool building. The basic advantages of the multitool machine tools shown at the exposition are the broad technological possibilities of machining, the high degree of automation (about 80% of the represented machine tools of the investigated group operate in the automatic control mode), and use of modern digital programmed control systems.

The People's Republic of Bulgaria presented an interesting complex made up of two jig-boring machine tools, model RV 001 (equipped with 8-spindle turret heads) and a robot which loads the machined parts. Each machine tool is equipped with a digital programmed control system, model Programma 30. In addition, it is possible to note the productive universal model RV 110 milling machine with manual control.

From among the machine tools of the Hungarian People's Republic it is necessary to note the machine tools of digital program control, milling machine model MV 16-11NC -nd multitool model TC3CNC and MC500CNC. The model MC500CNS machine tool (Fig 1) designed for complex machining of cast iron and steel housing parts (the dimensions of which do not exceed 500x500x500 mm) aroused special interest among the specialists in that it is made up of standardized assemblies. The standardized assemblies include the main drive, the feed drive, the tables, the device for automatic tool and product replacement.

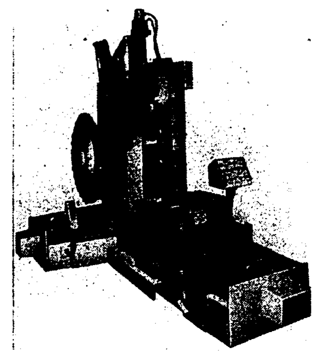

Figure 1. Multitool model MC500CNC machine tool (Hungarian People's Republic)

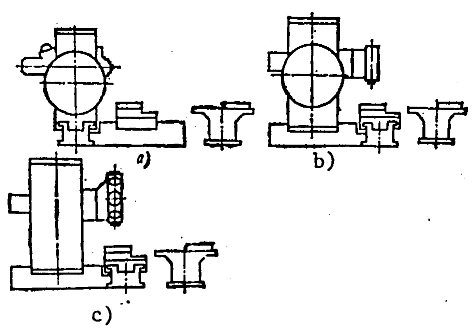

Figure 2. Schematic of the compositions of the multitool machine tools (Hungarian People's Republic) based on standardized assemblies: a -- with horizontally arranged spindle; b -- with vertical arranged spindle; c -- with turret head

The main drive is manufactured in three executions: 1) the DC motor and the three-step gear box (basic execution); 2) the asynchronous motor and gear box in which the rpm of the spindle is switched using electromagnetic couplings; 3) the adjustable DC motor connected directly to the spindle of the machine tool (for machining parts made of light alloys and nonferrous metals). The spindle stock is also made in three executions: 1) with horizontally arranged spindle; 2) with vertically arranged spindle; 3) with eight-spindle turret head. The basic technical parameters of these compositional versions are presented below.

Execution of the spindle stock	With horizontal spindle	With vertical spindle	With turret head
No of spindles	1	1	8
Rpm limits of the spindle:			
For machining steel-cast iron parts	35.5-1800	35.5-1800	35.5-1800
The same, by order	71-3550	71-3550	71-3550
For machining parts made of light alloys and nonferrous metals	140-7100	140-7100	140-7100
Engine power, kilowatts	11-15	11-15	11-15
Greatest torque on the spindle, kg-meter	80	80	80
ISO spindle cone number	50	50	50

The feed drives with respect to all coordinate axes are identical and consist of a high-moment motor and screw-nut transmission. The limits of the operating feeds are 1 to 2000 mm/min, the fast displacement speed is 10 m/min.

The tables are made in the following types: 1) the dividing rotating table with square face plate (500x500 mm) which can have circular feed; 2) the universal rotary-inclined table with square face plate (500x500 mm) which provides for maching parts from five sides; 3) the stationary table (500x800 mm); 4) stationary table (500x800 mm) with built-in rotary-dividing table (face plate 500 mm in diameter); 5) stationary table (500x800 mm) with two built-in rotary-dividing tables (face plate 500 mm in diameter). The structure of the automatic system of the tool made up of a tool holder and manipulator has two executions: 1) with drum type holder for 30 tools; 2) with chain holder for 36, 40 and 48 tools.

Fig 2 shows the schematics of the composition of the multitool machine tools based on the above enumerated nomenclature of standardized assemblies.

Among the machine tools presented by the German Democratic Republic, it is necessary to note the model FQ400 bracket-milling machine, the two-standard jig-boring machine model BKOZ 1400x2240 and the multitool machine tools models C500/03 and CBKO2900 with digital programmed control.

The Polish People's Republic was represented by the multitool machine tools model FUM63NM with vertical spindle and a holder for 24 tools mounted on a stationary standard. On the machine tool the following technical designs were realized: main drive electric motor with 15 kilowatts power; feed drive using high-component motors; the application of a turret (Polish People's Republic production) with reading precision of 0.01 mm in the feed drive; hydraulic unloading in the moving joints of the table; guides made of polymer of the polytetrafluoroethylene type; the model USNMUMS331Fc digital programmed control system (development and production of the Polish People's Republic).

Among the Soviet machine tools presented at the exposition, great interest was aroused among the specialists by the 6904VMF2 multitool machine tool (production of the Odessa Precision Machine Tool Plant imeni 25th Congress of the CPSU) and the 6906VMF2 (production of the Vitebsk Machine Tool Building Plant imeni S. M. Kirov). The machine tools are designed for all around machining of housing parts of medium size from four sides without adjustment. The coordinate displacement of the cross table and the headstock, the speeds of their displacement and subsequent clamping, the spindle rpm, tool changing and the machining cycles are programmed on the machine tools. There is a possibility of manual introduction of diameter and light correction for the tool. The operation of all assemblies of the machine tools is monitored by a digital display.

The most numerous exhibit was that of Czechoslovakia. Some of the technical solutions realized in the machine tools of the drilling-milling-boring group are investigated below.

Fig 3 shows the model FQH50A multitool machine tool designed for machining (under small-series production conditions) of housing and flat parts with greatest weight of 750 kg, the dimensions of which do not exceed 500x500x500 mm. The milling of various surfaces, drilling, boring and reaming of holes and the machining of the inside threads are realized on the machine tools.

The composition of the machine tool is in accordance with the scheme that is traditional for milling machines with digital programmed control (the bracket headstock is displaced vertically along the side guides of the standard rigidly attached to the base of the machine tool; the table of the machine tool is a cross table).

The main drive is realized from a 16 kilowatt DC electric motor and a two-step gearbox controlled by electromagnetic toothed couplings. The continuous regulation of the spindle rpm is insured within the limits of 14 to 2000 rpm. The headstock is balanced using a hydraulic cylinder.

The feed drives with respect to all three coordinates are standardized; the motion from the high-component DC motors is transmitted directly to the ball screws 50 mm in diameter with a pitch of 10 mm. Continuous regulation of the feed is realized within the limits of 10 to 1000 mm/min, the high speed with respect to all three coordinates is 10 m/min. The extreme positions of the moving parts of the machine tool are limited by terminal breakers. Line inductosins are used as the measuring converters.

The rotating and dividing table is executed in the form of a separate unit which in assembled form is installed in the cavity of the longitudinal slides. The discreteness of the angle of rotation of the table is 5°. Before rotation the face plate of the table is lifted by a hydraulic cylinder, and then it is rotated by the required angle as a result of longitudinal displacement of the table slides (for rotation of the face plate by 5° it is necessary to displace the slides by 5 mm along the X-axis).

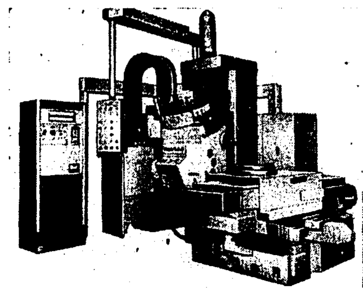

Figure 3. Model FQH50A multitool machine tool (Czechoslovakia)

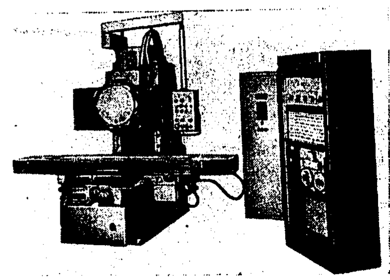

Figure 4. Model FCR50NC machine tool with digital programmed control and turret head (Czechoslovakia)

The drum type tool magazine designed for 30 tools is located on the headstock. Before replacing a tool, its vertical position is changed to horizontal by a manipulator. Then by using a double-clamp arm, the tool is changed in the machine tool spindle. A machine tool was shown at the exhibition, in the magazine of which the tool was arranged in technological sequence although it is theoretically possible also to use a coded tool. The tool change time is 8-12 seconds.

The tool is equipped with units for lubricating the headstock and stabilizing its temperature. Lubrication is fed to the responsible moving joints from a central system.

In the ordinary execution the machine tool has the following precision indexes: positioning precision ±0.02 mm (with respect to the X and Y coordinates at a length of 500 mm), division accuracy (of the rotating table) ±3". For the analogous machine tool of increased precision the indicated characteristics are ±0.015 mm and ±1.5" respectively.

The machine tool was shown at the exposition with the programmed control system model Philips 6663. The program is fed into memory manually (when machining the first part) or by magnetic tape.

Fig 4 shows the model FCR50NC machine tool with turret head and model NS350 digital programmed control system, and Fig 5 shows a vertical milling machine model FC50V. It is interesting to note that both machine tools are made up of the same base assemblies (vertical standard, base, cross table with dimensions of 500x2000 mm).

The model FC50V machine tool is equipped with a device for climb milling. The control of the automatic operating cycle by the given program is realized using adjustable stops. On the basis of the model FC50V machine tool it is possible manufacture a machine tool with program control and also a machine tool with electrocontact forming unit.

During the work of the exposition, a scientific-technical symposium was held on the problems of metal cutting machine tools with digital program control which was participated in by representatives of the member countries of the CEMA. In one of the reports specialists from Czechoslovakia discussed the prospects for the further development of machine tools with digital programmed control in Czechoslovakia in detail. The creation of such machine tools (with any automation level required for the customer) is based on the principle of unit construction of machine tools from standardized assemblies.

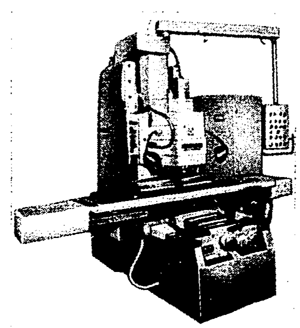

Figure 5. Model FC50V vertical milling machine (Czechoslovakia)

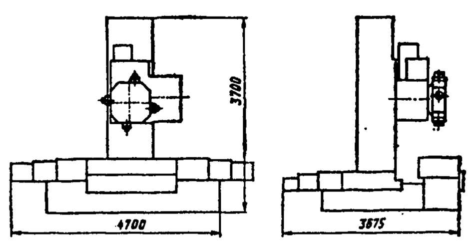

Figure 6. MCFR A80 unitized machine tool (Czechoslovakia)

The following basic restrictions are adopted: 1) table width 630, 800, 1000 and 1250 mm; 2) versions of compositions of the machine tools with table width of 630 and 800 mm: longitudinally moving table and transversely moving standard; headstock with horizontal spindle (arrangement on the standard, bracket or symmetric); headstock with vertically arranged spindle or turret (placement on the standard symmetric); 3) versions of the compositions of the machine tools with table width of 1000 and 1250 mm: longitudinally moving table and transversely moving standard; stationary table and standard with cross displacement; headstock with horizontal spindle (placement on the standard bracket); 4) drum type tool magazines (with limited number of cells) and chain type (with the number of cells needed by the customer.

The model MCFRA80 unitized machine tool (Fig 6) was also shown at the exposition. It is made up of standardized assemblies. The vertically arranged headstock is equipped with a four-position turret; the automatic tool changing is done in two positions of the turret; number of tools in the magazine 15.

Technical Specifications

Dimensions (widthXlength) of the table, mm	800x1750
Vertical stroke of the headstock, mm	750
Limits of the operating feeds, mm/min	1-3000
Engine power, kilowatts	15-24

Conclusions

1. The first specialized exposition of metal cutting machines and forging and pressing equipment from socialist countries again confirmed the trend in the development of machine tool building aimed at creating highly automated machine tools which insure complex machining of parts with one setting of it.

2. When building the machine tools of the drilling-milling-boring group with digital programmed control, the principle of unitized construction of the machine tools from standardized assemblies is widespread.

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METALWORKING EQUIPMENT

EAST GERMAN ARTICLES ON NEW MACHINE TOOLS

Digital Program Machine Tools

Moscow STANKI I INSTRUMENT in Russian No 11, Nov 79 pp 2-4

[Article by P. Sachowitz and W. Pabst: "Soviet Digital Program Control Machine Tools at the Experimental Center of the Ashersleben Machine Tool Plant"]

[Text] In the plan for the further development of technical cooperation and the sharing of information between the scientific-technical journals of the GDR and the USSR an agreement has been reached between the editors of the journals FERTIGUNGSTECHNIK UND BETRIEB (Berlin, GDR) and STANKI I INSTRUMENT about an exchange of articles.

This section contains articles that were written by specialists from the GDR and sent to the editors of the Soviet journal by the editors of FERTIGUNGSTECHNIK UND BETRIEB.

We have in turn sent our colleagues from the GDR article by Soviet specialists, which are being published in FERTIGUNGSTECHNIK UND BETRIEB No 11, 1979.

In the GDR's metal working industry DP [digitally programmed] metal cutting machine tools from the USSR are being used more extensively; these machine tools promote a significant intensification of production.

The first Soviet DP machine tools were delivered in 1973 to the "7 Oktober" Machine Tool Building Combine in Berlin.* At the Wema enterprise (Ashersleben) of the "Fritz Heckert" (Karl Marks Stadt) Machine Tool Building Combine in 1975 an experimental center was organized, where the Soviet DP machine tools are in operation. The most important tasks of the experimental center are*: testing the first imported Soviet DP machine tools under conditions of the GDR's machine tool building industry; the

* Schuckar D Aufbau und Ergebnisse des Experimentalzentrums mit sowietischen NC-Maschinen in der DDR. FERTIGUNGSTECHNIK UND BETRIEB, 25 (1975). 5.

drawing up of unified operational norms for these machine tools; and the solving of problems for the improvement of production.

The results of the tests are being passed through the technical center of the Soviet Export-Import Association V/O "Stankoimport" to the plant-manufacturers of the machine tools in the USSR for use in further improving the product. The work of the experimental center is making a significant contribution to socialist economic integration.

Upon conclusion of the first stage of the construction of the experimental center in November 1977 in the city of Ashersleben there was a conference of the users of the Soviet DP machine tools. Participating in the conference were representatives of the GDR's Ministry of Machine Tool Building Industry, of the Soviet manufacturers of the DP machine tools, V/O Stankoimport, the National Foreign Trade Enterprise WMW Export-Import (Berlin), the national enterprise Importservice (Karl-Marks stadt), and the users of the Soviet DP machine tools. Discussed at the conference were the experience of work of the experimental center and the prospects for the further use of the Soviet DP machine tools.

Below are examined the more important matters that were discussed at this conference.

From 1975 through 1977 at the experimental center the following DP machine tools were set up: a horizontal milling and drilling machine tool, model 2611F2; a vertical-drill machine tool, model 2R135F2 with a revolving capstan; a semiautomatic centering lathe, model 1B732F3; a horizontal milling and drilling machine tool, model 2A622F2.

The first organizational measure was to create a group for the technological preparation and maintenance of the DP machine tools. The functions of this group includes such matters as the assembly and putting into operation of the machine tools, training personnel, the programming, maintenance and general coordination as well as the preliminary tuning and use of the tool and the securing of the billets.

An office for coding was formed based on existing GDR offices for the manufacture of the punched tape. The centralized tuning of the tool using Soviet BV 2015 instruments was organized to adjust the tool to the milling and drilling machine tools and the BV 2010 for adjusting the tool to the lathes.

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* Unger H. Experimentalzentrum fur sovjetiche NC-Maschinen. - "Die Wirtschaft", 32 (1977), 12.

The presence of a sharp cone (7 : 24) in the spindle of the horizontal milling and drilling machine tools makes it possible to use an instrument of GDR production. During boring they use drill bits with hard alloy blades for working at increased cutting modes. The cutting bar assembly is fitted out with modern control drill bits. The use of crowned drills for processing the holes for the whole reduces the number of work transfers. A new boring tool designed by the Schmalkalden machine tool building combine has been tested and manufactured according to TGL 31699 norms. Particularly good results were obtained during the work by the tool with two cutting edges. On the vertical -drill machine tool with a revolving capstan there were no occurrences of difficulties with the use of the tool, because six spindles have a Morse cone. On the semiautomatic lathe an efficient tool of GDR production is used. The billet clamp is accomplished using standard means that are used in production.

The assembly and putting into operation of DP machine tools were carried out by Soviet specialists. The acceptance of the machine tools was conducted according to conditions of acceptance of the plant-manufacturer considering the special requirements of the user. Training on maintenance of the DP machine tools, working on them and on programming took place during their being put into operation with the help of Soviet specialists, who represented the plant-manufacturers. In addition a training course was organized at the manufacturing plants.

The programming was accomplished primarily by hand and was only partly automated. For the semiautomatic centering lathe it was possible to use a postprocessor that was developed by the Research Center of the machine tool building industry (Karl-Marks stadt). This same research center designed a postprocessor for the model 2A622F2 machine tool.

The maintenance of the machine tools during the warranty period was performed by the plant-manufacturers. Following the warranty period maladjustments were eliminated jointly by the user, representatives of plant manufacturers and the Technical Center of V/O Stankoimport.

The DP machine tools in the Experimental Center work with a full load for three shifts. At present each machine tool is serviced by one worker; in the future it is planned to have multi-machine tool servicing.

The horizontal milling and drilling machine tool, model 2611F2, (Fig. 1) is manufactured by the Ivanovskiy Heavy Machine Tool Building Plant imeni 50-letiya SSSR and is intended for four-sided, chiefly finishing, processing of complex housing parts weighing up to 2,000 kilograms. The coaxial holes can be processed from one installation. The machine tool has a lengthwise sliding stand, a transversely sliding turning table and a vertically sliding spindle drill chuck. The frequency of revolution of the spindle is switched by program.

On the model 2611F2 machine tool it is possible to perform drilling, boring, countersinking, hole expanding, threading, face processing, circular groove cutting and milling on a right angle cycle. The cutting of circular grooves and reverse countersinking are accomplished manually; all remaining operations are done automatically. Constant cycles are used when processing holes.

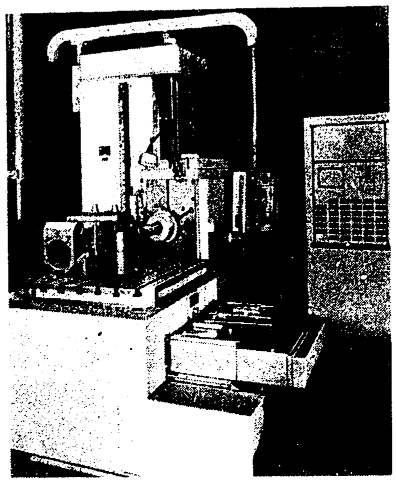

Fig. 1 Horizontal milling and drilling DP machine tool, model 2611F2

As the result of technological tests at the plant-manufacturer and a random check by the customer the following indicators of precision were obtained: tolerance at the mid-centering distance and at the distance between the hole and base surface in production conditions was ± .02 millimeters, when tested ± .016 millimeters; the class of accuracy of the holes IT7 or IT6 (with hole expanding); deviation from coaxial alignment is no greater than .01/300 millimeters; the radial wobble is .005 to .01 millimeters.

The horizontal milling and drilling DP machine tool, model 2A622F2, (Fig. 2) is manufactured by the Leningrad Machine Tool Building Production Association imeni Ya. M. Sverdlov and is intended for four-sided processing of complex housing parts made of pig iron and steel (weighing up to 4,000 kg) by cantilevered boring bar. It is possible to process through holes from one installation. The machine tool has a manually sliding spindle, a turning table with lengthwise and transverse sliding and a vertically sliding spindle drill chuck.

The use of the model 2A622F2 machine tool is almost the same as the 2611F2. During acceptance testing the machine tool withstood a tolerance to sizes in the ± .026 mm range.

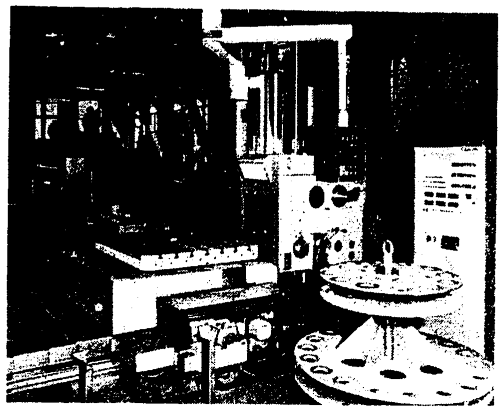

Fig. 2 Horizontal milling and drilling DP machine tool, model 2A622F2

The semiautomatic centering lathe, model 1B732F3, (Fig. 3) is manufactured by the Moscow Machine Tool Building Plant imeni Sergo Ordzhonikidze and is to be used for processing large billets such as shafts (diameter up to 400 mm and a length up to 2,000 mm). The rigid design of the machine tool and the high rating of the drive ensure a high productivity when processing billets even with a large tolerance (for example, forged billets). The machine tool is equipped with a six-position revolving capstan.

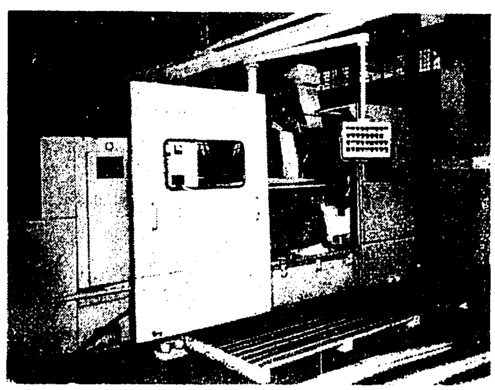

Fig. 3 Semiautomatic centering lathe with DP, model 1B732F3

The model 1B732F3 machine tool incorporates various versions of lengthwise turning, face processing, cutting and threading and also the manufacture of all sorts of conical and spherical surfaces. The model 1B732F3 comes with a radial carrier plate. Tests have shown that on this machine tool it is wise to also use a hydraulic plate DFKK 400.

During tests on the machine tool in the experimental center the following data was obtained: accuracy toward the X axis (diametral) is $\pm$ .025 mm; toward the Z axis (length) the accuracy is $\pm$ .015 mm.

The vertical drilling machine tool, model 2R135F2, with revolving capstan (Fig. 4) is manufactured by the Sterlitamak Machine Tool Building Plant imeni V. I. Lenin and is equipped with a cross table and a six-position revolving capstan.

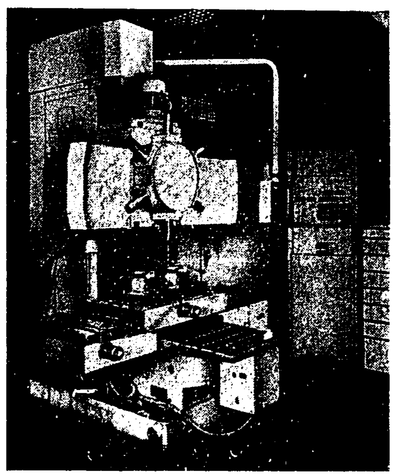

Fig. 4 Vertical DP drilling machine tool, model 2R135F2, with revolving capstan

The model 2R135F2 machine tool is intended for processing covers, flanges, plates and other such small and medium-sized parts. The machine tool performs vertical drilling, boring, countersinking, hole expanding and threading. The manufacture of through holes, threaded holes, graduated holes and cylindrical and conical countersinks is possible.

The wide range of the frequency of revolution and feed makes it possible to process steel, pig-iron and non-metallic billets. The maximum diameters of the billet to be processed are 500 X 400 X 250 mm.

In tests the following accuracy was achieved: .02 mm toward the X axis and .01 mm toward the Y axis.

The economic effectiveness of using these machine tools (in comparison with similar machine tools without DP) is created by reducing the processing time (due to the combining of operations, the use of a highly productive tool and the clamping of several billets) and by freeing basic workers. The appropriate data is given below:

Machine tool model	2611F2	2A622F2	2R135F2	1B732F3
Reduction in processing time, (average), %	50	35	30	35
Number of workers freed	2	No data	1	2

The use of the machine tools can be shown in the example of the model 2R135F2 machine tool. The dynamics of technical standdowns during testing is represented in Fig. 5. It is clear that following the start up period the expected time of standdowns averages four hours per week, i.e. approximately 3.5 per cent of the time available (similar data were obtained for three other DP machine tools).

The time of standdowns in the assimilation period can be significantly reduced by the following steps: good organization of supply of spare parts and thorough familiarity by repairment with the machine tool and its control system even during the start-up period (this makes it possible to significantly reduce the amount of time spent in locating malfunctions).

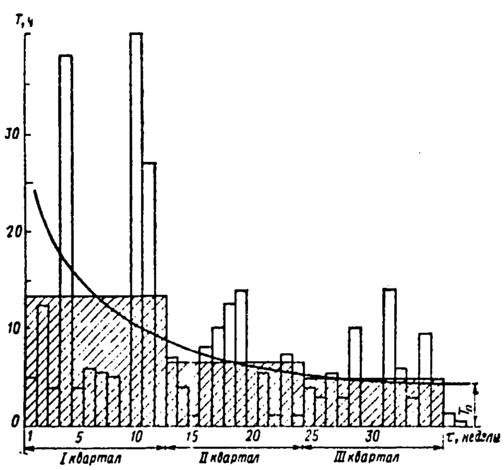

Fig. 5 Technical standdowns T of a vertical drilling machine tool, model 2R135F2 during time "t": the shaded area denotes standdowns during a quarter; the unshaded area denotes daily standdowns; the curve depicts averaged data; T_0 is the average expected time of standdowns in the future.

The DP systems of all four machine tools are very reliable: only 10 per cent of all standdowns were caused by their malfunctionings. These are the systems "Razmer-2M" (model 2611F2 machine tool), P32-3m (model 2A622F2 machine tool), N22-1M (model 1B732F3) and "Koorinata S70" (model 2R135F2). On the whole the technical standdowns of the DP machine tools that were examined during the period of assimilation are similar to the standdowns of corresponding machine tools that are produced in the GDR.

Prospects for using Soviet DP machine tools. After completion of the first working stage in the experimental center the Soviet DP machine tools will find wide application (first at the "Fritz Heckert" combine). The experience that is gained will make it possible in the next few years to increase the number of Soviet DP machine tools.

During maintenance of the Soviet DP machine tools the repair (in most cases) and supply of spare parts will be accomplished by the user. To meet the need for spare parts the national enterprise Importservice will create an appropriate store of spare parts. Later this enterprise will organize additional professional training for personnel who service the DP machine tools. A "Technical Center" of V/O Stankoimport has been established to render assistance to this service.

The efficient use of the Soviet DP machine tools in the GDR's metal-working industry will be promoted by the import of a relatively small product list of machine tools and control systems. The assimilation of a large number of similar machine tools will provide significant advantages; for example, an improvement in the supply of spare parts, a reduction is expenditures for maintenance and repair, and an increase in the efficiency of the organization and technical preparedness when the machine tools are being used.

Enterprises of the "Fritz Heckert" combine are being assisted by the engineering office of the combine during the assimilation of the Soviet DP machine tools. The most important matter during the assimilation of the DP machine tools is the output of the comprehensive solution for the improvement of the technological process, i.e., the drawing up of special technological norms, technological charts for special tool chucks, a catalogue of attachments for clamping billets, rules for sharpening the tool, guidance in programming, and a unified formula for the technological preparation of the DP machine tools.

Later an information center will be organized in the engineering office, where information must be gathered, put into convenient forms (information memory), and published concerning Soviet DP machine tools (technical characteristics, fields of technological application, commercial and economic data, auxilliary means for technological preparation). On this basis assistance will be given to the combine's enterprises, starting with advice in selecting a DP machine tool prior to preparation work for putting it into operation. Based on the results obtained, one can expect in the near future to see expanded utilization of Soviet DP machine tools.

Digital Program Control Lathe

Moscow STANKI I INSTRUMENT in Russian No 11, Nov 79 pp 5-7

[Article by K. Schnaubelrauch: "Digital Program Control Lathe of the "7 Oktober" Machine Tool Building Combine"]

More than 2,000 DP lathes have been manufactured by enterprises of the VEB "8 Mai" (Karl Marks Stadt) and VEB "Hermann Matern" (Magdeburg) of the machine tool building combine "7 Oktober" and delivered to many nations of the world (trade mark "NYLES").

At the machine tool building combine "7 Oktober" on the basis of the lathe, model DF315NC (VEB "Hermann Matern"), and the lathe, model DFS400NC (VEB "8 Mai"), there has been created a range of single-spindle DP lathes. The first machine tools of this range were first imported to the USSR in 1973. The machine tools, which comprise this range, make it possible to automate the processing of complex parts in conditions of small-scale and middle-scale series production. These machine tools are capable of manufacturing parts (diameter of 25 to 630 mm) from a rod or to process billets (diameter of 25 to 800 mm) that are secured in a plate or in centers.

For this range of machine tools the following designators are used: DS - centering lathes; DSt - rod-shaped lathes; and DF - chucking lathes.

The range of machine tools includes model sizes 2, 3, and 4. The basic parameters of the machine tools and their design features make it possible to use a highly productive cutting tool that is fitted with plates made of a hard alloy and a powdered ceramic material.

The DP lathes can process steel, pig-iron, non-ferrous metals, light alloys and non-metallic materials. For billets they use rolled, pressed and poured rods and pipes or forged billets. At present the series production of the machine tools model size 2 and model DF3/NC-S has been assimilated.

Model size 2 includes machine tools models DS2/NC (Fig 1); DSt/NC (Fig. 2), and DF2/NC (Fig. 3). Model DS2/NC is intended for the automatic processing of complicated configured shafts and also for turning parts such as bushings in conditions of small-scale and middle-scale series production. The model DSt2/NC machine tool can manufacture complicated parts from a rolled rod with a diameter up to 80 mm. On the rear end of the spindle there is a second plate for clamping the rod. The spindle is automatically orientated and indexed. Both plates clamp and release the rod using an electric clamping attachment. Becuae it is possible to replace the plates, the machine tool can handle billets with a diameter of up to 250 mm. The length of processing is regulated by the sliding of the rear drill chuck.

The model DF2/NC machine tool is for processing (in conditions of small-scale and medium-scale unified series production) simple and complex parts with a diameter of up tc 500 mm which are secured in a plate. The machine tool has two six-position tool capstans which are positioned on transverse skids. The upper capstan is for processing external surfaces and the lower is for interior surfaces. This positioning of the capstans prevents them from colliding.

Technical characteristics

Model	DS2/NC	DSt1/NC	DF2/NC
Maximum dimensions of processing in millimeters:			
Diameter above bench	280	280	500
Diameter above skids	160	160	250
Length	1000	500	200
Diameter of hole in spindle, mm	52	82	62
Maximum frequency of revolution of spindle, RPM	2400	2240	2800
Number of tools	8	12	12
Speed of rapid change of position, in meters per minute	9	9	10
Drive capacity in kilowatts	16/25	16/25	20
Type of DP contour system	NC-431	NC-431	NC-431

In model size 2 along with the DP lathes there are also hammer automatic lathes, models DS2/N and DF2/N. These machine tools are for large-scale series production and are produced in various designs.

Fig. 1 Model DS2/NC centering lathe

Model size 3 includes machine tool models DF3/NC-S (with cycled control) (Fig. 4), DF3/NC-B (with contour control) and DS3/NC. Centering lathe model DS3/NC replaced the popular model DFS400NC machine tool that is produced by VEB "8 Mai". In the upper and lower revolving capstans one can install 12 tools, which makes it possible to process (in conditions of

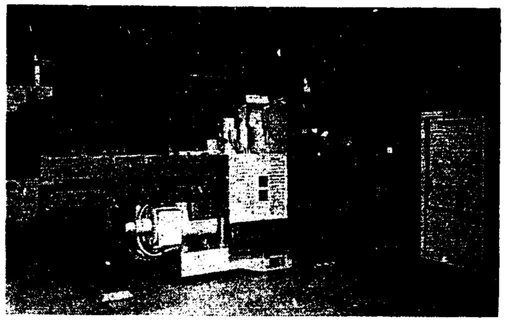

Fig. 2 Rod-shaped lathe, Model DSt/NC

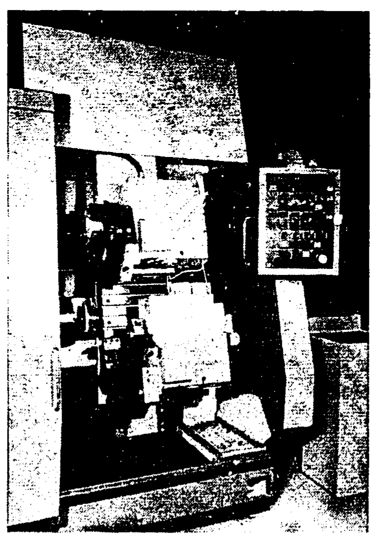

Fig. 3 Chucking late, Model DS2/NC

medium-scale and large-scale series production) all standard parts. On this machine tool it is also possible to process parts that are secured in a plate. As 12-position disk capstan is used as a tool clamp.

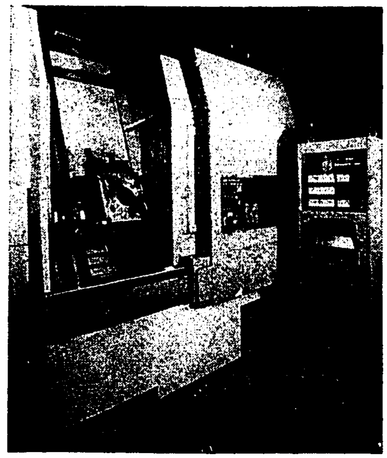

Fig. 4 Chucking lathe, Model DF3/NC-S

The model DF3/NC-B machine tool is for processing billets of varying complexity in conditions of unified, small-scale and medium-scale series production.

Technical Characteristics

Model	DF3/NC-B	DF3/NC-S	DS3/NC
Maximum dimensions of processing in millimeters:			
Diameter above bench	750	750	450
Daimeter above transverse skids	400	400	315
Length	315	315	2000
Frequency of revolution of spindle, RPM	2240	2240	2200
Number of tools	12	12	12
Speed of rapid change of position, in meters per minute	10	10	10
Drive capacity in kilowatts	37	37	42
Type of DP system	NC-431	NC-621	NC-431

A representative of model size 4 is the highly productive centering lathe, model DS4/NC, on which it is possible to also process parts in a plate. In the 12 radial grooves of the revolving capstan one can install tool clamps with drill bits. On the disk of the revolving capstan one can install an axial cutting tool or plate for clamping the boring bar. The automatic changing of position of the rear drill chuck into the required position is accomplished with the use of an electric motor.

Technical Characteristics

Maximum dimensions of processing, in millimeters:

Diameter above bench	630
Diameter above the transverse skids	450
Length	2500
Frequency of revolution of spindle, RPM	1800
Number of tools	12
Speed of rapid change in position, meters per minute	10
Drive capacity in kilowatts	50
Type of DP system	NC-431

The bench in all of the machine tools in this group is inclined. The forward surface is inclined at 15 to 20 degrees to vertical plane. The closed box-like form of the bench gives in considerable rigidity, which enhances the precision of processing. The machine tools provide for the unhindered discharge of shavings with the help of a transporter that allows the machine to perform reliably.

The range of machine tools use as the main drive along with alternating current drives also thyristor drives of direct current, which provides for a large range of frequencies of revolution at a high capacity. In machine tools of model size 2 the frequency of revolution can be regulated without stages from 20 to 2,800 RPM. The machine tools, which are intended for large-scale series production, basically use alternating current drives. In the model DF3/NC-S machine tool they install this kind of drive along with an automatic speed control, which permits the 16 frequencies of revolution to be switched automatically. To avoid thermal deformations the main drive is seperated from the spindle unit.

The feed drive. In all models of the machine tools the lengthwise and transverse movements are accomplished from the direct current motors through the ball-type screw gage. The continuously variable regulation of the feed (.01 - 3000 millimeters per minute) is provided by the use of the type NC-431 digital programming system.

In the DF series machine tools the support consists of a lengthwise drilling rig and transverse skids. The great weight of the transverse skids and the cutting head are compensated for by the hydraulic load relief. In the series DS and DSt machine tools they use exclusively disk revolving capstans (Fig. 5) with 8 to 12 positions. In the series DF machine tools on the transverse skids two cutting heads are installed, or two disk 6-position revolving capstans (See Fig. 3), or 8- and 6-position revolving capstans with a vertical axis.

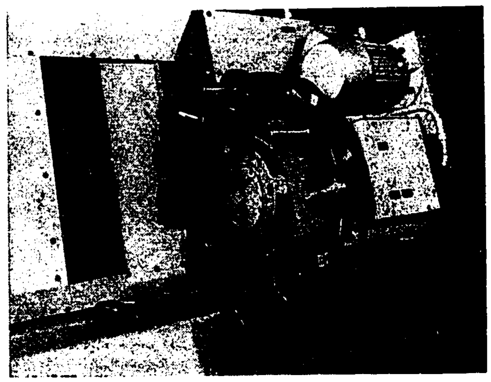

Fig. 5 Twelve-position disk revolving capstan for machine tool, model DSt2/NC

In the model DF3/NC-S machine tool they use a 4-position revolving capstan, on each side of which one can install additional drill bits. The precise orientation of the capstan is accomplished with the use of face geared linkage of the Hirt type. All cutting heads are very rigid. It takes 1.5 seconds to replace a head.

Electrical equipment is installed in the machine tool. The model DF3/NC-S machine tool is delivered with a type NC-621 DP system, in which is used the first microprocessor of GDR production. All other machine tools in this series are supplied with a system of contour programmed control of the NC-431 type. In the future all of the machine tools will use the computer device type CNC-600, that is manufactured by VEB Numerik "Karl Marx" (Karl Marks-Stadt).

Fig. 6 shows the parts that are processed on the DP lathes. The rod of the hinge (Fig. 6a) (the material is steel 45; diameter of the billet is 80 mm and the length is 300 mm) is processed on the model DS2/NC machine tool. The billet is placed between the carrier plate center and the revolving rear center. The cutting speed is 90 to 500 meters per minute; the frequency of revolution of the spindle is 450 to 2,200 RPM. The processing time is 3.45 minutes.

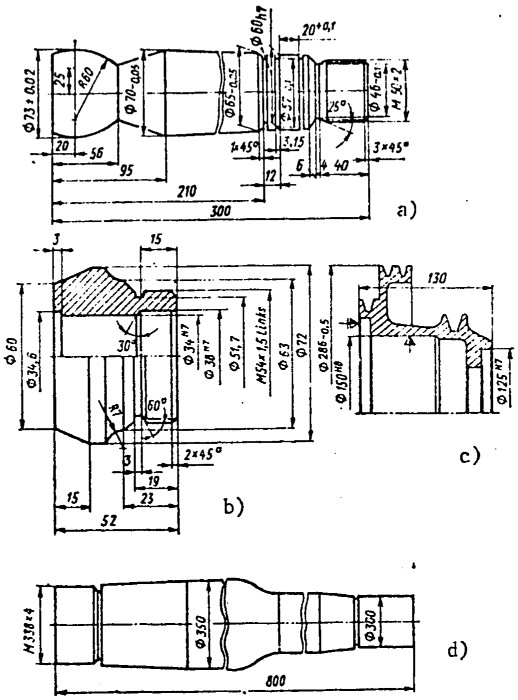

Fig. 6 Parts processed
on)P machine tools

The pig-iron pulley (Fig. 6b) of V-belt transfer is initially and finally processed from two sides on model DF2/NC machine tool. The tool is installed in two 6-position disk revolving capstans. For initial processing (cutting speed is 400 to 500 meters per minute) they use a tool with plates made of a powdered ceramic material; for the final processing they use a tool with plates made of a hard alloy. The pulley is installed in a special clamping chuck. The processing time is 8.5 minutes.

The sliding ball-bearing (Fig. 6c) (Material is steel 45; rod diameter is 78 mm) is fully processed on the model DSt2/NC machine tool by a tool with plates made of a hard alloy. The cutting speed is 34 to 380 meters per minute; the rod feed is accomplished by an automatic device. The processing time is 3.7 minutes.

The shaft (Fig. 6d) (material - steel 60; length is 800 mm and the maxi imum diameter is 350 mm; the billet weight is 670 kilograms) is initially and finally processed on model DS4/NC machine tool. All of the tools, except for the thread-cutting drill bits, are equipped with plates made of

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a powdered ceramic material; the thread-cutting drill bits are equipped with replaceable plates made of a hard alloy. The cutting speed during final processing is 1,000 meters per minute; the processing time is 20.3 minutes.

In this manner, due to the great power of the drive, the large range of frequencies of revolution, the high frequency of revolution (which in the future will be further increased), the large feeds, the interchangeability of the cutting heads and the possibility of using a highly productive cutting tool, the machine tools that are manufactured by the "7 Oktober" Machine Tool Building Combine are very productive and ensure production efficiency.

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