

VERTICAL KNEE-TYPE
MILLING MACHINES

6T12-1, 6T13-1

Operator's Manual

6T12-1.00.000 re

Part I

STANKOIMPORT

USSR

MOSCOW

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1 GENERAL INFORMATION

ID number _____
Model (Make) _____
Date of placing machine in service _____

Knee-type milling machines 6TI2-I and 6TI3-I (Pic.1 and 2) are designed for various milling works of various parts from different materials under the condition of piece production and batch manufacturing. The machines provide for machining of vertical and horizontal planes, slots, angles, frames, toothed gear wheels, etc.

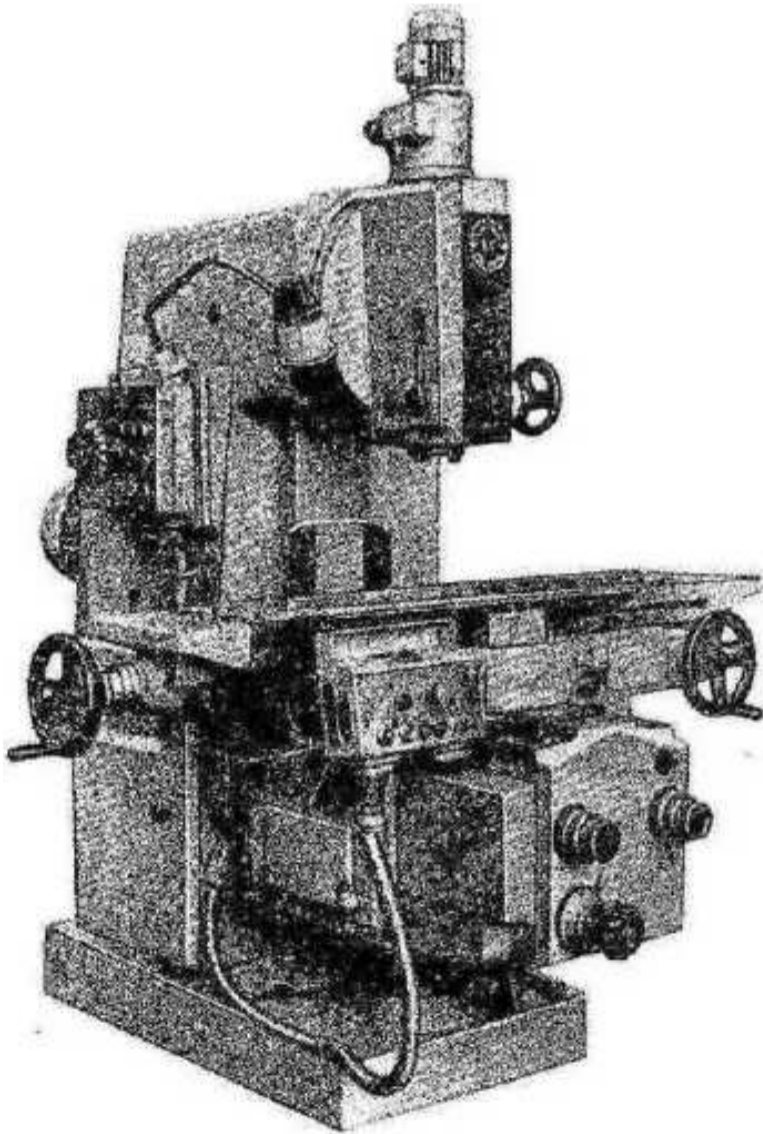
Machines **6TI2-I** and **6TI3-I** are fabricated with maximal level of unification and have similar kinematic diagrams.

Application of indexing attachment, round rotary table and other attachments expand the manufacturing capabilities of the machines.

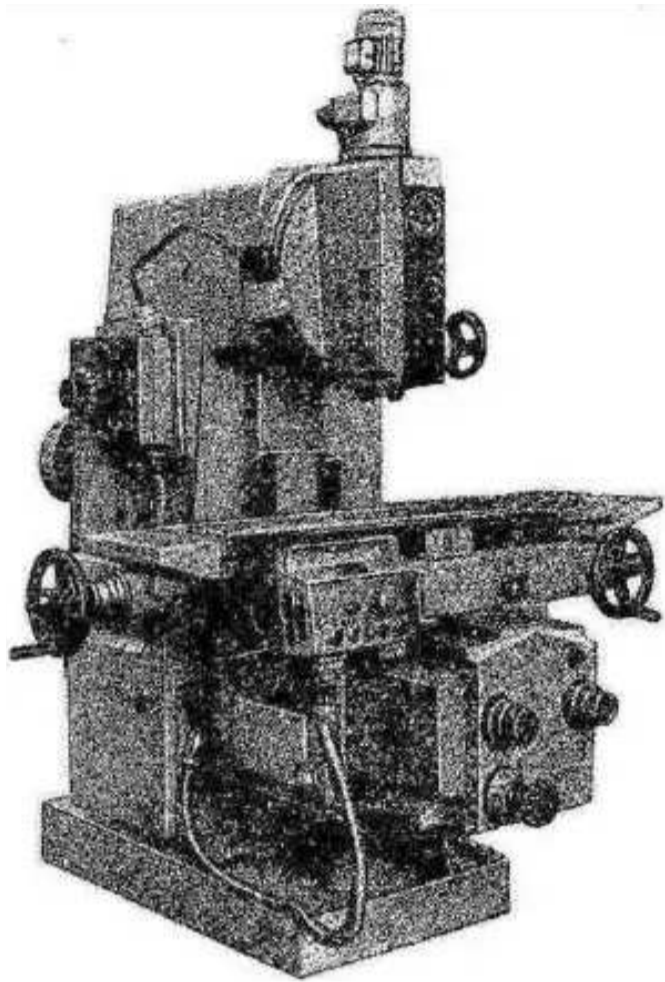
The ability to adjust a machine to various semiautomatic and automatic cycles allow for simultaneous operation of several machines, successfully use the machines for different works in flow-line manufacturing.

The machines are designed for the countries with moderate, cold and tropical climate.

**DIRECTIONS AND RECOMMENATIONS GIVEN IN THE OPERATOR'S MANUAL
MUST BE FOLLOWED!**



Pic. 1. Knee-type milling machine **6TI2-I**



Pic. 2. Knee-type milling machine 6T13-I

2 MAIN TECHNICAL DATA AND SPECIFICATIONS

2.1 Basic parameters and dimensions according to State Standard (GOST) 165-81

Parameter name		Dimensions	
		6T12-I	6T13-I
Accuracy class accord. to GOST 8-82		R(Regular)	R(Regular)
Dimensions of table work surface, mm	width	320	400
	length	1250	1600
Number of T-slots		3	
Width of T-slots, mm	central	18 N8	
	outer	18 N12	
Distance between T-slots, mm		63	100
Biggest table movement, mm	lengthwise	800	1000
	crosswise	270	340
	vertical	420	430
Spindle end GOST 24644-81, feed row 4, rev. 6		50	
Number of spindle rotation speed		18	
Spindle speed range, min ⁻¹		31,5 ... 1600	
Number of table feeds		22	
Limits of table feeds S, mm/min	lengthwise	12,5 ... 1600	
	crosswise	12,5 ... 1600	
	vertical	4,1 ... 530	
Proportional creep mode, mm/min		I/2s	
Fast table travel speed, mm/min	lengthwise	4000	
	crosswise	4000	
	vertical	1330	
Distance from spindle nose face to table working space,	minimal	30	70

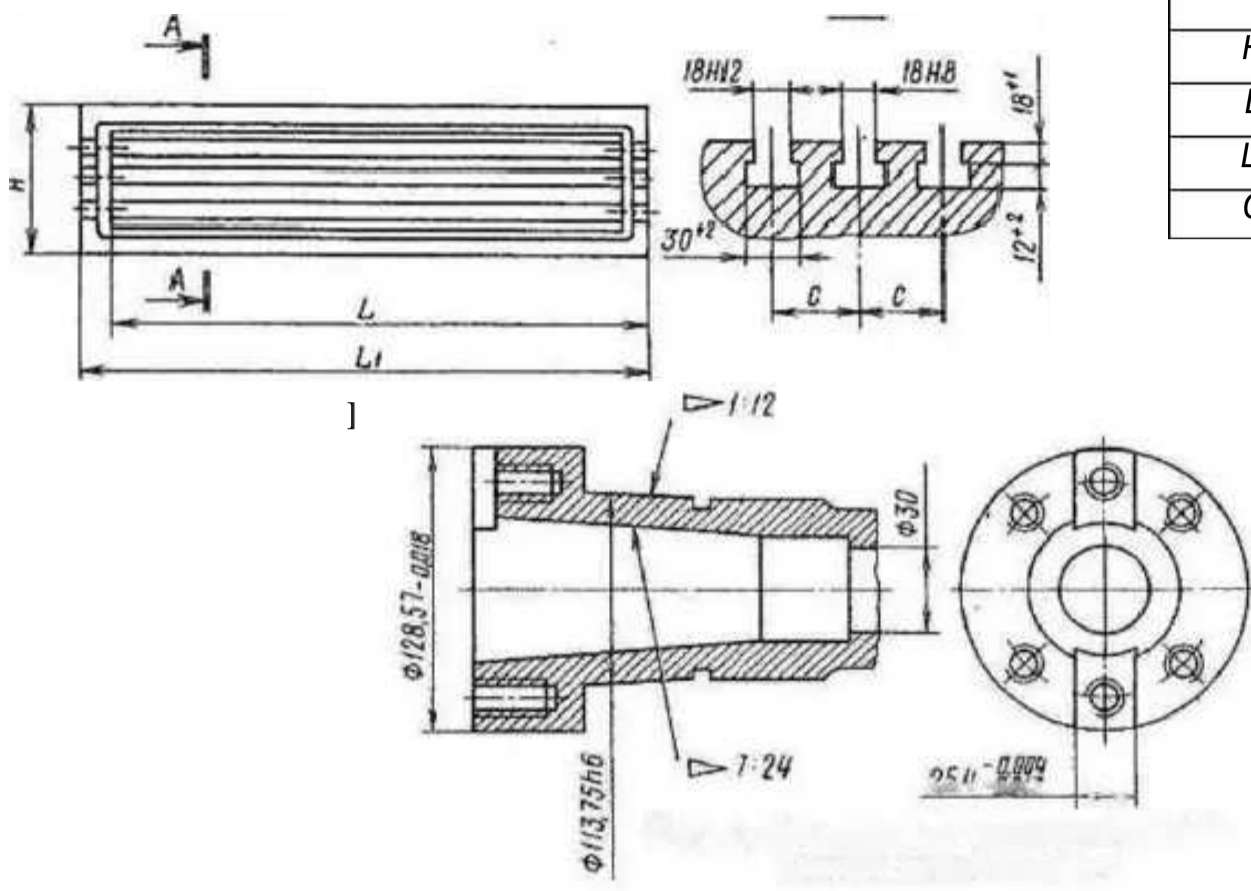
mm			
	maximal	450	500
Distance from rotating head axis to bed guide rails, mm		350	420
Table travel at one dial circle graduation, mm	lengthwise, crosswise, and vertical	0,05	
Table travel for one full rotation of dial, mm	lengthwise	6	
	crosswise	6	
	vertical	2	
Spindle quill stroke (vertical), mm		70	80
Spindle quill travel on one full rotation of dial, mm		4	
Spindle quill travel on one circle graduation of dial, mm		0.05	
Maximal angular span of spindle head, degree		±45	
Scale division value of head rotation, degree		I	
Max. weight of machined part and attachment installed at the machine, kg		400	630
Physical dimensions of the machine, mm	length	2280	2570
	width	1965	2252
	height	2265	2430
Weight of machine with electric equipment, kg		3400	4250
Corrected sound power level, dBA		98	103
Biggest allowable cutter diameter for rough machining, mm		160	200

See Pic. 3 6 coupling sizes and mounting dimensions.

2.2. Machines' mechanics

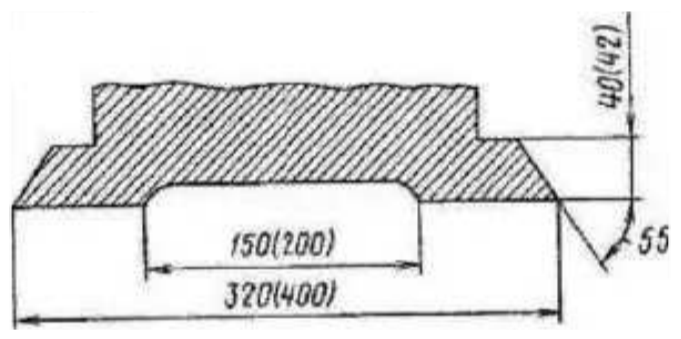
2.2.1 Primary motion mechanics

Spindle rotation rate, min ⁻¹	Spindle max. allowable torque, Nm		Drive power at spindle, kW	
	6T12-1	6T13-1	6T12-1	6T13-1
31,5	1010	1370	6,56	8,89
40	1010	1370	6,55	8,87
50	1010	1370	6,55	8,87
63	1010	1370	6,55	8,87
80	797	1079	6,55	8,87
100	636	862	6,53	8,86
125	508	690	6,53	8,84
160	396	538	6,52	8,84
200	316	428	6,50	8,80
250	253	342	6,50	8,80
315	200	272	6,48	8,78
400	157	212	6,48	8,70
500	125	169	6,44	8,68
630	100	132	6,41	8,57
800	77	103	6,36	8,46
1000	60	80	6,24	8,32
1250	47	62	6,08	8,00
1600	36	46	5,93	7,57

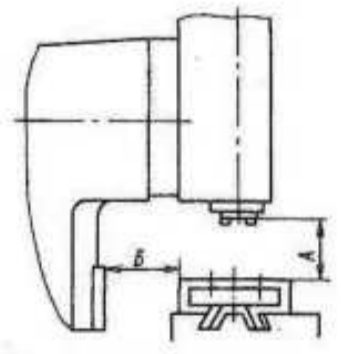


Dimension, mm	6T12-1	6T13-1
H	320	400
L	1250	1600
Lt	1325	1700
C	63	100

Pic. 4 Horizontal spindle face coupling sizes and mounting dimensions



Pic. 5 Coupling sizes and mounting dimensions of the bed guide rails in brackets)



Размер, мм	6T12-1	6T13-1
A	30... 450	70... 500
B	70... 340	60... 400

Рис. 6. Габарит рабочего пространства

Dimension, mm	6T12-1	6T13-1
A	30... 450	70... 500
B	70... 340	60... 400

Pic. 6 Dimensions of work space

2.2.2 Mechanics of feeds

Stage number	Table feed, mm/min	Stage number	Table feed, mm/min
--------------	--------------------	--------------	--------------------

	lengthwise and crosswise	vertical		lengthwise and crosswise	vertical
	6T12-16	6T13-1		T12-1	6T13-1
1	12,5	4,1	13	200	66,6
2	16	5,3	14	250	83,3
3	20	6,6	15	315	105,0
4	25	8,3	16	400	133,0
5	31,5	10,5	17	500	166,6
6	40	13,3	18	630	210,0
7	50	16,6	19	800	266,6
8	63	21,0	20	1000	333,3
9	80	26,6	21	1250	416,6
10	100	33,3	22	1600	530,0
11	125	41,6	Fast travel	4000	1330
12	160	53,3			

2.2.3 Biggest allowable cutting force

Table feed	Biggest cutting force, N	
	6T12-1	6T13-1
Lengthwise	15000	20000
Crosswise	12000	12000
Vertical	5000	8000

2.3 Technical specifications of electric equipment

Parameter name		Dimensions	
		6T12-1	6T13-1
Number of electric motors installed at a machine		4	
Electric motor of the main movement drive	type	4AI32B4	4AI32M4
	power, kW	7,5	11
	rotation rate, min-1	1455	1460
Electric motor of the table feed drive	type	4AM90M4	4AM100S4
	power, kW	2,2	3,0
	rotation rate, min-1	1425	1435
Electric motor of mechanical tool clamp	type	4AA56B4	
	power, kW	0,18	
Electric motor of centrifugal pump	rotation rate, min-1	1365	
	type	X14-22M	
	power, kW	0,12	
	rotation rate, min-1	2800	
Total power of all electric motors, kW		10	14,3

3 SCOPE OF DELIVERY

Designation	Name	Quantity per machine		Note
		6T12-1	6T13-1	
	...			
			
	Documentation			
6P112-I.00.000PЭ	Operator's manual. Supplied at Client's request at extra charge	Quantity as per the order -		
	Appliances			
	Toolholder GOST 13785-68 6222-0032 Ø 27	1	1	
	Machining vise with manual drive mechanism rotating with straight grips of normal grade of accuracy 7200-0220-01 GOST 14904-80	1	1	
	Universal indexing head: UDG-D-250 UDG-N-160	1	1	
6P82.OIIB.01	Housing	1		For guarding of interchangeable gear wheels UDG-D-250
6P83.OIIB.01	Housing	1		For guarding of interchangeable gear wheels UDG-N-160
6P82.74.000	Rotary table with a mechanical drive reducer Ø 400 mm	1	1	

4 SAFETY MEASURES

4.1 Safety requirements to servicing personnel

Read thoroughly and understand the manual before operating the machine.

The persons acquainted with the general operational safety requirements at milling works, who studied the peculiarities of the machine, and labor safety measures, given in this section of the operator's manual, are allowed to operate the machine.

4.2 Safety requirements during installation and repair works

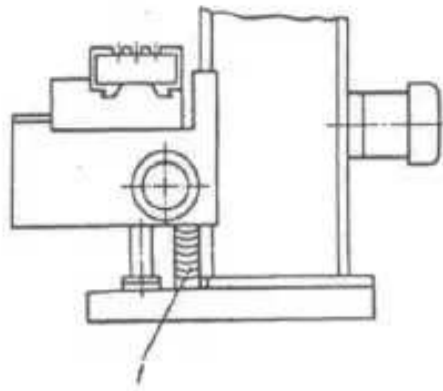
4.2.1. Unpacking and transportation. See the section "Installation sequence" of the manual.

4.2.2. Installation. The machine shall be safely secured and connected to the electrical grounding system. Grounding circuits resistance shall not exceed 0,1 Ohm.

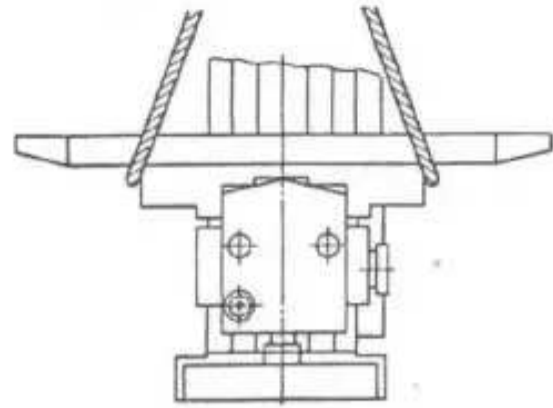
4.2.3. Repair works. During the repair works related to removal of the covers from niches containing moving parts (gearbox, feeding unit, console), disassembly and removal of components, the machine must be de-energized.

4.2.4. It is recommended to put a support 1 underneath (Pic. 7) in order to prevent the drop of console during disassembly of a screw drive.

4.2.5. During disassembly of console bed (Pic. 8) in assembly with the table and slide, before disassembly of the slide-bar, it is recommended to put up the console with a crane.



Pic. 7 Installation of support under console during disassembly of the vertical movement screw drive



Pic. 8 Putting up the console weight using a crane

4.3 Safety requirements to main structural components and control systems

4.3.1. Machine operator may operate exclusively the controls located on the external side of machine. Door of the electric cabinet shall be locked using a special key. Only qualified electricians are allowed to open the electric cabinet door.

4.3.2. The extreme table positions reached during lengthwise, crosswise, and vertical movements are limited by end stops. *OPERATING THE MACHINE WITH REMOVED END STOPS AND FAULTY SEQUENTIAL CONTROL DIVICES, DISABLING THE FEED IS STRICTLY*

PROHIBITED!

4.3.3. Braking action of spindle is automatic after pressing the "Stop" button. Time until spindle stop does not exceed 5 - 6 seconds.

4.3.4. Spindle disabling is blocked with feed. At simultaneous drives shutoff the spindle drive shuts off later, than that of the feed drive.

4.3.5. Direction of handles and handwheels rotation of manual controls corresponds to the direction of movement of the machine parts.

4.3.6. Handle of transverse and vertical movement of the table is blocked with feed drive. During manual movement of the table (when the handle is moved in) the electric circuit of the corresponding feed is open.

Table longitudinal movement handwheel, located at the table butt end, is blocked from random closing in case of mechanical feed by the spring. Duplicating handwheel at the slide assembly front butt end for mechanical lengthwise feed is disengaged by a selector switch.

In the process of machine operation, it is necessary to maintain unfaulty operation of the above devices, and condition of mounting seats for handwheels, handles, and shaft necks, onto which they are mounted.

IT IS NOT ALLOWED TO OPERATE THE MACHINE IN CASE OF FAULTY LOCKING DEVICES.

4.3.7. IT IS NOT ALLOWED TO SPINDLE GEARSHIFT DURING MACHINE OPERATION.

4.3.8. Cooling liquid nozzle must be securely fixed. *IT IS NOT ALLOWED TO ADJUST, RE-INSTALL THE NOZZLE DURING MILLING OPERATION OR SPINDLE ROTATION.*

4.3.9. *IT IS NOT ALLOWED TO PERFORM AUXILIARY OPERATIONS (WORKPIECE MOUNTING, DEMOUNTING, MEASURING, ECT.) DURING TOOL ROTATION.*

4.4. Safety equipment, included into the engineering design

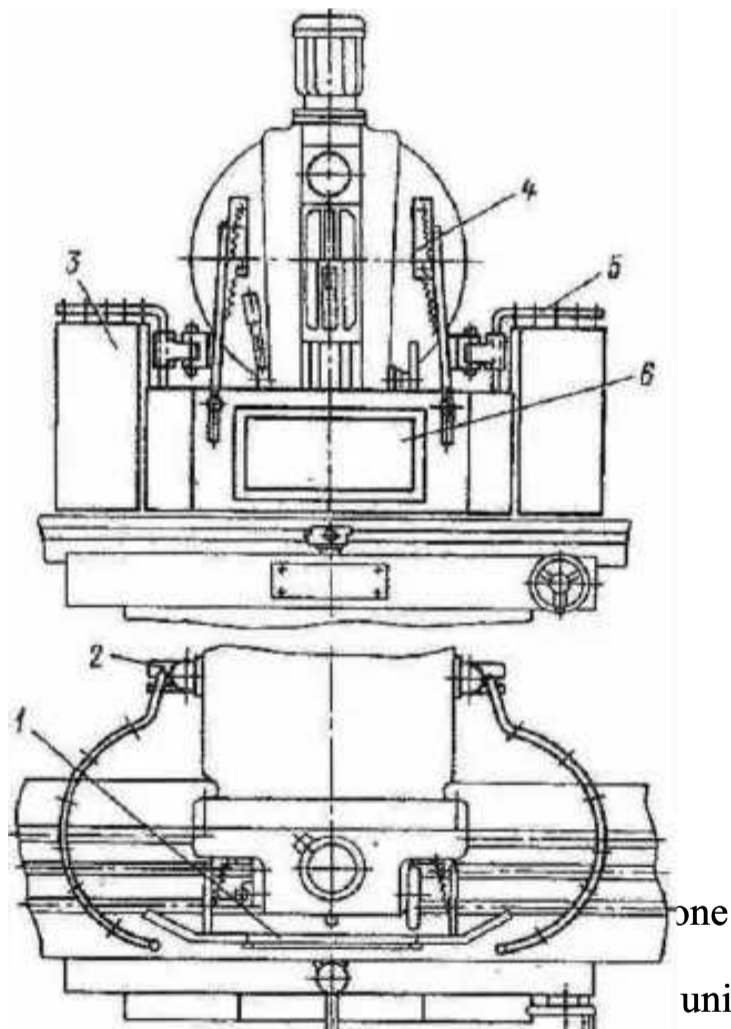
4.4.1. Work zone is protected with safety device (Pic. 9). It is designed to protect the operator of the machine, and personnel located next to the machine, from the bouncing outgoing swarf and coolant-cutting fluid. The protection guard is composed of a screen 1, four-bar linkage 4 for its movement and height adjustment, blinds 3, suspended on brackets 5.

The structure envisages the possible of changing the height of the blinds' position by moving the brackets in the hinge 2. During installation and de-installation of a workpiece or tool replacement, the screen 1 is put upwards and the blinds' components are put to the left and right side to the needed angle. There is an inspection window 6 in screen 1 envisaged to observe the tool zone.

IT IS STRICTLY PROHIBITED TO OPERATE THE MACHINE WITHOUT SAFETY DEVICE.

4.4.2. When operating the rotating table, driven by the speed reducing drive of a power transmission, it is a must to protect the rotating jointed shaft with a casing. **IT IS STRICTLY PROHIBITED TO OPERATE THE MACHINE WITH DISMOUNTED CASING.**

4.4.3. Tool retention in the machine's spindle is mechanized.



When unit drive is activated, the spindle is automatically braking, which excludes its rotation during clamping.

IT IS STRICTLY PROHIBITED TO OPERATE THE MACHINE WITH THE FAULTY BRAKING SYSTEM.

4.4.4. Switching the spindles on is only possible when the tool is clamped. The repeated tool clamping is needed, after the isolating switch is open or the emergency STOP button pressed.

4.4.5. In case a mechanical chucking device is used to clamp a workpiece, there are terminals located on the panel of electric control cabinet to connect the clamp control units. **IT IS A MUST TO REMOVE THE JUMPER** between the terminals in this case.

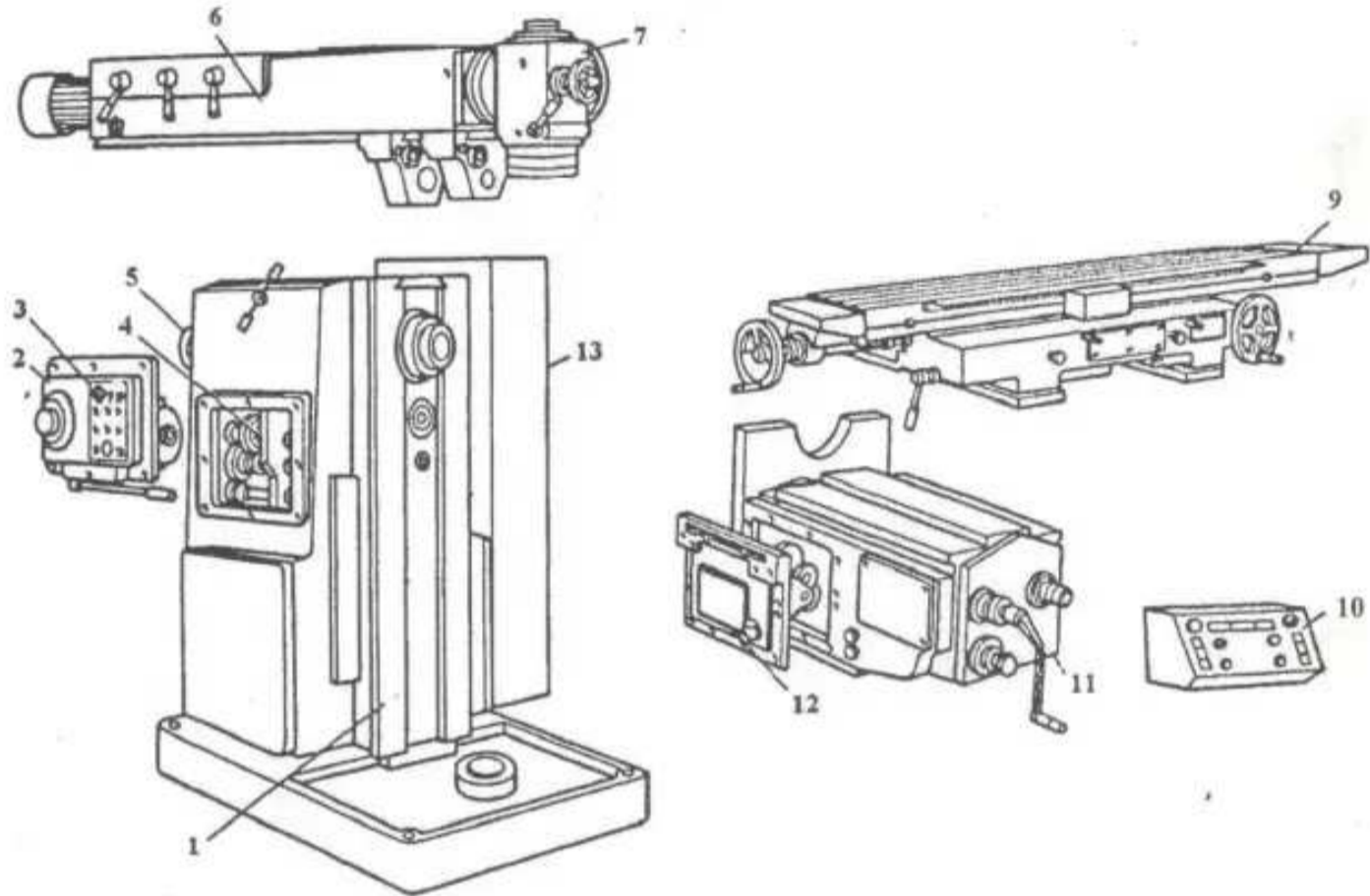
4.4.6. Isolating switch is equipped with the lockout device, disconnecting the machine from the power supply circuit, when the electric cabinet door is opened.

4.4.9. Feed drive is equipped with the overload-relief clutch, excluding machine breakage from overload and obstacles for table travel.

5 CONFIGURATION OF THE MACHINES

5.1 See Pic. 10 for general view of the machines with designation of its main components.

5.2. See Table 1 for the list of main components.



Pic. 10 Location of the main components of the machine

Table 1

List of machine's components

Designation		Nomination	Position number at Pic 10	Note
6T12-1	6T13-1			
6T12-1.10	6T13-1.10	Bed	1	
6T82G-1.85	6T82G-1.85	Side control panel	2	
6R82.5	6R83.5	Gear shift mechanism	3	
6T12-1.30	6T13-1.30	Gearbox	4	
6R12.32	6R13.32	Rotating head	5	
6R12K.93	6R13K.93	Set of electromechanical tool clamping unit	6	The set includes electromechanical head 7921-0001
6T82G-1.81	6T82G-1.81	Control station	7	
6T82G-1.70	6T82G-1.70	Table and slide assembly	8	
6T82G-1.41	6T82G-1.41	Feed deceleration mechanism	9	
6T82G-1.84	6T82G-1.84	Main control panel	10	
6T82G-1.60	6T82G-1.60	Console	11	
6T82G-1.40	6T82G-1.40	Feed box	12	

6 DESIGN, OPERATION OF MACHINE AND ITS MAIN COMPONENTS

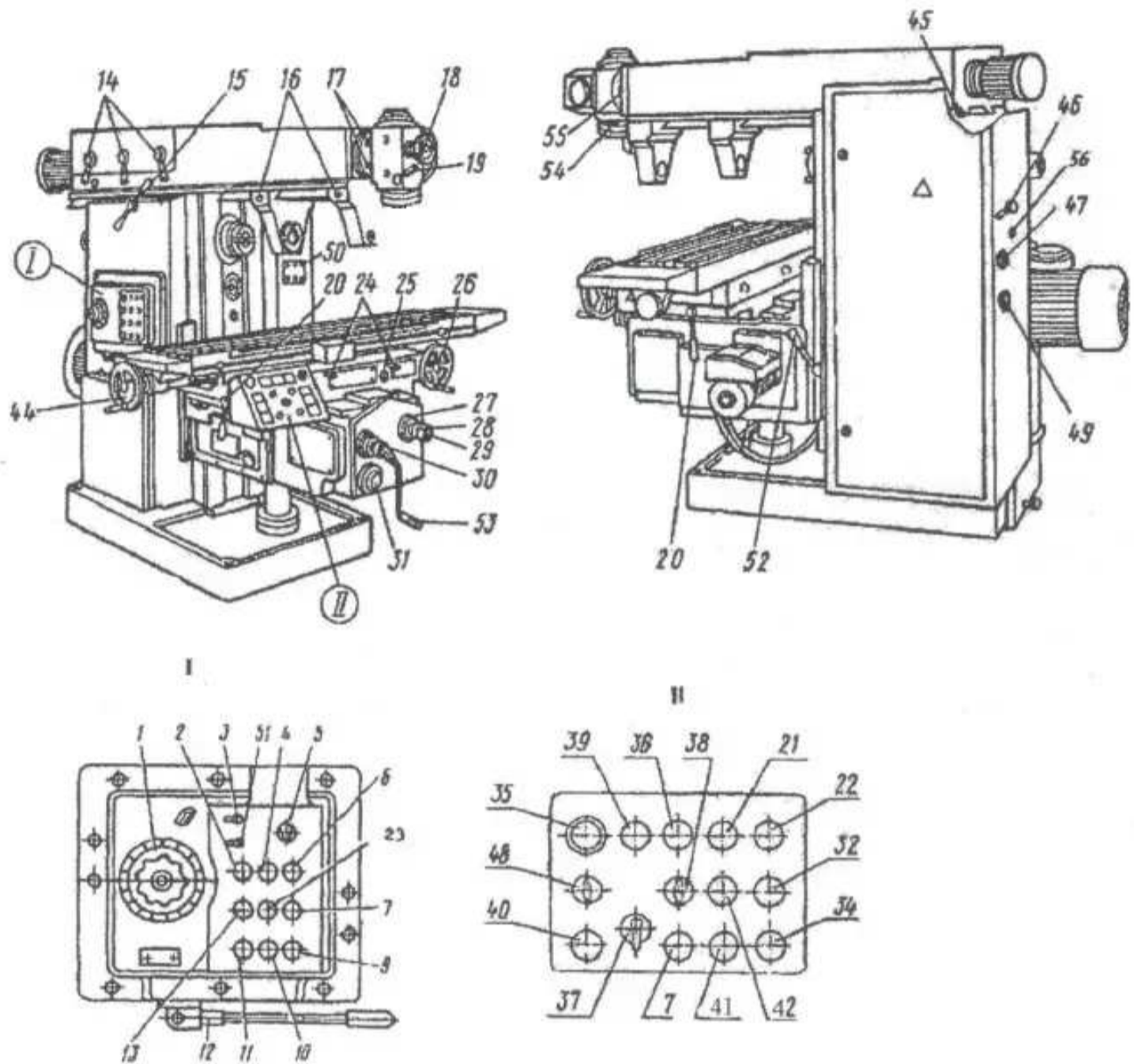
6.1 See Pic. 11 for the general view with nomination of controls.

6.2. See Table 2 for the list of controls, and Table 3 for the list of graphic symbols of the controls.

List of controls

Table 2




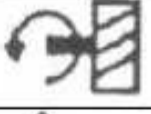

Position at Pic. 11	Controls and their designation
1	Indicator of spindle rotation speed
II	“Spindle joggle” key
3	“Tool clamping – de-clamping” switch
4	“Table travel “advance – left -- upwards” key
5	Selection of table travel direction switch
6	“Table travel “backwards – advance – downwards” key
7	“Stop table travel” key
8	“Decelerated feed” key
9	“Fast table travel” key (duplicate)
10	“Stop” key, emergency
13	“Stop spindle” key (duplicate)
12	Handle of spindle gearshift
2	“Spindle start” key (duplicate)
14	Head swiveling hexagonal shank
15	Handle of spindle sleeve chuckle
16	“Table travel left” key
17	“Table travel right” key
18	“Longitudinal table movement stop” key
19	“Spindle stop” key
20	“Spindle start” button
21	Table clamps
22	Table mode switch “Manual – Mechanical”
23	Handwheel of manual lengthwise table travel
24	Vernier ring
25	Crosswise table movement indicator dial
26	Manual crosswise table travel
27	Manual vertical table travel
28	Mushroom feed-shift knob
29	“Stop” button, emergency
30	Machine mode of operation switch
31	“Decelerated feed” key
32	“Fast table travel” key
33	“Vertical table travel stop” key
34	“Downward table travel” key
35	Guide rail clamps
36	“Upward table travel” key
37	Handwheel of manual lengthwise table travel (duplicate)
38	“Crosswise table travel stop” key
39	“Advance table travel” key
40	“Backwards table travel” key
41	Spindle quill moving-out handwheel
42	Head clamp on the bed
43	Isolating switch
44	“Left – right” spindle rotational direction switch
45	Cooling pump On – Off switch
46	Control panel selection key
47	Automatic cycles selection switch
48	Console clamp
49	Handle of vertical and crosswise table travel (detachable)






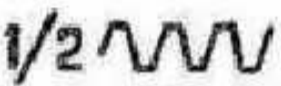








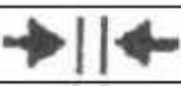
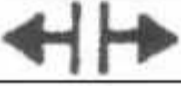
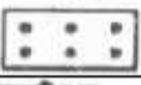

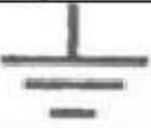

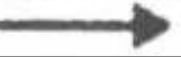






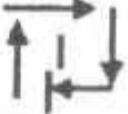

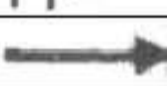

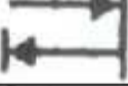

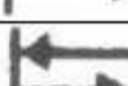



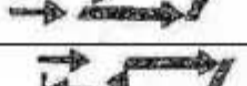
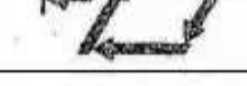

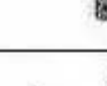
Pic. 11 Location of machine controls

6.3. See Table 3 for the list of graphic symbols

Table 3

Symbol	Implication
	Main power supply switch
	Spindle with milling tool
	Milling tool
	Counterclockwise spindle rotation
	Coolant-cutting liquid pump

	Switching off
	Switching on
	Switching on at constant pushing effort
	Fast travel
	Feed
	Creep mode
	Operation with manual control
	Nut free play adjustment
	Charging
	Lubrication of guide rails
	No shift in motion
	Lightning
	Flywheel
	Control
	Tool clamping
	Tool de-clamping
	Main control panel
	Ground insulation failure
	Grounding
	Brake engagement
	Table
	Round table
	Clockwise spindle rotation
	Travel left
	Travel right

	Travel from operator
	Travel to operator
	Travel upwards
	Travel downwards
	Cycle start
	Semiautomatic mode of operation
	Simple milling cycle right
	Simple milling cycle left
	Simple milling cycle right with reverse
	Simple milling cycle left with reverse
	Pendulum (reciprocal) milling
	Frame cycles
	Horizontal frame with counterclockwise tracking
	Horizontal frame with clockwise tracking
	Vertical frame with clockwise tracking
	Vertical frame with counterclockwise tracking
	Cabinet closed
	Cabinet open

6.4. Gear-train (kinematic) diagram

Main movement driving is performed from a flange motors through flexible coupling (Pic. 12). Spindles rotation rates are varied by shifting three gear arrangements along the splined shafts. The gear box provides 18 different rotational speeds to the spindle.

See Pic. 13 for spindle rotation rates diagram, which explains the main movement mechanism structure.

Feed drive, engaging the rapid travel chain, working feed chain is performed from the flange mounted motor, located at the right side of the console. Using four double sprocket wheels and a single movable toothed gear wheel transmission by gearing the feeding box provides for 22 various feeds (Pic.12), which are transferred to the drive output shaft, provided with a drive clutch of fast travel, work feeds' clutch, and a safety ball-type clutch. The movement from the tooth wheel rim 59 of the overload release clutch is transferred to the movement feeding box to feeding screws, where there are two control electromagnetic clutches with mutually antithetic directions of rotation.

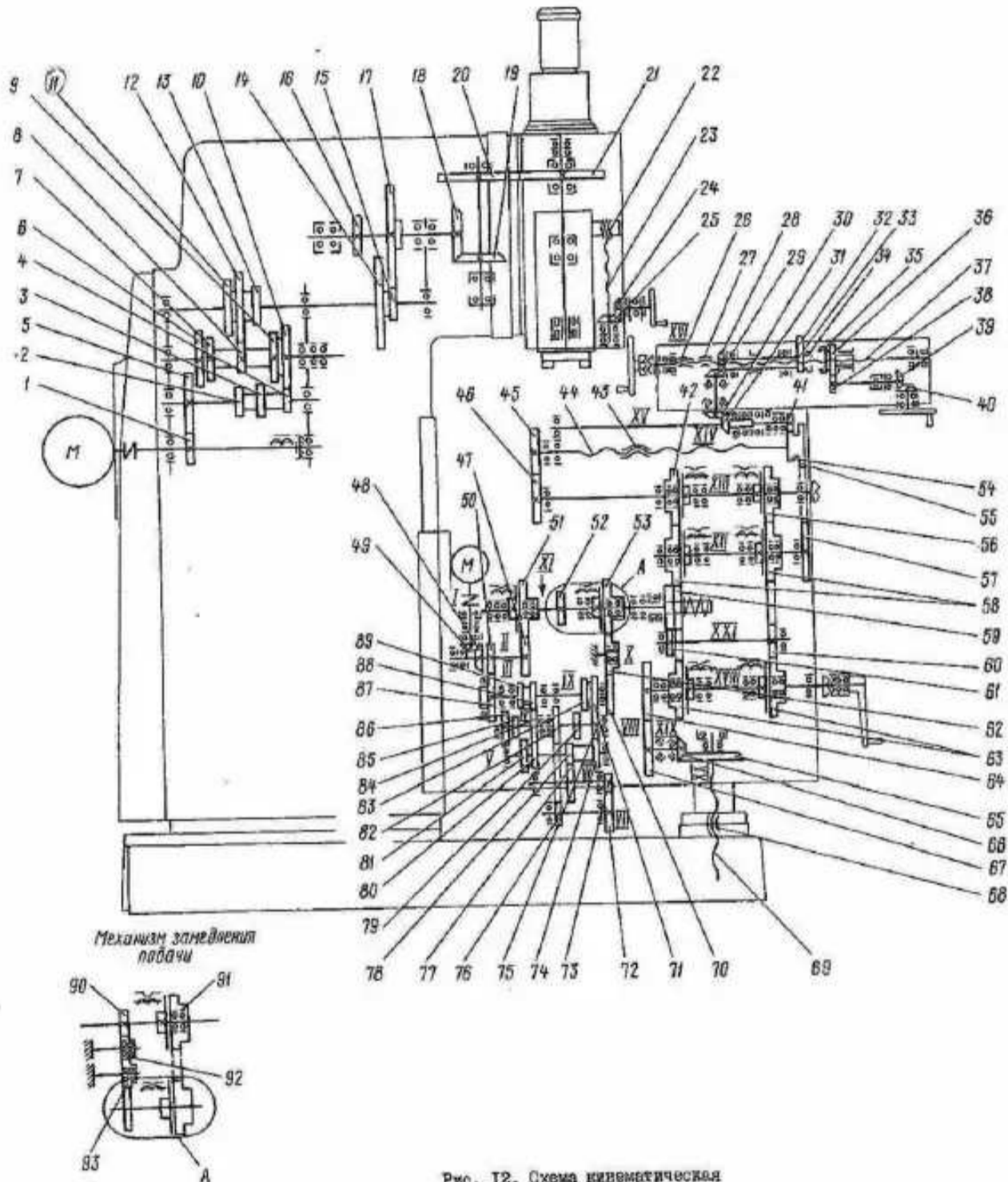
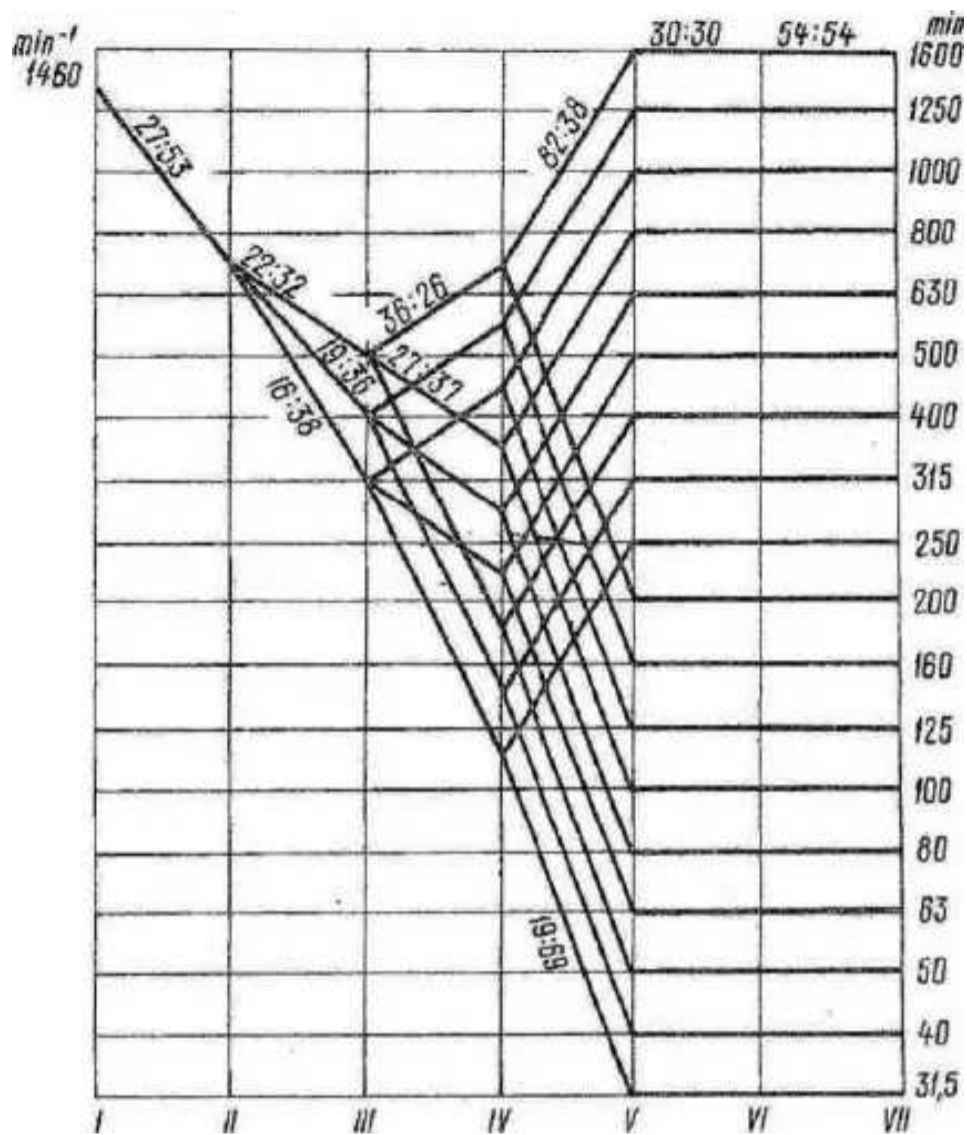


Рис. 12. Схема кинематическая

Pic. 12. Gear-train (kinematic) diagram



Pic. 13. Diagram of spindle rotation frequencies shaft

Table travel in the designated direction is provided by engaging the corresponding clutch in the distribution gear box.

The fast travels result by engagement of the fast travel clutch 51 and the feed motor, which movement through bevel gears 49 and 48 transfer to shaft II, and then through sprocket 47 is transferred to the clutch tooth wheel rim 43, freely rolling off on shaft XI and interlocking with the electromagnetic clutch of fast travel engagement.

Work travels are provided by engaging the feed clutch 53 on the operating motor and disengaged clutch of fast travel. Rotation rate of the output shaft XI on the switched-on feed is determined by position of sliding sprocket wheels inside the feeding box.

Upon engaging the mechanical travel of machine table the movement start follows with time delay of up to 2 seconds.

Movement transfer to the income of reduction unit is performed by the gear wheel of clutch 53, freely rotating at shaft XI. Movement from the reduction unit when the creep feed clutch is engaged is transferred to gear wheel 52, rigidly connected to XI. The clutch of fast travel and working feeds is disengaged when deceleration is engaged.

Table trial-and-error manual movements are performed by flywheels 23 and 37 (Pic. 11). Slide assembly and console travels – by detachable handle 49, carousel movement sleeve – flywheel 41.

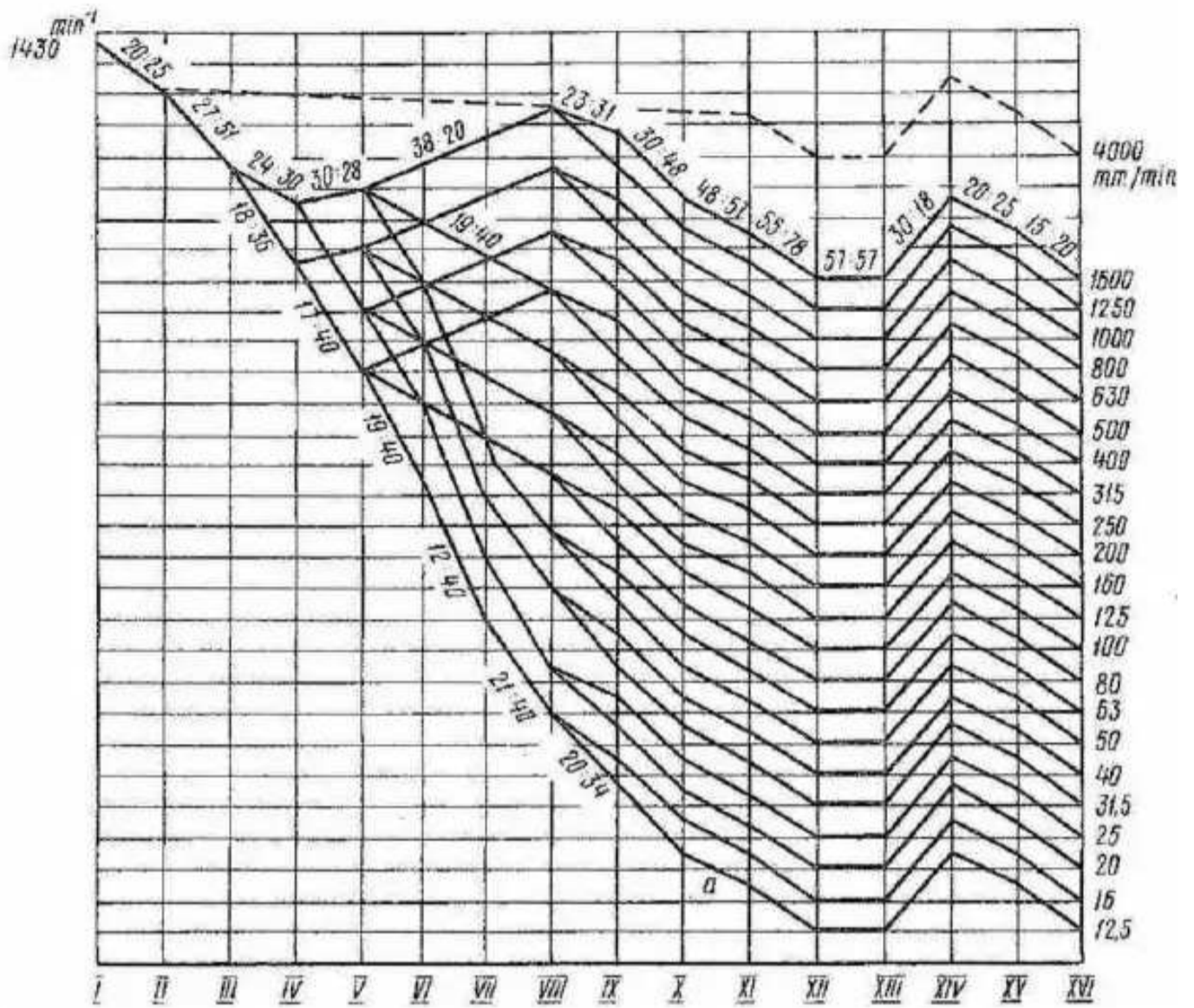
See Pic. 14 for the diagram, explaining the structure of feeding mechanism of the machine (vertical feeds are three times as small as the lengthwise and crosswise).

See Table 4 for the list of gear-train (kinematic) diagram elements.

Table 4

Included into	Position at Pic. 12	Number of toothed gear wheel teeth or threads of worm gear, driving screws	Module or pitch, mm
Gearbox	1	27	3
	2	19	4

	3	22	4
	4	16	4
	5	53	3
	6	35	4
	7	27	4
	8	17	4
	9	32	4
	10	38	3
	11	37	4
	12	46	4
	13	26	4
	14	82	3
	15	19	4
	16	38	3
	17	69	4
	18	26	3,5
	19	26	3,5
	20	72	3
	21	72	3
	22	1	4
	23	1	4
	24	31	1,5
	25	31	1,5
Table and slide assembly	26	1	6
	27	1	6
	28	20	3
	29	15	3
	30	25	2,5
	31	20	2,5
	32	15	3
	33	30	3
	34	48	1,5



Pic. 14. Diagram of lengthwise and crosswise feeds

Continued Table 4

Included into	Position at Pic. 12	Number of toothed gear wheel teeth or threads of worm gear, driving screws	Module or pitch, mm
Table and slide assembly	35	48	1,5
	36	50	2
	37	1	6
	38	25	2
	39	18	2
	40	24	2
Console	41	18	3
	43	78	2
	44	1	6
	45	51	3
	46	51	3
	47	48	2,5

	48	25	2
	49	20	2
	50	27	2,5
	51	57	2,5
	52	41	2,5
	53	57	2,5
	54	30	3
	55	57	2,5
	56	78	2
	57	57	2,5
	58	78	2
	59	55	2
	60	38	2
	61	38	2
	62	48	2,5
	63	78	2
	64	52	3
	65	51	2,5
	66	17	2,5
	67	52	3
	68	1	6
	69	1	6
	70	30	2,5
	71	34	2,5
	72	40	2,5
	73	12	2,5
	74	38	2,5
	75	20	2,5
	76	21	2,5
	77	40	2,5
	78	19	2,5
	79	23	2,5
	80	28	2,5
	81	40	2,5
	82	40	2,5
	83	31	2,5
	84	30	2,5
	85	36	2,5
	87	51	2,5
	88	24	2,5
	89	18	2,5
Feed deceleration mechanism	90	19	2,5
	91	53	2,5
	92	22	2,5
	93	22	2,5

Note:

1. For 6T13-I machine: bevel wheels 18 and 19 possess $z = 39$, $m = 3,5$; horizontal wheels 20 and 21 - $z = 70$, $m = 3,5$.
2. For the machines with electric equipment for 60 Hz the number of wheel gear 1, 5, 47, 46 teeth equals subsequently to 24, 56, 18, 25
3. 34-35 - gear half couplings

6.6 Brief description of machine mounting assemblies

6.6.1 Bed

Bed – is a main mounting assembly, which houses all the machine components and mechanisms.

Rigidity of the machine bed is achieved at the sake of extensive base and big number of strengthening ribs.

Console travels along the vertical guide rails of the bed. Swiveling attachment is fixed to bed's shoulder.

A plank with cams is installed at the left side of the bed to limit the console travel.

The electric cabinet is installed on the bed at the right side.

Main movement and tool retention mechanism electric motors are flange mounted to bed's back. There are components of electric equipment located in niches of the bed.

There is an oil tank inside the body frame of the bed. The bed is mounted on the baseplate, which serves as support for console elevating screw. There is a coolant pump installed in the back of the baseplate.

6.6.2 Swiveling head (Pic. 15) is centered in the circular recess of bed's neck and fixed to it with four bolts, fit inside the T-shaped groove of the bed flange (bolts tightening shall be made with special wrench 6R12.Sh.40 for 6TI2-I machines and special wrench 6R13.0P.40 for 6TI3-I machines).

Swiveling head spindle is a two-bearing shaft, installed in the sliding sleeve.

Rotation is transferred to the spindle from gear box through the pair of bevel wheels and the pair of horizontal wheels, installed in the head.

6.6.3 *Gear box* of the horizontal is mounted directly inside the body of the bed. Connection of the gear box with electric motor shaft is made by flexible coupling. Two triple and one double cluster gears are mounted on the intermediate shafts. Electromagnetic coupling 2 (Pic. 16) is installed on the motor shaft, which serves for spindle braking during arresting stop.

It is possible to inspect the gear box through the window at the right side of the bed.

At the output shaft of gear box the bevel gear I is installed, which is engaged with the gear wheel of swiveling head.

На выходном валу коробки скоростей смонтирована коническая шестерня I, находящаяся в зацеплении с шестерней поворотной головки.

6.6.4 *Change gear box* allows to select the required gear without consecutive switching through intermediary stages.

Rack bar 1 (Pic. 17), shifted by the shifter lever 5, using sector 2 through shift fork 10 (Pic. 18) moves the roll 3 with the shifting disk 9 in axial direction. Shifting disk rotates with the speed gauge 11 through the bevel gear 2 and 4. The disk has several lines of openings of a particular size, located opposite to pins 8 of rack bars 5 и 7, interlocking pairwise with gear wheel 6.

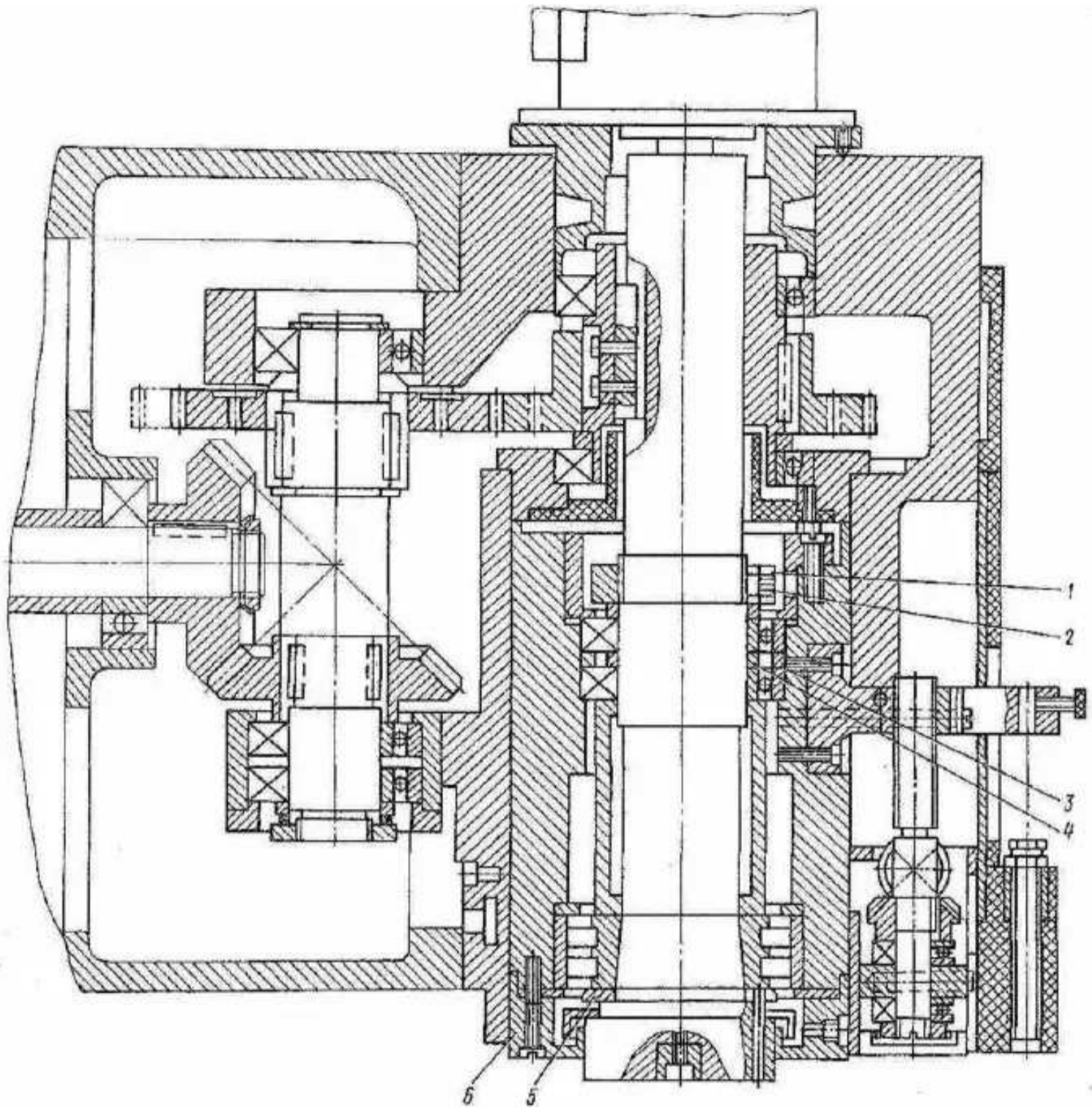
There is a shift fork fixed at one of each pair of the rack bars. During shifting the disk a reciprocative movement of rack bars is provided by pressing onto the pin of one of the pair. Hereat the forks in the end of disk travel take the position, corresponding to interlocking of particular pairs of gear wheels. The pins 8 of rack bars are spring-mounted to exclude dead stop of gear wheels while shifting. Fixing of dial indicator during gear selection is provided by ball 1, engaging into the slots of star gear 12.

Adjusting spring 13 for exact notching of dial indicator and standard effort for its rotation is provided by the plug fitting 14.

Handle 5 (Pic. 17) in the engaged position is hold by spring 4 and ball 3. Whereat the indentation of the handle is engaged into the flange slot.

Correspondence of speeds to the values shown at the indicator is provided by a particular position of bevel gear 2 and 4 (Pic. 18) after interlocking. Correct interlocking is fixed by center marks at butt ends of the mating teeth and gash or during fixing the indicator to the position of the speed $31,5 \text{ min}^{-1}$ and the disk with forks into the position of the speed $31,5 \text{ min}^{-1}$.

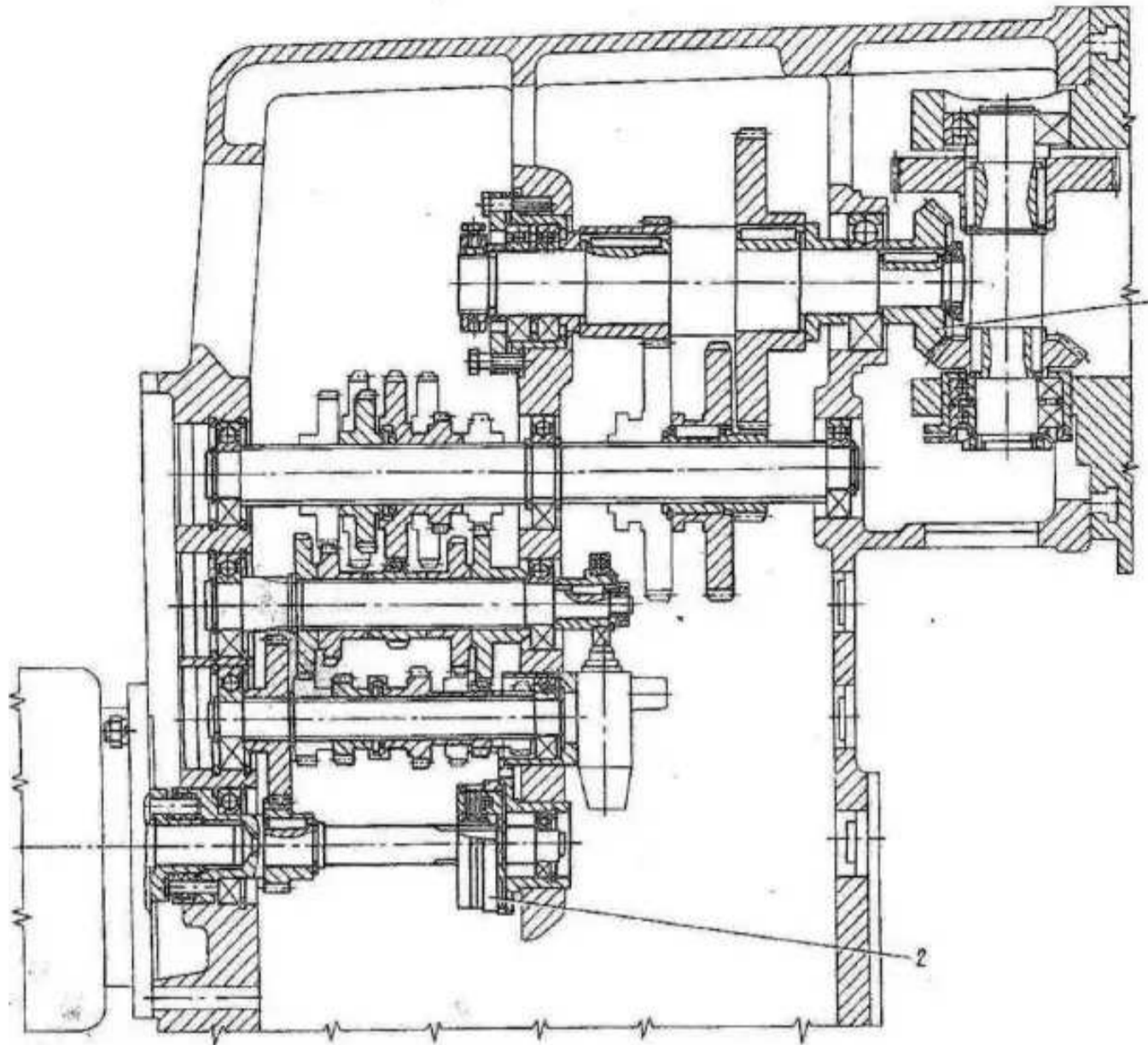
The gap in the interlock of bevel gear and pinion shall not exceed 0,2 mm, as the disk may rotate up to 1 mm due to the above. Lubrication of the switch box the lubrication system of the gear box by splashing oil incoming from the pipe located in the upper part of the bed. Non-availability of oil-fog might result in inadmissible heating of the forks' side plates and cause the forks' jamming, deformation and breakage.



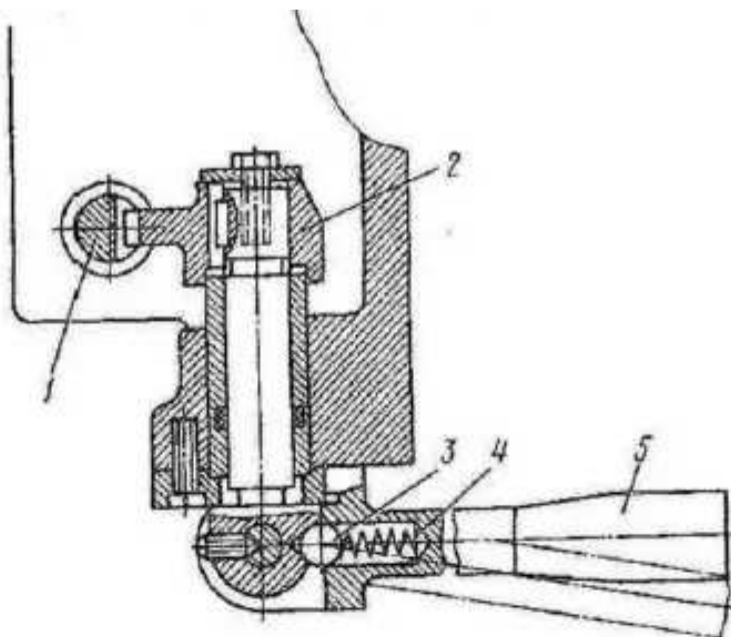
Pic. 15. Swiveling head

6.6.5 Feeding box (Pic. 19) provides for table travel along three coordinates with the given speed.

Rotation to the incoming wheel I of the feeding box is transferred from the gear rim 5 (Pic. 21), installed at shaft 7 of the console. The speeds obtained as the result of clutching the sprocket wheels are transferred through outgoing wheel 3 (Pic. 19) and idle gear 20 (Pic. 21) to feeding clutch 18, installed at the outgoing shaft 16 of fast travel chain, positioned inside the console. The feeding box and the fast travel chain are protected by the ball-spring overload release clutch 22 from breakages at overloading. Value of the torque, developed by the clutch, is regulated by change of effort of the springs, acting upon the balls, positioned in slots at the butt-end of the sprocket wheel. In case of feeding mechanism overload the balls, acting against the springs, are pressed out from the slots and the sprocket wheel 21 starts to slip against the shaft 16, meanwhile the work feed is arrested.



Pic. 16. Gear box

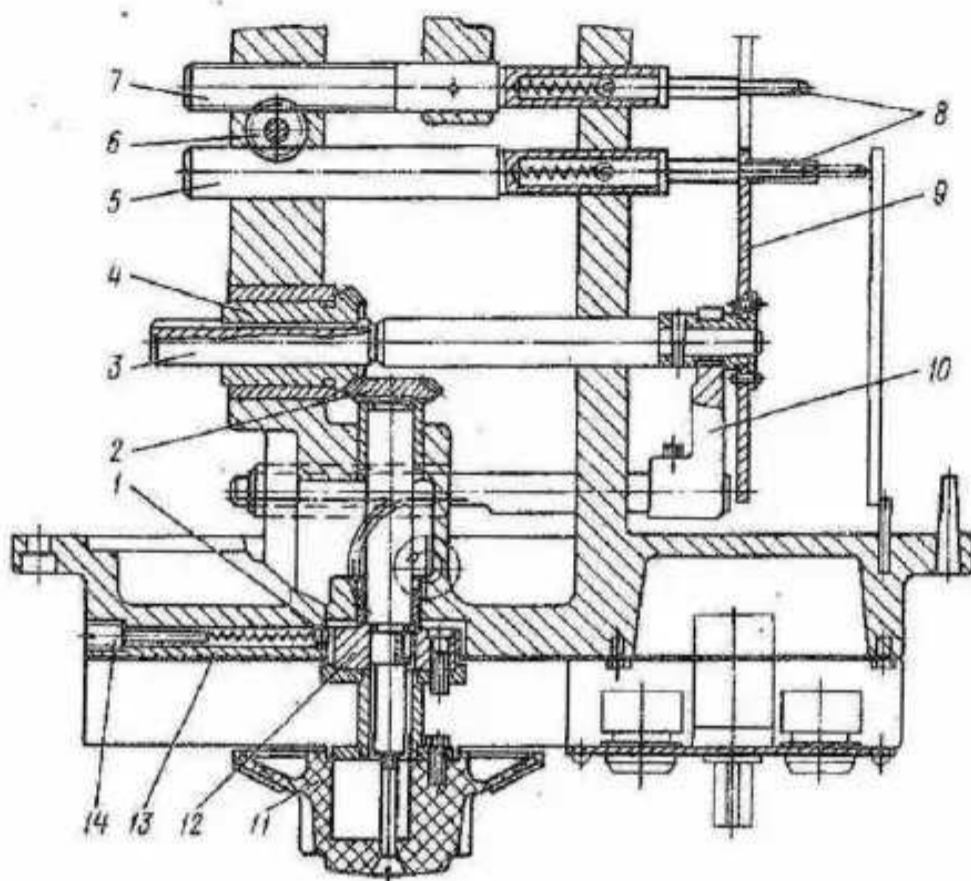


Pic. 17. Gear shift mechanism

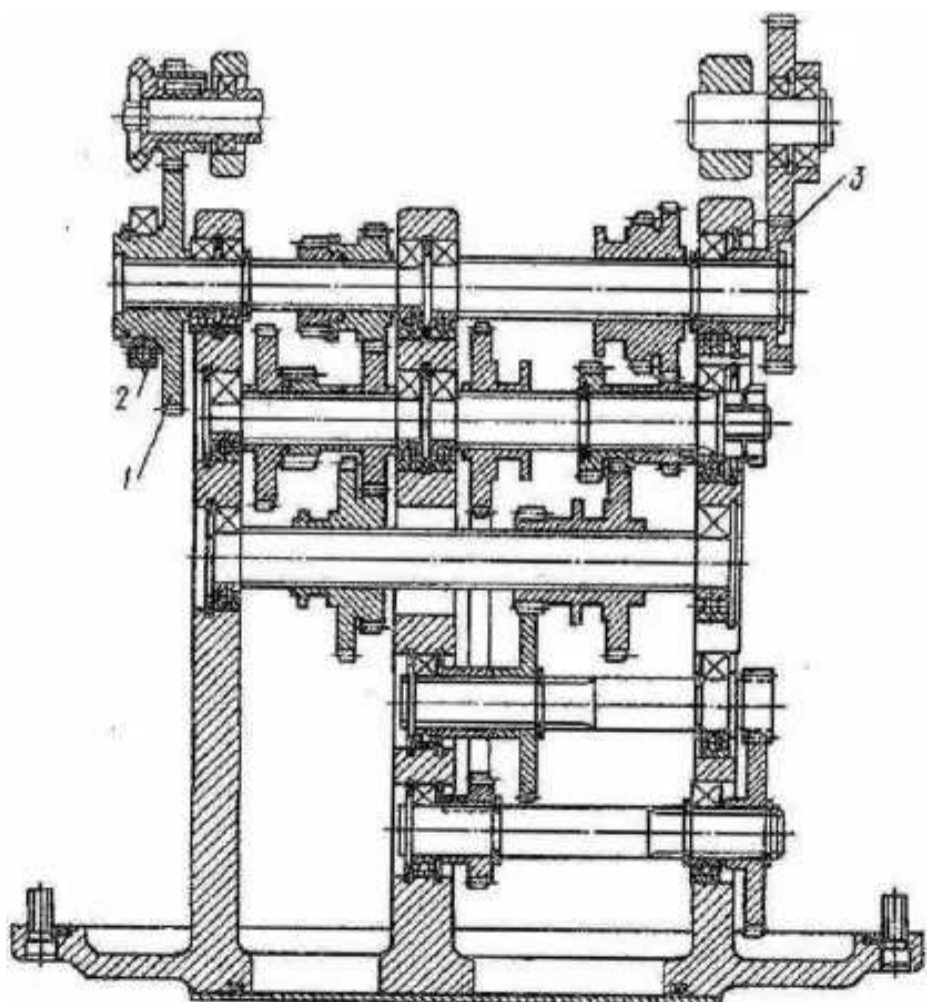
The clutch is considered to be adjusted correctly, if it does not shift during fast upward travel of the console and along any other coordinate.

Supply of lubricant to feed drive units is performed by a plunger oil pump with the drive from a ball bearing 2 (Pic. 19), fit on the eccentric wheel hub of input wheel.

6.6.6 Feed change mechanism (Pic. 20) engages the rigidly connected with the shaft 6 disc 7, movable along the shaft axis disc 2, rod 5 with switching forks.



Pic. 18. Cross section view along the main axes of gear box



Pic. 19. Feeding box

During switching the discs move in the opposed direction and, acting of the butt-ends of the rods, move them and the switching gear wheels connected with them in the axial direction.

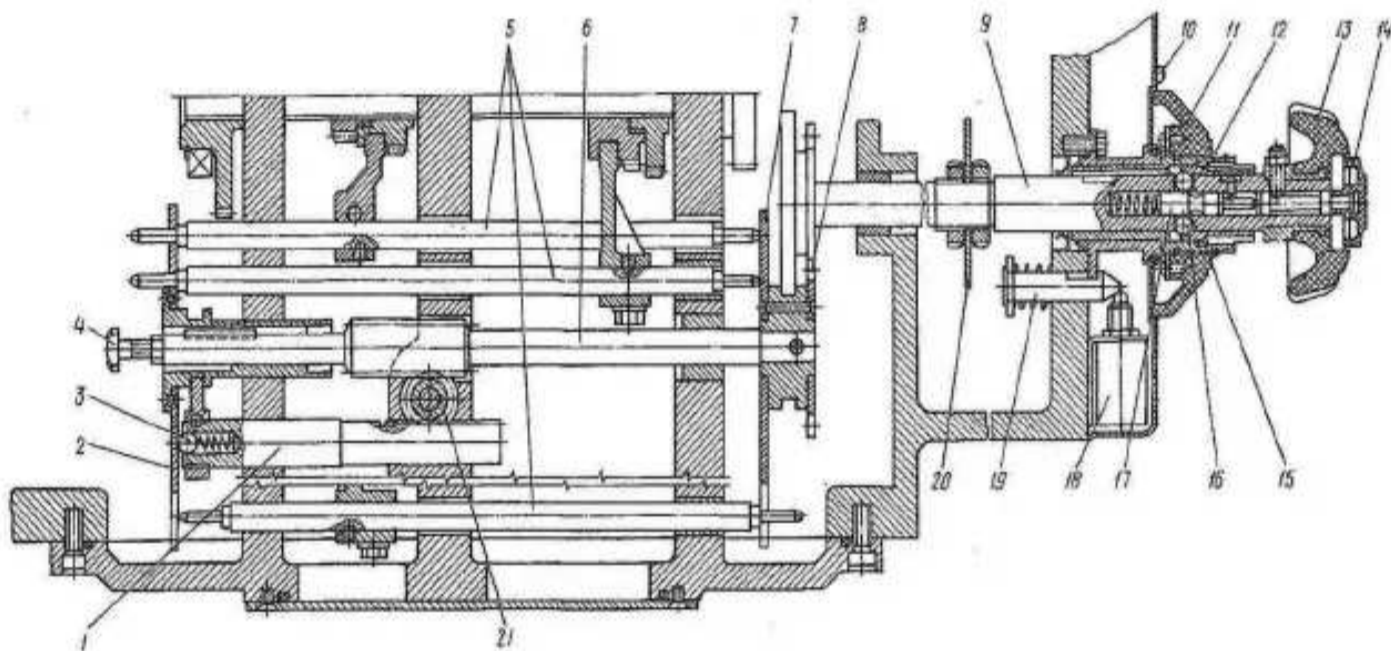
The given direction of the rods' movement (right – left) is provided by the availability of openings in the discs, positioned opposite to the corresponding butt-ends of the rods. The disc 7 hub is provided with a circular groove and the sprocket wheel 8, by which means the feed switching mechanism is connected with control shaft 9.

In order to switch a feed it is necessary to push the knob 14 and pull out the mushroom knob 13 out to its limit. Whereat the shaft 9 shall pull after it the connected shaft 6 with disc 7. Disc 2, connected by rack bar 1 and sprocket 21 with shaft 6, in this case shall move into the opposite direction until its hub stops against the screw 4, and the rod ends shall come out from the discs. Then rotating the mushroom knob 13 round its axis set the needed value of feed against the indication arrow 10 according to the dial scale 11.

Feed switch is performed by moving the mushroom knob in axial direction up to the initial fixed position. If it not impossible to bring the knob into the initial direction, then repeat shifting the knob to yourself. Thereat by the contact of disc 20 through pusher 19 the terminals of limit switch 18, which control the pulse switching on of feed motor, shall be closed; after which the return of the mushroom knob into the initial position shall go smooth.

Displacement of discs 2 and 7 in axial direction is prevented by shaft 9 fixation in the engaged position with two balls 16 and sleeve 15. After pushing the button 14 the balls go into the circular groove of the roll 17 and free shaft 9 from fixation. Fixing rotation of switching discs is performed by the spring-loaded ball 3, located in the opening of rack bar 1.

6.6.7 Console is a basic unit, integrating the units of machine's feed chain. Chain of fast travel, movement distribution box to driving screws, and control shaft of feed change mechanism are built-in directly into the console body. Detachable feeding box with the oil feeler hose is flange mounted at the left side of console, and also the indicators of pump operation and oil level gauge of the console oil tank. Reducing unit of creep movements, the feeding motor, and the distribution box for electromagnetic couplings power supply, located under the motor protection casing, are installed.



Pic. 20. Mechanism of feed switch

Availability of the distribution box with terminal strips allows to check for continuity the electric circuit of any electromagnetic coupling inside the feed drive without opening the console. There are buttons of intermittent oil feed to the table guide-rails, slide assembly, located at the front butt-end of the console. There is also mushroom knob of feed switch located here.

The console body is divided by a cross-wall into two compartments. The front compartment contains the built-in movement distribution box to driving screws. Access to the clutches for inspection and repair works is provided through the windows: through the right-side window – to overload-release coupling and transverse movement couplings; through the left-side window – to the vertical movement couplings.

De-installation and installation of the clutches of lengthwise movement is made through the opening in the console front wall, closed with the flange face of the clutch shaft bearing.

It is recommended to keep the original settings of the position of interlocking limit switches, providing disengagement of electromagnetic clutches, when using the detachable handle for trial-and-error movements, when dismantling the shafts with the table transverse and vertical movement clutches.

Fast travel chain are the two pairs of permanently coupled gear arrangements, installed on the shafts 11, 7 and 16 (Pic. 21), wheel gears 9, 6 and 3 of the above gear are rigidly connected with the shafts 11 and 7, and the driven gear wheel 15 is freely rotating on the shaft 16 and rigidly connects to it when the fast travel coupling 14 is engaged.

There are the feed switching clutches 18, and the overload release coupling 22, through which movement is transferred to movement distribution box to driving screws, on shaft 16 besides the coupling of fast travel.

From coupling shaft 25 through gear wheels 2 and 1 rotation is transferred to the screw of transverse movements 32. The rotations are transferred from shaft 27 through cylindrical gear pair 29, 30 and bevel gear 5 and 4 (Pic. 22) to the screw of vertical movements.

Rotations to the screw of lengthwise movements are transferred from shaft 28 by means of the double gear arrangement 26, freely installed at the end of the screw of transverse movements, to spline shaft 31.

Further the rotation through two bevel gear pairs 12, 13 and 14, 4 is transferred to sleeve 10 (Pic. 24), connected with the screw of lengthwise movements 1, by means of sliding key.

6.6.8. Mechanism of a feed proportional deceleration (Pic. 23) is designed to double reduce the feed during cutting and tool break-off during milling.

Gear wheel I for mechanism deceleration is an input wheel, wheel 3 – output. The input wheel is engaged with gear wheel 19 (Pic. 21), freely rolling on shaft 16, output – with wheel 17, rigidly fit at the same shaft.

Engagement of deceleration mechanism into operation is performed by clutch 2 (Pic. 23). During the above the feed clutch is disengaged. Deceleration mechanism engagement is performed in the manual mode by the switch 31 (Pic. II) on the main control panel or by button 8 on the side panel, and in the automatic mode – by the cam, installed in the front plane of the table and activating the unit of limit microswitches.

During engagement of decelerated feed by a button or by a cam, the duration of decelerated movement shall be determined by the time of pushing the button or the length of the cam.

6.6.9. The table and slide assembly provide for the lengthwise and crosswise movements of the table (Pic. 24, 25). Driving screw I (Pic. 24) receives rotation through the sliding key of sleeve 10, installed in the gear half coupling 5 and bushing 7. Sleeve 10 through splines receives rotation through gear half coupling 6 during its engagements with gear half coupling 5, rigidly connected with bevel gear 4. Half coupling 5 has the annular gear, which engages with the gear wheel of the rotating table drive. Half coupling 6 has the annular gear to perform rotation of longitudinal feed screw from flywheel. Rotation to the annular gear is transferred from gear wheel 4 (Pic. 25), which is spring loaded for the case when a gear tooth goes against another tooth. Engagement of the annular gear 3 of half coupling 6 with gear wheel 4 is only possible, in case of disengagement of half coupling 6 with half coupling 5 (Pic. 24) and is performed by movement of rack I (Pic. 25) from switch 6, fixed on roller 2.

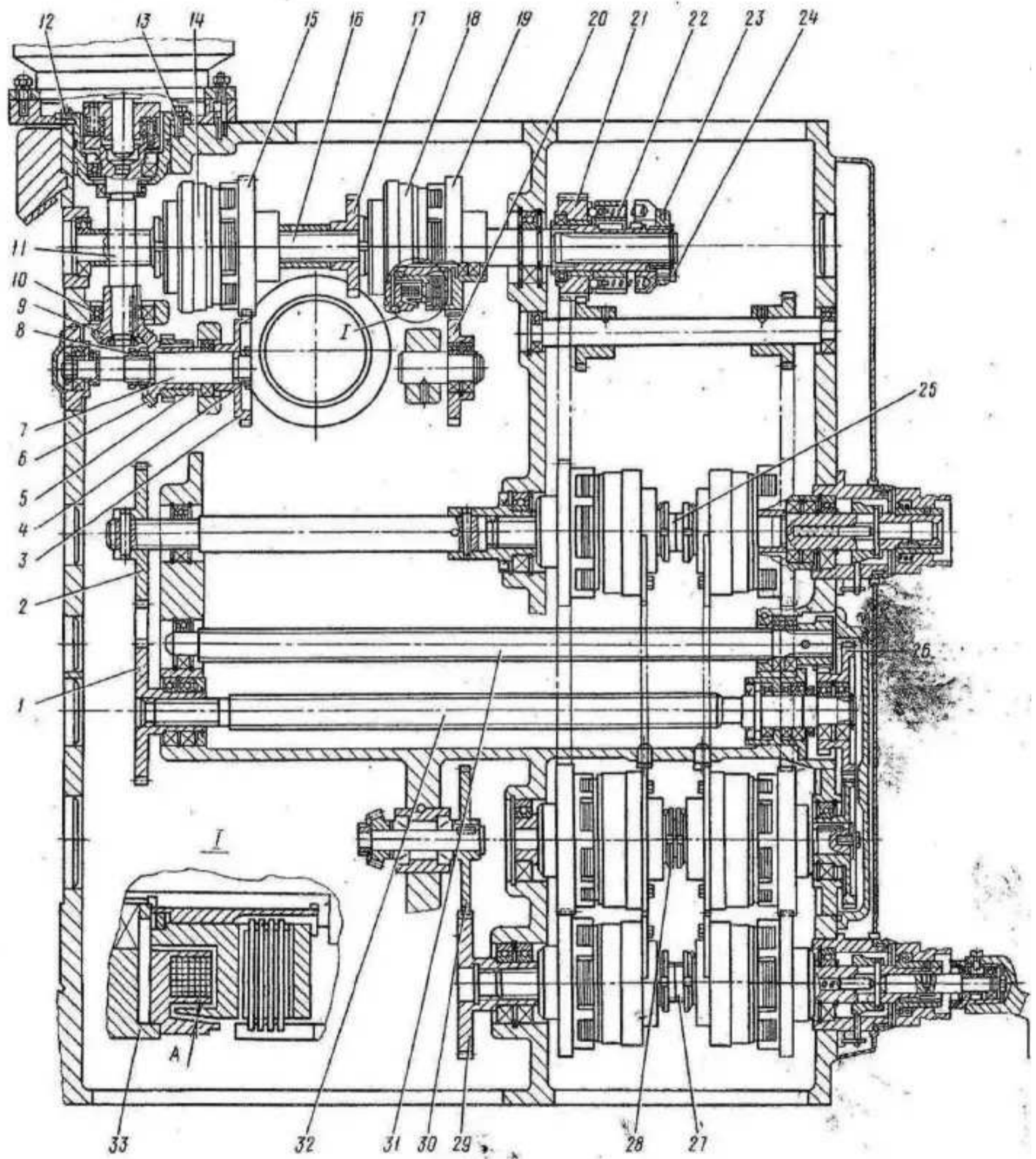
In such a way flywheel 5 blocking is performed.

Nuts 2 and 3 of driving screw I (Pic. 24) are located in the left side of slide assembly.

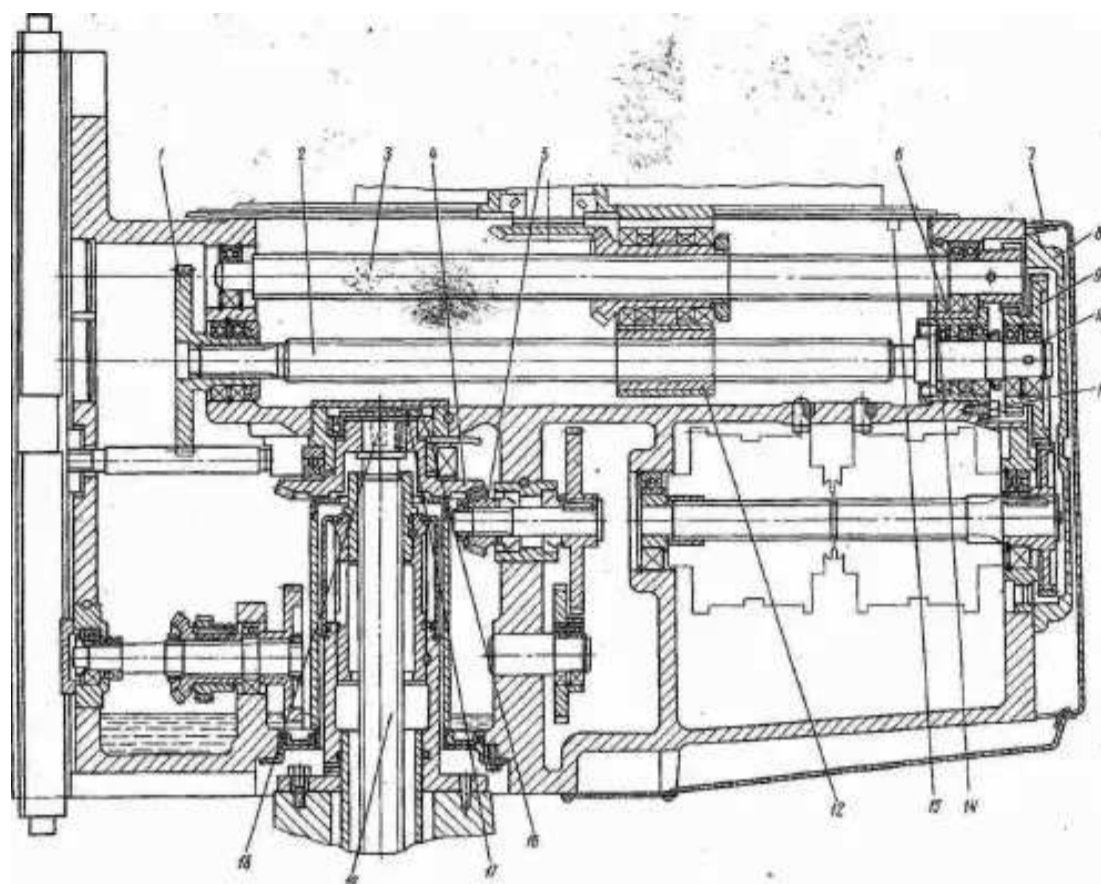
The right nut 3 is fixed by two pins in the body of slide assembly; the left nut 2, thrusting its butt against the right nut, worming out the play in helical pair during its rotation.

The table is connected with the driving screw with brackets, which installation at the butt ends of the table is performed according to the actual location of the screw and fixed with positioning pins. Thrust bearings are installed on the different ends of the screw, which eliminates its work for longitudinal bending. Preliminary tightening of driving screw using the nuts with the force of 1000 – 1250 N (100 – 125 kg·f) during its installation.

Tightening of slide assembly on console guide rails is provided with bars 9, which effect the cam of roller 8.



Pic. 21. Development drawing of the console



Pic. 22. Cross-sectional view along the crew of vertical movements.

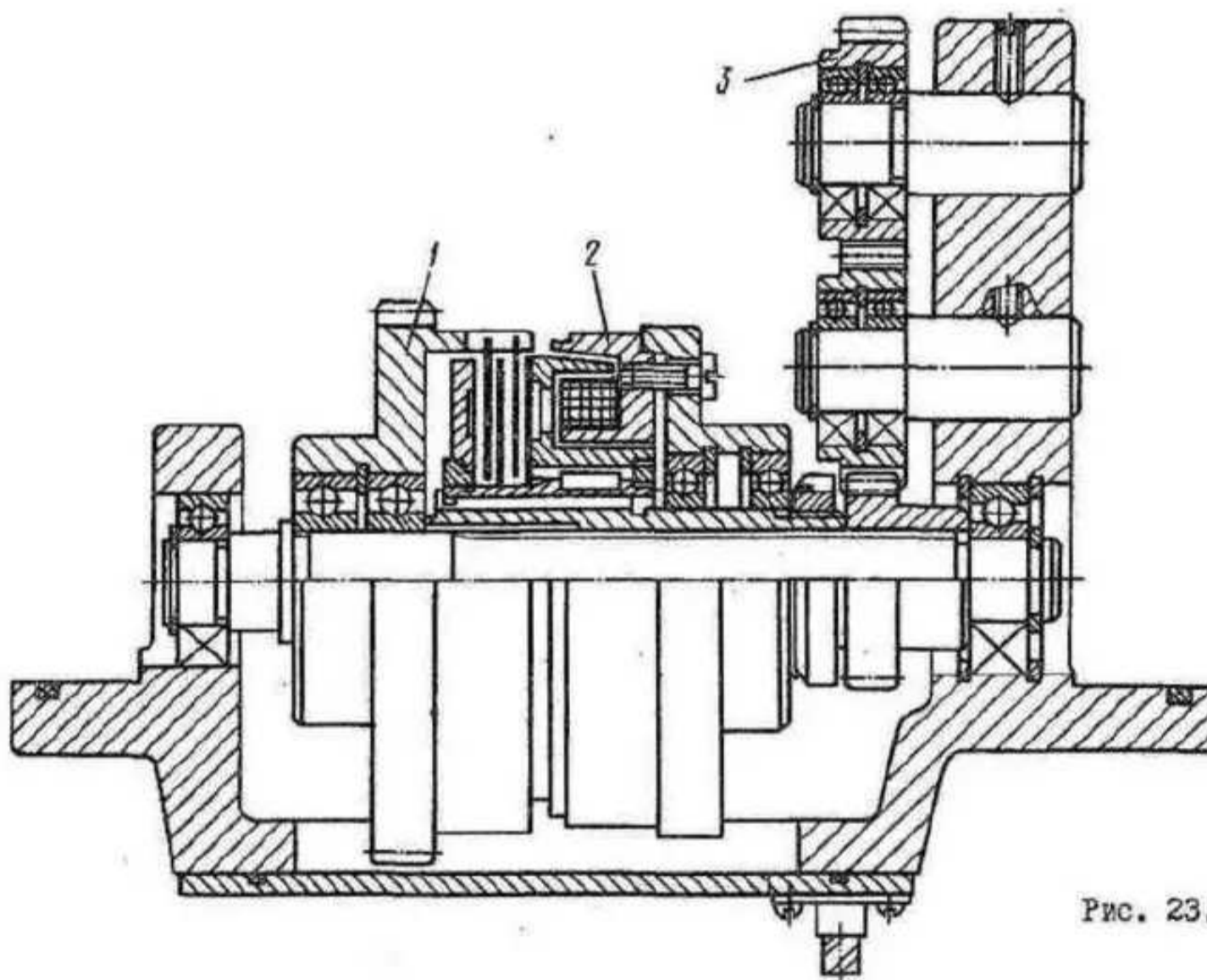
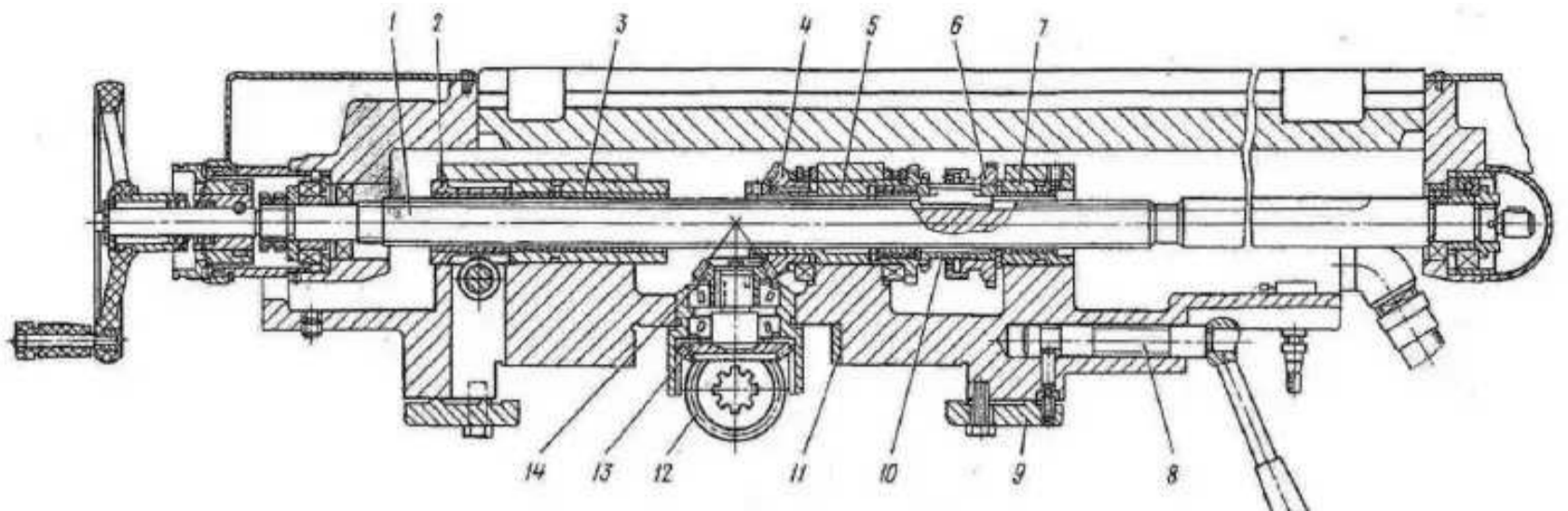
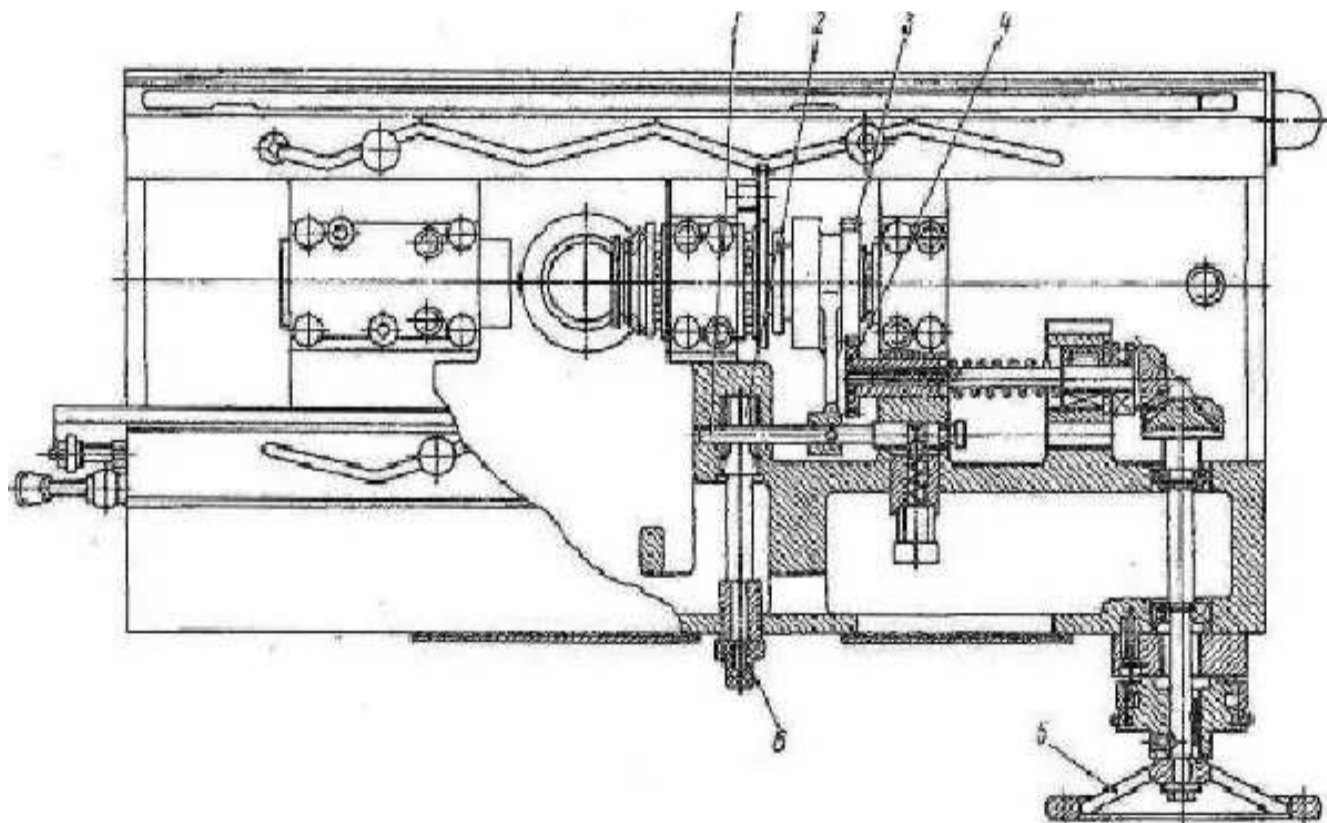


Рис. 23. М
П

Pic. 23. Mechanism of proportional feed deceleration



Pic. 24. Cross-sectional view along the longitudinal movements screw



Pic. 25. General view of slide assembly

6.6.10. Electromechanical tool clamp (Pic. 26) is designed to clamp the tools in machine's spindle.

Clamping and de-clamping of tools is performed by a travelling rod 3, mounted inside the spindle 5. Reciprocal movement of rod 3 is provided by its threaded connection with the castellated shaft 2, receiving rotational movement from the head of electromagnetic tool clamp 1. At the end of rod 3 there is a T-head, which is connected to the T-shaped slot of gripping unit 4, threaded into the mill arbor with a cutter.

Installation of cutters to Toolholderx is made depending upon their size and type (Pic. 27).

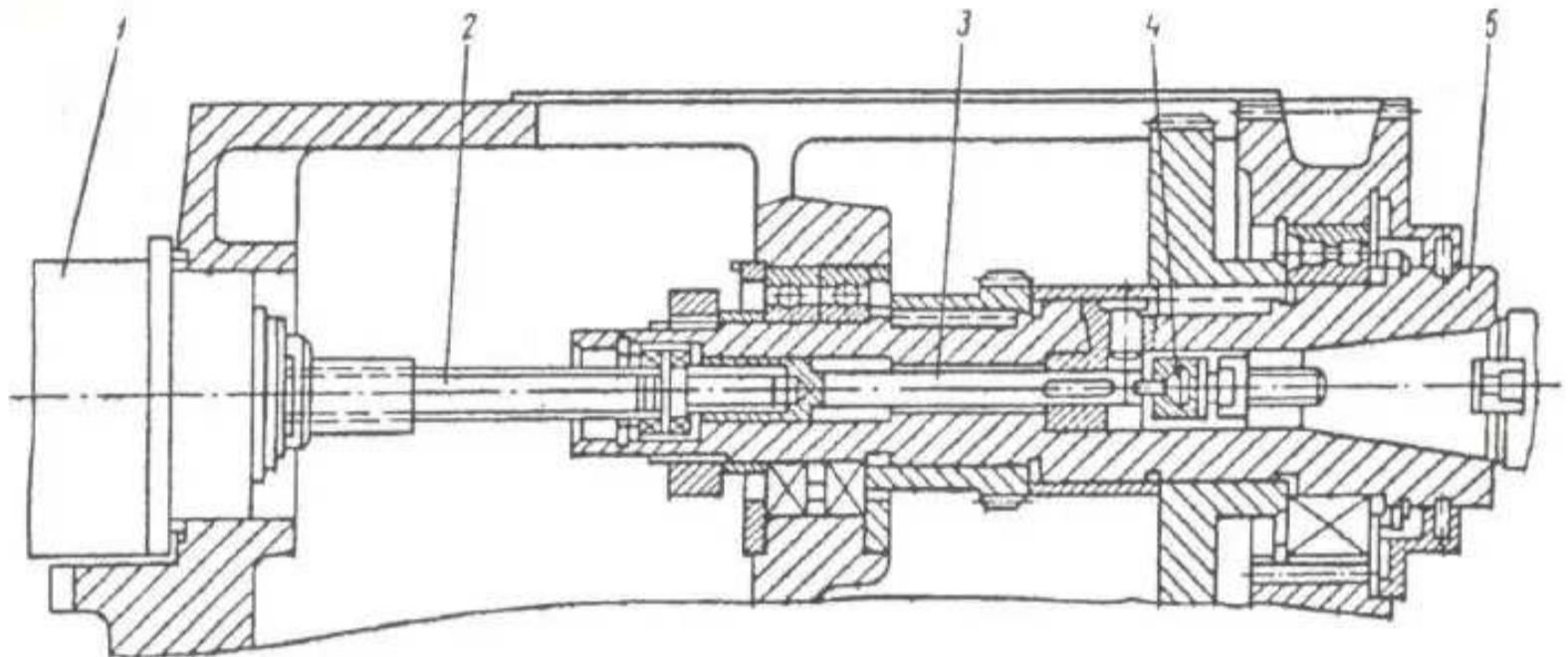
Clamp 1 shall be installed in such a way, that T-slot shall be perpendicular to the driving slots at mill arbor or cutter 3 and sized to $43 \pm 1,5$ mm.

Clamping of mill arbor in the spindle 2 is made in the following sequence: install the mill arbor with the cutter into the spindle cone hole and by rotating it by the angle of 90° connect with the rod head 3 (Pic. 26). Put switch 3 (Pic. 11) into the position "Tool clamping". Whereat the Toolholder with the cutter shall be pulled inside the spindle. End of clamping can be determined by snapping of the cam clutch of the mechanism.

For tool de-clamping: switch off the spindle using the button 11 or 19 and make certain the spindle comes to a stop. Put the switch 3 into the position "Tool de-clamping" and hold it until the cutter Toolholder shall

not travel out from the spindle for the length not exceeding 15 - 20 mm, i.e. toolholder shall disengage with the spindle driving keys.

In case of big travel of mill arbor the roller 2 (Pic. 26) might twist out completely from the rod 3. Then for clamping a tool it is needed to push the rod along the axis in such a way, as to twist the threaded end of the roller into the threaded hole of the rod.

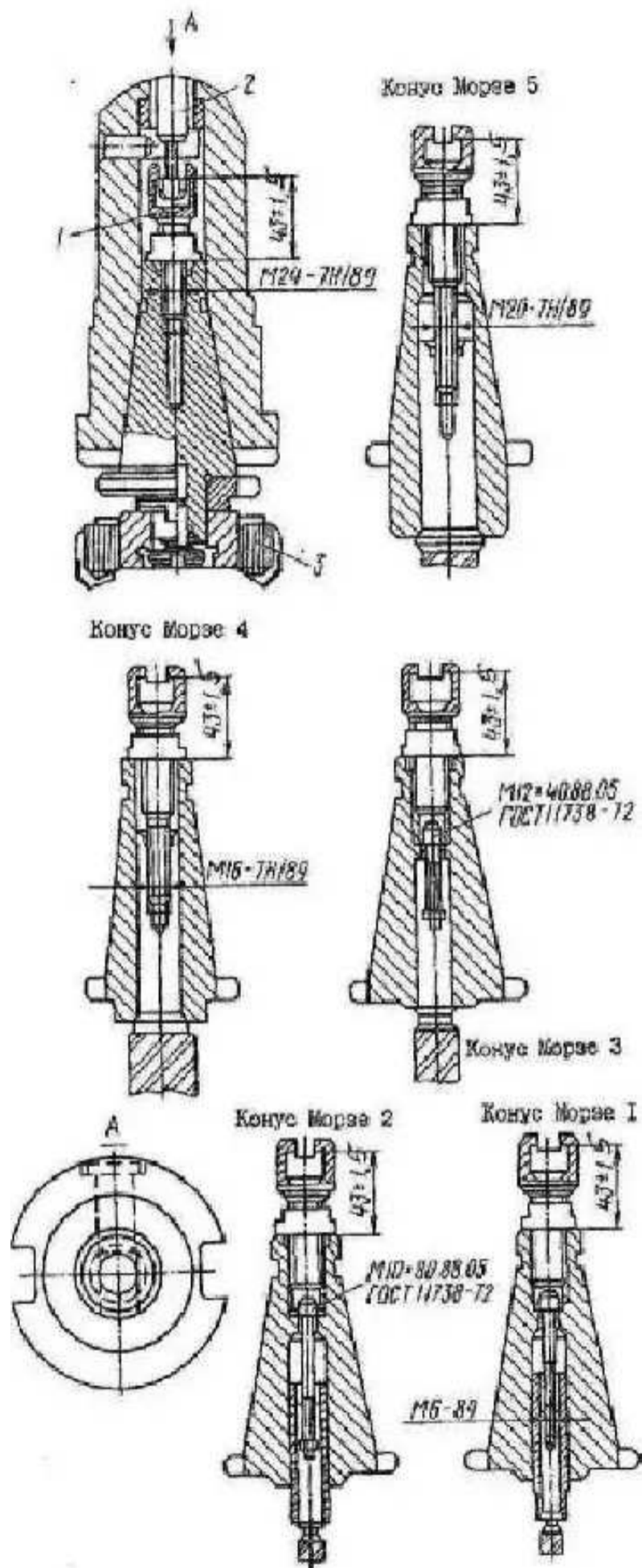


Pic. 26. Construction of electromechanical tool clamp

IMPORTANT! PERFORM TOOL CLAMPING BEFORE INITIAL SWITCHING OF A SPINDLE.

At spindle rotation check without tool, perform the no-load retraction of rod 3 to snapping of the cam clutch, simulating tool clamping, otherwise the spindle shall not be engaged.

The adapter sleeve for taper shank end mills equipped with Morse taper adapter 3, the adapter sleeve shall be used with the taper rate 7:24 (Pic. 28).



Pic. 27. Installation of cutters on toolholders

7. LUBRICATION SYSTEM

7.1. See Pic. 29 for the principal diagram of lubrication.

7.2. See Table 5 for the list of lubrication system components and lubrication points.

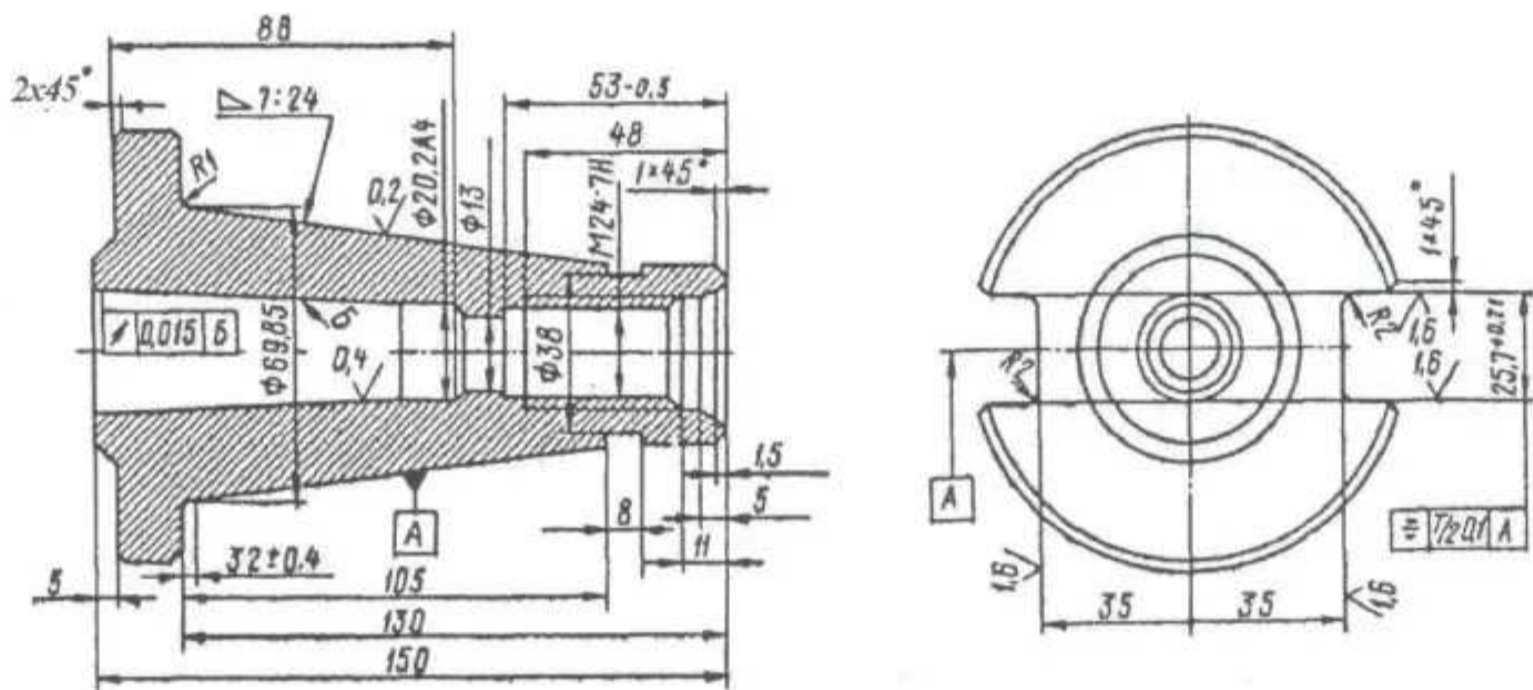
7.3. Work description

Lubrication is provided by the following systems:

7.3.1. Centralized lubrication system of gear wheels, gearbox bearings, and change gear box components.

The above system includes the tank 2 (Pic. 29), located inside the bed, filter 4, plunger pump 6 and oil-distributing box 7. Pump (Pic. 30) of the system operates from the camshaft gear, mounted on one of the shafts of the gear box.

Control after lubricant supply and its level in the tank is visual using oil level gauges 1 and 9 (Pic. 29).



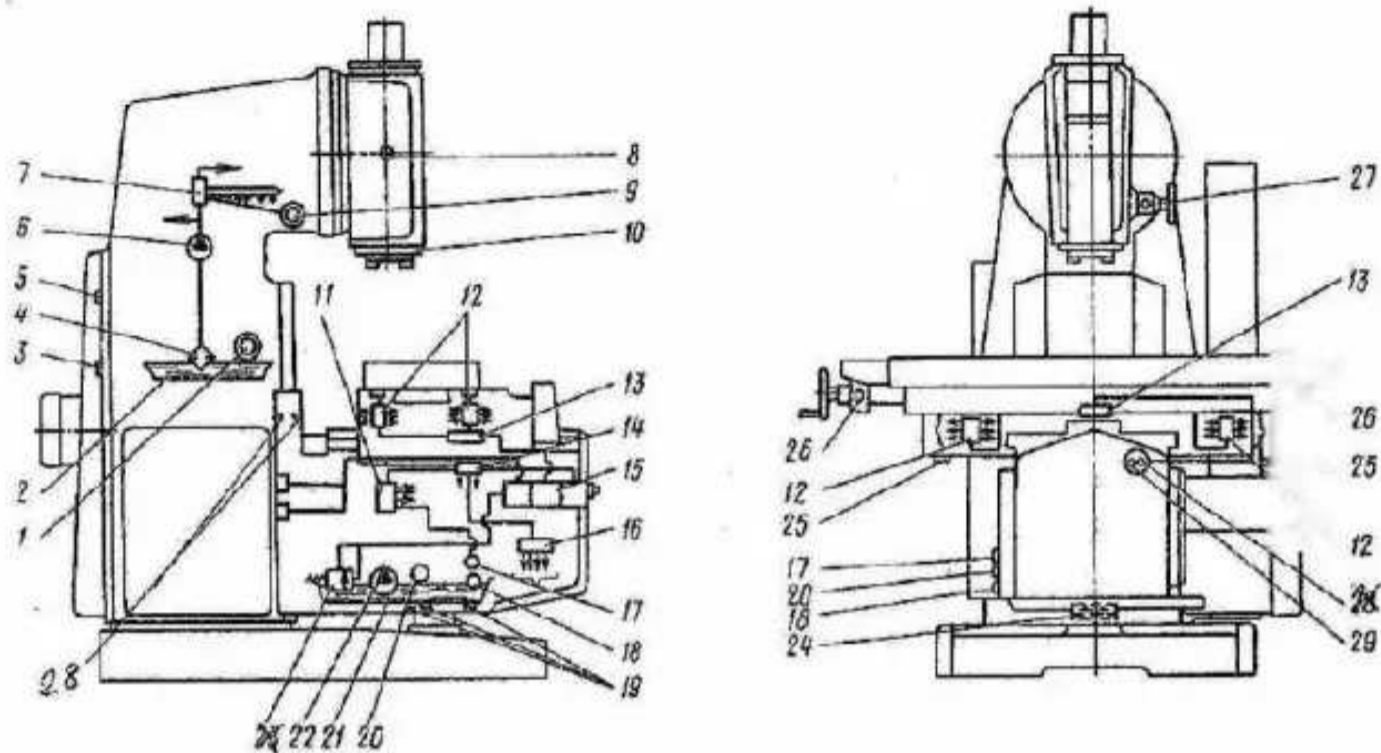
Pic. 28. Adapter sleeve

7.3.2 Centralized lubrication system of gear wheels, bearings of feeding box, console, console guide rails, sliding assembly and the table.

The above system includes the tank 21, located inside the console, plunger pump 22, slide valve 15, oil distributors 11, 12, 13, 14, 16. See Pic. 31 for the design of console lubrication pump, Pic. 32 – for the slide valve distributor.

Oil availability in the tank is checked using the oil level gauge 18 (Pic. 29), pump operation is checked using oil level gauge 17.

Lubrication of guide rails is performed intermittently pushing the button 28, table guide rails – by pushing the key 29.



Pic. 29. Principal diagram of lubrication

7.3.3. Periodic lubrication

The above system is envisaged for lubrication of the bearings of the end supports of the table longitudinal feed screw 26, spindle bearings 8, and mechanism of rotational head sleeve movement 27. It is performed manually by gun-greasing.

7.3.4. Flood lubrication

The above system is designed for lubrication of the console vertical travel screw. Oil sump is located inside the mounting post 24.

Oil level control is performed using the wire feeler gage at the extreme top table position through the filler hole. When the feeler gage hits the sump bottom it shall show the level of 4 – 6 mm. Wire of \varnothing 2 -3 mm shall be used as feeler gage.

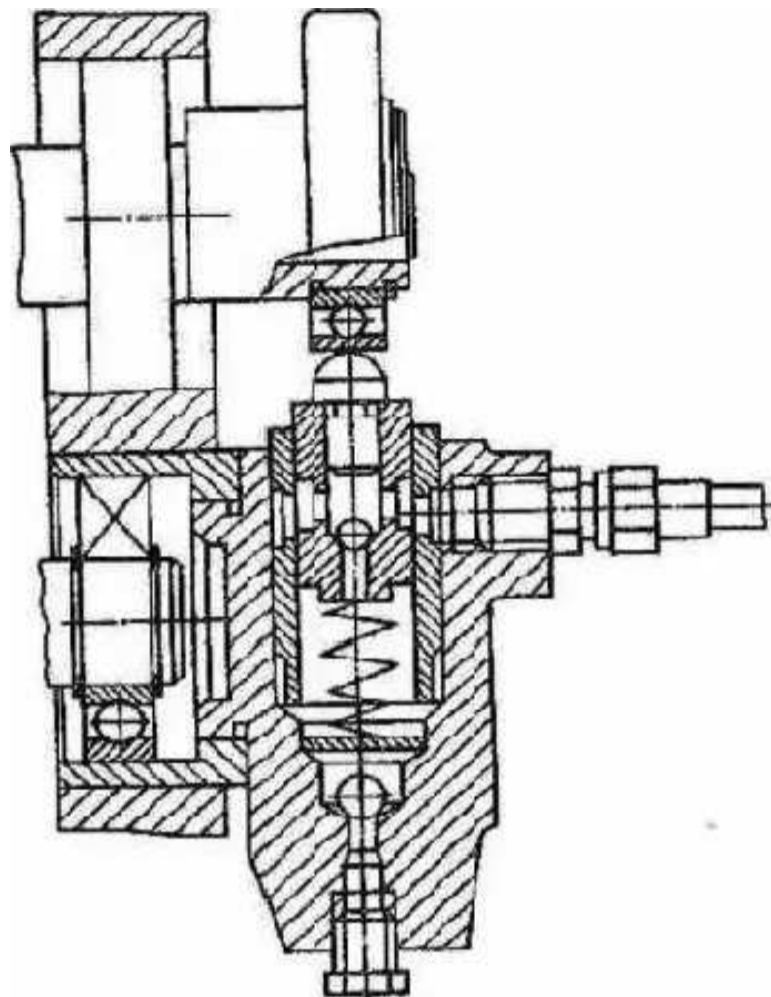


Рис. 30. Насос смазки коробки скоростей

Pic. 30. Gear box lubrication pump

7.4. Installation and operation instructions

It is necessary to fill the tank inside the bed through filler hole 5 (Pic. 29) with I-30 A GOST 20799-75 oil to the middle of oil level gauge 1 before machine start up.

Fill in the console tank through filler hole 20 with I-30A GOST 20799-75 oil to the middle of oil level gauge 18. It is not recommended to exceed the above level.

Gun-grease with consistent lubricant ONaKa 2/11-3 OST38.01145-80 using greasers 26 and 27 of the table longitudinal driving screw support and the mechanism of sleeve movement, and using greaser 8 – spindle bearings with the grease TSIATIM 201 GOST 6267-74.

Fill in the oil sump of the vertical movement screw mounting post with I-30A GOST 20799-75 through filler hole. Filling with oil above the recommended level shall cause driving the excess lubricant onto the machine base.

Oil all the guide rails manually using an oilcan with I-30A GOST 20799-88 lubrication oil.

In 2 – 3 minutes after the machine start the oil shall display in the corresponding indicator of pump operation both during the initial start up, and during the machine operation. It is necessary to maintain control over the oil supply using the oil level gauges.

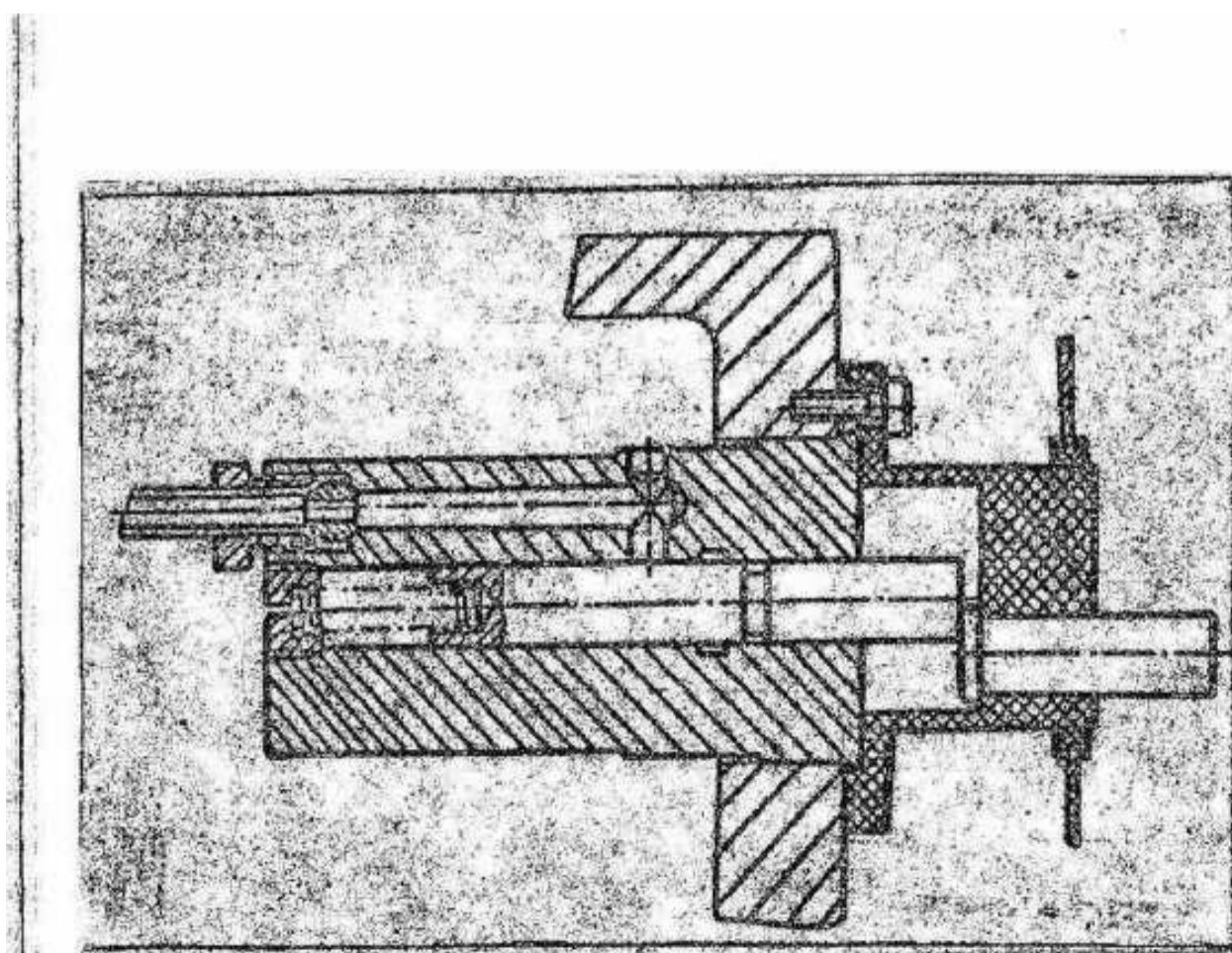
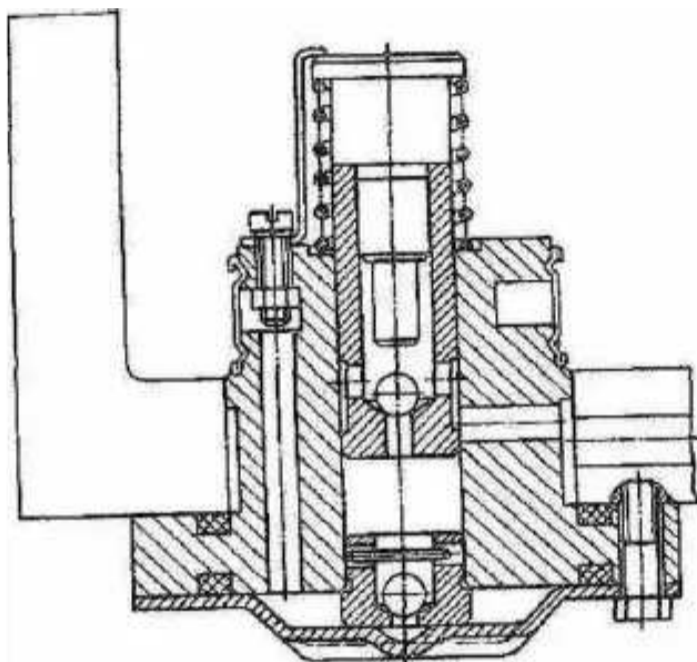
ATTENTION! IT IS STRICTLY PROHIBITED TO OPERATE THE MACHINE IN CASE OF FAULTY SYSTEM OF LUBRICATION.

First oil replacement in the bed and console oil tanks shall be made in a week of operation after machine start up, second – after one month of operation, and in the process of operation – every three months of operation.

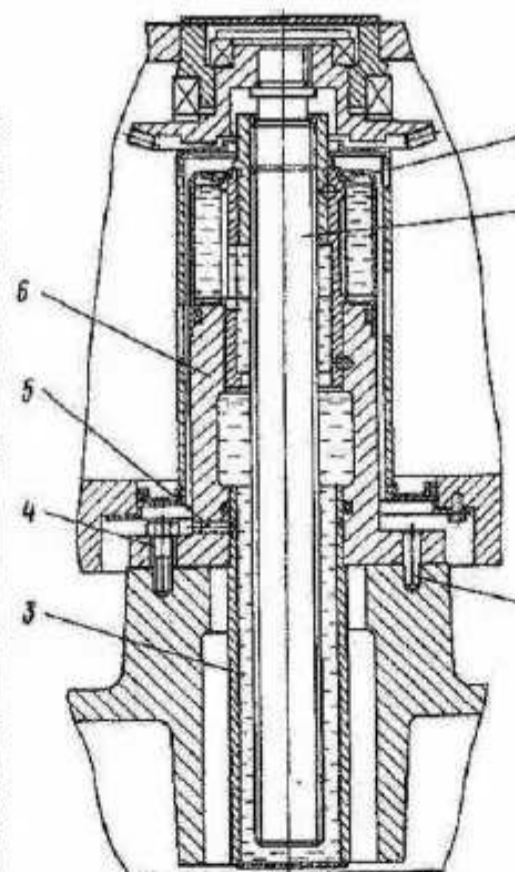
The oil level shall be refilled proportional to its loss.

Oil drain shall be made through drain holes 3 and 19.

Console upright movement screw mounting post oil tank 3 (Pic. 33) flushing shall be made at least once a year. It is necessary to move the console in the upright position for flushing. Put a stop timber with cross-section not less than 150x150 mm and the length 420 - 450 mm to the machine base under the console bottom in the area of guide rails. Use the manual movement handle to put the console on top of the timber, turn off the securing screw 4 and remove the pins 2. Manually screw the column 6 down to the vertical screw 1 until tank 3 comes out from the machine base. Put an oil trough underneath the column for oil collection, undo screw 5, put oil tank 3 down. Reassemble in reverse order after flushing and refill clean oil into filler hole 7.



Pic. 32. Lubrication pump of slide valve distributor



Pic. 33. Lubrication of the vertical travel screw

Table 5

List of lubrication system elements, greasing points, and lubrication materials

Position on Pic. 29	Nomination	Lubrication frequency	Lubricated elements	Component of	Lubrication material	Amount of lubrication oil refilled
1	Oil level gauge					
2	Bed oil tank	Every three months		Bed, Gear box	Oil I-30A GOST 20799-88 Kinematic viscosity index @ 50oC: 28 – 33 cSt	24 liters for 6T12-1 machines 27 liters for 6T13-1 machines Oil change every three months
3	Drain hole			Same		
4	Filter			"		
5	Filler hole			"		
6	Plunger pump			"		
7	Oil distributor	Continuously	Gear box gear wheels, brake coupling	Gear box	Oil I-30A GOST 20799-88	
8	Push-button oiler	Once per month (extend the sleeve)	Upper spindle bearings	Rotating head	TSIATIM 201 GOST 6267-74 consistent grease. Drop point temp. 175oC	
9	Gear box pump monitoring indication device			Gear box		
10	Push-button oiler	Once per month	Front spindle bearing	Swivel head	TSIATIM 201 GOST 6267-74 consistent grease	
11	Oil distributor	Continuously	Electric feeding couplings, vertical screw bearings and bevel gear and pinion	Console	Oil I-12A GOST 20799-88	
12	Oil distributors	Periodically once per shift	Slide assembly upper and lower guide rails, driving screw, driving screw drive bearings, gear wheels	Table and slide assembly	Oil I-12A GOST 20799-88	
13	Fork oil distributor					
14	Oil distributor	Continuously	Electric coupling of cross travel	Console	Oil I-12A GOST 20799-88	
15	Slide valve			"		
16	Oil distributor	Continuously	Electric couplings of lengthwise and vertical travel, feed box gear wheels	"	Oil I-12A GOST 20799-88	

Table 5 Continued

Position on Pic. 29	Nomination	Lubrication frequency	Lubricated elements	Component of	Lubrication material	Amount of lubrication oil refilled
17	Console pump monitoring indication device			“		
18	Oil-level Indicator			“		
19	Oil drain			“		
20	Filler hole			Console		
21	Console oil tank	Every three months		“	Oil I-12A GOST 20799-88	10 liters for 6T12-1 machines 14 liters for 6T13-1 machines
22	Plunger pump			“		
23	Safety valve			“		
24	Pillar tank	Every 5000 hours of work	Driving screw	“	Oil TE-15	1,3 liters
25	Oil drain					
26	Push-button oiler	Once per month	Table driving screw supports	Table and slide assembly	ONaKa 2/11-3 OST38.01145-80 consistent lubricant	
27	Push-button oiler	Once per month	Bearings of sleeve driving mechanism	Swivel head	TSIATIM 201 GOST 6267-74 consistent grease	
28	Slide valve start button	Periodically 1 – 2 times per shift	Console vertical guide rails lubrication	Console	Oil TE-15	0,2 liters
29	Slide valve start button	Periodically once per shift	Table and slide assembly mechanism and guide rails lubrication	“		

Note. In case the lubrication materials given in the list of lubricants are not available, only the lubricants with the main specifications corresponding to the indicated, may be used.

8 INSTALLATION PROCEDURE

8.1 Unpacking

When unpacking the machine delivered in the transport package, first remove the upper cover of the packing box, then the side ones. Take precautions to avoid any damage of the machine with the unpacking tools. Make sure that the set of the machine is complete and all accessories supplied are available in accordance with the packing list or “Contents of delivery”.

8.2 Transportation

During transportation of the packed machine, the ropes must be positioned in accordance with the designated fastening points on the packing box. The rope must be selected based on the gross weight of the packed machine.

The unpacked machine must be transported in accordance with Figure 34. Prior to transportation of the machine, make sure that all mobile units are carefully fixed. The sliding frame with the table must be pulled to the shield of the console and the body.

When transporting to the place of installation and putting on the ground, avoid hard pushing of the machine.

Prior to installation, the open surfaces of the machine must be carefully cleared from any anti-corrosive coating. The remaining grease must be removed with clean tissues moistened in mineral white spirit.

In order to prevent corrosion, the cleared non-painted surfaces must be greased with the thin layer of lubricant (I-30A GOST 20799-88).

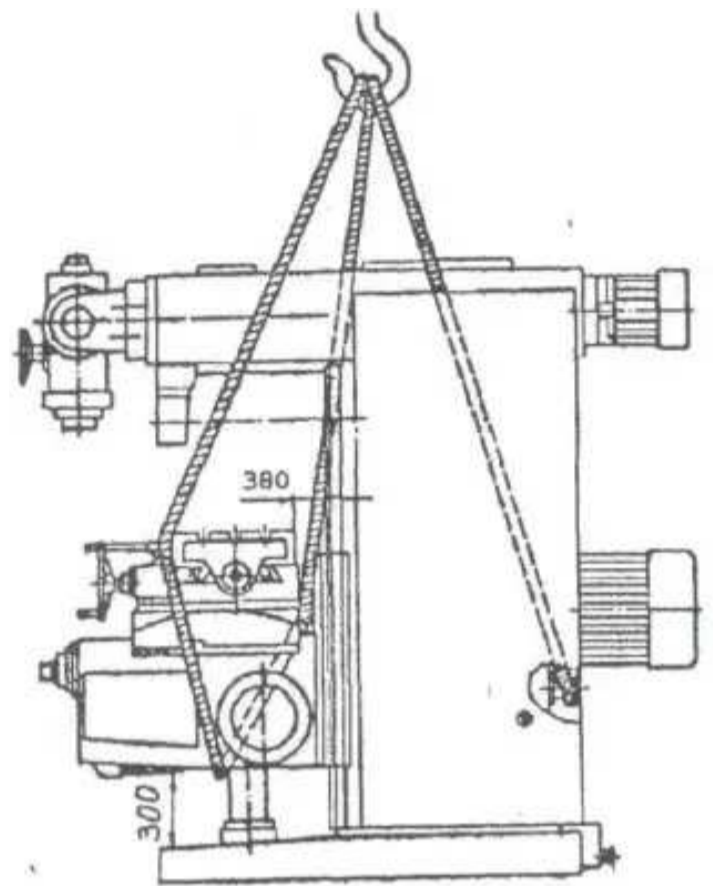


Fig. 34 Machine transportation scheme

8.3 Assembly and installation

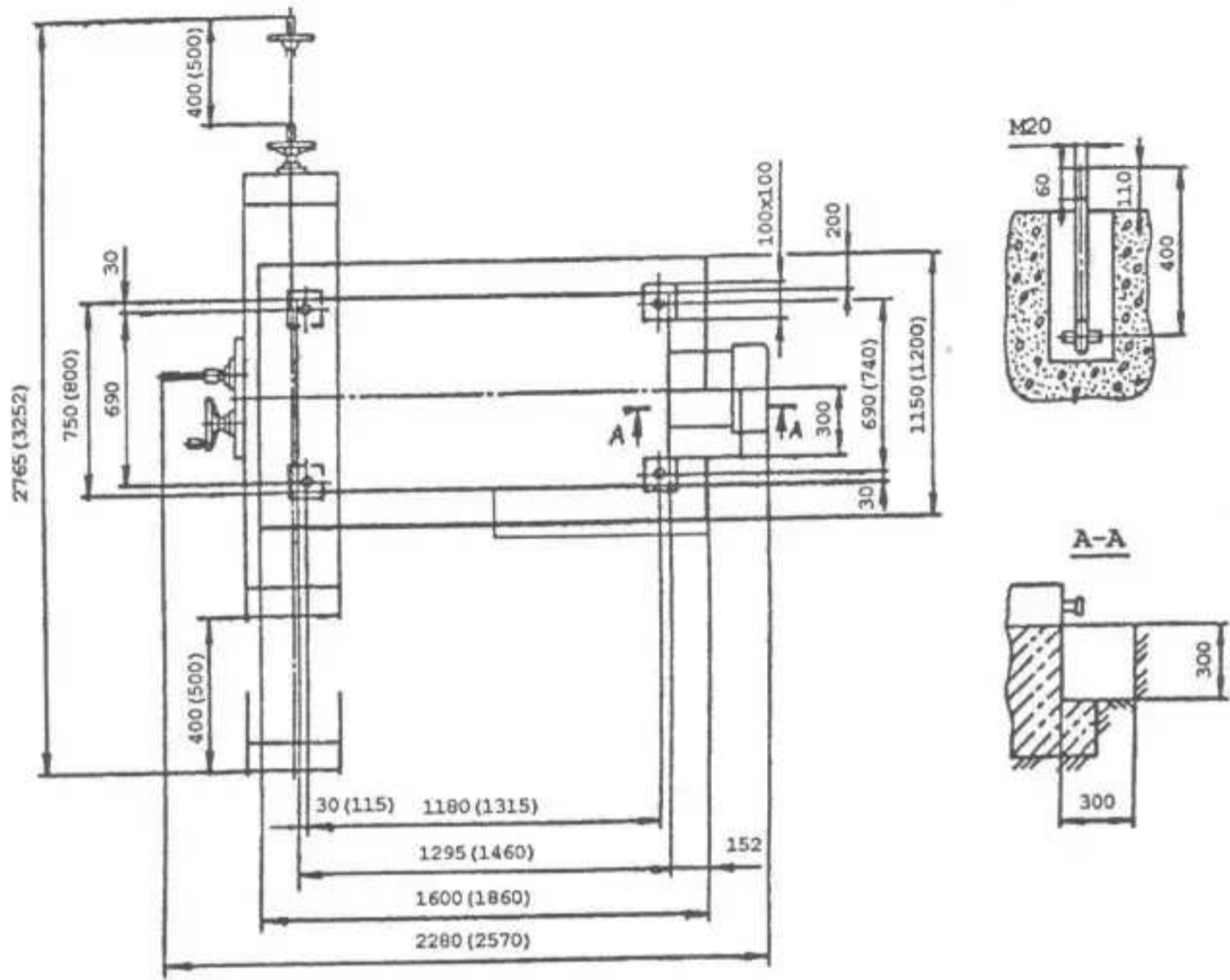
Installation of the machine without special basement is allowed only on concrete floor with thickness not less, than 300 mm. In all the other cases to provide for stable and precise operation it is required to prepare the concrete basement according to Pic. 35. Footing depth of the basement depends upon the soil properties. It is required to provide for the anchor bolt wells and a pit for coolant drain from bed foundation.

The machine shall be aligned at the foundation with steel wedges. After the final alignment the machine shall be grouted with cement grouting and after its curing fixed with the foundation bolts.

Points of grounding and workshop power supply installation are provided in the Section “Electric equipment” (Part II of the Operation Manual).

8.3.1. Installation accuracy

Rate of deviation in the process of machine alignment shall not exceed 0,04/1000 mm. Machine table shall be put into the middle operating position during alignment. See the data referring to precision norms and rigidity of the machine in Section “Acceptance Information” (Part III).



Pic. 39. Installation drawing for the machines (in brackets see the dimensions for 6T83Sh machine)

8.4. Preparation for the initial start-up and initial start-up of the machine

Before the initial start-up it is necessary to do the following:

Ground the machine connecting to the general shop floor grounding system.

After checking the electric power supply network and the electric equipment voltage for matching, connect the machine to electric power supply network. Before switching the power supply, make certain, that all the switches, which have a fixed “0” position, shall be put into the above position.

Acquaint yourself with the kinematics, design of structural units and technical specifications of the machine.

Study the machine controls, designation and functioning of the controls, check the operation of all the machine units using your hand force.

Follow all the indications listed in sections “Lubrication system”, “Tool cooling” and “Electric equipment” referring to start-up.

For thorough acquaintance with the machine run it on idle speed, check functioning of controls, test switching the speeds of spindle rotation, table feeding, lubrication system functioning using the oil level gauges.

IMPORTANT! IT IS STRICTLY PROHIBITED TO OPERATE THE MACHINE IF THERE IS NO OIL IN THE OIL LEVEL GAUGES.

If switching the spindle speed the spindle handle does not reach the dented position, it means that gear wheels did not engage. Under the above circumstances it is needed to push the button “Spindle joggle” (Pic. 11), which is located at gear box. It shall be followed by an impulse motor start, which allows for regular engagement of gear wheels during switching.

IMPORTANT! IT IS STRICTLY PROHIBITED TO SHIFT SPINDLE GEARS DURING OPERATION, AS IT MIGHT CAUSE BREAKING OF GEAR TEETH.

During machine operation in idle mode it is necessary to check the functioning of emergency buttons 10, 29 “Stop”, functioning of limit switches, limiting machine’s unit travel in the limit positions.

After making certain that all the machine mechanisms are functioning properly, you can start to adjust the machine for operation.

8.5 Operation procedure

8.5.1 *Setting, tuning of the machine and modes of operation*

Setting spindle's rotation frequency and the values of table feed are indicated in Sectors 6.6.4 and 6.6.5.

Setting the graduated dials of travel into the initial position for counting shall be made as follows: the graduated dial 25 (Pic. 11) is pushed away and in such a position rotated to alignment of the dial zero mark with the reference starting point arrow of movement at annular ring 24.

Full alignment of the graduated dial arrow with the indicator shall be achieved by rotation of annular ring 24.

The following mounting assemblies shall be tightened to increase the machine rigidity:

- sleeve of spindle – handle 15;
- slide assembly on console guide rails – handles 35;
- console on the machine bed guide rails – handle 48.

Tightening of the table in slide assembly guide rails during cross-feed work or certain table tightening during heavy duty modes during longitudinal feed shall be made with screws 21.

IMPORTANT! IT IS STRICTLY PROHIBITED TO SWITCH ON THE MECHANICAL RUNNING WITH TIGHTENED HANDLES.

See Section 6.6.10 for clamping cutters in spindle.

8.5.2 Automated cycles of table travel

The following cycles of table travel are provided in the machine:

- a) Simple left: fast left – feed left – stop; fast right using the button “fast (cycle)” stop.

For the cases, when for convenience of workpiece removal, it is necessary to move it away from the cutter at fast travel of the machine, one more cam is installed, switching from feed left to fast left.

- b) Simple right – similar to the first with start of movement to the right side.

c) Slip-stick left similar to the first with repetition of movements fast left – feed left, for which purpose additional cams are installed.

- d) Slip-stick right – similar to the previous one with start of movement to the right side.

- e) Simple left with automatic reverse: fast left – feed left – fast right – stop.

- f) Simple right with automatic reverse – similar to the previous one with start of movement to the right side.

g) Slip-stick left with automatic reverse – similar to cycle “e” with repetition of movements fast left – feed left, for which purpose additional cams are installed.

- h) Slip-stick right with automatic reverse – similar to the previous with start of movement to the right side.

i) Pendulum milling: fast right – feed right – fast left – feed left – fast right, etc. Direction of the start of movement is determined by extreme table position. Whereat one of the sequencer pins shall be depressed by the limiting end-piece.

The machine also provides the parts processing by frame in automatic cycle:

- a) horizontal frame with the cycle start by moving table to the right

table (fast to the right - feed to the right) - slide (feed to the bed) - table (feed to the left) - slide (feed from the bed) - table (fast to the left - stop);

- b) vertical frame with the cycle start by moving the table to the right:

table (fast to the right - feed right) - console (feed downward) - table (feed to the left) - console (feed upward) - table (fast to the left-stop).

In both cases contouring is executed counterclockwise.

To expand the machine technological capabilities, provided is the frame cycle diagram adjustment to execute contouring clockwise.

To this end, execute switching in the machine electrical circuit in accordance with the instructions in "Electrical Equipment" section (part II of the Maintenance Manual).

Each of the above cycles can be executed with feed slowed down.

Control after the table movements during automatic cycles is provided by cams acting onto the corresponding sequencer pins. In order to set the machine to automatic operation it is necessary to install the cams according to cut-map and workpiece dimensions. After it the table shall be put into the initial position according to cycle scheme. Whereat the cam, limiting the table travel, shall press the corresponding sequencer pin. After which the switch 30 (Pic. 11) shall be put into the position “Auto cycle”.

Select the cycle type using switch 47.

If frame cycles are selected, set switch 46 to the "Horizontal frame" or "Vertical frame" position. In other cycles, the switch 46 should be set to zero position.

If a slow table feed is required in the cycle, then set the switch 31 to the "On" position.

The function of the command device pins in accordance with the selected cycle is shown in Fig. 36.

Cycle start is performed by pushing button 32 "Fast table travel" (Fig. 11) on the main control board.

Right and left cycle stop is automatically performed (by the cam) in cycle end. It is possible to push the buttons 7 and 11 on the side control board and button 19 on the main control board in order to stop the cycles in any intermediary position, and to stop the pendulum milling.

Cycle repetition is only possible starting from the initial position.

See Pic. 37 for the examples of machine setting for automatic cycles.

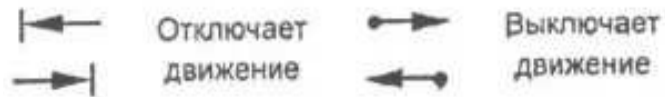
Three cam nominations are used for longitudinal table travel, one for lateral and vertical.

By rotating them by 180° they are used to push the sequencer pins symmetrically located referring to the axis of cam fixation.

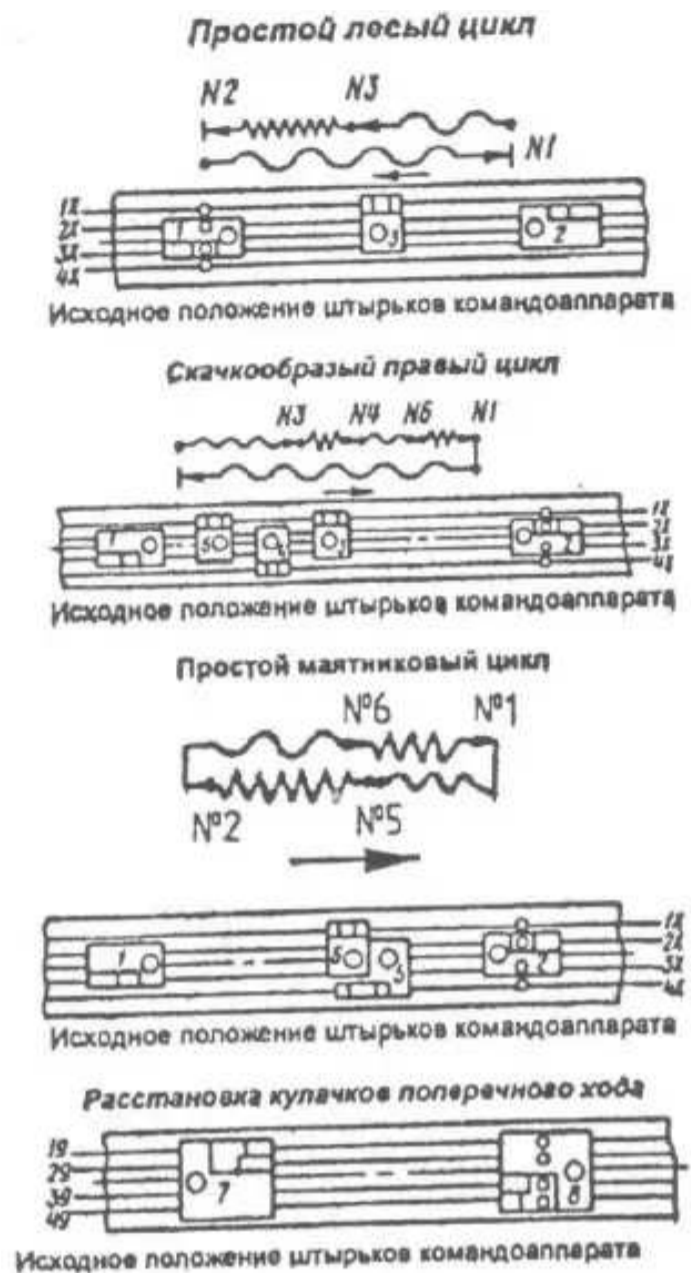
Purpose of the cams may vary depending upon the cycle scheme, that is why it is necessary to maintain strict control over the correspondence of cams positioning and position of switches, which determine the cycle type.

НОМЕР ЦИКЛА	1	2	3	4	5	6	7	8	9	10
1X										
2X										
3X										
4X										

НОМЕР ЦИКЛА	СВЯЗКА			НОМЕР ЦИКЛА	КОНСОЛЬ		
	1	2	3		1	2	3
19				12			
29				22			
39				32			
49				42			



Pic. 36. Cycle schemes and designation of sequencer pins



Pic. 41. Setting machine to automatic cycles

8.6 Adjustment

During operation of machine there is a need to adjust particular components to recover their normal operation mode.

8.6.1 Adjustment of spindle bearings of swivel head (Pic. 15)

Axial play adjustment in a spindle is made by means of grinding rings 3 and 4. Excessive play in the front bearing 4 shall be eliminated by grinding semi-rings 5 and tightening nut 1.

Adjustment is performed in the following sequence:

- move forward the spindle sleeve;
- remove flange 6;
- remove semi-rings;
- wind out threaded plug from the right side of head's body;
- unlock nut 1 through the opening by unscrewing the screw 2;
- lock the nut 1 with a steel rod;
- turning the spindle to position behind the liner block tighten, and therewith move the bearing inner race;
- after checking the play in the bearing make the rolling inspection of spindle at maximal rotation speed during one hour;
- measure the play value between the bearing and spindle collar, where after grind rings 5 to the necessary value;
- reinstall semi-rings 2 and fix them;
- bolt down flange 6. In order to eliminate the radial play of a semi-ring with the value of 10 μm , it is necessary to grind approximately by 120 μm .

8.6.2 Adjustment of the spindle gearbox (Pic. 18)

The graduated dial fixation at speed selection is provided with ball 1, entering the slots of sprocket 12.

Adjustment of spring 13 is made by plug 14 with checking the graduated dial and its rotation effort.

8.6.3 Adjustment of the feed drive overload-release clutch (Pic. 19)

Adjustment of the feed drive overload-release clutch shall be made through the window at the right side of console. In order to perform the above, it is necessary to loosen screw 24 (Pic. 21), rotate nut 23 clockwise. Doing the above the torque increase.

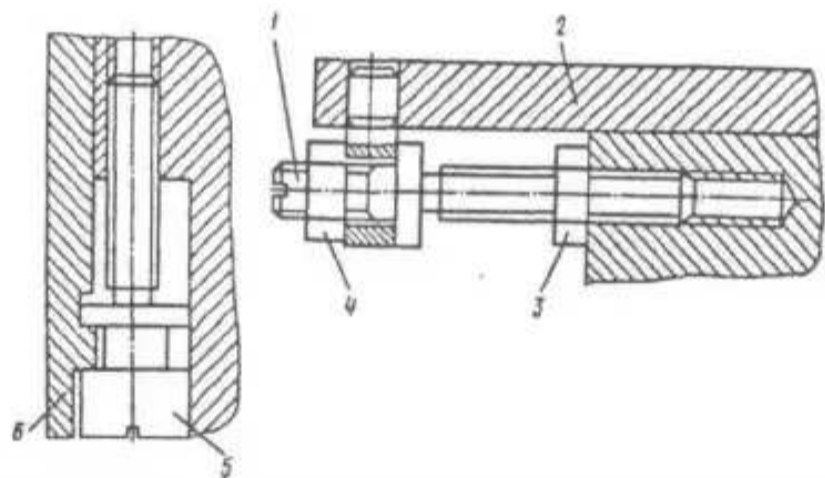
The clutch is considered adjusted if it does not actuate at quickly simultaneous table movement upward and by any other axis.

8.6.4 Adjustment of table wedges, slide assembly, and console (Pic. 38)

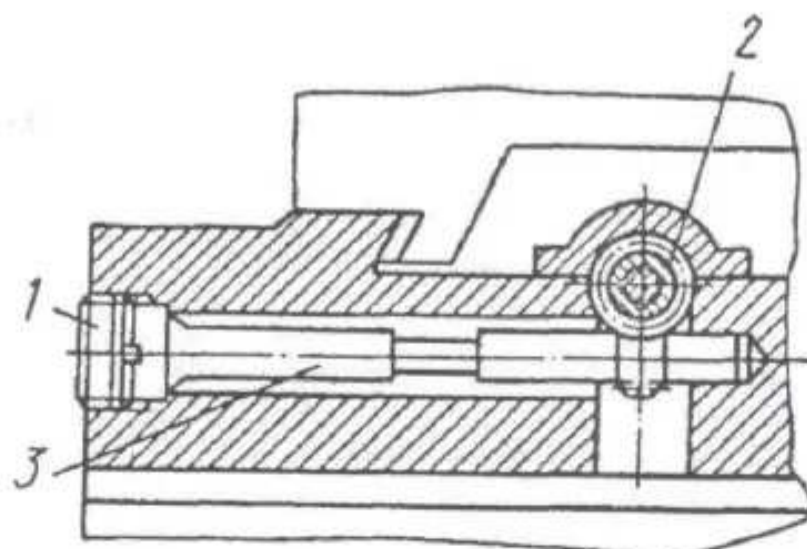
The gap in table guide rails and slide assembly is adjusted with wedges. Adjustment of table wedge 2 is made under the condition of loosened nuts 3 and 4 by tightening screw 1 using a screwdriver. After checking of the adjustment with manual table movement, the nuts are securely tightened. The gap in the guide rails of slide assembly is adjusted with wedge 6 using screw 5. Extent of adjustment is checked with manual movement of slide assembly or console.

8.6.5 Adjustment of the gap in lengthwise movement screw (Pic. 39)

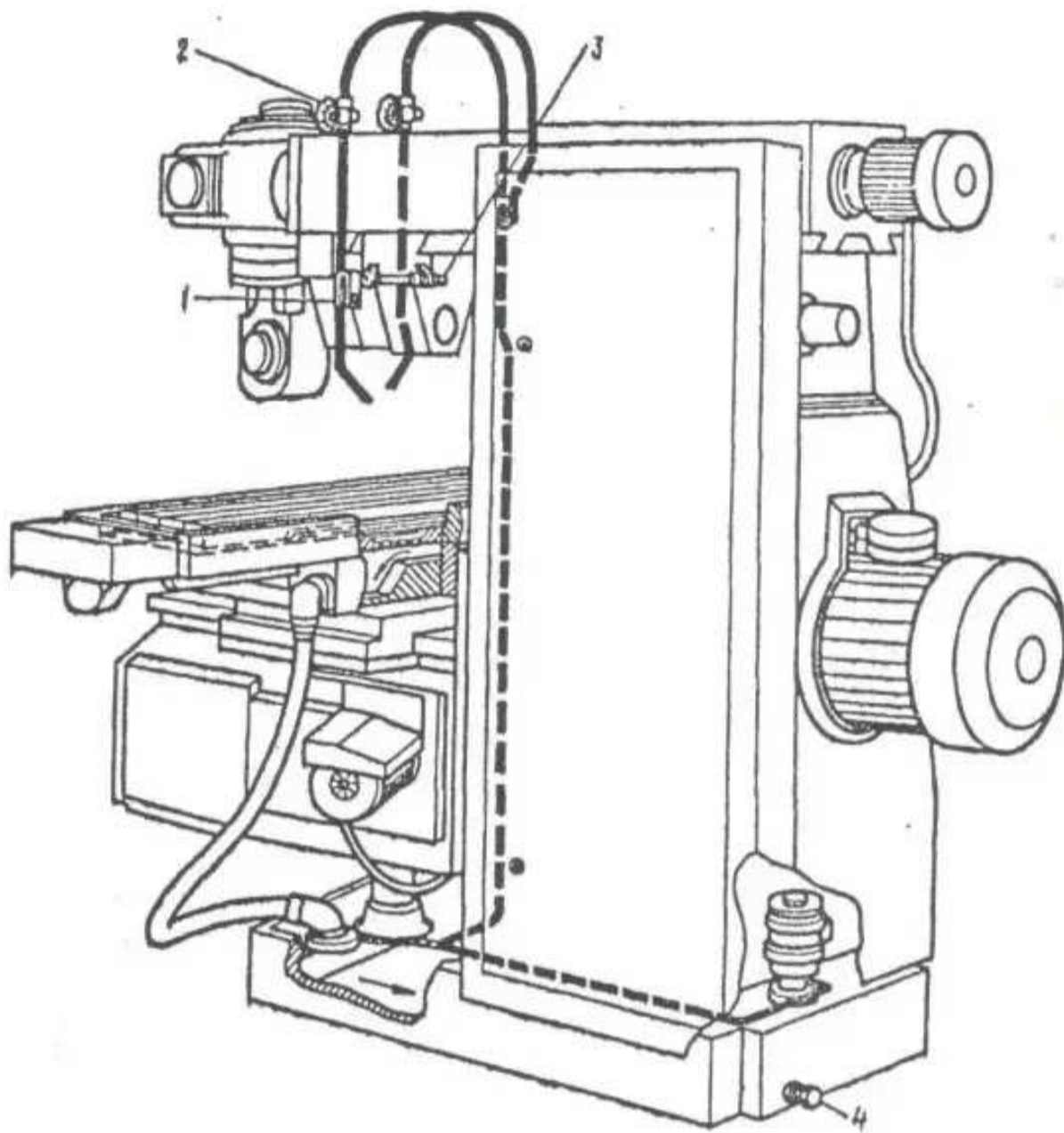
In order to regulate the gap it is necessary to loosen nut 1 and, rotating roller 3, tighten nut 2. It is necessary to tighten the play until the driving screw play, which is checked by checked by the lengthwise movement handwheel rotation, shall not exceed 5 dial graduations. The table shall not jam along its complete length during manual movement of the table. After adjusting nut 1 by tightening, fix roller 3 in the set position.



Pic. 38 Adjustment of wedges



Pic. 39 Gap adjustment in lengthwise movement screw



Pic. 40 Tool cooling

8.7 Tool cooling

Machining cast iron under any methods of milling and machining of steel with any carbide tooling is performed without cooling of cutter tools. It is recommended to use tool cooling in case of machining steel with high-speed cutters.

Cutting fluid supply to the point of cut is provided by sufficient maneuvering characteristics of the nozzle advance system. If nut 1 (Pic. 40) is loosened, the nozzle can be turned at any angle and adjusted by height. When setting the nozzle, pay special attention not to place the nozzle under the cutter.

The cutting fluid from the tank located at the machine foundation is pumped and flows down the table slots, table trough, through the openings in the table to the slide assembly channel, and then through the hose into the foundation of the machine. The point of cutting fluid drainage is protected from obstruction with cutting chips with a dismountable shield. There is a grate installed in front of the openings. A grating cover protects foundation trough for the cutting fluid collection. Filling of cutting fluid is made through the same grating.

IT IS STRICTLY PROHIBITED TO REMOVE THE COVER DUE TO THE POSSIBILITY OF TANK OBSTRUCTION AND DAMAGE OF COOLING PUMP.

Switch 45 (Pic. 11) turns the cooling pump on and off. The cutting fluid flow control valve is tap 2 (Pic. 40), which can stop the cutting fluid supply for a maximum of 10 minutes.

In case of longer cut off of the cutting fluid it is necessary to stop the cooling pump. The system shall be dismantled intermittently (every half a year) and flushed under pressure.

Cutting fluid drainage from the machine foundation during its periodic cleaning shall be made through hose 3, for which purpose in the machine basement there shall be a pit made to accommodate a tank.

Foundation cleaning during heavy overall shall be made after dismantling the console and the bed. In case of changing the milling direction the nozzle might be installed to the other side.

THE NOZZLE MUST BE RELIABLY SECURED; IT IS STRICTLY FORBIDDEN TO READJUST THE NOZZLE DURING MILL CUTTING.

9 POSSIBLE FAILURES AND THEIR TROUBLESHOOTING

Various failures are possible with the machines. Many of them are due to negligence to the requirements of the operator's manual.

Under any circumstances before troubleshooting it is necessary to study the list of possible failures and Section 6 of the operator's manual.

Possible failures and their troubleshooting

Failure	Description	Possible causes	Elimination
No lubrication of gearbox or lubrication of unit providing for feed movement	No oil supply to pumps' performance control gage observed or is negligible. Table guide rails lubrication is insufficient or none.	There is no oil in the tank. Lubrication pump filter is clogged. Pump or system failure.	Feel the oil to the middle of oil level gage. Clean the pump filter. Check the pump, system operation, and if needed dismount for repair.
Feed motor is running, but there is feed movement	Whereat fast travel is performed	Feed switch mushroom knob is not completely engaged	Put the mushroom knob to its stable position
No feed available for three coordinates	Whereat fast travel is performed	Low voltage or no voltage at the electromagnetic coupling of feeding	Check the voltage and working order of the corresponding coupling
No fast travel	Whereat feeding is performed	Low voltage or no voltage at the electromagnetic coupling of fast travel	Same
No creep feed	Whereat fast travel and feeding are performed	Low voltage or no voltage at the electromagnetic coupling of creep feed	“
No feeding for one of the directions of travel	There is feeding available for other directions of travel	Low voltage or no voltage at the corresponding electromagnetic coupling of direction selection	“
Overload-release clutch disengages at normal feeding load	Crackling in the front console compartment at the right side		Adjust the overload-release clutch

See the Section "Electric equipment" for troubleshooting of possible faults of electric equipment. (Part II of Operator's Manual).

10 PECULIARITIES OF DEINSTALLATION AND INSTALLATION AT REPAIR

10.1 Deinstallation and installation of slide assembly to console

For deinstallation of slide assembly from console it is necessary to follow the following sequence: remove the decorative mold-pressed cover 7 (Pic. 22), installed in the console front butt-end, unscrewing its fastening screws in advance; remove cover 8; remove retaining ring 10 and double block 9 from the screw of crosswise movements 2; unscrew the flange fastening screws 11.

Clamp with the clamp handles the slide assembly on console guide rails and take the front supports of spline shaft 3 and screw of crosswise movements 2 out of their mounting sockets. For the above purpose it is necessary to insert the handle of manual movements into the socket of the right-side graduated dial and rotate it counterclockwise until the cooperative movement of the screw of crosswise movements 2 and spline shaft 3 stops. After which it is necessary to extract, manually using the extraction unit, the spline shaft, turning preliminarily the screw of crosswise movements 6 to the angle, securing free passing of the bearings of shaft 3 over the flattened surface of the screw flange face. Screw out the screw using the screwdriver or punching pin into the smooth hole in the end of the screw. After dismantling of wedge 11 (Pic. 24), disconnection of plates 9, lubrication hoses, cooling and electric wiring, secure slings to slide assembly and take them off the console guide rails.

Mount the slide assembly to the console in inverse sequence. There is a certain peculiarity in mounting the crosswise movement screw. In order to put the spline shank of screw 2 into the spline broach of gear wheel 1 (Pic. 22), it is necessary after installation of slide assembly and the wedge, screw down the screw into nut 12 with unclamped slide assembly. If the screw in assembly with the flange 6 did not enter completely into the console boring, it is necessary, using the handle of manual movements, put into the socket of right-side graduated dial of the console, with the left-to-right wobbling movements to the angle of 60° , move manually the slide assembly to the direction of vertical guide rails of the console. At this the spline shank of the screw shall enter into the spline broach of the gear wheel 1. Further installation follows the regular procedure.

10.2 Dismounting and mounting the gearbox

Dismounting of the gearbox is performed using common practices, considering the available lifting devices.

In the upper part of the cylinder base flange of the gear box there are two M12 screw-treaded bores for eyebolts, stopped with screwed plugs.

In order to provide for proper operation of gearbox after its repair and assembly, tightening of forks on rods 5 (Pic. 20), to prevent axial rotation, shall be performed last.

Before tightening the forks, it is necessary to install the switching discs by rotation around the swivel axis in such a way, as to ensure the gauge marks available on one of the planes of each disc, to be placed perpendicular to the mating face of feeding box. Then move the discs to the stop in the counter direction. Put the switching gear assemblies of feeding box into the position, described in Pic. 17, and then tighten the forks to the rods.

The above position of gear assemblies and switching discs corresponds to the feeding rate, equal to 50 mm/min. The same feeding rate shall set on the graduated dial at the front butt-end of the console before installation of the feeding box, after which completion it is necessary to check the correspondence of actual feeding to value set according to the graduated dial.

After the feeding box installation, be sure to check the compliance of the actual feed and graduated dial feed values.

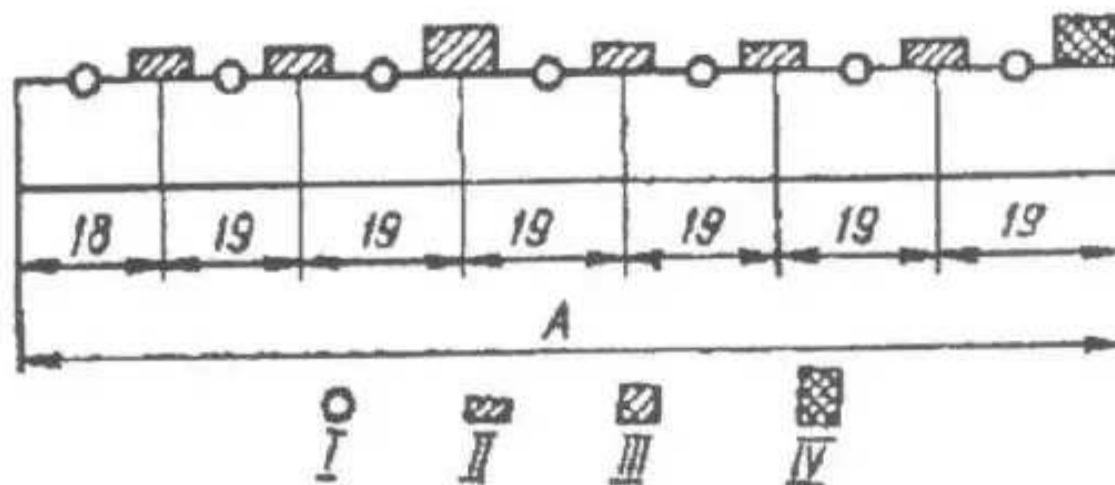
In case of its inconsistency of actual feeding to the set value, it is necessary to extract the wire stop-ring 12 (Pic. 25) from the groove, move out the graduated dial 11 to dead stop, and rotating it around its axis place set according to the graduated dial against the indicating arrow the feeding value corresponding to its actual value.

After it move the graduated dial to front until dead stop and place the stop-ring 12 into the groove.

10.3 Dismounting and mounting of the feeding drive motor shaft

In order to dismount motor shaft 11 (Pic. 21) it is necessary to remove in advance the top motor compartment casing, feed drive motor, feed gear box, and it needed the terminal box, located above the motor. After screwing screws 13 move the shaft in axial direction using extracting device to dead stop of bearing 10 into shaft 16, after which, inclining shaft 11 to console bottom, take it out of the bore. Install after repair in inverse sequence.

Adjust lateral gap of bevel gear wheel and pinion 9 and 6 engagement using screws 12, 13, and nuts 8 and 4.



Pic. 41. Repair works schedule:

A – months; I – inspection; II – slight repair; III – medium repair; IV – capital repair

11.2. Inspection

11.2.1. Visual inspection (without dismantling to detect defects) of the machine in general and by mounting assemblies.

11.2.2. Inspection and checking of status of the mechanisms of the drive of main movement and feeding.

11.2.3. Adjustment of the gaps of table feeding screws.

11.2.4. Adjustment of spindle bearings.

11.2.5. Functional check of the operation of gear and feeding switching mechanisms.

11.2.6. Adjustment of table wedges, slide assembly, console and extending overarm.

11.2.7. Visual inspection of guide rails, trimming of chippings and scorings.

11.2.8. Tightening of loosened fastening pieces.

11.2.9. Checking the operability of the limiting cams.

11.2.10. Checking the status and slight repair of cooling and lubrication systems.

11.2.11. Checking the status and repair of restraint devices.

11.2.12. Detecting the parts to be replaced during the next repair (starting from second slight repair).

11.3. Slight repair

11.3.1. Partial disassembly of mounting assemblies.

11.3.2. Flushing of all mounting assemblies.

11.3.3. Adjustment or replacement of all roller bearings.

11.3.4. Trimming of chippings and scorings on gear wheel teeth, slide blocks, and shift forks.

11.3.5. Scraping and trimming of wedges and planks.

11.3.6. Trimming of movement screws and replacement of worn nuts.

11.3.7. Trimming of chippings and scorings of table guide rails and work area.

11.3.8. Replacement of worn and broken fastening pieces.

11.3.9. Check and adjustment of gear switching and feeding mechanisms.

11.3.10. Repair of lubrication and cooling systems.

11.3.11. Machine test on idle speed, checking for noise level, heating, and precision of machining a workpiece.

11.4. Medium repair

11.4.1. Machine disassembly to mounting assemblies.

11.4.2. Flushing of all mounting assemblies.

11.4.3. Visual inspection of disassembled mounting assemblies.

11.4.4. Making list of defects.

11.4.5. Adjustment or replacement of spindle bearings.

11.4.6. Replacement or reconditioning of spline shafts.

11.4.7. Replacement of worn bushings.

- 11.4.8. Replacement of worn gear wheels.
- 11.4.9. Reconditioning or replacement of worn movement screws and nuts.
- 11.4.10. Scraping or replacement of adjustment wedges.
- 11.4.11. Repair of pumps and fittings of lubrication and cooling systems.
- 11.4.12. Reconditioning by scraping or grinding of guide rail surfaces, if their wear exceeds the acceptable level.
- 11.4.13. External painting of machine.
- 11.4.14. Machine test on idle speed (on all speeds and feeds), checking for noise level and heating.
- 11.4.15. Testing the machine for precision and rigidity according to GOST 17734-81.

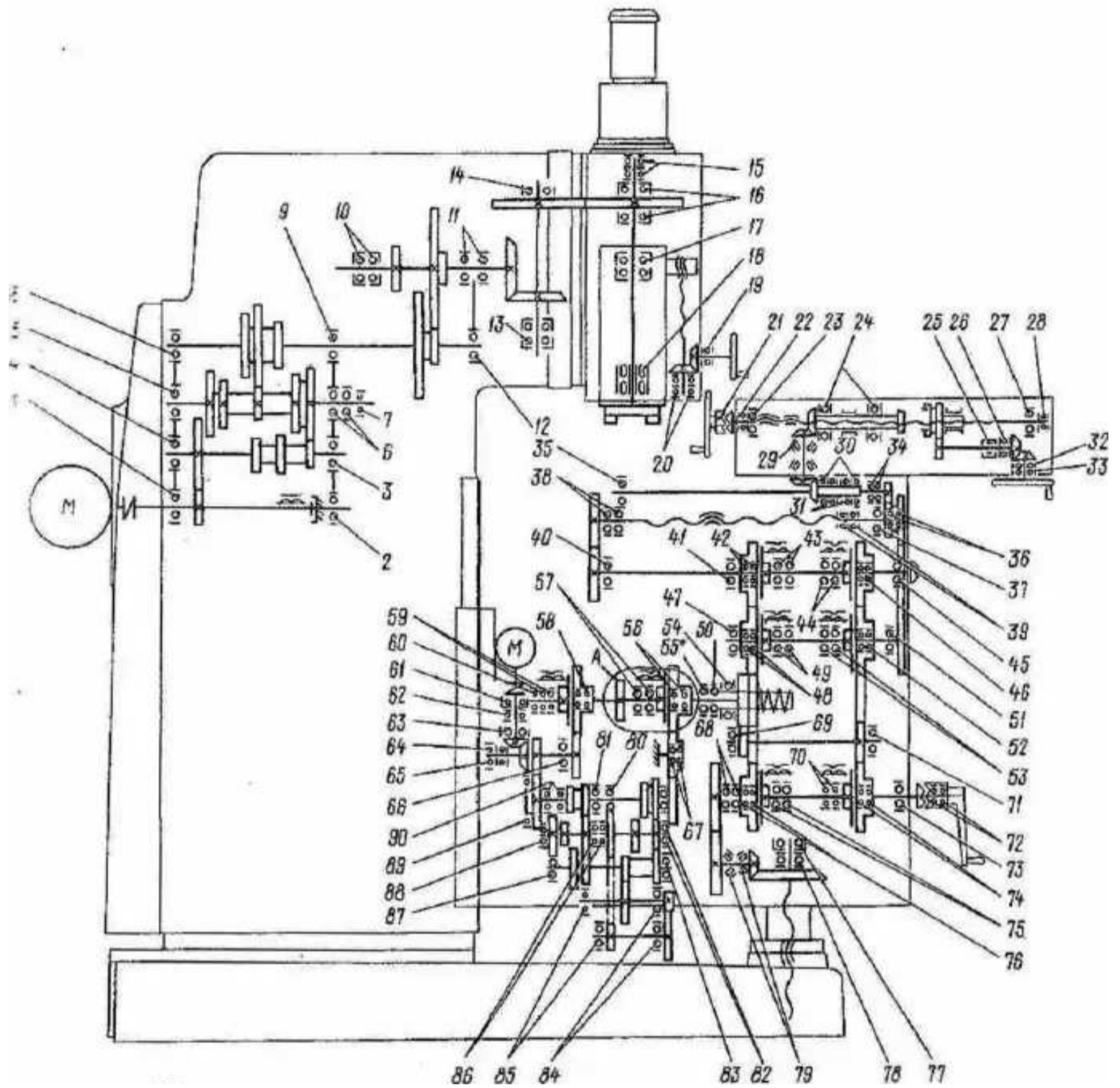
11.5. Capital repair (Heavy overall)

The capital repair is performed with total disassembly of all the machine. As the result of the repair every worn mounting assemblies shall be reconditioned or replaced, besides its initial precision, rigidity and power shall be recovered. The character and scope of works for this type of repair are determined for particular operational conditions.

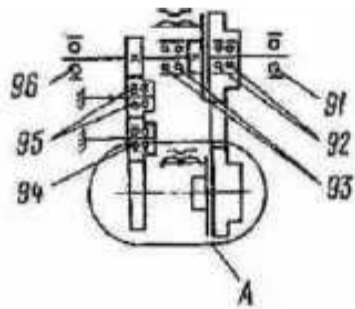
12. INFORMATION ON CHANGES IN THE MACHINE

Nomination and designation of machine components	Basis, name of document	Date of changes	Maintenance characteristics of the machine after changes	Position, name and signature of responsible person

13. SPARE PART MATERIALS



Feed slowing mechanism



Pic. 42 Layout chart for bearings

Name	Bearing class	Including	Position on Pic.42	Quantity for each machine	
				6T12-I	6T13-I
Bearings GOST 831-75					
462G4K	0	6T82G-1.60	64	1	1
46212	6	6T12-1.30	10	2	2

Bearings GOST 7242-70		6P12.32	13	2	2
60106	0	6T82G-1.60	34	2	2
60202	0	6T82G-1.60	72	2	2
60204	0	6T82G-1.60	35	1	1
60206K	0	6T82G-1.70	36	2	2
		6T82G-1.60	23, 27	2	2
60208	0	6T82G-1.60	50	1	1
60209	0	6T82G-1.60	41, 47, 68	4	4
60212	0	6TI2-1.30	1	1	1
80104	0	6T82G-1.63	69	1	1
60204	0	6T82G-1.63	71	1	1
S0206	0	6T82G-1.60	45, 73	2	2
80209	0	6T82G-1.60	51	1	1
Bearing GOST 8338-75					
1000904	0	6T82G-1.41	94, 95	4	4
7000107	0	6T82G-1.41	93	2	2
7000109	0	6T82G-1.60	57, 59	4	4
	0	6T82G-1.69	43, 44, 49, 70, 53, 75	6	6
Bearing GOST 7634-75					
3182118	4	6P12.32	18	1	-
3182120	4	6P13.32	18	-	1
Bearing GOST 4060-78					
943/25	0	6T82G-1.70	21, 25	3	3

55 For 6TI3-I machine

APPENDIX

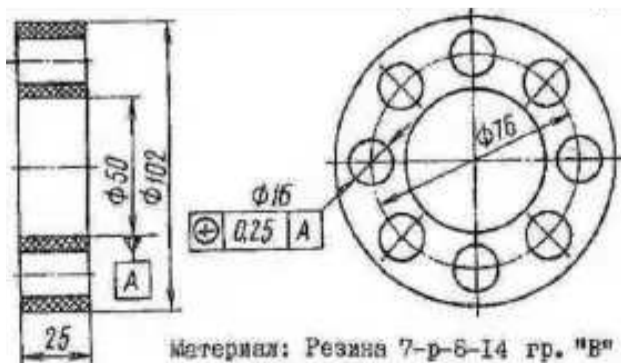
WEAR PARTS LIST

Name	Description	Machine		Including	Picture No.
		6T12-I	6T13-I		
Ring	6M82.3.93A	X		Gear box	1
Ring	6M83.3.91A		X	Gear boxes of horizontal and vertical spindels	2
Toothed gear wheel	6P82.3.48	X	X	Gear box	3
Driving screw	6T82G-1.60.282	X		Console	4
Driving screw	6T83T-1.60.261		X	Console	5
Nut	6T82G-1.66.201	X	X	Console	6
Bimetallic nut	6T82G-1.70.003	X	X	Table and slide assembly	7
Driving screw	6P82.7.161A	X		Table and slide assembly	8
Driving screw	6P83.7.38		X	Table and slide assembly	9
Bimetallic nut	6M82.7.101	X	X	Table and slide assembly	10
Bimetallic nut	6M82.7.102	X	X	Table and slide assembly	11
Collar		X	X	Console	-
Ring	1-55x80-2 GOST 8752-79 6T82G-1.64.911	X	X	Motor shaft	12

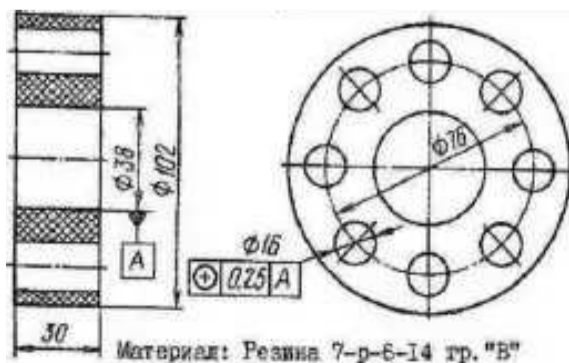
LIST OF ROLLER BEARINGS

Name	Bearing class	Including	Position on Pic. 42	Quantity for each machine	
				6T12-1	6T13-1
Bearings GOST 8338-75					
104	0	6T82G-1.41	91	1	1
105	0	6T82G-1.70	32	1	1
		6T82G-1.40	85,90	4	4
106	0	6T82G-1.60	67	2	2
107	0	6T82G-1.60	37, 56, 58, 40, 66	7	7
		6T82G-1.60	38, 55*		

		6T82G-1.69	42, 46, 48, 52, 74, 76	12	12
		6T82G-1.64	63	1	1
109	0	6T82G-1.40	89	1	1
110	0	6T82G-1.70	30	2	2
204	0	6T82G-1.41	96	1	1
205K	0	6T82G-1.40	80, 84, 87	4	4
		6T82G-1.41	92	2	2
206K	0	6T82G-1.40	82	2	2
		6T82G-1.60	60	1	1
		6T12-1.30	2	1	1
210	0	6T12-1.30	7	1	1
		6P13.32	14	-	2
215	0	6P13-1.30	11	-	2
303	0	6T82G-1.40	88	1	1
304	0	6T82G-1.40	81,86	3	3
		6T82G-1.70	33	1	1
305	0	6T82G-1.40	83	1	1
307	0	6T12-1.30	3	1	1
308	0	6T12-1.30	6	1	2
309	0	6T12-1.30	5, 12	2	2
311	6	6T12-1.30	8	1	1
		6P12.32	14	1	-
312	6	6P12-1.30	11	1	-
407		6T12-1.30	4	1	1
Bearings GOST 333-79					
7205	0	6T82G-1.60	79	2	2
7208	0	6T82G-1.70	29	2	2
Bearings GOST 6874-75					
	0	6P12.32	20	2	2
8104	0	6T82G-1.60	65	1	1
8105	0	6P12.32	19	1	1
		6P12K.93	15	2	2
		6T82G-1.70	26	1	1
		6T82G-1.64	62	1	1
8107K	0	6T82G-1.60	39	2	2
8110	0	6T82G-1.70	31	2	2
		6T82G-1.60	54	1	1
8113	0	6T82G-1.60	77	1	1
		6T82G-1.70	24	2	2
8120	0	6T82G-1.60	78	1	1
8209	0	6T82G-1.70	22, 28	2	2
Bearings GOST 831-75					
46109B	0	6T82G-1.64	61	1	1
46117Л	5	6P12.32	17	2	-
46120Л	5	6P12.32	16	2	-
46120	5	6P13.32	17	-	2
461241	6	6P13.32	16	-	2

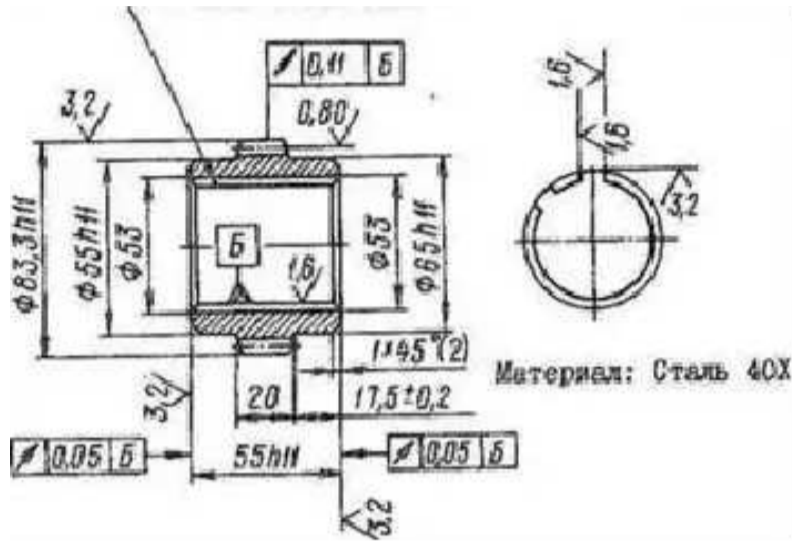


Pic.1. Ring 6M82.3.93A



Pic.2. Ring 6M83.3.91A

d-8x46H8x50H12x9D10



Module	m	4
Number of teeth	Z	17
Normal original profile		GOST 13755-81
	£	
Accuracy degree according to GOST1643-81	-	8-180C
Original profile minimum additional offset	E _{на}	-0,080
Deviation of measurement	upper	E _{аа} +0,036
center-to-center spacing	lower	E _{а1} -0,120
Tolerance for fluctuation of measurement center-to-center spacing	per wheel	F ₁ 0,071
	on one tooth	f ₁ 0,036
Tolerance for fluctuation of general standard part length	F _{vw}	0,028
General standard part average length	W _m	33,21 -0,066 -0,126
Pitch circle diameter	d	68
Maximum circumference speed, m/sec	v	1,87
Designation of mating gear drawing		6P82.3.44

Pic.3 Tooted gear wheel 6P82.3.48

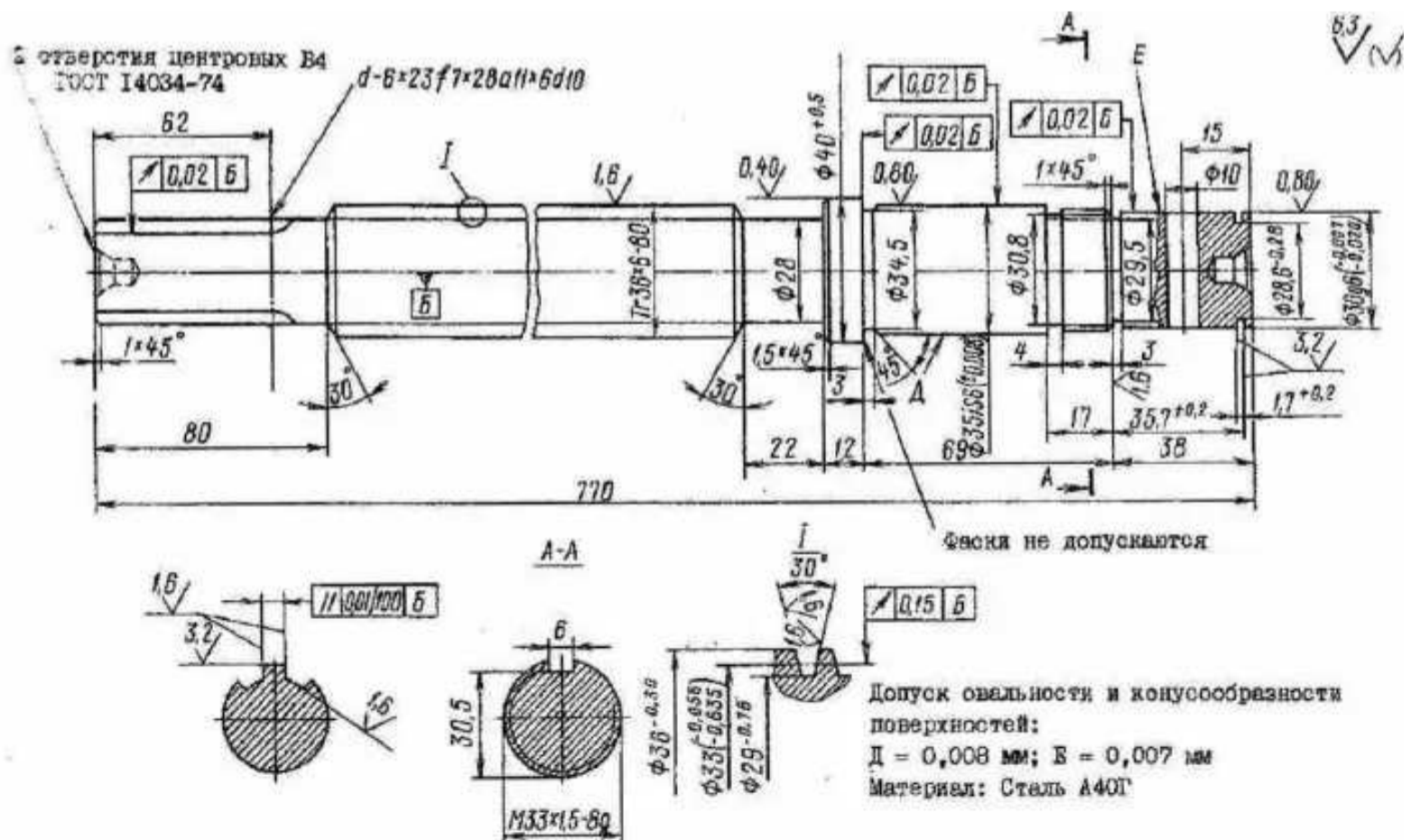
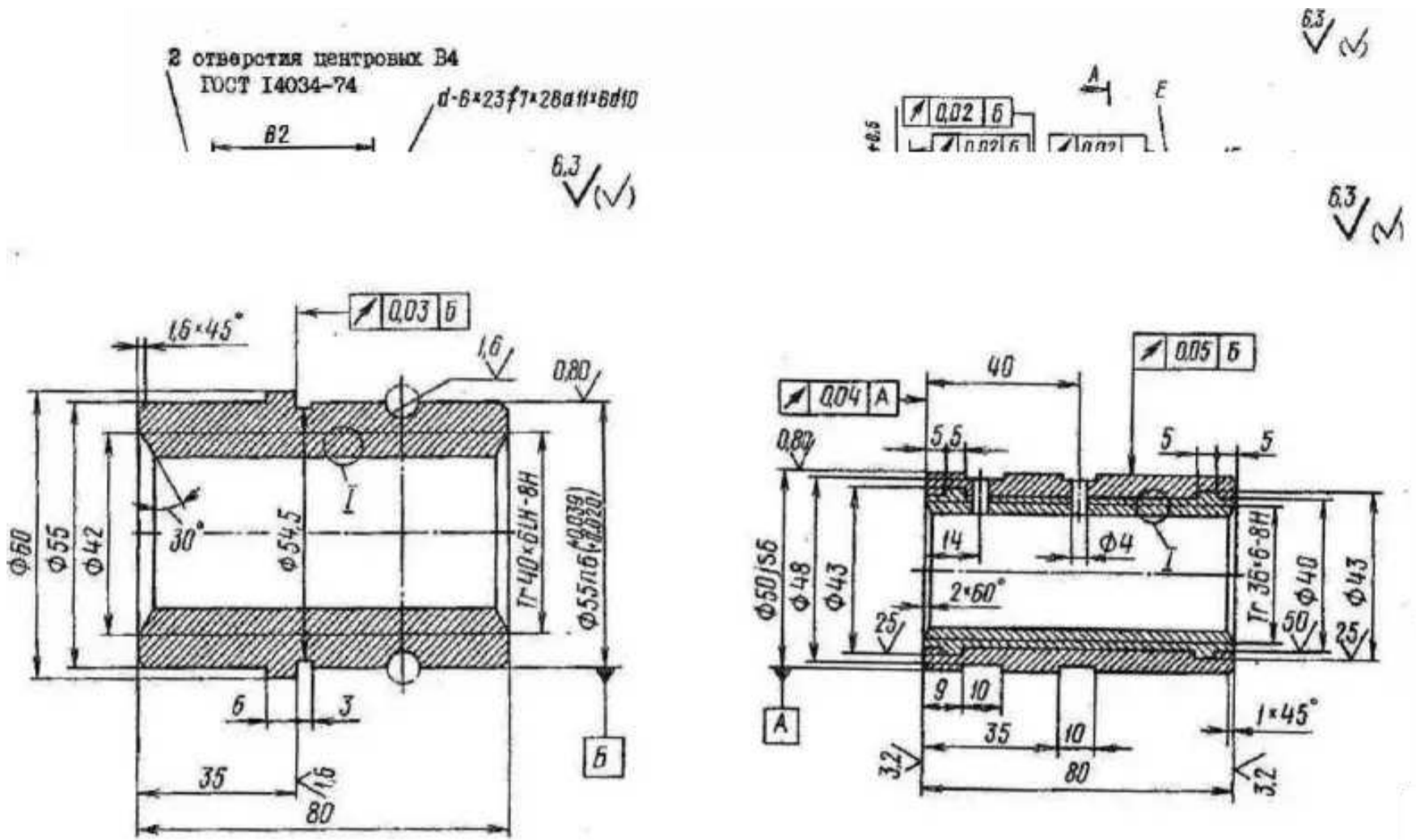
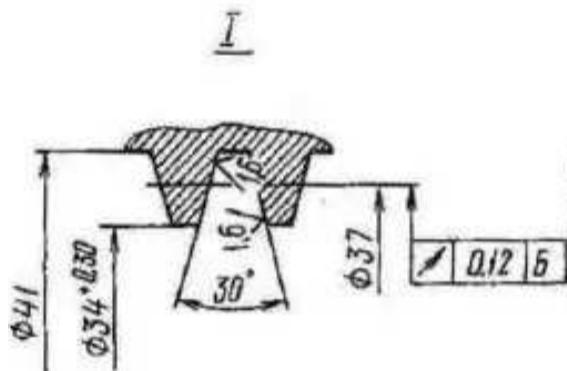


Рис. 4. Винт ходовой 6ТВ2Г-1.60.282

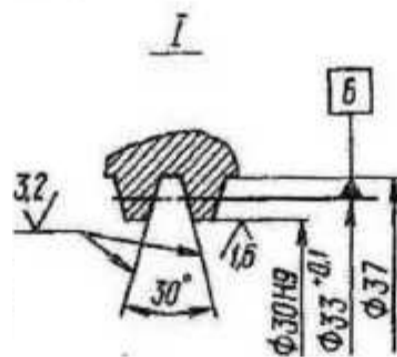


Pic. 5. Driving screw 6T82G-1 60 261



Material: Bronze Br.01C5-5-5

Pic.6. Nut 6T82G-1.66.201



Material: Steel 45; Bronze Br.01C5-5-5

Pic.7 Bimetallic nut 6T82G-1.70.003

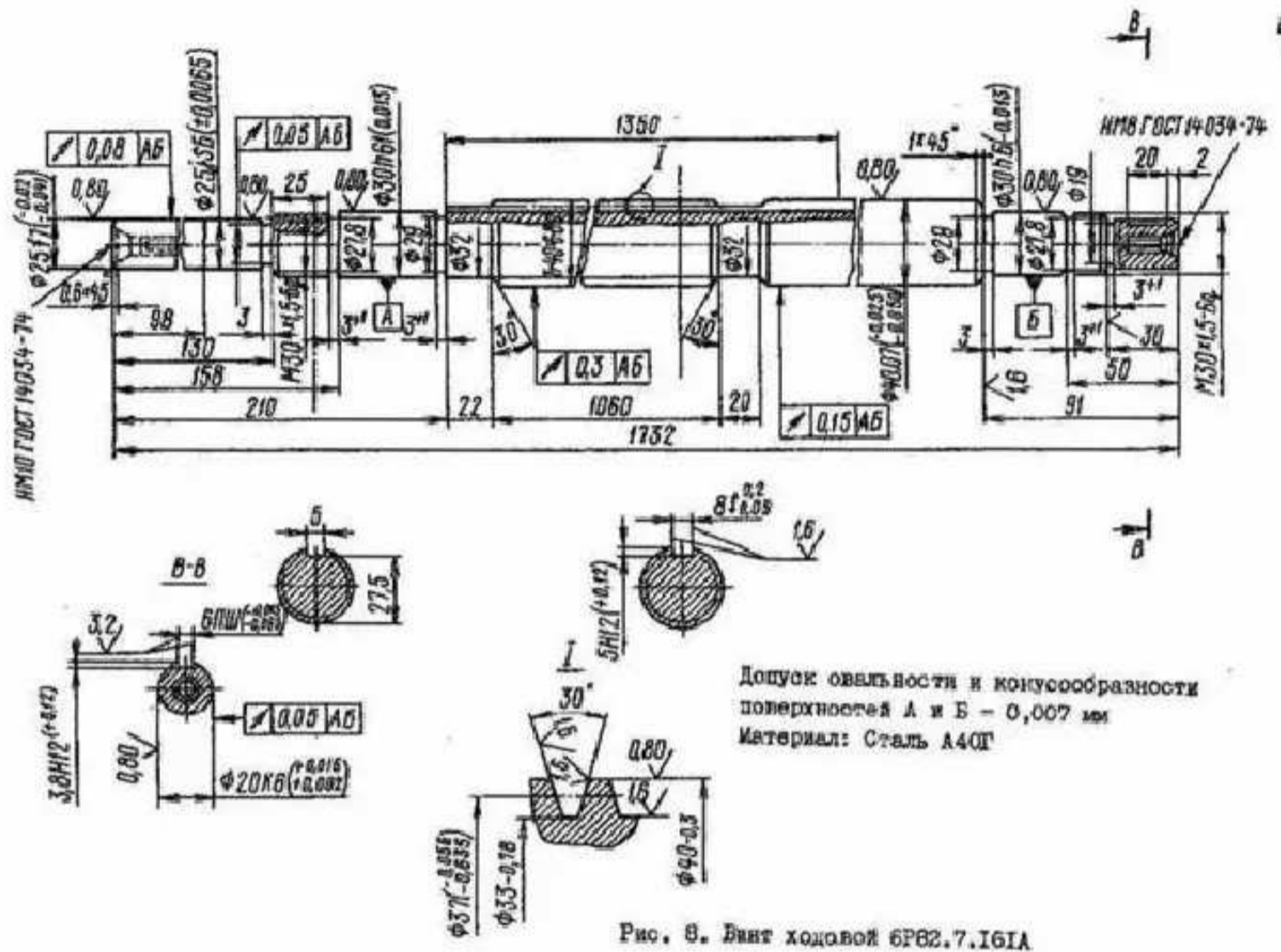
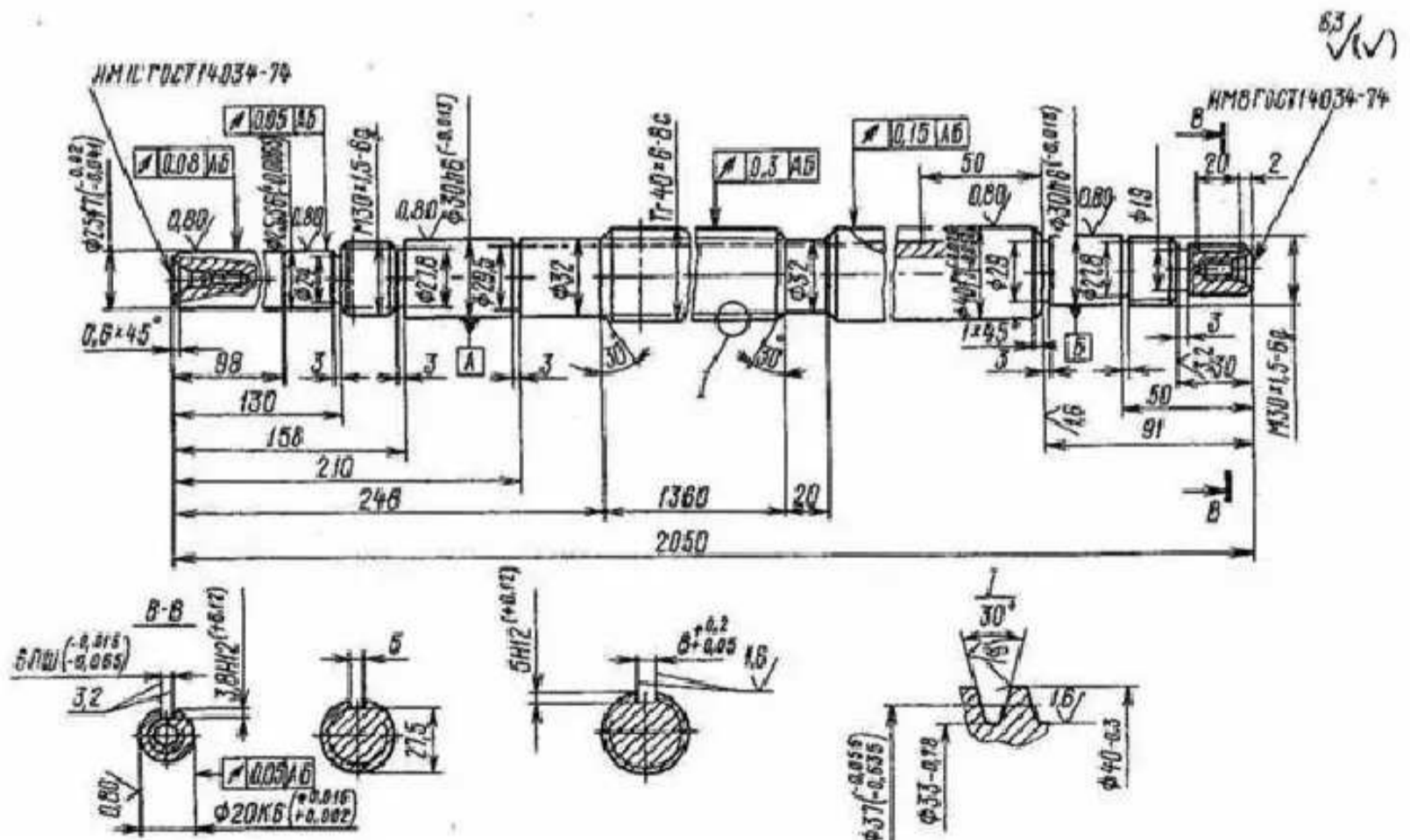


Рис. 8. Винт ходовой 6P82.7.161A



Ovality and conicity tolerance for
A and B surfaces = 0.007 mm
Material: Steel A40Г

Pic.9. Driving screw 6P83.7.38

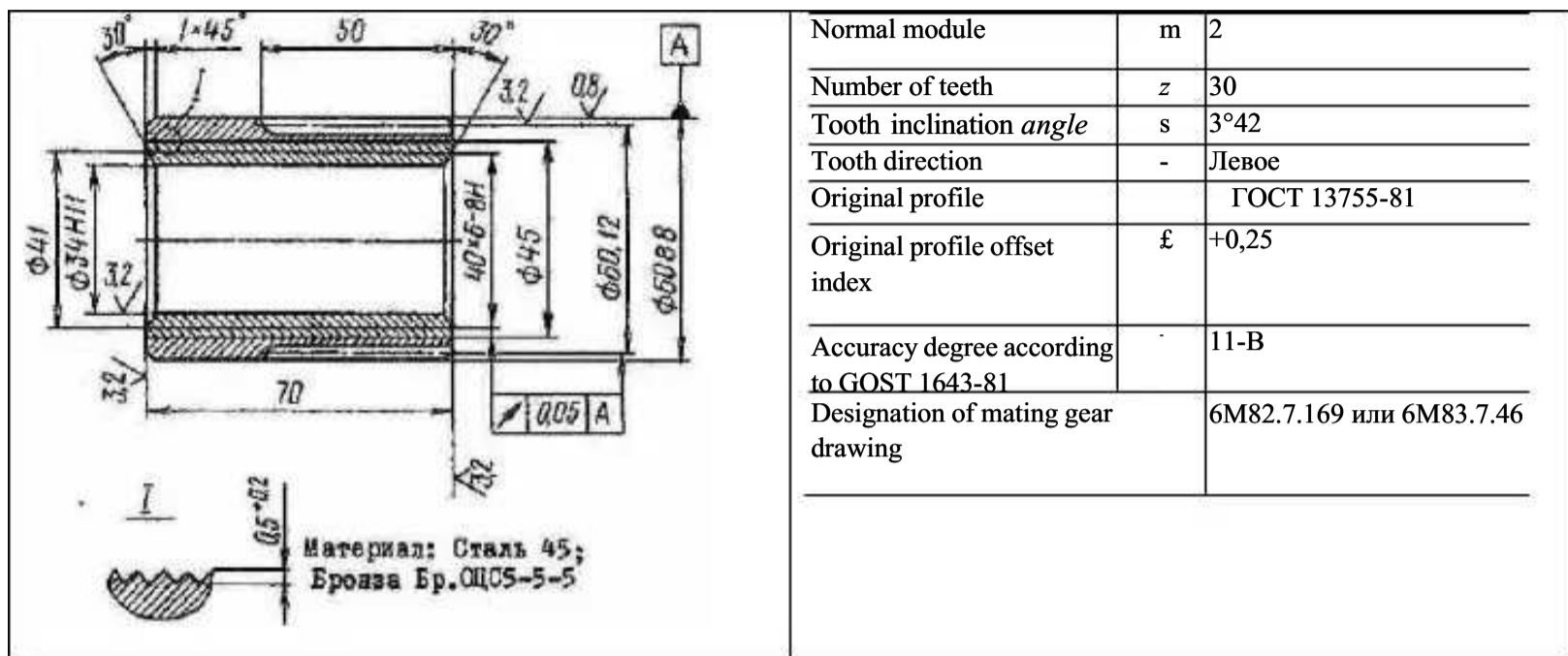


Fig.10. Bimetallic nut 6M82.7.101

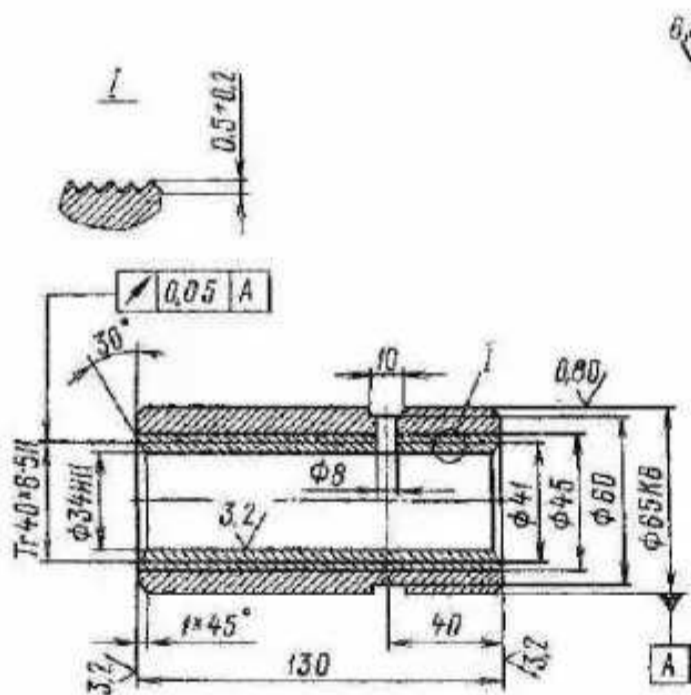


Fig.11. Bimetallic nut 6M82.7.102

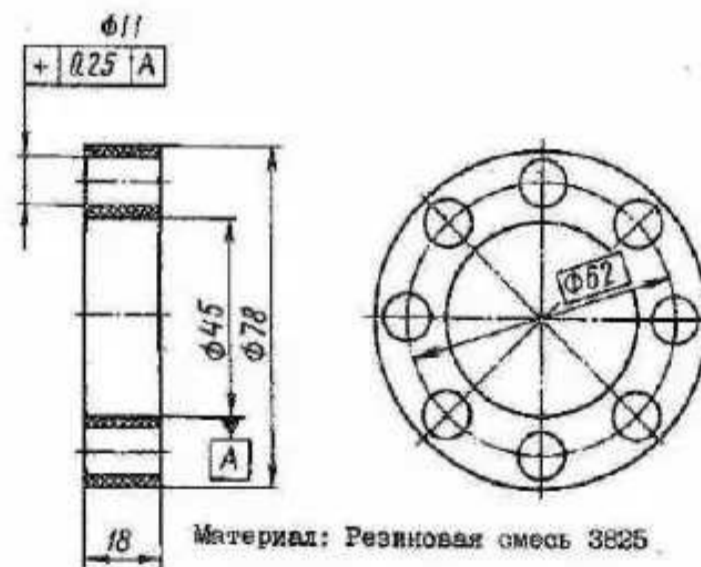


Fig.12. Ring 6T82G-1.64.911

В связи с постоянной работой по совершенствованию изделия, повышающей его надежность и улучшающей условия эксплуатации, в конструкцию могут быть внесены незначительные изменения, не отраженные в настоящем издании.