28 JUNE 1979 (FOUO 5/79) 1 OF 1

JPRS L/8550

28 June 1979

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EUROPE

TRANSLATIONS ON EASTERN EUROPE

SCIENTIFIC AFFAIRS

(FOUO 5/79)

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CZECHOSLOVAKIA

DATA ON NUCLEAR PRESSURE VESSEL PRODUCTION GIVEN

Prague TECHNICKY TYDENNIK in Czech 1 May 79 p 5

[Article by H.A.J.: "Welded Ringlets"]

[Text] This kind of welding calls for a first-class specialist trained for a specific task. It also requires prime physical condition such as is, for example, required of professional pilots. The Power Engineering Enterprises of the Skoda Works in Plzen has some 50 welders with these qualifications. It can be said that the number of available welders is a factor codetermining production.

The ringlets we are talking about (they should properly be called rings, but that's what Skoda workers call them) in reality have a diameter of almost 4 meters and each weighs several tons. Joined together they constitute the reactor pressure vessel, the most important part of nuclear power plants.

The reactor pressure vessel houses the complete active zone of the reactor, the control devices and the internal reaction monitoring system. It is made of alloyed steel of high homogeneity, purity, outstanding mechanical properties and is highly resistant to damage by radiation. In short, it must offer an absolute guarantee that the body of the reactor will remain intact during operation of the power plant. This is why such stringent demands are placed on the welders' skill and the quality of their work. The safety of the nuclear reactor is of the 10^6 order of magnitude, in other words, the probability of an accident is 1:1,000,000.

Individual parts of the reactor vessel are forged and then most carefully machined by exact machine tools. Machining yields up to 40 percent waste. When welded the complete reactor vessel is more than 14 meters high with 140-millimeter-thick walls and weighs 275 tons.

At Plzen we were able to see the construction of the reactor hall where these products of giant dimensions but of clockwork precision will be produced. When completed the modern production hall will have more than 18,000 square meters of work space representing an area of three soccer fields. Welding, heat treatment, machining and testing of the pressure vessels and of the internal parts of the reactor will take place in two departments of the hall where production has already started. Another department will be the workplace where horizontal and vertical hardening and programmed horizontal drilling with automatic tool exchange will take place. Premises for the linear accelerator for testing welds on the pressure vessel by radiography to a depth of 450 millimeters and for a giant electric furnace for temperatures up to 850°C with a work space 7.5 x 7.5 x 15 meters in size are also under construction in the hall. A defectoscopic workplace and a number of unique machines, robust positioners, devices for turning pressure vessel components weighing up to 150 tons etc, will also find accommodation in the hall.

According to Josef Pesta, manager of the Power Engineering Enterprises, 5 reactors are expected to be built at Plzen by 1980 and another 18 in subsequent years. The first two are destined for Hungary, the others for a domestic customer, for the GDR, Cuba... The goal is an annual capacity of four reactors.

The pressure vessel, seven parts welded together--with the bottom and the top in addition to the rings--must have a life expectancy of up to 40 years. And absolutely no uncontrolled radiation contained by the walls must escape from it. This is why production calls for absolutely perfect materials and absolutely exact and reliable workmanship. And the Plzen Skoda Works are just the place where these conditions can be met.

Caption: The socialist work brigade of draftsmen places spacings of 1,343 openings on the spherical bottom which will be built into the pressure vessel. From the left: Rudolf Coufal, Miloslav Sanda, and Foreman Otta Pasek.

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CSO: 2402

CZECHOSLOVAKIA

USE OF ROBOTS FOR SMALL PRESSWORK PRODUCTION DESCRIBED

Prague STROJIRENSKA VYROBA in Czech No 3, 1979 pp 171-176

/Article by Eng Robert Kadrmas, Instrumentation and Automation Plants, Trutnov: "Installation of Industrial Robots for the Control and Operation of Eccenctric Presses Used in the Production of Small-scale Flat Components"/

/Text/ The introduction of automated production processes is one of the ways in which it is possible to boost labor productivity. However, there are some workplaces whose nature precludes the introduction of fully automated systems for instalation NC machinery. This problem is especially evident when it comes to the manufacture of small-scale, flat, metallic pressed pieces on eccentric presses in conjunction with repeated small- and medium-lot production processes. For reasons having to do with plant technologies or plant capacities, the utilization of technically advanced mechanisms proves to be impossible. Using old technology for the production of these components, the annual volume of labor time expended on individual eccentric press operations at ZPA-Trutnov /Instrumentation and Automation Plants in Trutnov/ ranges between 4 and 5.4 seconds per workpiece. Forceps are used to manually insert semifinished goods into the open press machines in which bending, calibrating, perforating, sinking, and other operations are carried out.

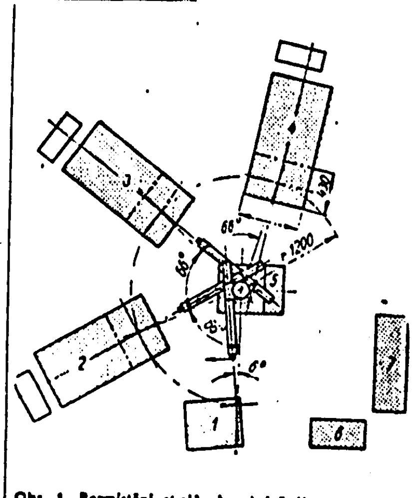
If we take into account the fact that there is an absolute shortage of workers willing to perform monotonous press operations which are accompanied by a great deal of noise and the need to attend uncomfortable work stations and which entail a relatively greater danger of occupational injury, low skill ratings, and two-shift work schedules, then it becomes quite clear that we must move ahead with plans for the automated performance of these kinds of operations.

These facts in particular gave rise to the idea of installing an industrial robot capable of performing press operations that would reduce the impact of these negative factors to a minimum.

The design plans for an "Unattended Work Station" are the product of a team project carried but by specialists in various fields from ZPA Trutnov. This kind of work station is designed along the lines of a "work-enveloped robot." Even though this sort of arrangement is not always advantageous, the installation of a robot equipped with three arms is bringing about a reduction in the job-operation cycle of the whole system and thereby also enhancing the time-efficiency of the robot's utilization. This is especially important in the case of brief machine-operation times such as those which obtain in the operation of eccentric presses where materials handling jobs account for a large part of the operator's workload. Another virtue of this design is its low capital intensiveness when combined with the utilization of conventional accentric presses and only one industrial robot.

This unattended work station consists of three LENR-40A eccentric presses (manufactured by the Smeral Engineering Works), a feed unit (manufactured by ZPA Trutnov), a MHU-Junior 305 industrial robot (manufactured by the Swedish firm Electrolux), and a central control module (manufactured by ZPA-Trutnov) (see figure 1).

Figure 1. Machinery Layout for an "Unattended Work Station"



Obr. 1. Rozmístění strojů „bezobslužného pracoviště"; 1 — podávací jednotka; 2, 3, 4 — lisy LENR 40A; 5 — robot MHU — Junior; 6 — řídicí skříň MHU; 7 — hlavní řídicí skříň

Key:

1. Feed unit
2. LENR-40A presses
3. LENR-40A presses
4. LENR-40A presses
5. MHU-Junior robot
6. MHU control module
7. Central control module

The individual working machines are arranged in a circle with a radius of 1.2 meters at central angle intervals of 1.152 rad (66°). This arrangement is necessitated by the technical parameters of the robot and the floorplan dimensions of the presses. The robot attends four work stations by means of three arms whose basic operational movements are synchronized. For this reason it is necessary during installation to pay special attention to machinery setup accuracy. For purposes of this design application a positional tolerance of ±0.5 mm (referring to the axis of the work tables) and a height tolerance of ±0.1 mm were found to be satisfactory.

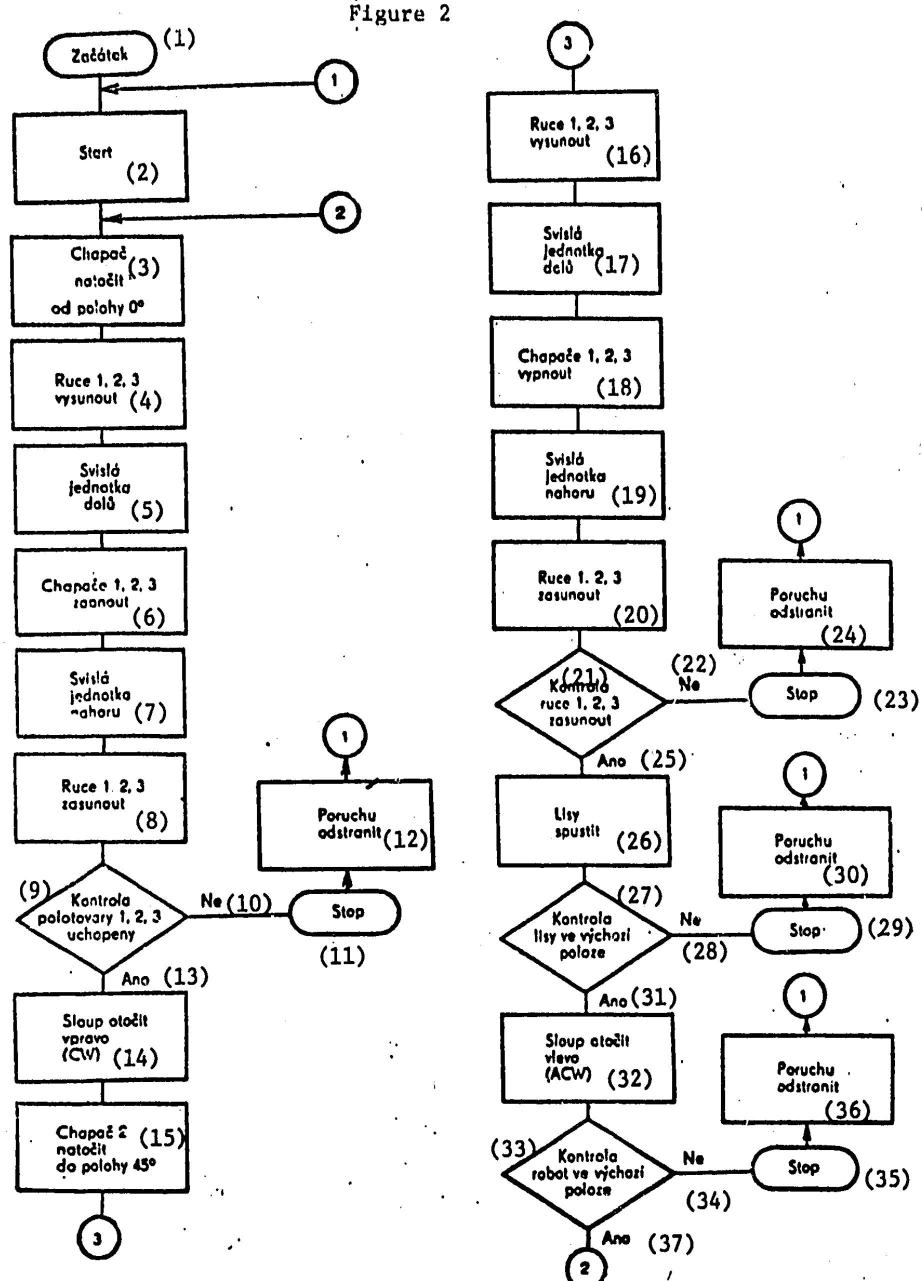
The first work oven is the feeder unit which is used to align workpieces and place them in their prescribed positions. The feeder unit consists of a universal column and mechanical parts which are replaced as required for the production of different components. These parts are readily interchangeable, since any given mechanical part is mounted on the centering pins of the column, by means of which the position of any given part is clearly fixed vis-a-vis the other machines and the robot. The lining up of workpieces is accomplished either in a vibrator, or workpieces are picked up and straightened outwhile they are being cut right on the press before going into the receiving bin. When a vibrator is used the bin is filled automatically, and this process is controlled by a photoelectric diode.

Workpieces from the feeder bin are moved by a pneumatic cylinder controlled by an electromagnetic valve from the main control module. The positions of the cylinder (i.e., the movement of the workpieces) are controlled by means of two microswitches, and the signals transmitted by these switches are picked up in the main control module.

In addition, two microswitches are also installed on the disengaging cams of eccentric presses for the purpose of monitoring press positions and verifying the completion of press operations. The signals of these microswitches together with the signals form the feeder unit are transmitted to the central control module as "opertion completed" and "machines in starting position." Upon receiving all of these signals the central control module issues the command that activates the robot, which after completing its programmed functions sends out a signal to the central control module that tells it that the "robot is in its starting position." And so the whole cycle is automatically repeated as long as no defect occurs in the system's operation (see figure 2 which presents a block schematic of the "unattended work station").

The tools used on the presses are designed so that their position can be precisely set to match shifts in the position of the robot arm and the settings of the other machines. The centering plates and the column with its movable journal are used to make these precision settings. But the alignment adjustments is not necessary. The tools themselves are of a conventional design. Only in the case of the No 3 press tool has a mechanism been attached for ejecting the finished pressed piece from the tool, thereby shortening the work cycle by 2.5 seconds, since the need for the No 3 robot arm to extract the finished pressed piece has been eliminated. When this "unattended work station" is shut down for long periods of time these tools can also be used on presses that are man-operated.

Figure 2



[Key on following page]

Key:

1. Start
2. Activate system
3. Swivel claw grip form position of 0°
4. Extend arms 1, 2 and 3
5. Upright unit down
6. Close claw grips 1, 2 and 3
7. Upright unit up
8. Insert arms 1, 2 and 3
9. Pick-up of workpieces 1, 2 and 3 checked
10. Negative
11. Stop
12. Correct problem
13. Affirmative
14. Rotate column to the right (clockwise)
15. Swivel claw grip 2 to a position of 45°
16. Extend arms 1, 2 and 3
17. Upright unit down
18. Disengage claw grips 1, 2 and 3
19. Upright unit up
20. Insert arms 1, 2 and 3
21. Insert arms 1, 2 and 3 checked
22. Negative
23. Stop
24. Correct problem
25. Affirmative
26. Activate presses
27. Starting position of presses checked
28. Negative
29. Stop
30. Correct problem
31. Affirmative
32. Rotate column to the left (counter-clockwise)
33. Starting position of robot checked
34. Negative
35. Stop
36. Correct problem
37. Affirmative/repeat process starting with step no 2/

An MHU-Junior 305 industrial robot with three arms is used in this "unattended work station" system (see figure 3). It is of modular design and has an electropneumatic drive system which permits very rapid robot movements. The simple program on the programming disk can be readily changed to conform to the technology being used for the production of any given component.

A pretested program can be firmly plugged into the programming receptacle, which is replaced for every component that is being produced, but, of course, only insofar as it proves to be necessary to change the robot's program. The high degree of positioning accuracy makes it possible to insert workpieces both on edge and on end. Accuracy and speed are a function of the mass of the workpiece that is being handled. In our case the weights of these workpieces range between 0.02 and 0.04 kg. But at these weights the accuracy with which the workpieces are inserted is greater than that specified by the manufacturer. Namely, in the case of the rotating unit the specified tolerance is ±0.00052 rad, which at a radius of 1,200 mm represents a tolerance of ±0.63 mm. In our case, however, we place the workpiece on two pins that are 2 mm in diameter and separated by a gap of 11.5 mm without running into any problems.

Technical Specificantions of the MHU-Junior 305 Robot

Working path of robot arm:	0-500 mm with lateral range of 170-1,225 mm
Number of stops	3
Max. speed	1 meter per second^{-1}
Accuracy of repetition	final position ±0.1 mm intermediate position ±2mm
Arm load	5 kg max.
Maximum lift (same for all arms):	0-150 mm with lateral range of 0-700 mm
Number of stops	2
Max. speed	0.5 meter per second^{-1}
Accuracy of repetition	±0.1 mm
Maximum rotation (same for all arms):	angle 0-3.491 rad
Max. speed	3.142 rad^{-1}
Accuracy of repetition	±0.00052 rad
Claw grips:	mechanical, pressurized, electromagnetic
Max. swivel	angle 0-3.142 rad
Number of stops	2

The dimensions of the angle of swivel within a tolerance of ±0.087 rad can be adjusted for each arm separately.

Control system:	PTP /expansion unknown/
Memory capacity	30 or 60 steps
Memory system	step counter

The operation of the machines in the "unattended work station" system is broken down as follows:

1. The No 1 arm operates the feeder unit and the No 1 press;

2. The No 2 arm operates presses No 1 and No 2;

3. The No 3 arm operates presses No 2 and No 3 and it can extract pressed pieces from the tool area of the third press and drop them on to a pallet as long as the robot is programmed to perform this function.

At ZPA-Truthnov the No 2 arm of the robot was equipped with a swivel-type claw grip, and the No 2 and No 3 arms have induction switches which are used to monitor the picking up and extraction of workpieces from tool areas. The design of this "unattended work station" makes it possible to produce pressed pieces that meet the following conditions:

a) the workpiece must lend itself to being lined up and placed in a specified location in a specified position;

b) pressing operations are limited by the force rating of the press (400 kN) and the system is capable of performing a minimum of 2 and a maximum of 3 consecutive pressing operations;

c) the workpiece can be turned in the No 2 arm at an angle of 0-3.142 rad;

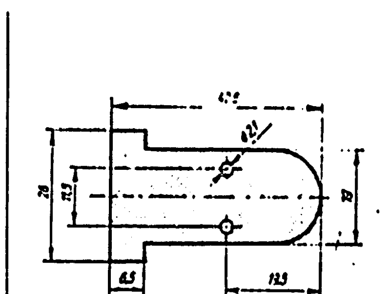
d) The component material must be ferromagnetic so that it can be picked up by electromagnets.

The system is protected against breakdowns in several ways. In order to prevent the activation of presses while the arms of the robot are still in the press work areas the press activation command is preceded by an intermediate step that checks the starting position of the robot and signals that the arms have been inserted. If it turns out that the robot is not in its starting position the central control module will withhold the command to activiate the presses. Another system protection technique consists in checking to make sure that a workpiece has been extracted from the tool area. If the workpiece has not been extracted, the work cycle is stopped. The robot itself is programmed in such a way that every final position is checked, and the cycle is interrupted if it is found that a preceding step was not completed. Other checks are made to monitor the performance of pressing operations, the positions of press hammers, the position of the feeder unit cylinder, and the ejection of finished pressed pieces. After the whole cycle is completed, a command is issued to activate the robot. The interlocking coordination of all steps is insured by the central control module.

The pressed pieces are produced in monthly or quarterly batches amouting on the average to from 30,000 to 50,000 units per batch. The net weight of the eight components (see figures 10 and 11) selected to be produced by this "unattended work station" comes to 19 tons per annum. For every scheduled operation this quantity of materials is transferred from an in-process intermediate stockpile to the work station and back again. In cases where these components are processed in three separate operations the volume of materials hauled back and forth per annum comes to 57 tons. Intermediate operational handling at this "unattended work station" has been cut back by 38 tons per annum, and manual operational-materials handling has been eliminated altogether.

Using the old technology, when workpieces were placed in the presses manually, the amount of labor time expended on the average for three operations was 16.7 seconds, whereas with the installation of the robot total labor time dropped to 7.5 seconds. In terms of estimating the amount of manpower conserved by this automated process it turns out that the reduction in labor times resulted in a 122.7-percent increase in labor productivity. One important factor, which cannot be measured quantitatively, is the altered nature of the work process itself. The demands that are being made with regard to the skill levels of worker-operators are increasing, and the bonds of the man-machine relationship are being relaxed. The job duties of the operator in this case are focused mainly on the performance of supervisory functions, making small repairs on press tools, performing minor maintenance duties, and the lubrication of the robot and the press machines. The operator also places additional workpieces in the feeder bin and collects finished pressed pieces. In view of the duration of and frequency of these functions it follows that one worker ought to be able to supervise as many as three of these systems.

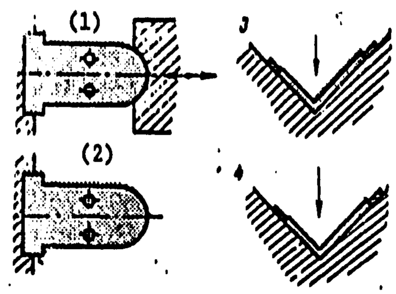
Figure 10.



Obr. 10. Rozměrový náčrtek představitele: materiál 12 041, tloušťka 2 mm

Dimensional sketch of typical workpiece:
material--12 041; thickness--2 mm.

Figure 11.



Ways in which pieces are placed in individual work areas:
(1) work area No 1 (feeder unit) operation: feed workpiece;
(2) work area No 2 (press No 1) operation: bending;
(3) work area No 3 (press No 2) operation: calibration;
(4) work area No 4 (press No 3) operation: perforation.

For a two-shift work schedule and a single automated system it is estimated, on the basis of setup costs (excluding press setup costs) and on the basis of conserved manpower, that capital costs can be recovered within a period of slightly less than 3 years. However, this investment-recovery estimate is not final. This system is giving rise to new recommendations for changes in the design and technological specifications of finished components that are commensurate with the capabilities of this system, and it is to be expected that still greater gains will be made in terms of the conservation of labor time, especially so in situations where several machines are being operated simultaneously. In suggesting a flexible production system for simple pressing operations we have proceeded from an awareness of the fact that the application of industrial robots must be governed by cost-effective rules and principles which apply to the procurement of any piece of productive machinery. In addition, this kind of industrial robot must be able to perform its work more cheaply than human workers, single-purpose machines, or some state-of-the-art machine tool. For this reason also, the installation of such a robot at ZPA-Trutnov is trictly pragmatic and in line with the conditions that govern the selection of components that are to be manufactured as finished products.

In conclusion, we would like to add that the application of industrial robots in the area of simple pressing operations is rather difficult from an engineering standpoint, especially so in view of the lack of practical domestic experience and knowledge in this field. And this is why it is necessary to promote good teamwork practices among technologists, tool designers, peripheral equipment designers, and technology designers working in this field. The practical application of industrial robots should not be viewed as a panacea that will eliminate all problems affecting the manufacture of pressed pieces, but rather strictly as a new and advanced technology which will serve not only to enhance productivity, but also and above all to contribute to the humanization of the working environment.

1. Bernard, I. "Automatizace manipulace v tvarecich procesech" /The Automation of Materials Handling in Forming Processes/, PROGRES (Journal of the Engineering Technology and Economics Research Institute /VUSTE/), No 3, 1978.

2. Havrila, M. "Vyuziti prumyslovych robotu a manipulatoru pro oblsluhu obrabecich stroju v pruznych systemech" /The Utilization of Industrial Robots and Materials-handling Devices for the Operation of Machine Tools in Flexible-schedule Production Systems/, STROJIRENSKA VYROBA, Vol 24, No 11, 1976.

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11813
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CZECHOSLOVAKIA

Z-400 SIMPLE-NC FACING TURRET LATHE DETAILED

Prague STROJIRENSKA VYROBA in Czech No 3, 1979 pp 205-208

/Article by Jan Zohorna, SIGMA national enterprise, Hranice/

/Text/ With respect to their machinability on NC machines rotary components can be classified as:

a) components with complex shapes, in which case a continuous control system can be used to good advantage,

b) components with simpler shapes, for whose machining on NC machines a rectangular control system is suitable.

With regard to components in category (b), that is, flange- or busing-shaped components, a prototype model of a simple NC facing turret lathe was drafted and produced at the SIGMA national enterprise in Hranice (see figure 1). In the course of designing this system the greatest emphasis was placed on the model's dependability, effectiveness, and simplicity so as to avoid the necessity of setting up lengthy and complicated training programs for engineers and electrical maintenance personnel.

The prototype machine is equipped with a left compound slide rest with cross slide rests pitched at an angle of 20° on which rests a tetrahedral electro-hydraulically controlled toolhead. Movement along any coordiate coordinate axis is effected by means of a hydraulic roller controlled by a system of conventional linear RSRJ /expansion unknown/ switchboards and choke valves.

An important addition to the slide rest and major technical innovation in combination with the NC system is the four-station dead-stops bracket located on both coordinate axes supplemented by a tilting pin (see figure 3). Both of these devices are electrohydraulically controlled. The desire position of the four-station bracket is slected in the program. Adjustable stops with micrometric crews can be installed on the bracket at various positions. These extra devices can be used to position slide rests within a power of resolution that is better than 0.01 mm. Where necessary stabilizing devices can be used on each coordinate axis.

In order to measure positions an HA-321 position sensor (manufactured by Tesla-Kolin) was used on the prototype model that is attached to the slide rest by means of a precision geared rack and pinion. The type of position sensor that was used makes it possible to work with pieces of the smallest programmable dimensions, i.e., down to 0.1 mm.

The effectiveness of the slide rest drive mechanism powered by hydraulic cylinders and linear-motion pistons has been fully emdonstrated, and in the case of this kind of machining work this system, when combined with the stop system described above, serves as a replacement for expensive ball screws equipped with power-assist units.

This kind of feed drive mechanism also has a direct effect on the control system by making it possible to design this system in a much simplified version.

Basic Technical Specifications:

Spindle nose CSN /Czechoslovak State Standard reference number/ 20 1006	A1 6-165
Inner spindle taper	Morse 6
Diameter of spindle in nose bearing	105 mm
Slope angle of cross slides	20°
Swing over cross slide	300 mm
Swing over longitudinal slide	550 mm
Nominal max. diameter of lathe work	300 mm
Max. length of facing lathe work	200 mm
Max. length of boring lathe work	155 mm
Rotary speeds of working spindle--total range	63-1,000 rpm
Series A	63-90-125-180 rpm
Series B	90-125-180-250 rpm
Series C	180-250-355-500 rpm
Series D	355-500-710-1,000 rpm
Feed rates (eight stages)	16-22-32-45-61-90-122-200 mm/min

Fast feed	2.7 m/min
Spacing gap between top faces (min.) spindles and toolheads (max)	214 mm 424 mm
Stroke of cross slide rest	170 mm
Stroke of longitudinal slide rest	210 mm
Number of turret toolhead positions	4
Max. cross-section of cutting tool	25 x 25 mm
Diameter of chuck	200 mm
Measuring device sensor	HA-321
Number of controlled axes (X,Z)	2
Data input mechanism:	ball-type step-by-step slector (40 columsn per step)
Position indication--absolute	0.1 mm
Min. programmable work path	0.1 mm
Number of dead stops:	
axis X	4
axis Z	4
Max. recurring inaccuracy of starting position in automatic cycle where:	
s'/rate of feed/ 125 mm/min.	0.03 mm
s'=200 mm/min.	0.1 mm
s'=2.7 m/min.	1 mm
at dead stop (s'=200 mm/min.)	0.005
Axial force of slide rests at oil pressure of 2.94 MPa	6,200 N
Slide-rest drive mechanism	hydraulic cyclinders

Adjustment Procedures

According to the programming sheet, cutting tool holders with tools clamped in place are preadjusted in an optical instrument. The stepping cylinder is set for the appropriate columns and series by means of balls in accordance with the coding table (see table 1.)

Table 1. Z 400 NC Coding Table

Sloupec krok. vol. (1)	Funkce (2)	A	B	C	D	(3) Osazení krok. vol.			
1–2	START – KONEC PROGRAMU (4)					1	2		
	Začátek programu } programuje se samostatně v kroku (5)					●			
	Konec programu						●		
3–5	NOZOVA HLAVA (6)					3	4	5	
	1 .... 1. poloha (7)						•	●	
	2 .... 2. poloha						●		
	3 .... 3. poloha						●	●	
	4 .... 4. poloha					●			
6–8	OTÁČKY (8) řada (9)	A	B	C	D	6	7	8	
	1 ...	63	90	180	355			●	
	2 ...	90	125	250	500		●		
	3 ...	125	180	355	710		●	●	
	4 ...	180	250	500	1000	●			
	5 ...	0 – Zabrzděno (10)				●		●	
	6 ...	0 – Odbrzděno (11)				●	●		
9–12	SMER (12)					9	10	11	12
	1 .... +X					●			
	2 .... −X						●		
	3 .... +Z							●	
	4 .... −Z								●
13–16	POSUV (13)					13	14	15	16
	1 .... 16 mm/min								●
	2 22							●	
	3 32							●	●
	4 43						●		
	5 61						●		●
	6 90						●	●	
	7 ... 122						●	●	●
	8 ... 200					●			
	9 ... Rychloposuv (14)					●			●
	0 ... 0					●			●

/Table 1 continued on following page/

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Table 1. continued

(1)	(2)	17	18	19	
17–19	POMOCNE FUNKCE (15)				
	1 .... najetí na pevný doraz (16)			●	
	2 .... zpevnění po koincidenci (17)		●		
	3 .... zpevnění po koincidenci		●	●	
	4 .... neobsazeno (18)				
	5 .... neobsazeno				
	6 .... neobsazeno				
	7 .... neobsazeno				

(1)	(2)	20	21	22	23
20–23	(19) Narážkové bubínky				
	1X .... 1. poloha pro osu X (20)				●
	2X .... 2. poloha pro osu X			●	
	3X .... 3. poloha pro osu X			●	●
	4X .... 4. poloha pro osu X		●		
	1Z .... 1. poloha pro osu Z		●		●
	2Z .... 2. poloha pro osu Z		●	●	
	3Z .... 3. poloha pro osu Z		●	●	
	4Z .... 4. poloha pro osu Z		●	●	●
		●			

(1)	(2)	24	25		
24–25	SPOLUVLEK OSY Z (Programuje se řídicí osa X) (21)				
	1 .... smysl vlečné osy je shodný (22) +X....+Z −X....−Z		●		
	2 .... smysl vlečené osy je opačný (23) +X....−Z −X....+Z	●			

(1)	(2)	26	27	28	29	30	31	32	33	34	35	36	37	38	39
26–39	SOURADNICE Z (24) Dráhy souřadnic se programují v desetinách mm (25)	200	100	80	40	20	10	8	4	2	1	0,8	0,4	0,2	0,1
		. 100		. 10				mm . 1				. 0,1			

Key:

1. Step selector column
2. Function
3. Step selector setting

/Key continued on following page/

Key continued:

4. Program start, finish
5. Program start and finish are programmed independently during a given step
6. Toolhead
7. Position
8. RPMs
9. Series
10. Brake applied
11. Brake released
12. Direction
13. Feed rates
14. Fast Feed
15. Auxiliary functions
16. impact with dead stop
17. post-coincidence stabilization
18. Voided
19. Stop drums
20. Position for axis
21. Parallel draw of Z-axis (Guiding X-axis is programmed)
22. direction of draw axis is congruent
23. direction of draw axis is reversed
24. Coordinates 2
25. Paths of coordinates are programmed in tenths of millimenters

In a BB /expansion unknown/ operational mode one component is turned, and, depending on the results, adjustments are made by altering the position of the balls. Adjustments of tools used for precision lathe work are made by turning a fine-lead step screw.

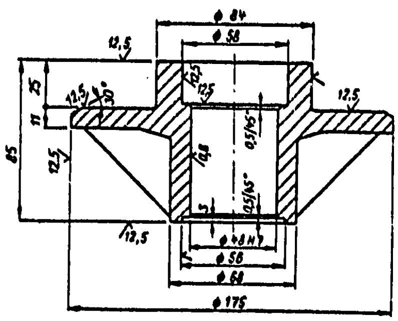
So, up to the point where the selected dead stop settings are made; the manner in which this maschine is adjusted does not differ from other kinds of NC lathes. In view of the fact that on the average only 1 to 3 stop settings need to be made, setup delays are negligible, and, moreover, these minor delays are amply offset by the low breakdown rate of the machine as a whole due to the simplicity of its design.

Typical Workpieces Suitable for Machining on a Z 400 NC Machine

Workpiece specifications:

Name of workpiece	Wheel hub (see figure 5)
Material	cast steel 42 2653
Net weight of workpiece	2.7 kg
Number of clamping operations	2
Machine time during clamping operations 1 and 2	16.20 min.
Name of workpiece	Sealer element
Material	grey cast iron
gross weight of workpiece	4.90 kg
Number of clamping operations	2
Machine time during clamping operations 1 and 2	10.67 min.

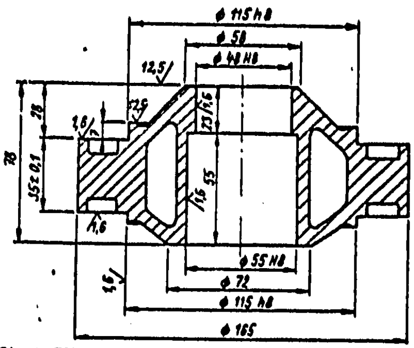
Figure 4.



Obr. 4. Náboj

Wheel hub

Figure 5.



Obr. 5. Těleso ucpávky

Sealer element

Conclusion

The trial-run operation of the prototype turret lathe machine on a two-shift schedule since April 1976 has confirmed the inherent advantages of this design concept bearing in mind the maximum dependability of all of the lathe's component parts, their effectiveness, simplicity, and ease of manufacture (including the manufacture of the control system).

The combination of numerical controls with programmable dead stops and hydraulic slide rests shows that it is possible to manufacture a new type of so-called "NC-program" machine which can do an adequate job of filling the gap between program-controlled and current-generation NC-type machines.

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END