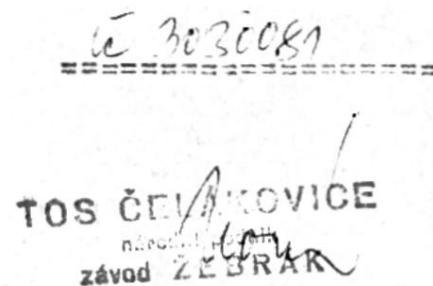


Serial number stamped on the machine



Handwritten serial number: 3030081

Stamp: TOS ČELÁKOVICE
závod ZEBRÁK

As the construction of our machines is constantly being improved and adapted to the latest working conditions, it is not possible for us to guarantee that these operating instructions correspond in all their details to the machine which we have delivered to you. We therefore ask users of our machines to always state the type and part number of the part when ordering spare parts, so that the order can be executed in accordance with the version of the machine delivered.

Dear Sirs,

We recommend to your best attention this manual of service instructions. It contains everything you need to know about the installation, operation and start-up of the machine and the use of all its functional parts. What seems to us to be of the utmost importance is that it is in the first place the foremen and the operators of the machine who must be familiarized with the correct installation and operation of the machine. It is precisely for these people that the instruction manual is intended.

Before starting the machine, familiarize yourself with all the driving and control elements.

The working precision of each machine is checked using the most precise measuring instruments, and the care with which this control has been carried out guarantees a precision corresponding to the acceptance standards in force for its types of machines.

For this accuracy to be maintained, it is necessary to carry out the transport and the installation of the machine with all the useful precautions.

By observing all the recommendations contained in this manual, you will avoid losses and you will be satisfied with the accuracy and performance of the machine.

We recommend that you take the best care of the entire optical system.

We wish you much success and the best results in your work with our machines.

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1. TECHNICAL CHARACTERISTICS

General data

Useful surface of the vertical table mm 216 x 680 Useful surface of the table d
 square mm 240 x 600 Diameter of the pin dama the front
 bearing mm 4 5 Conical cavity in the spindle ISA 40
 Spindle speeds - number 18 50 – 2500 18

extreme values rpm

Advance - number extreme
 values in three directions mm/min 8 - 400

Fast moving mm/min 1340 Headstock stroke - by
 hand mm 200 automatic mm 190 Moving the
 head holder gives an overhang

of mm 42 Table travel longitudinally,

by hand mm 300

automatic mm 290 Table travel vertically,

by hand mm 350

automatic mm 340 Total power absorbed

by the machine kW 2.7 Weight of the machine kg.....
 750

Standard accessories

1. Electrical equipment including motors and distribution cabinet electric
2. Watering device with pump
3. Cantilever chuck, 5 pieces, \emptyset 16x29, \emptyset 22x19, \emptyset 22x37, \emptyset 27x23, \emptyset 27x47
4. Complete stop system 5. Drive rings between chuck and spindle 6. Collet set + collet sleeve + threaded coupling 7. Horizontal spindle clamping bolt 8. Complete tool set 9. Grease pump by hand 10. Fixed square table 11. Service instruction manual: 2x

Optional accessories /delivered on special order/

1. Machining tool holder
2. Support arm
3. Vertical milling head 4. High-speed milling head 5. Mortising head 6. Tilting table 7. Swivel table 8.

Divider

9. Control chuck 10. Eight special 8x collets 11. ISA 40/Morse 1, ISA reduction sleeves. 40/Morse 2, ISA 40/Morse 3. 12. ISA 40/ \emptyset 16, \emptyset 22 and \emptyset 27 long type milling chuck including rings 13. Boring head including 3 boring tools 14. Machine vice 15. Dial gauge 16. Clamping flanges

DESCRIPTION OF THE MACHINE

The FN-20 tool milling machine is the lightest type of machine in the range of FN-20, FN-32, FN-40 tool milling machines. This range follows up successfully with the proven FF-22A and FN-25 machines.

In the construction of the FN-20 milling machine, account was taken not only of the experience gained during the production of older types, but also of the wishes and observations of customers. In comparison with the FN-32 and FN 40 types, the FN-20 machine stands out for its high range of speeds and for its partially high rapid traverse, allowing, in addition to standard machining, very economical machining of light metals and small parts.

Not only the technical side but also the external appearance of the machine has been studied in cooperation with the best workers from Czechoslovakian research institutes.

In keeping with tradition, the machine is designed as an interchangeable three-block system, of which the upright with the frame contains the control mechanism. The movable milling headstock with the spindle mounted on bearings carries out the movement of the transverse feed. The longitudinal feed and the vertical feed are carried out by the console with the vertical table.

a/ Gearbox, _____

The gearbox is located in the upper part of the pillar and is driven by a self-contained motor through a simple two-V-belt transmission.

The gearbox mechanism provides 18 speed stages and its structure is 3 x 3 x 2 /fig. 2/.

The hardened and ground sprockets including the shafts are made of high-quality nickel-chrome steel. The last element of the gear box is a cylindrical gear wheel, allowing continuous meshing with the gear wheel of the sliding headstock. The engagement of any gear stage is effected by moving the corresponding toothed wheels, on the one hand by means of a cam-disc controlling sliding levers, and on the other hand by means of release forks for the choice of the accelerated range or the slow range of speeds.

b/ Box of advances

The feed box is located in the inner part of the upright and is driven by an autonomous electric motor through a duplex chain. The mechanism of the box has 18 stages of advances and a stage of rapid movement, v. fig. 2. Changing transmission stages is based on the same principle as changing gears /v.a1.a/ above/. The choice of advance is made by action on a push button on the control panel, the choice of rapid movement is made by hand using the control lever, any advance stage being engaged.

The machine is protected from dangerous overloads by a ball safety clutch, located in the advance box and set to the optimum torque.

Any inexperienced manipulation of the adjustment screws of this clutch can cause damage to the machine.

c/ Strawberry headstock

The headstock slides in the upper prismatic guide of the upright. The horizontal spindle mounted on bearings is connected with the gearbox by a gear. The headstock's upper prismatic guide is designed to receive the machining head holder.

d/ Console

On the front guide of the upright slides, in the vertical direction, the console with the horizontally movable vertical table. The mechanical advance in the two directions mentioned is derived from the advance box by an eloidal gear. The single, cross-moving lever controls, via a claw clutch, the selected feed.

3. INSTALLING THE MACHINE /fig. 1 and 3/

The machine is transported to the place of its installation either on iron logs or by means of a crane, the sling having passed under two bars introduced into the openings in the frame /fig. 3a/. The machine is installed on a solid floor or on a solid foundation prepared in advance, stripped of the anticorrosive coating and well cleaned. Then it is wedged using metal wedges. This being done, the headstock top cover should be removed and the machine leveled to 0.03 mm/1000 mm /v, fig. 3b/. Once the machine is level, seal it with liquid cement mortar. If the machine must be fixed to the floor, the M16 anchor bolts must be placed in the holes in the foundation before installing the machine. These bolts should only be tightened after the foundation block has completely taken hold and, in doing so, the leveling should be checked using a spirit level. After leveling the top cover should be replaced to prevent impurities from entering the headstock. The cover must be fixed in place by turning the eccentric 30.

WARNING ! Before removing the anticorrosive coating from the screws movement, avoid operating the handwheels.

4. ELECTRICAL EQUIPMENT AND CONNECTION TO THE MAINS

/fig. 4. 5. 6, 7

The machine is equipped in the producing factories with electrical equipment for the type of electric current desired by the customer. The electrical equipment corresponds to the CSN 34 1630 requirements "Electrical equipment of operating machines". The entire installation is connected in the producing factories and is tested there, so that the purchaser only has to couple the contactor cabinet to the upright and connect the machine to the mains.

The contactor cabinet must be transported, using a crane, in the immediate vicinity of the machine. Then you have to remove the rear cover of the frame and pass the bundle of conductors, fixed from one of these ends, to the terminal block of the machine, through the reinforced elbow provided for this purpose. This elbow must then be fixed, using nuts, by one of its ends to the frame and by the other to the contactor cabinet. The machine is coupled to the contactor cabinet by connecting the numbered conductors in the contactor cabinet to the correspondingly numbered terminals in the machine.

The RSTNF terminals, located at the bottom left of the contactor cabinet, are used to connect the machine to the mains. This terminal block is covered and the cover has a warning flash.

The connection is made using a copper conductor with a section of 1.5 mm². /or an aluminum conductor with a section of 2.5 mm²/.

Very important is the correct earthing which must comply with the regulations in force for the various sectors.

Once the machine is coupled with the contactor cabinet and connected to the mains, the main switch on the contactor cabinet is closed. The signal lamp on the push-button panel lights up. When push buttons A2, A3 are pressed, the spindle should rotate in the direction of the arrow of the respective push button. If this is not the case and the direction of rotation is opposite, two current supply phases must be inverted. Circuit breakers, terminals etc. may have loosened during transport. We therefore recommend that you check the tightness of the circuit breakers, the operation of the pushbuttons of the thermal protection relays, and ensure, if necessary, that the terminals on the devices are fully tightened.

Before shipping from the production plants, the machine has been tested and equipped with the necessary circuit breakers and thermal protection relays set according to the rated current of the electric motors. If, during operation, there are frequent faults of the circuit breakers or disengagement of the thermal protection relays, it is to be assumed that the loading conditions of the electric motors have changed. These causes must therefore be sought and eliminated, but it is forbidden to reinforce the circuit breakers.

Distribution of devices, _____

a/ In the contactor cabinet:

On the upper crosspiece are the circuit breakers P1 of the main motor, P2 of the advance control motor and the circuit breakers P3 of the primary winding of the transformer T1. On the second crosspiece are located the S3 contactor used to start the advance motor and the S4 contactor used to start the pump motor, the P6 circuit breaker protecting the control circuits, the P4 circuit breakers, P5 protecting the 6 and 24 V outputs.

The third crosspiece includes thermal relays F1 for the main motor, F2 for the advance motor and F3 for the pump motor. On the fourth crossbeam are located the transformer T1 and the contactors S1, S2 for starting the main motor. The lower crosspiece carries the current supply terminal block D1 and the coupling terminal block D2. On the side wall of the cabinet there is the main switch VH and on the opposite side the socket D3 for the connection of the lighting unit.

b/ On the machine:

On the pushbutton panel are the pushbuttons A1 for stopping the main motor, A2 for starting the motor in one direction of rotation with light signaling, A3 for starting the motor in the opposite direction, A4 for the stop of the feed motor, A5 for starting, with light signaling, of the feed motor. The rotary knob A6 is used to choose the mode of operation of the sprinkler pump: in its left position, the pump is started simultaneously with the main motor, in the middle position, the pump is switched off, and in the right position is in permanent activity. Pilot light H4 signals the operation of the sprinkler pump, pilot lamp HO signals the state of the main switch.

If the machine is delivered with the optical device, the switch V1, used to switch on and off the lighting of the graduated scale of the optics, is located on the push-button panel.

List of devices used

a/ In the contactor cabinet

Function	Designation	Type	Voltage, current
Main switch VH		N4 52 3211-031R	500V, 16A
Contactor of main motor	SI, S2	V03c	220V, 50/60/Hz, 15A
motor contactor	S3	VM4	220V, 50/60/Hz, 4A
advances Sprinkler pump	S4	VM4	220V, 50/60/Hz, 4A
contactor Transformer	T1	S0-02, 150VA	Prim: 220, 380, 415, 500V Sec. I.: 220V - 70VA Sec. II.: 24V - 30VA 48V, 10A
24V D3 side socket		5061-55	500V
Thick headed	D2, D1	6035-10	

Main engine circuit breaker	P1	E27 incorporated	15AT-220V 10AT - 380-440V 6AT-500V
Motor circuit breaker advances	P2	E27 incorporated	10AT - 220V 6AT - 380-440V 4AT-500V
Transformer primary circuit breaker	P3	E27 incorporated 4A	
Output circuit breaker	P4	E27 incorporated	4A
Power outlet circuit breaker	P5	E27 incorporated	2A
220V control circuit breaker	P6	E27 incorporated	2A
Main motor thermal protection relay	F1	R100	5A - 220V 3.4A - 380-440V 2.3A - 500V
Motor thermal protection relay advances	F2	R100	3.4A - 220V 2.3A - 380-440V 1.5A - 500V
Pump motor thermal protection relay			0.5 - 220V 0.34A - 380-440V 0.23A - 500V

b/ On the machine

Push button to stop the main motor	A1	2 36A01 red	380V, 6A
Right hand main engine start push button	A2	236C20	380V, 6A
Left hand main engine start push button	A3	236C20	380V, 6A
Push button to stop the engine of the	A4	236A01 red	380V, 6A

advances

Push button to switch on the motor of the advances	AT 5	236C10	380V, 6A
Push button for preselection of the sprinkler pump	A6	236B11	380V, 6A
Pushbutton "Central stop" to stop the machine	A7	236A01, red	380V, 6A
Indicator lamp indicating the closing of the main switch	HO	236E white	24V, 1.5W
Pilot lamp signaling the start of the main motor on the right	H1	arranged in the push button A2, green	24V, 1.5W
Indicator lamp signaling the start of the main engine on the left	H2	arranged in the push button A3, green	24V, 1.5W
Pilot lamp indicating the starting of the engine of the advances	H3	arranged in the push button A5, white	24V, 1.5W
Indicator lamp indicating the start-up of the sprinkler pump	H4	236E, blue	24V, 1.5W
Thick headed Bipolar inverter for the lighting of the optics	V1	6C35-10 4166/2-14	500V 250V, 4A

Electric motors used

Goal	From. Kind	Power Voltage	Fluent	RPM Shape
------	------------	---------------	--------	-----------

main engine	M1 AP9OL-4 1.5kW	380/220V 3.6/6.2A	1430 legged
Motor of advances	M2 2AP9OL-8 1.1kW	380/220V 3.2/5.8A	910 flanged
Sprinkler pump	M3 CC64-12/ 0.125kW	380/220V 0.44/0.76A	2880

5. LUBRICATION /fig. 8/

Before starting the machine, you must: a/
lubricate the machine according to the lubrication plan at all the lubrication points
b/ check and, if necessary, top up the oil in all the gearboxes.

1. Gearbox,

Check in the oil level indicator **1** on the left and at the top on the front of the pillar.
Filling and draining through holes **2** and **3** on the rear cover of the gearbox /
accessible after removing the side cover/.

2. Box advances,

Check in the oil level indicator **4** left and down on the front of the pillar. Filling the oil
through the hole on the rear cover of the advance box **5**. Draining through connection
6 in the rear space /accessible after removing the rear sheet metal cover/.

3. Frame

Control using a gauge; height of the level approximately 275 mm /console in its
extreme high position/. Filling through hole **7** in the frame accessible after removing
the lower cover/. Drain hole **8**
in the frame

Lubrication plan

No.	Grease point	Lubricant quantity	Lubrication frequency	of
1. 2. 3.	Gearbox	D4		Every 6 months
4. 5. 6.	box of advances	D4		Every 6 months
7. 8.	vertical screw	D4		Every 6 months
9.	Console table guide	P4	2x26 cm ³	1x per day
10.	Console vertical guide			
11.	Console hand wheel shaft	P4	4x15 cm ³	1x per day
12.	Console hand wheel shaft, Release rod			
		P4	2x5 cm ³	1x per day
		P4	1x10 cm ³	1x per day
13.	Vertical feed hand wheel bearing	P4	1x5 cm ³	1x per week
14.	Release device shaft	P4	2x10 cm ³	1x per day
15.	Drawbar coupling bearing,			
lower.		P4	1X10cc	1x per day
	Traction auger bearing 16.			
	Traction auger toothed wheel	P4	1x5 cm ³	1x per day
17.	Table front guide			
	Release fork slider			
	Coupling Drive bevel gear	P4	1x 50 cm ³	1x per day
	Release fork shaft			
18.	Advance handwheel bearing longitudinal			
19.	Upper drawbar coupling bearing.			
		P4	1x5 cm ³	1x per week
		P4	1x5 cm ³	1x per day
20.	Wheel bearing	P4	1x5 cm ³	1x per day

	21. Feed			
lever joint	housing /dismantle every six months, lubricate the cleaned joints with grease/ 22. J4 spindle front bearing 23. J4 spindle	K3		1x per 6 months
rear bearing	24. J4 horizontal screw		5 cm ³ 1x per week	5 cm ³ 1x per week
			1x per week	10 cm ³ 1x per day

Legend of the lubrication plan:

ÿ oil J4 4.5°E/50°C

O oil P4 4.5°E/50°C ÿ

grease K3

-.-. greasing frequency: once a week -.-.- greasing frequency: once a day --- greasing frequency according to the greasing plan

6. STARTING UP AND DRIVING THE MACHINE /fig. 7, 9, 10, 11, 12/

As soon as the machine has been connected to the mains and lubricated, it is ready for trial operation. First of all, check the sequence of phases on the terminal block of the electrical cabinet. Pressing the feed push-button activates the feed box and using the headstock feed control lever starts the headstock.

If the direction of feed of the headstock corresponds to the position of the lever, the sequence of the phases is correct. Otherwise, two phases must be reversed.

The control of the machine is centralized on the one hand in the push buttons on the control panel, and on the other hand in the levers for the selection of the size of the speeds and advances and in the levers for the change of the direction and direction of advances /0276 doll and 2230 console/.

To start, we put the gearbox and the headstock to the test. With the machine stationary, engage the slowest gear, this means orienting the gear selector disc 655 so that the number 50 is below the plate with the m/min indication and that the middle lever 666 is placed under the designation of the lower range. Spindle rotation movement is controlled by three pushbuttons in the top row of the control panel:

button A1 is used to switch off the main motor, button A2 starts the electromotor and the spindle, the direction of rotation corresponding to the arrow above the button; the A3 button reverses the direction of rotation of the spindle / only operates after stopping the main engine/.

After checking the operation of the push-buttons at the slowest gear engaged, gradually increase the speed until you reach the highest floor, taking care that in the high range of speeds the spit only works for five minutes.

After this operation check, let the machine run at medium speed, i.e. approximately 250 rpm, for 4 - 6 hours.

This step ensures the abundant lubrication of all the elements of the gearbox and the headstock.

Two pushbuttons in the middle row of the panel are used to control the advances: button A4 switches off the advances of the electromotor, button A5 starts the electromotor and advances them.

In the same way as for the gearbox, is engaged, using the lever 1262 and the disc 1251, the lowest stage of the advances and the operation of the push buttons is checked. Then the size of the advances is increased while simultaneously engaging the advances of the table and the headstock.

WARNING !

Having to set the console or the headstock in motion, the blocking jaws must be loosened in the three directions of advance. These blocking elements are intended to increase, during machining, the rigidity of the moving carriages and to reduce the stress on the displacement screws and nuts.

Their blocking and unblocking is ensured as follows:

Transversal movement of the doll: by

the pin 237, operated using a square socket wrench; console vertical advance

by handle screw 1826;

horizontal travel of the tables:

eccentric with handle 2130.

The races of all the moving elements are limited, on both sides, by the fixed limit stops 386, 388 automatically disengaging the automatic advance. It is forbidden to remove these stops or change their position.

To limit the strokes to any length, the machine is equipped, in each direction, with two centering stops. adjustable 367.

To spread the workpiece or the tool to the desired distance, in addition to automatic feed, manual feed is used, derived from handwheels /214 headstock, 1926 console/. These handwheels are connected to the displacement screws by a sliding claw coupling, which is out of mesh during automatic advance, so that the handwheel remains stationary.

The reading of stroke lengths can be done in the three directions of the advances:

a/ on the rotary dial 269, 1979, 1980 with centesimal graduation and whose position can be locked using a nut; b/ on standard version machines: on the ruler graduated in millimeters,

using a movable index 403, 2255, 2259. c/ on

the comparator fixed in the support 381, 2219, 2218. The length

required is set using gauge blocks of the corresponding value, applied to the ruler using a follower or fixed bezel.

d/ On "OPTIC" machines, lengths are read using precise rulers and optical devices. For the description of the operation, see.

page

7. WATERING /fig. 11/

The machine is equipped with a sprinkler pump with autonomous electromotor with a power of 0.125 kW. The pump is located in the frame acting as a coolant reservoir and is accessible after removing a cover. The coolant is delivered by the flexible pipe 2360 through the adjustment valve 2357 and the nozzle 2337 to the tool. The pump is controlled by switch A9 with pilot light H4. When this switch is turned to the right, the pump is started independently, when it is turned to the left to the AUT mark, the pump is started, automatically started at the same time as the main motor starts, the liquid is flows through flexible pipes attached to the workpiece table from where it flows through the sieves into the tank and through the collecting orifice in the frame to the settling tank where the sludge is deposited. Through a weir the purified liquid arrives in the main tank.

Maximum full of liquid	22 liters
Maximum quantity discharged	3 liters/minute

8. ATTACHING THE VARIOUS TOOLS /Fig. 14, 15/

- a/ Tools with bore \varnothing 16, 22 and 27: using short or long chucks, fitted with an ISA 40 taper shank with surface thread /fig. 14a/.
- b/ Morse taper shank tools 1, 2, 3: using reduction sleeves 4407, 4408, 4409 /fig. 14b/.
- c/ Cylindrical shank tools: using pliers 4376, staggered by 2 mm \varnothing 8, 10, 12, 14, 16, 18, 20, 22 mm /fig. 15c/. d/ Cylindrical shank tools: using collets 2843, staggered by 0.5 mm, from \varnothing 1 to \varnothing 12, collet sleeve 2837 /fig. 15d/ and threaded coupling 2841.

9. MACHINE MAINTENANCE

a/ Adjusting the clearance of the horizontal spindle /fig. 13/

This work must be entrusted to a truly experienced and safe worker.

Spindle bearings retain their small mounting clearance much longer than plain bearings. It is therefore very rare that they have to be readjusted. Above all, it is necessary to measure the play in their housing. For this purpose, the support /rod/ of the indicator is fixed in the side groove of the headstock and the indicator is applied from the side to the collar of the spindle. By gently spreading the pin /with the help of an angle iron etc./, we note the size of the gap and after releasing the pin, we note how much. value the pin no longer returns to the original data of the comparator before the measurement. We will proceed in the same way in the vertical direction /the two values are generally almost the same, barely 0.01 mm/ and we will take their average as a basis. Suppose these values are 0.006 and 0.008 mm, the average is therefore 0.007 mm, and multiplying it by 12 /= the taper in the bearing is 1:12/, we will have $12 \times 0.007 = 0.084$ mm. Note this value and make the adjustment, while taking the opportunity to clean the bearings.

Loosen the two eccentric clamping pins /30/, disengage the cover and the headstock, loosen the clamping rod /33/, disengage the conical cavity cover /16/ forwards, push the pin /121/ out, unscrew nut /36/ and push clamping rod /33/ out of spindle /22/ forwards. Then remove retaining ring /131/, ring /46/ and spring /128/. Release the nuts /50,51/ by bending the retaining plates /139, 140/ out of the slots in the nuts and loosening the nuts. Remove nut /50/ and retaining plate /139/.

Push the bearing inner race /145/ backwards using a suitable flat rod and unscrew the screws /95/ from the front spindle cover. Using an aluminum or wooden mallet, drive the pin /22/ forwards, so that it is possible to completely disengage the nut /51/, and tap the wheel /19/ gently to move it backward; Orient sleeve /42/ so that groove is opposite spring /126/.

Bring out the pin successively, knocking it fully forward. Care must be taken to avoid damaging the wheel /19/ and the toothed cylinder below.

Fold the collar /24/ forwards, remove the front cover /45/ and then, using a tube, drive out the ring /47/ with the inner bearing race /144/ and the thrust bearings at the bottom of the pin.

This done, the ring /47/ can be grinded to reduce it to the calculated value /of 0.084 in our example/, so that the two surfaces of the ring are again perfectly parallel / maximum deviation 0.01 mm /.

After rinsing the bearings and other parts with very pure oil

fluid, reassemble the bearings in the reverse order and lightly lubricate them. Ring / 47/ must be fitted with its slanted edge pointing inwards.

b/ Adjusting play in the headstock guide /fig. 12/

The play in the guide can be observed in the manner indicated above, but the comparator must in this case be fixed on one of the vertical slides, the key being directed towards the headstock body.

If you really notice an increase in play in the guide, you make up for it in the following way: Detach the edges of the fabric covering of the upright, behind under the headstock, and move them aside towards the rear. The prismatic guide is fitted on the left side /looking from the rear/ with a conical gib which must be adjusted by carefully tightening the adjusting screw /1502/. Turning to the right reduces the clearance, turning to the left increases it.

The bias of the conical gib being 1:100 and the thread of the M10 screw /pitch 1.5/, the play decreases, per life turn, by $1.5:100 = 0.015$ mm. During the adjustment, it is necessary to check the clearance of the guide by advancing the headstock; for this purpose the handwheel /269/ is turned, the lever /267/ being disengaged. The advance should not work too hard, and for this the adjustment must be made with great sensitivity. Once the adjustment is complete, replace the protective bellows.

c/ Vertical table clearance adjustment /fig. 12/

The table clearance is adjusted using two gibs, one of which is conical and the other straight. Before making the adjustment, place the cross movement lever in its neutral position and remove the protective gaiter on the lower left side of the vertical table / seen from the rear/.

This makes the wedge adjustment screw /1991/ accessible. The clearance adjustment is carried out in the same way as that of the headstock.

If the clearance on the horizontal gib /1814/ must also be taken up, proceed as follows: Remove the end bearing of the screw /1921, 1922/, unscrew the guide screw from the bracket together with the bearing extreme 1921/, free the wedge using the adjusting screw /1991/ and disengage the table from the side guide. Unscrew, from the table, the horizontal gib and grind its support surface of the value of play observed.

d/ Adjusting the console's vertical guidance /fig. 9 and 10/

There are two adjustment methods here.

1° Adjustment by vertical wedge

This adjustment is made using the two opposite screws /2128/.

The lower screw is accessible after removal of the lower cover sheet, and the upper screw after removal of the upper cover sheet and after unscrewing the sheet metal cover of the vertical guide scrapers. To remove the upper covering canvas, the table must be moved to its extreme high position.

2° Adjustment of play in the two vertical gibs

This adjustment is made by trying the gibs /2100/ in their bearing surface. This can only be done after dismantling the console from the upright guide, and that is why we recommend that you delegate a specialist from the factories producing the machine,

e/ Duplex belt and chain tension /fig. 12/.

CAUTION! Open the main switch before proceeding with the voltage!!!

The V-belts and the chain are accessible after unscrewing the sheet metal covers at the rear of the upright and the frame. To tension the V-belts, turn the nut /1668/, which causes the motor to tilt around the axis /1664/. The tension of the chain of the box of advances is operated by tilting the motor plate /1140/ around the axis /1154/ after having loosened the axis /1154/ and the screw /1157/ then, one tightens the chain by pushing the plate upwards.

MACHINE ACCESSORIES

10. Support for machining heads and support arm /fig. 16a/

The bracket is used to attach the vertical, high-speed and mortising head and the support arm to the machine. The holder must be fixed in the upper guide of the headstock as follows: Using a rod passed through the eyelet /2994/, the holder is placed on the headstock, so that it protrudes one-third its front edge. In this position, the support enters the recess of the prismatic guide of the headstock. Then the support is introduced carefully /with regard to the cogwheels/ in the rear position marked "0". This position, where the gear wheel of the carrier does not mesh with the wheel of the headstock, can be used in the event that the mounted mortising head gets in the way while working with the horizontal spindle. However, the head must be turned 90°. The two positions of the support, marked A, B, increase the possibilities of use of the machine. In both positions the carrier can be disengaged using the lever /2956/. Position 0 is used to change the tool on the chuck of

long type milling or when changing the long type milling chuck. The support is automatically lubricated by the oil coming from the headstock. For safety reasons, the support must not remain on the machine without a machining head or the support arm attached to it.

11. Vertical head /fig. 16b/

Speed 50-2500 number of
 floors. 18 quill
 stroke 75 mm tilting
 head $\pm 120^\circ$ conical cavity in
 spindle. ISA 40

The vertical head is used for milling, boring and drilling operations. Before mounting the head on the support, position the "T" sliders /3162/ in the groove at 90° and secure them using the screws /3246/. Then we engage the head on the support shaft /2943/ and fix it with the screws /2981/.

WARNING ! Before tilting the head, the screws /3246/ must be loosened.

The method of fixing the tools is the same as we described when talking about the horizontal spindle. Screws /3158/ are not used for this purpose.

The field of application of the head is increased by the sliding sheath with return spring. The disengagement takes place using the pinion with square /3144/ and dial /3180/. The scabbard can be braked in any position by the lever /2956/. Insofar as the interrupted cut during milling produces abnormal thickness lines, we recommend that you brake the spindle using the knurled disc /3175/. But in doing so, you have to proceed gently.

Points 30 and 31 must be lubricated with oil 4.5°E/50°C /2 times 10 cm³ after 4 - 8 hours, depending on the speed of rotation/.

We advise you to use speeds of 2000 and 2500 rpm only exceptionally and for a maximum of 30 minutes. At the end of each interval, the head should be lubricated abundantly and allowed to cool.

For continuous work at these speeds we recommend using the high speed head.

The play in the bearings of the eloidal bevel gears can be adjusted using the nut 3268 which is accessible after dismantling the disc 3175, the flange 3174 and after loosening the retaining plate 3274. The nut adjustment of the counter-wheel bearings is accessible after removing the cover /3195/.

12. High speed head b /fig.17a/

Speed	400 - 10,000
number of floors	18 quill
stroke	75 mm
inclination	$\pm 120^\circ$

The high-speed head is used for machining, using cutters, of small diameters with cylindrical shank, for machining at high cutting speeds and for auxiliary grinding, The method of attachment to the head support , the dislocation of the sheath and its locking are the same as those of the vertical head.

Lubrication is centralized at points 40 and 41 and is done with oil of 4.5°E/50°C /2 x 10 cm³ of oil in intervals of 3-6 hours depending on the speed of rotation/. The spindle cavity is suitable for clamping with pliers and the clamping bolt /3343/.

The 1:4 transmission ratio is given by a pair of eloidal bevel wheels and a V-belt. We recommend using speeds of 8000 - 10000 in 15 minute intervals. In the event of permanent operation at these speeds, we recommend that you provide oil mist lubrication. Toothed belt 3535 can be changed after removing cover 3336 and discs 3397 and 3398.

Nut 3505 is used to take up play in the counter-toothed wheel bearings. Adjusting the play in the bearings of the counter-wheel is done in the same way as in the case of the vertical head.

13. Mortising head /fig. 17b/.

Number of outward and return strokes	16 - 105
Number of floors	9 Slide
stroke	70 mm The head
is adjustable from	$\pm 120^\circ$ Tool
clamp dimensions	18 x 18 mm The head is used

for mortising in a determined inclined plane.

Fixing and orientation of the head is carried out in the same way as in the case of a vertical and high-speed head.

The required number of outward and return strokes is selected using the speed control disc, in accordance with the plate on the mortising head /with the limitation there indicated on the lower range/. The stroke length of the slider can be adjusted in the uppermost position by loosening screw 3588 and moving the slider, using screw 3590, to the required position. Once the adjustment is finished, retighten screw 3588. The two screws are operated using the socket wrench supplied with the head.

The lubrication is centralized in 6 lubricators:

lubricator 50 oil 4.5°E/50°C 30 cm³ once a week
 lubricator 51 oil 4.5°E/50°C 10 cm³ every 4 hours
 2 grease nipples
 lubricator 52 oil 4.5°E/50°C 20 cm³ every 8 hours
 2 grease nipples
 lubricator 53 oil 4.5°E /50°C 20 cm³ every 8 hours

The backlash in the slide guide can be taken up using the left gib 3598 as follows: loosen the screws 3658 /5x/, loosen the screws 3675 /3x/ and by gently tightening the screws 3667 /3x/ take up clearance. Then retighten screws 3658 and 3675. In view of the non-uniform wear of the slider, the parallelism of its guide should be corrected by scraping.

14. Support arm /fig.18/

Maximum tool diameter 100 mm
 Maximum useful chuck length 200 mm
 Diameter of the milling chuck 16, 22, 27 mm
 including spacer rings and nuts
 Accessories drive ring 2281 guide piece 4433

The support arm is used when machining with a tool fixed to the long type cutter chuck. The support arm is fixed on the support.

Disengage the support with the support arm forwards, put the cutter chuck with drive ring 2281 in the conical cavity of the spindle and lock it using a locking screw in the cavity of the spindle. Engage the tool and the spacer rings on the chuck and tighten the nut, insert the support backwards and fix it using the eccentric pins. When working with chuck 0 16, guide sleeve 4433 must be used.

Lubrication is done with oil 4.5°E/50°C, 10 cm³ after 4-6 hours in the 3074 lubricators.

15. Square table /fig.19/

usable surface of the table 440 x 600
 Maximum weight of the workpiece 80 kg
 Groove spacing 45 Groove width .. 12 HB

The square table is used to fix the part for routine machining, or to fix the vice for machines or the swivel table, To fix the table, introduce the tabs 3781 into the grooves of the vertical table and block it by tightening the five 3846 screws with 3964 washers and 3962 nuts.

The table can be fixed in the two basic positions fig. 19a and 19b. In position "a", the tabs can be inserted into the first upper groove of the vertical table, where the square table sits above the level of the vertical table.

WARNING !

When working with the square table and with the headstock dislocated, the vertical stroke of the console is found to be shortened. This race is not limited by a stop !!!!

16. Turntable /fig.20/

Useful surface of the table 0 300
width of the grooves 12 HB

The swivel table attaches to the square table or the tilting table so that the working surface is parallel or vertical to the table. It is used for direct and indirect division, or with continuous orientation following the dial or the scale on the circumference of the table.

a/ Direct division.

By loosening handle 273 and pawl 3804, release the table. Loosen screw 3969 and turn divider plate 3765 or flange 3794 to the right, thereby disengaging the worm from the wheel. Then rotate the table freely according to the scale at the circumference of the table or 15° by 15° according to the notches in the dividing circle. After each division, the table must be locked using lever 273.

b/ Indirect division,

For indirect division, put the auger back in mesh with the wheel. Tighten screw 3869 and leave lever 273 disengaged and pawl 3804 removed. Choose the plate with the appropriate number of holes and after having loosened the nut 3841, place the needle. 3834 in the hole on the chosen circle of holes. Bring one of the arms 3748 and 3750 close to the needle and move the other arm by the corresponding number of

holes. After each division, the table must be braked using lever 273.

c/ Division according to the sundial

After loosening the nuts 3841 and 3802, the lever 3741 and the dividing plates 3765 can be removed. Fit the flange 3794 on the sleeve flange and secure it with the nut 3829. Engage the sleeve 3780, the dial with the nut and secure it to the end of the shaft using two screws 3879. Fit the handwheel 3753 and tighten the nut 3830 using the special spanner 3805.

Lubrication point 60

After removing the plug, pour 50 cm³ of 4.5°E/50°c oil /once a month/ into the hole.

Number of divisions	of whole											
2 3 4 5 6	45											
7 8 9 10	30											
11 12 13	22		17/34		19/38	21/42	21/46	18/36	20/40	29/58		
14 15 16	18											
17 18 19	15											
20 21 22	12										36/42	
23 24 25	11								9/36	10/40		
26 27 28	10											
29 30 31	9 8											
33 34 35	7 6				6/33							
36 37 38	6 6		17/34		19/38	21/42	21/46	18/36	20/40	29/58	39/39	18/42
39 40 41	5 5											
42 43 45	5 4											
46 48	4 4											
	4 3									25/40		
	3 3		10/34									
	3 3											
	3 3				28/38							
	3 2		17/34		19/38	21/42	23/36	18/36	20/40	29/58		
	2 2					12/42						
	2 2				3/33							
	2 2						42/46					
	2 2								27/36	30/40		
	2 2									24/40		
	2 2					18/39						
	1 1	9/27			11/33	13/39	14/42	12/36				
							9/42					
											6/58	
			28/31									
					24/33							
			22/34									
							24/42					
			17/34		19/38	21/42	23/46	18/36	20/40	29/58	16/37	
					14/38							
						12/39						
								9/36	10/40			
				8/41								
						6/42						
				4/43								
							44/46					
										35/40		

50	1								32/40	
51	1		26/34							
54	1		18/27		22/33	26/39	28/42	24/36	21/33	
55	1				22/38					
57	1									
58	1									32/58
60	1		17/34		19/38	21/42	23/46	18/36	20/40	29/58
62	1		14/31							
63	1					18/42				
65	1					15/39				
66	1				12/33					
68	1		11/34							
69	1						14/46			
70	1					12/42				
72	1							9/36	10/40	
74	1							8/37		
75	1								8/40	
76	1					7/38				
78	1					6/39				
80	1								5/40	
81	1							4/36		
82	1			4/41						
84	1					3/42				
85	1		2/34							
86	1			2/43						
87	1									2/58
90	1									
92	-						45/46			
93	-		30/31							
95	-						36/38			
99	-				30/33					
100	-								36/40	
120	-							27/36	30/40	
150	-								24/40	
180	-		17/34		19/38	21/42	23/46	18/36	20/40	25/58
200	-									18/40
240	-									15/40
273	-	9/27			11/33	13/39	14/42	12/36		
0	-								12/40	
306	-				9/33					
0	-							9/36	10/40	

17/ Tilting table /fig.21/

usable area of the table	225 x
500 Tilting around the horizontal axis, vertical to the table	45° Tilting around the horizontal axis, parallel to the table
30° Tilting around the vertical axis	30° Width of the grooves
spacing	12 HB Groove
	45

The tilting table is fixed on the vertical table instead of the square table. It is used for milling inclined surfaces, can be tilted in three directions according to the corresponding scales and locked in position. If a precise position of the work surface of the table is required, a dial gauge is fixed in the spindle and the position of the table is adjusted according to a precision square, a protractor or a sine ruler. Positioning in any direction is achieved by loosening the nuts 2323 of the respective direction screws, orienting the table to the desired position and retightening the nuts.

18/ Divider /fig.22/

Conical cavity in the broach	ISA 40
Maximum center distance ..	300 Height of the points
of the vertical position transversely	± 90° Orientation from the vertical position - towards the machine
the machine	15° from the machine
	10°

The divider is mounted on the useful surface of the vertical table. The dividing head with the spindle can be tilted around two mutually perpendicular axes according to graduated scales. Workpieces can be clamped in collets or cantilever chucks, or between centers, using the 4061 support arm and adjustable tailstock. We can perform direct division and . the Indirect division.

For direct division, the endless screw must be out of mesh. To do this, loosen the screws 4307 and turn the sleeve 4138 with the divider plate 4172 until refusal. Remove and turn the ratchet 4230, disengage the handle 4226 and try to turn the spindle by hand. If the eccentric sleeve 4138 is correctly oriented, the spindle can then be turned by hand, and in this position the sleeve must be immobilized by tightening the screw 4307. You can then, after retracting the pawl 4230, use the plate â 24 notches for direct division. After each division, the spindle must be blocked by tightening the handle

4226.

Before proceeding with the indirect division, the worm must be brought back into engagement with the wheel. Then we unscrew the nut 4264, we remove the crank 4145, the electric washer and the two alidade arms. Then we mount the dividing plate with the necessary number of holes, the arms, the washer and the crank 4145 and we tighten the nut 4264. engages in the respective hole. To facilitate the following divisions, approach one of the alidade arms of the needle and place the other further from the necessary number of holes. During the division, the arms turn together until the first comes to lean again on the needle.

For direct division as well as for indirect division, the spindle must be locked after each division by tightening knob 4226.

In addition to the division method that we have just described, it is possible to use the rotating minute dial, which is assembled in the same way as that of the pivoting table.

Fixing of the workpieces can be done in different ways. Thin parts attach to 2843 collets which fit into spindle with 2837 socket and tighten with 4165 screw, with 2841 threaded coupling. Most parts attach to a mandrel between the tip of the spindle 4078 and the tailstock 4199. For this fixing method, the support arm 4061 and the tailstock are used. The arm is engaged in the prismatic recess of the dividing head and tightened by means of screws 4295. An ISA 40 cone tip is inserted into the spindle and fixed by screw 4165. On the cylindrical part of the tip is mounted the driver with slider 4193 and tightened by the tightening screw. The drive dog is fixed on the chuck or the pin of the workpiece and the whole is mounted between the centers in such a way that the tailstock, after loosening the screw, is moved to the chuck or the workpiece to be machined; the tailstock is fixed with a screw, the tailstock tip is caught by the head 4392 and locked with the handle 4226, The workpiece can also be clamped in the chuck with the flange 4081.

Lubrication takes place at points 80, 81, 82 with oil at 4.5°E/50°C /3 x 10 cm³ / once a week.

Spindle play resulting from normal wear is adjusted as follows: put the worm out of engagement, fix the dial gauge opposite the point in the spindle and check, using the dial gauge, axial play by pushing the spindle in both directions of the axis. The maximum deviation during the rotation movement can be 0.01 mm. Any larger play can be eliminated by tightening nut 4219.

Division table for divisor

Number of divisions 2 3 4 5 6 7	whole	Partial crank turns								
8 9 10 11	20									
12 13 14	13	9/27			11/33	13/39	14/42	12/36		
15 16 17	10,8									
18 19 20	6,5									
21 22 23	5,4	18/27			22/33	26/39	28/42	24/36		
24 25 26	4,3							30/42		
27 28 29	3,3									
30 31 32	2,2	12/27							16/36	
33 34 35	2,2									
36 37 38	2,2				21/33					
39 40 41	2,1	9/27			11/33	13/39	14/42	12/36		
42 43 45	1,1					3/39				
64 45	1,1							36/42		
	1,1	18/27			22/33	26/39	28/42	24/36	19/38	
	1,1		17/34		21/42	23/46	18/36	20/40	29/58	
	1,1		12/34							
	1,1	6/27							8/36	
	1,1				4/38					
	1,1									
	1,1,1							38/42		
					27/33					
								34/46		
		18/27			22/33	26/39	28/42	24/36		
									24/40	
						21/39				
		13/27								
								18/42		
										22/58
		9/27			11/33	13/39	14/42	12/36		
			9/31							
								9/36	10/40	
					7/33					
			6/34							
								6/42		
		3/27						4/36		
					3/37					
					2/38					
					1/39					
	-			40/41						
	-							40/42		
	-			40/43						
	-				30/33					
	-	24/27						32/36		
	-							40/46		

48	-						35/42 30/36		
50	-							32/40	
52	-					30/39			
54	-	20/27							
55	-				24/33				
56	-						30/42		
58	-								40/58
60	-	18/27							
62	-		20/31						
64	-							25/40	
65	-					24/39			
66	-				20/33				
68	-		20/34						
70	-						24/42		
72	-	15/27						20/36	
74	-							20/37	
76	-				20/38				
78	-					20/39			
80	-		17/34		19/38 21/42 23/46	18/36 20/40 29/58			
82	-			20/41					
84	-						20/42		
85	-		16/34						
86	-			20/43					
88	-				15/33				
90	-	12/27						16/36	
92	-						20/46		
95	-				16/38				
96	-							15/36	
100	-								16/40
120	-	9/27			11/33 13/39 14/42	12/36			
180	-	6/27						8/36	
200	-								8/40
240	-							6/36	
270	-	4/27							
360	-	3/27							

19/ Drafting spare parts orders

Please mention in your spare parts order:

1/ subset of machines 2/ number stamped on the part 3/ number of parts ordered 4/ serial number and year of manufacture of the machine

20/ List of parts subject to wear

Denomination of the parts, post

screw ahead. of the doll 29
 headstock feed nut 202 horizontal
 table feed screw ... 1953 advance nut horizontal
 of the table 1930 screw of the vertical advance of
 the console 1790 console vertical advance
 nut 793 V-belt of the gearbox
 10x6x2000 557 cloth cover of the headstock
 guide 70 two cloth covers of the table
 guide 2017 upper fabric covering of the upright
 guide 1567 lower fabric covering of the upright guide
 1568 toothed belt of the head support $l=277.2$; $t=7.70$; $b=60$ 3032
 high speed head toothed belt $L=314$, $t=7.85$ $b=18$ 3535

Final remark.

The suggestions made in these operating instructions are the result of many years of experience in the construction of machine tools.

The raw materials used in the construction of the machines are of the very first order and the mechanical processes applied are the most perfected.

By observing the service instructions everyone will be able to obtain maximum precision and performance and minimize the wear of parts. If, despite everything, the machine gives rise to anomalies in service, whether caused by non-compliance with the prescriptions, by inexperienced handling or by accidental deterioration, the machine must be put out of operation immediately. Damage of less importance can be repaired directly in your workshops without detriment to the machine, in the event of more serious damage it is in your interest to consult us on the means of remedying it. When ordering spare parts from us please give us the name and number of the part or a detailed description of the function of the part in the machine, together with a sketch.

OPTICAL READER ASSEMBLY S 0 D 200

Use and Care Guide

Summary:

- 1 - Application
- 2 - Description
- 3 - Technical characteristics
- 4 - Reading and zeroing
- 5 - Accessories
- 6 - Handling and maintenance

List of illustrations

Fig. 1 - Arrangement of readers on the machine Fig. 2 - Sketch of reader Fig. 3 - Transport of the machine equipped with optical devices

1/ Application

The SOD.200 digital reader is an optical device intended for reading, on a glass scale, the movement of machine tool parts in any desired coordinate. The reading is carried out in hundredths of a millimeter with an accuracy of 0.003 mm.

2/ Description

The reader takes the form of a rectangular box from which emerge the illuminator 1, the hundredths wheel 2 and the objective sleeve 3. The reading window illuminated by transparency is divided into two parts: in one of them one reads the whole millimeters after adjustment of the mark of the scale against the double mark, in the second one reads the indication in hundredths of millimeter. The adjustment of the sliding double marker is carried out using the wheel 2 provided on the side wall of the reader. When this knob is turned, the double marker moves and the magnitude of its movement is projected in the window in the form of an indication expressed in hundredths of a millimeter. If the reader does not have a prism viewing box, the window has a cover. The reader can be completed with a zeroing device with a range of ± 10 mm, supplied as optional equipment.

3/ Technical characteristics

Magnification of the scale on the frosted	15 x
Magnification of the limb on the frosted	6 x
Digital readout in	0.01 mm
Accuracy of settings	0.003 mm
Operating distance objective - scale	2.3 mm
Graduation and numbering of the scale in	1 mm
Light bulb	6 V/5 W
Reader weight	0.75 kg
Range of the zero-setting device	± 10 mm
Weight of the zero-setting device	0.75kg

4/ Reading and zeroing /fig. 2/

a/ Reading of the initial position without zeroing

The ruler mark is projected with the corresponding number in millimeters in the window outside the double mark. Turn the wheel for the division in hundredths 2 until the interval of the double marker reaches the marker projected in the window, Read in the second window the indication in

hundredths of a millimeter which gives the initial value of the position /for example 86.25 mm/. We must now move the table 30.55 mm in the negative direction. The calculated value is then 55.70 mm. From the value thus determined, adjust, using knob 2, the hundredths of a millimeter /0.70/ in the window. At this time, the dual mark has moved outside the mark against which it was preset. Then go back until the mark with the whole millimeters /55/ appears on the double mark. The displacement of 30.55 mm is thus carried out.

b/ Reading of the initial position with zeroing

Contrary to the previous procedure, do not bring the double marker against the projected marker of the scale using knob 2, but turn the knob until so that in the window for reading the hundredths appears 0.

Then turn knob 4 of the zero-setting device until the appearance, in the window for reading whole millimeters, in coincidence with the double mark, of the mark whose numerical indication ends with a zero /tel 160/.

The zero-setting device can be blocked with knob 5. You can then easily add the value which must modify the position of the table /for example $160 + 37.58 = 197.58$ /. Using the hundredths wheel 2, adjust the 0.58 thief in the hundredths of a millimeter reading window and move the reader in the positive direction until the appearance, in the whole millimeters reading window, in coincidence with the double marker, of the marker bearing the numerical indication 197. On the ground glass, one then reads the indication of the desired final displacement: 197.58.

5/ Accessories

Bulbs centered in their sockets

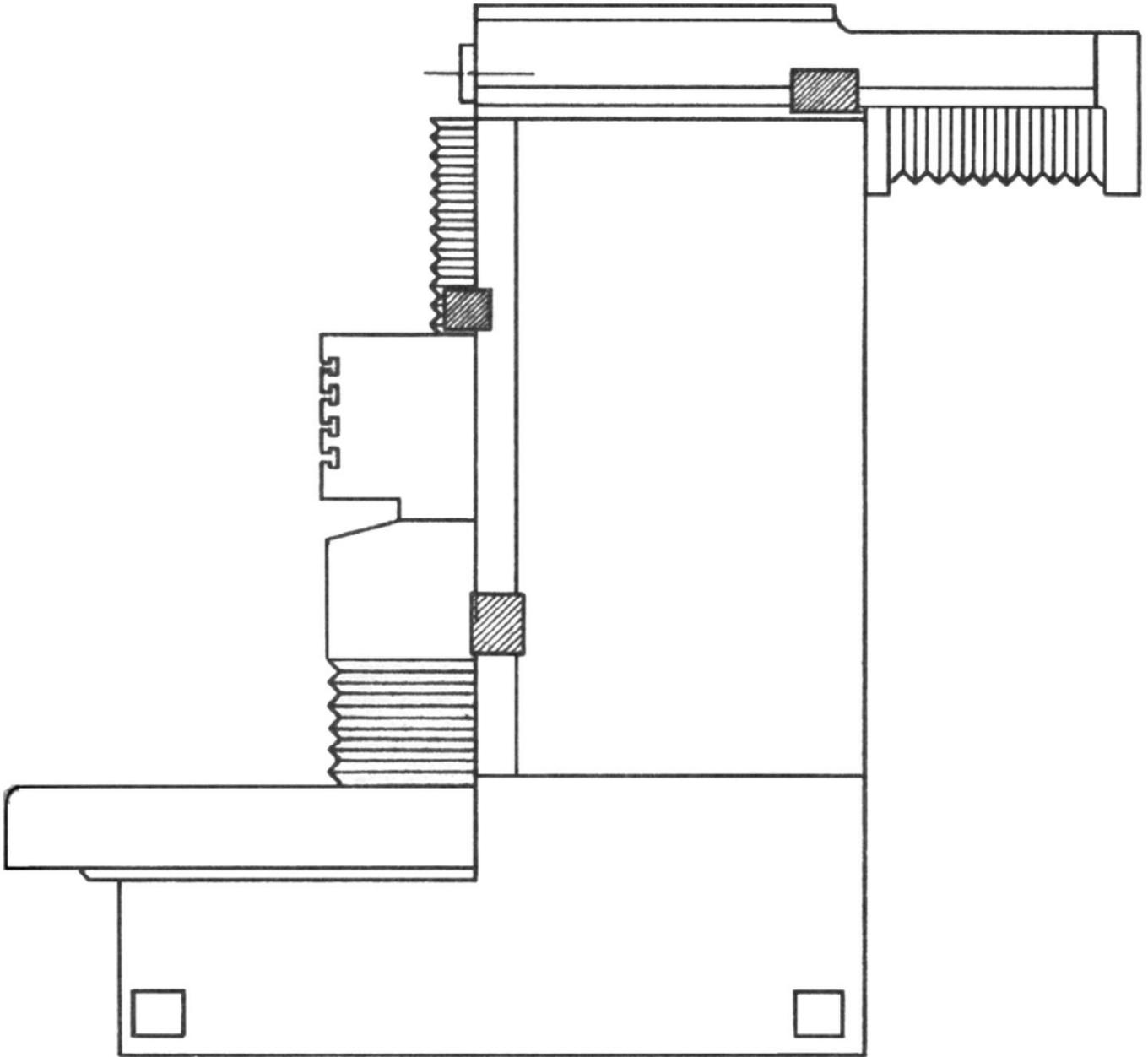
4 rooms

6/ Handling and maintenance of the reader

In the reader, only use bulbs centered in the socket, of the prescribed voltage and power. Adjust, in the reader, the illuminator with lamp 1 so that the two frosted glass windows are perfectly illuminated. To do this, push the illuminator into the reader and turn it until both windows are perfectly illuminated. Protect the reader against any mechanical damage, Keep it safe from aggressive fumes and handle it with care.

To clean the scale, ground glass and lens, use a cotton ball. Oily impurities can be removed with a cotton ball soaked in alcohol or ether. The objective lens is accessible in the position

scale limit. Never use coarse or soiled fabrics for cleaning.



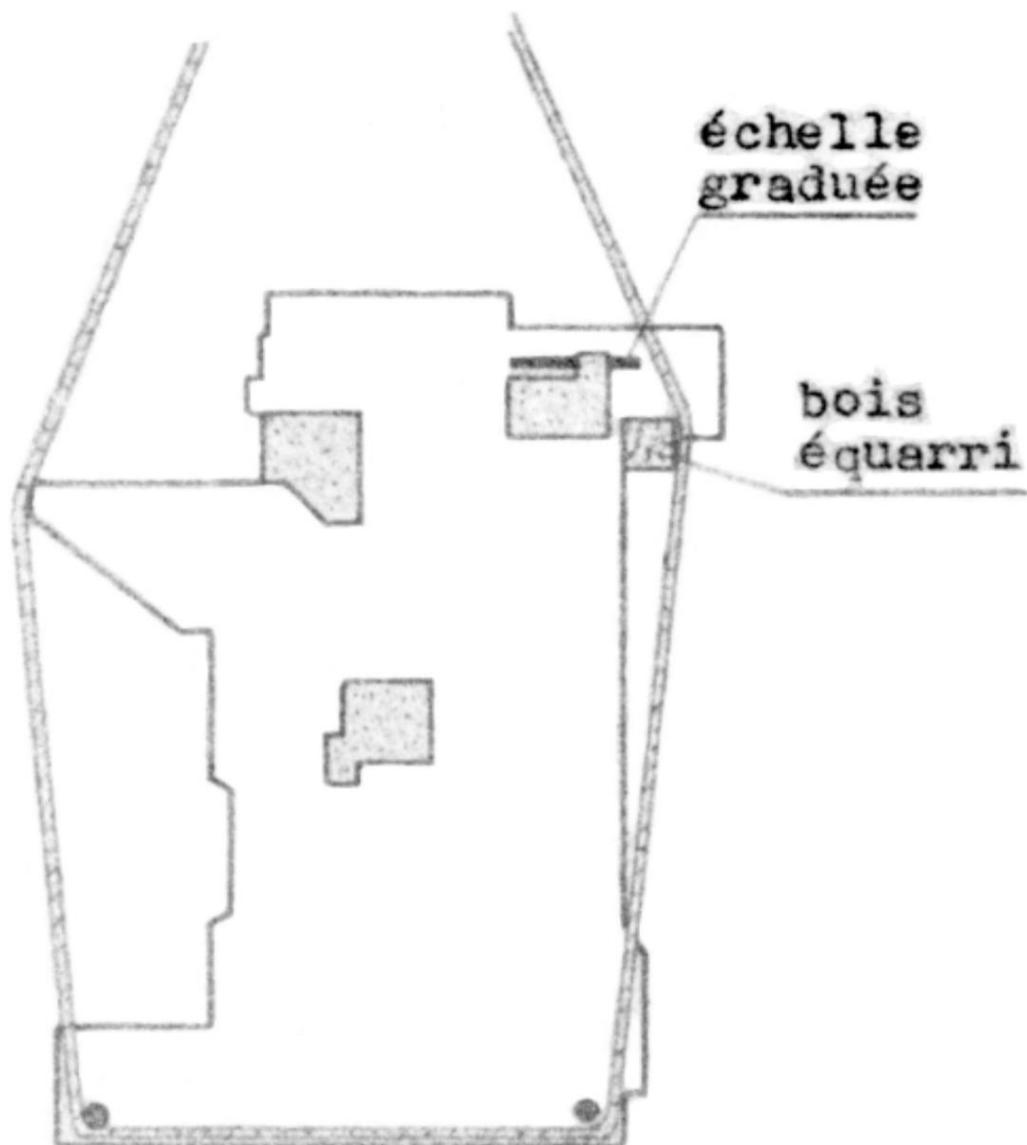
Optický odečítač SOD 200.

1

Fig 1 Optics

IMPORTANT NOTICE

Transport, using a sling, of the FN 20 OPTIK, FN 25 OPTIK, FN 32 OPTIK and FN 40 OPTIK



During transport of the FN 20 OPTIK, FN 25 OPTIK, FN 32 OPTIK and FN 40 OPTIK machines, it is necessary to proceed with the greatest precaution to avoid any damage to the optical device, and particularly to the graduated scale of the reader located on the body of the the doll (see sketch).

When lifting the machine it is necessary to use a squared timber of 6 x 8 x 50 centimeters which must be placed between the rear part of the headstock and the upright body, as shown in the sketch. The headstock should be moved forward as far as the dimension of the squared timber (6 cm) allows. The graduated scale must be covered with paper or another protective material (felt, rubber etc.). The sling must be fixed as reproduced on the sketch.

Fig 2 Optics

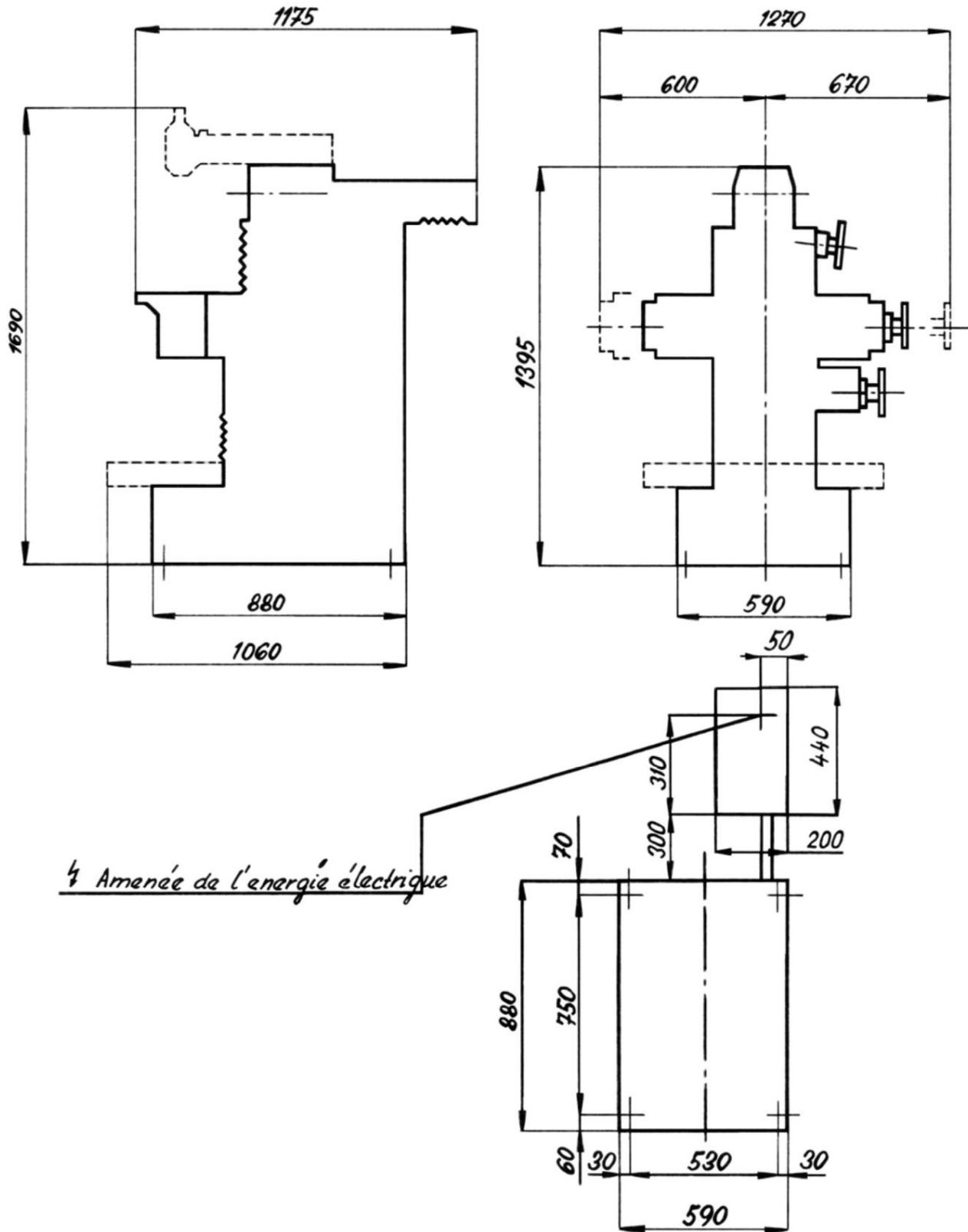


Fig. 1

1

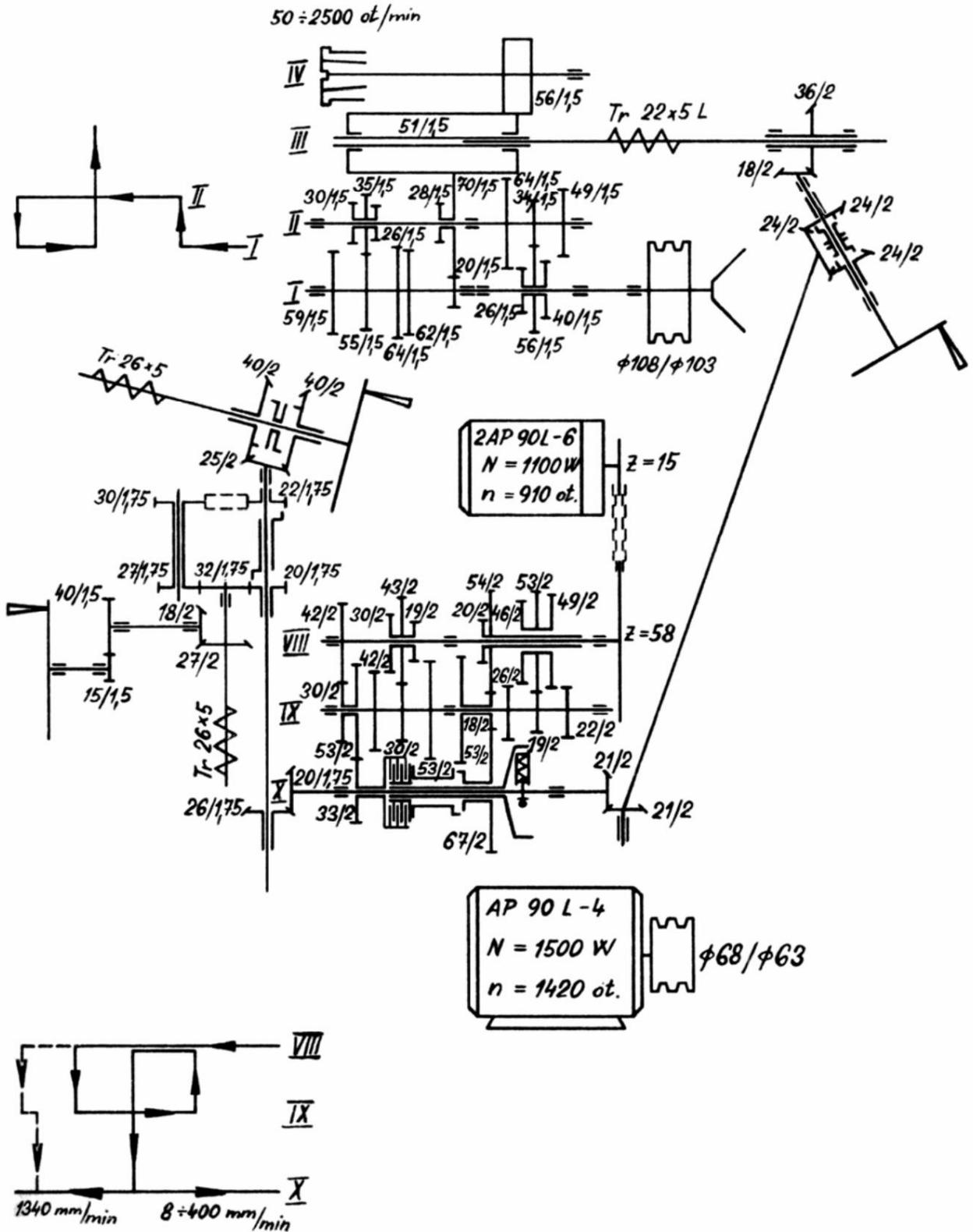
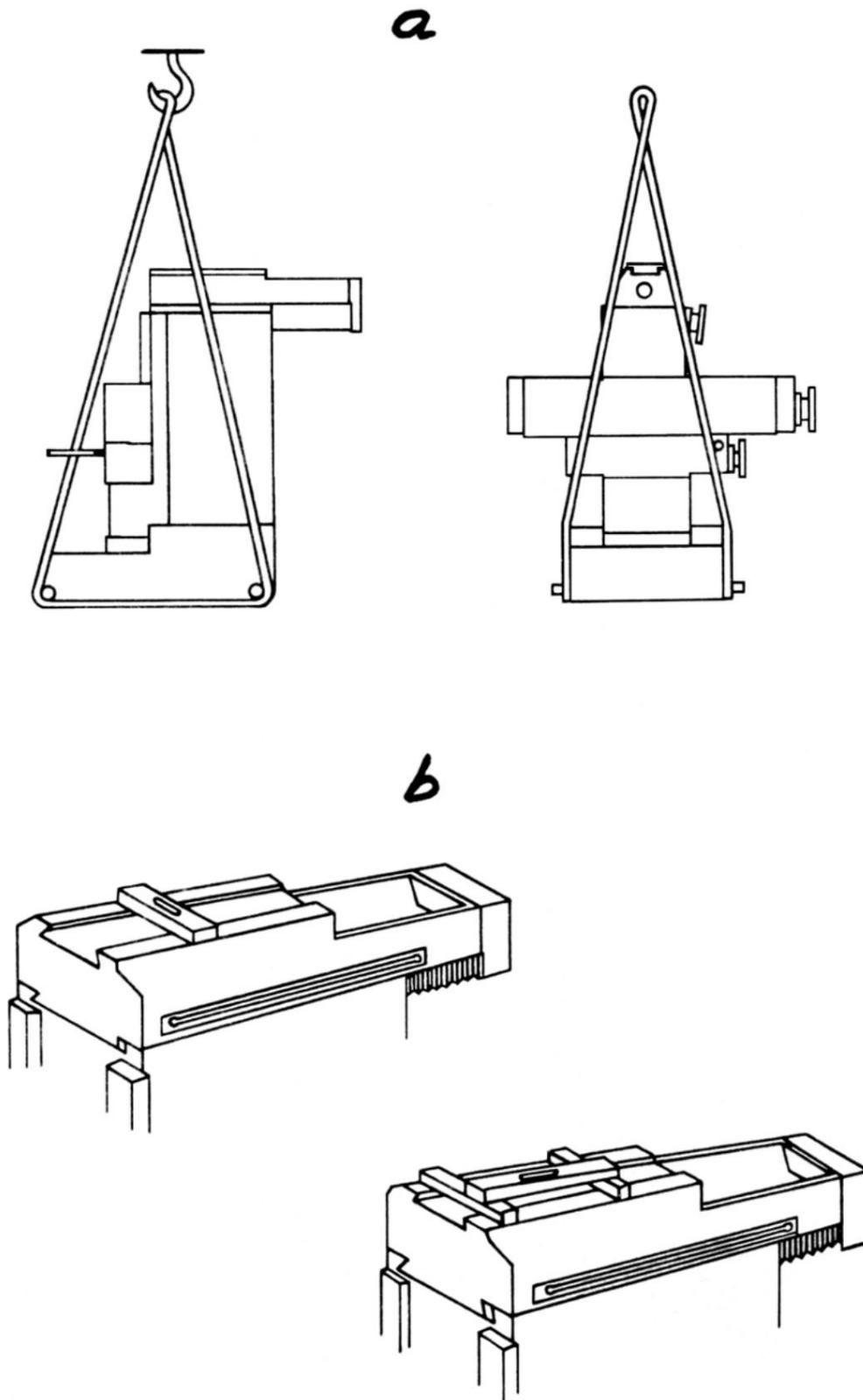
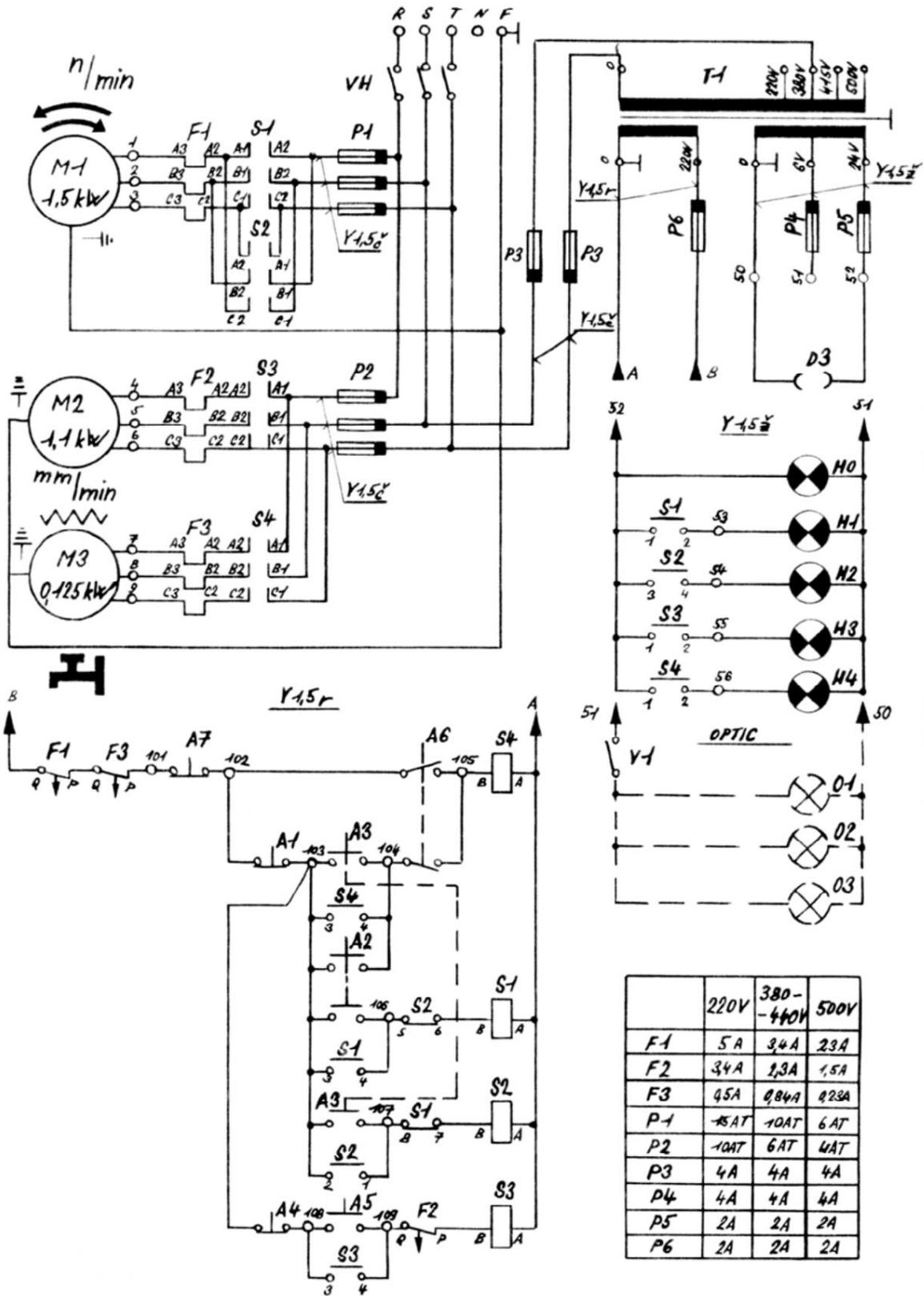


Fig. 2



3

Fig. 3



4

Fig. 4

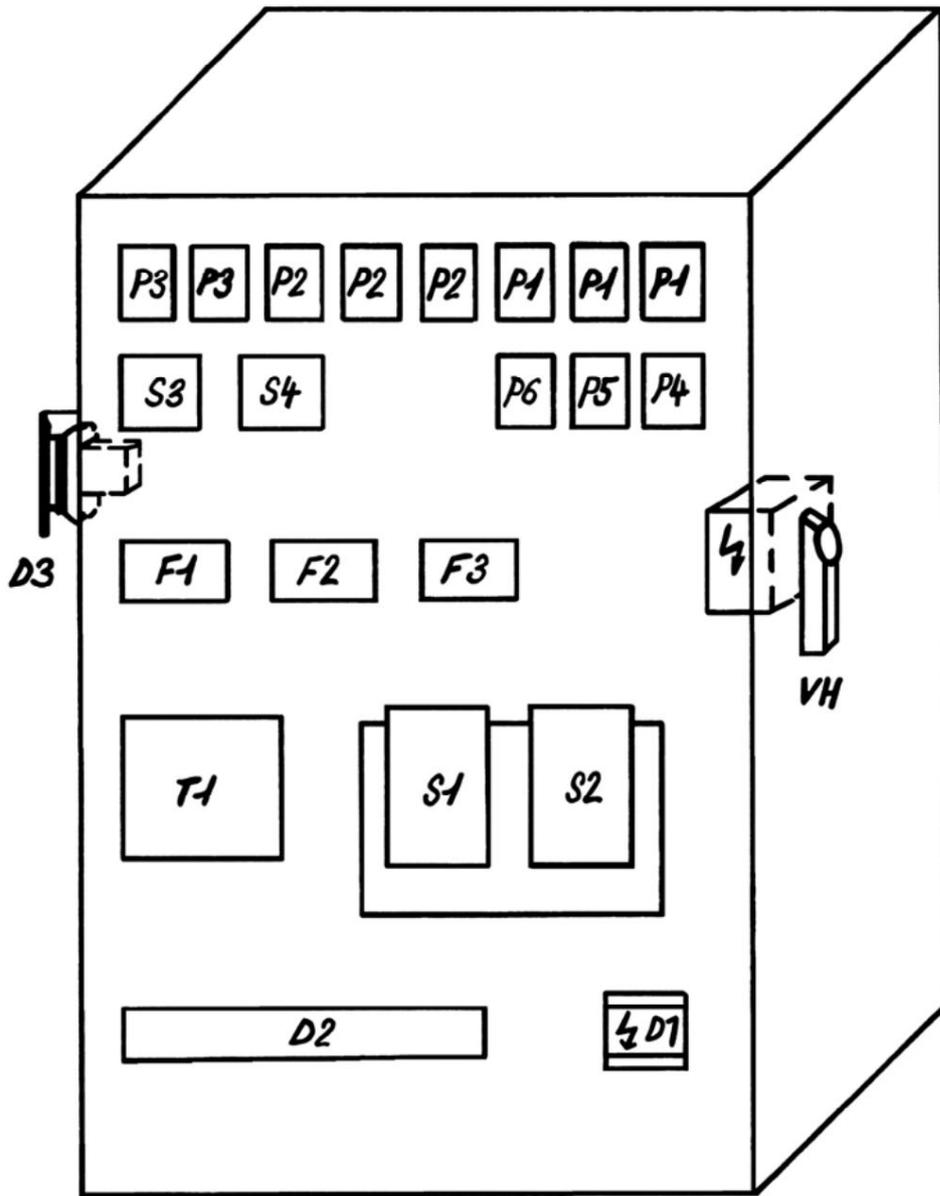


Fig. 5

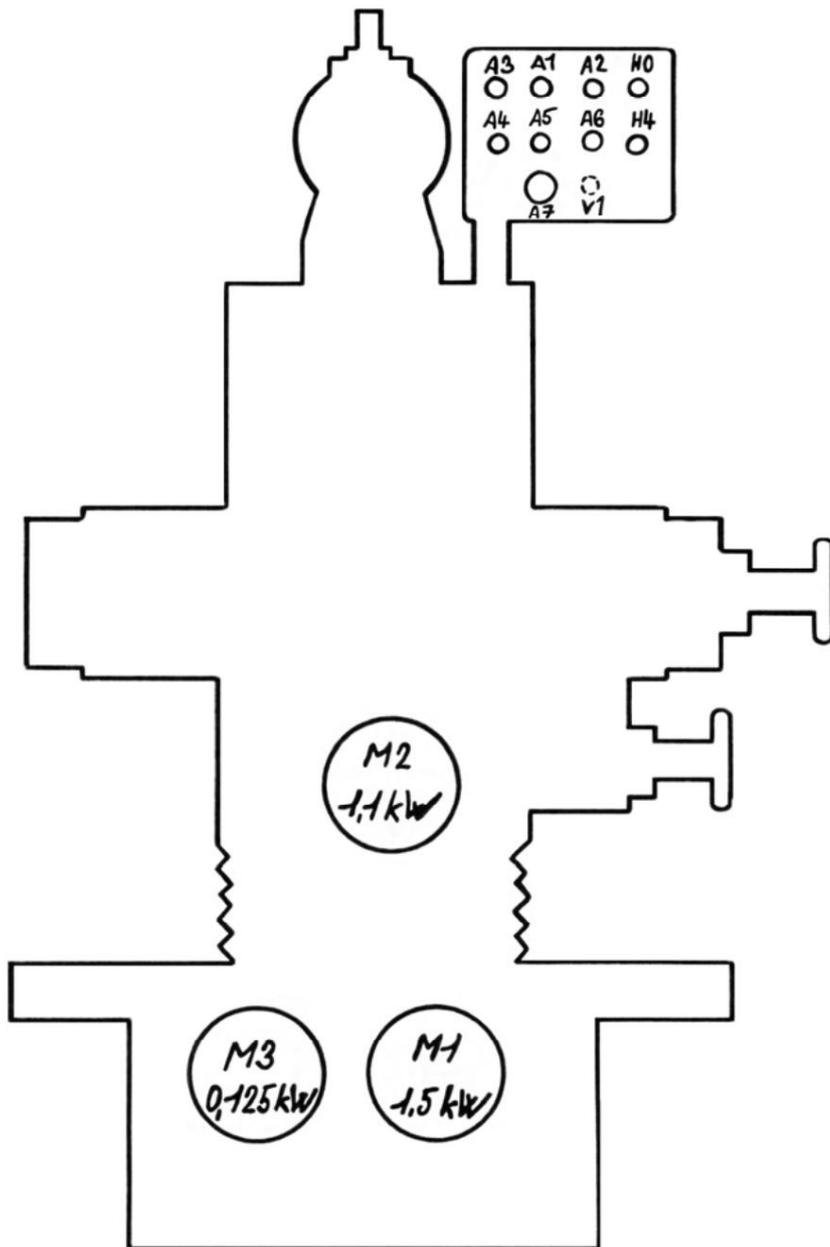


Fig. 6

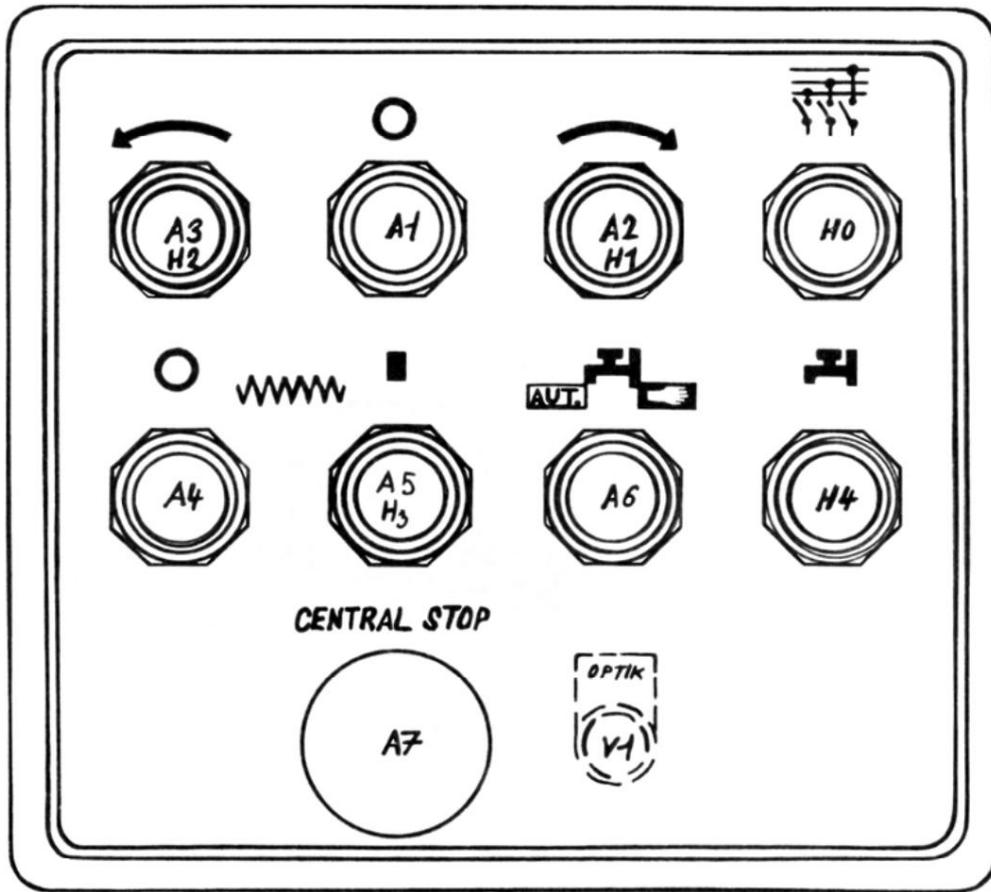


Fig. 7

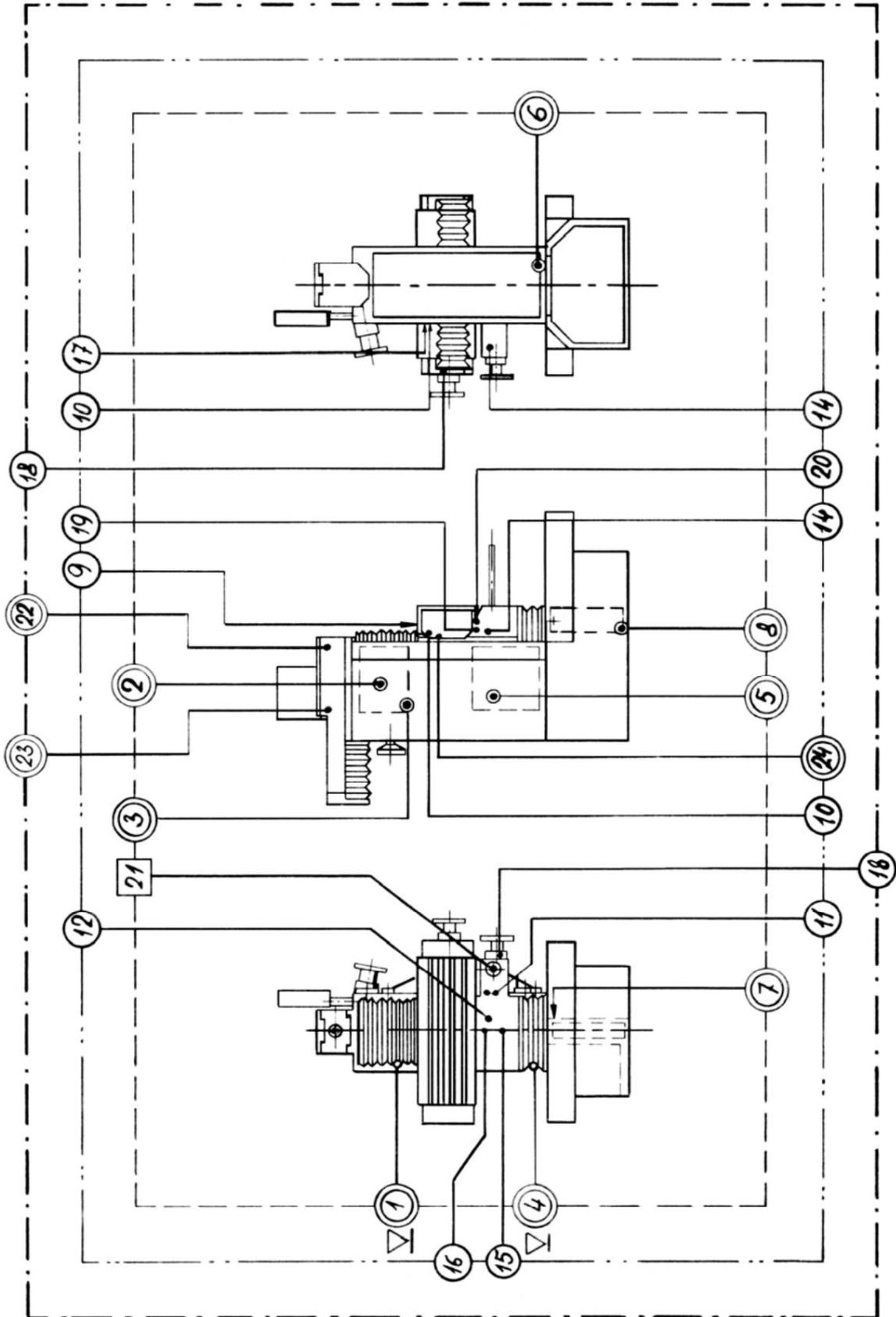
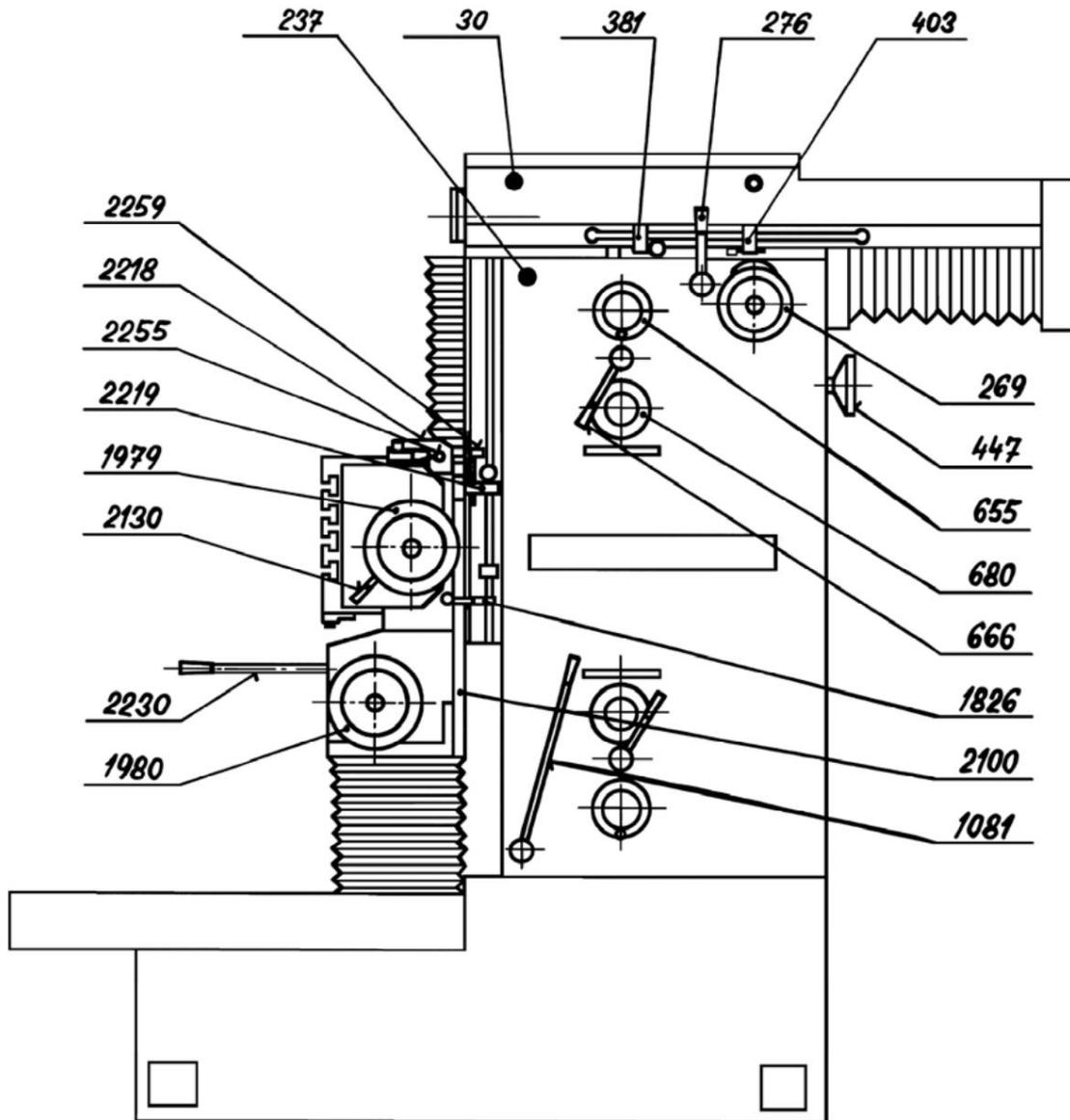


Fig. 8



9

Fig. 9

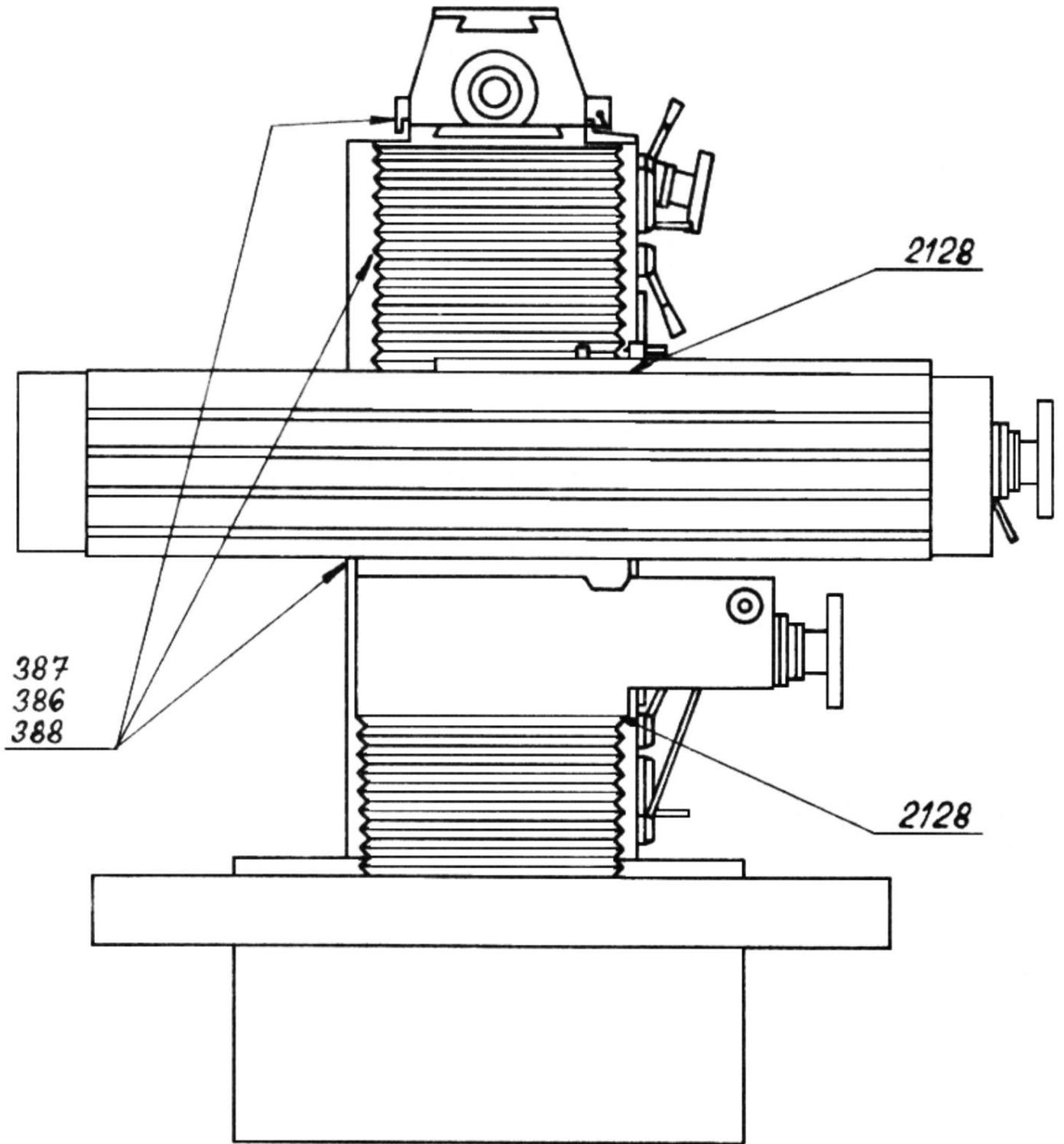


Fig. 10

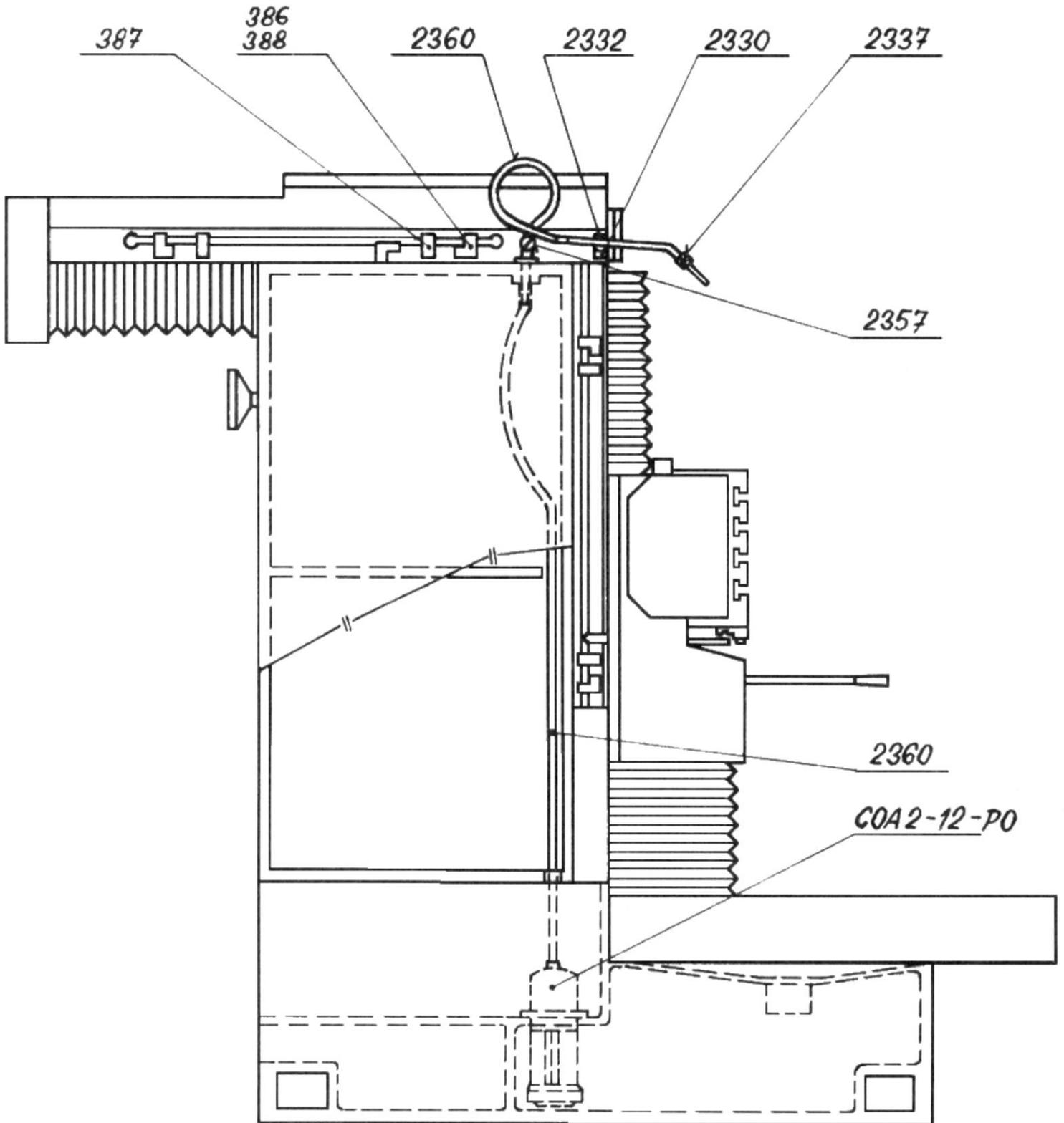


Fig. 11

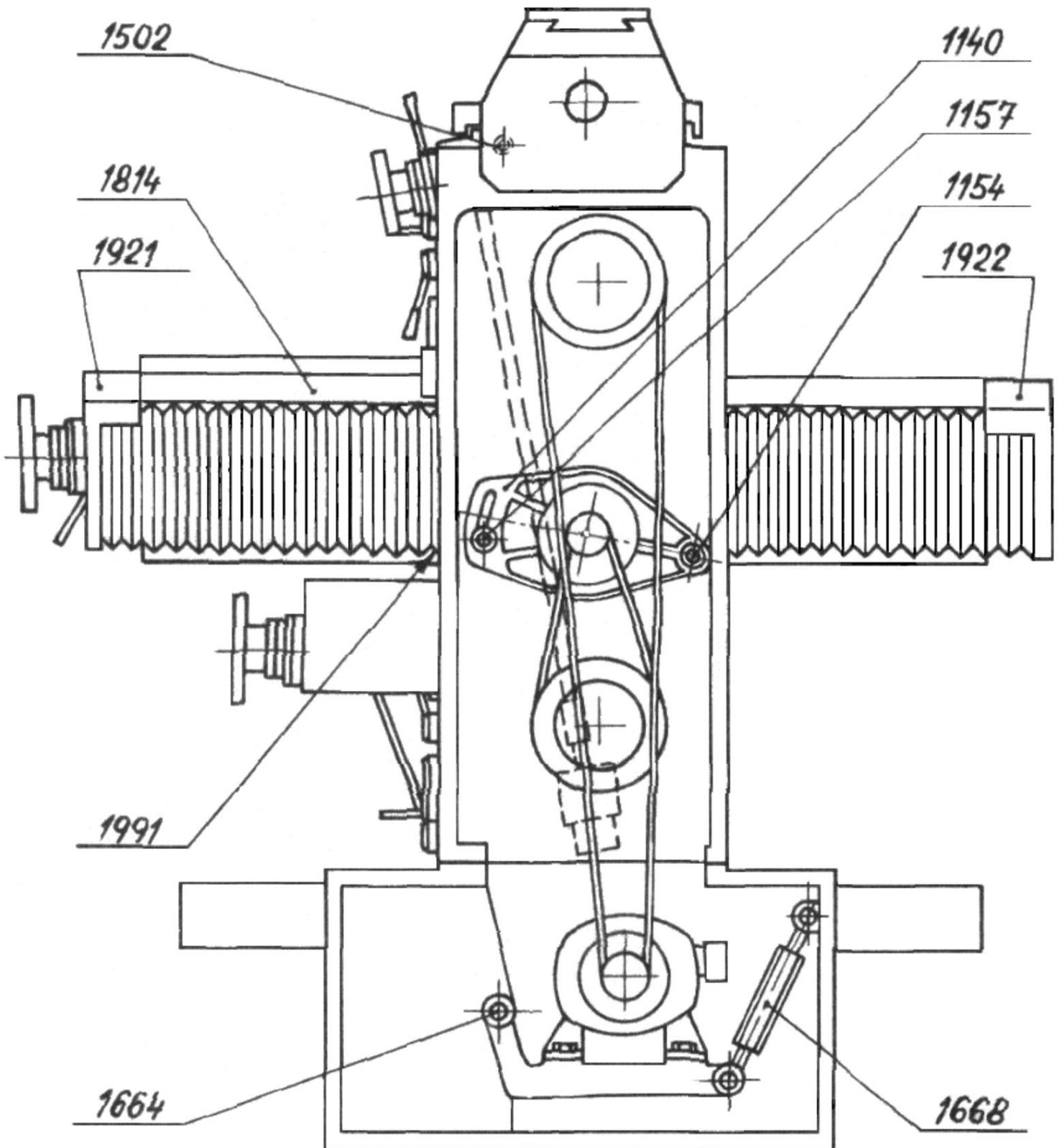


Fig. 12

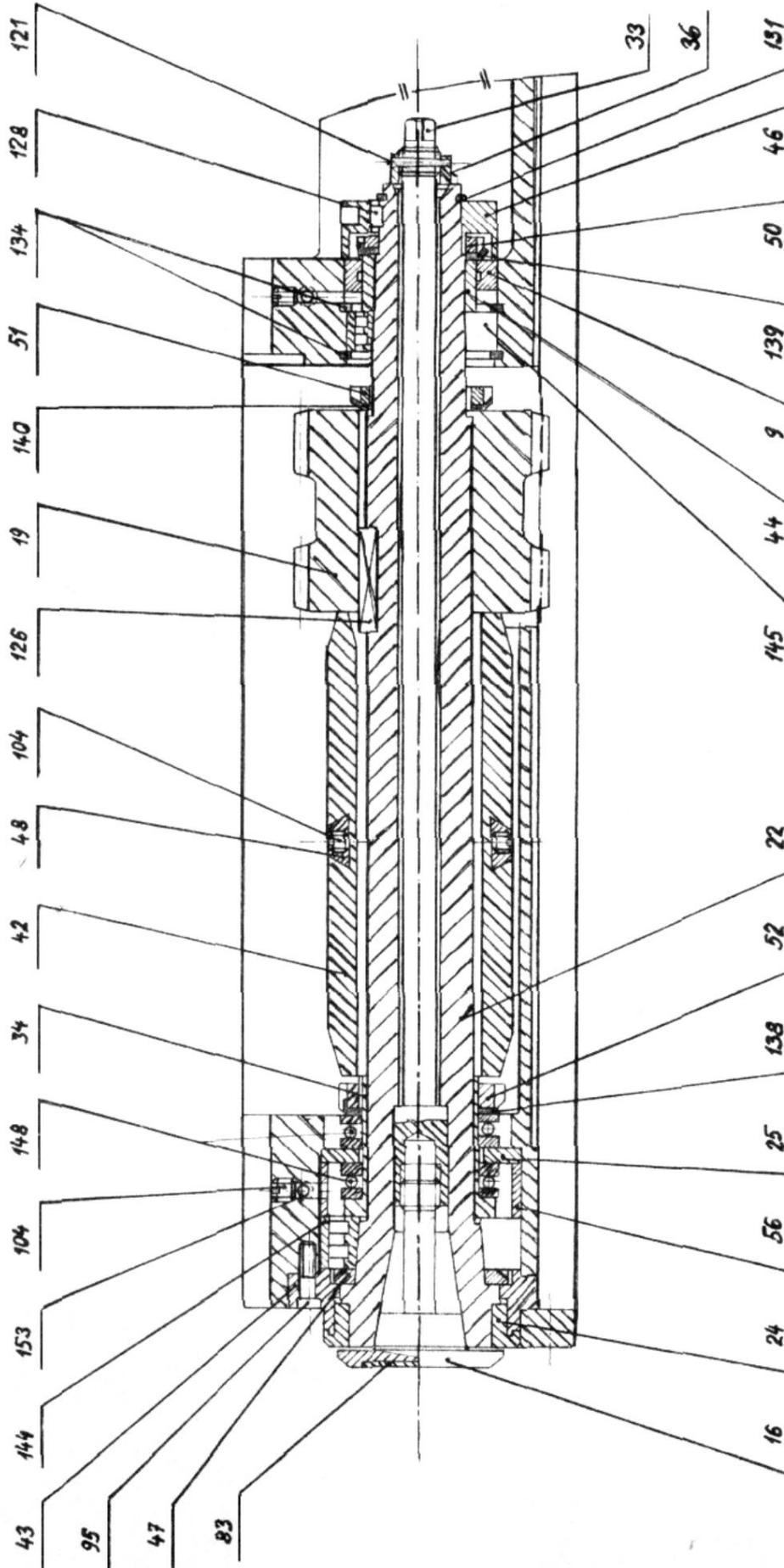
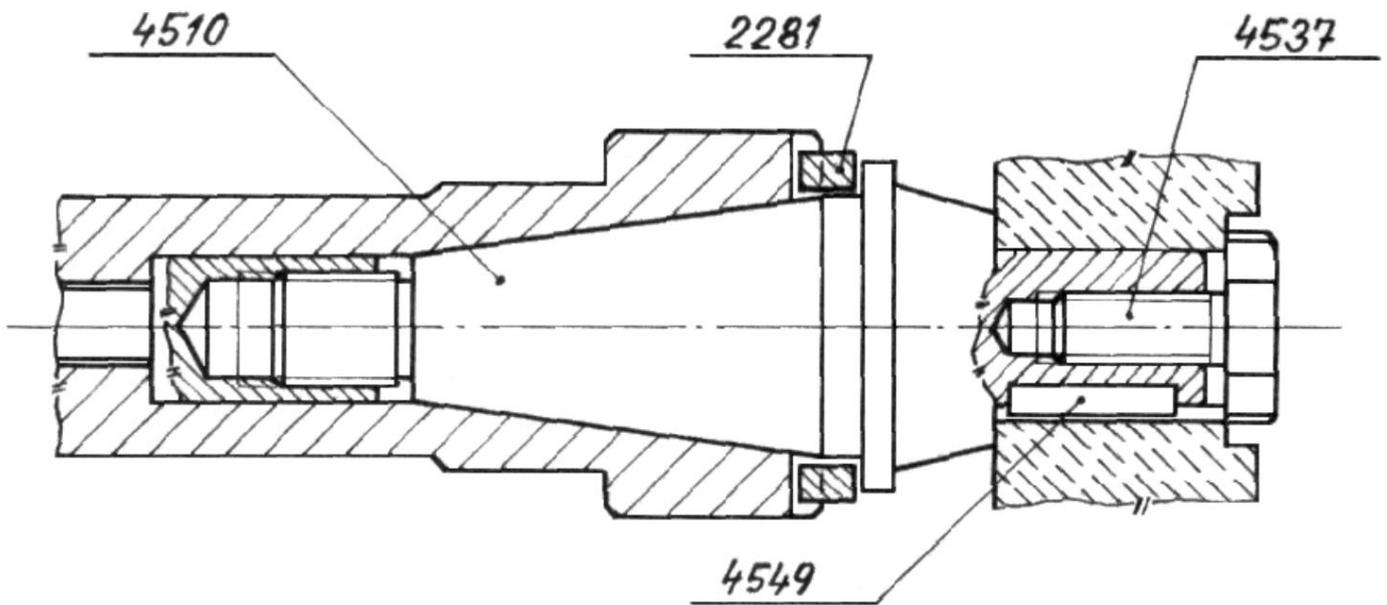


Fig. 13

a



b

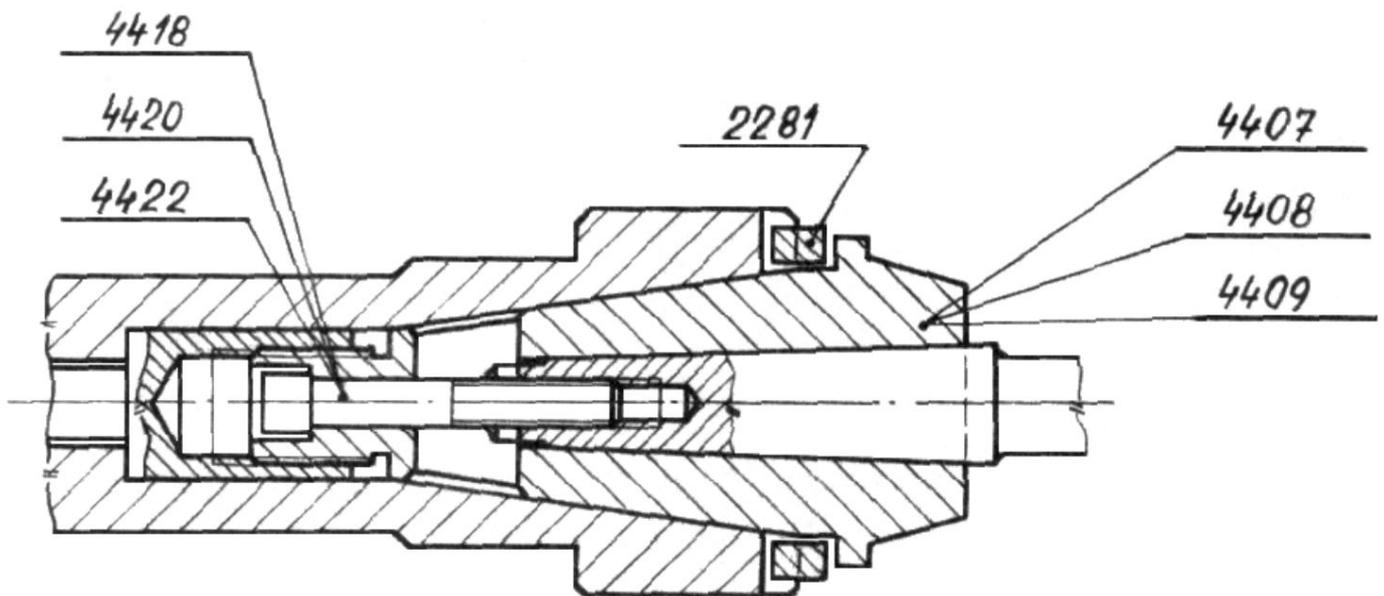


Fig. 14

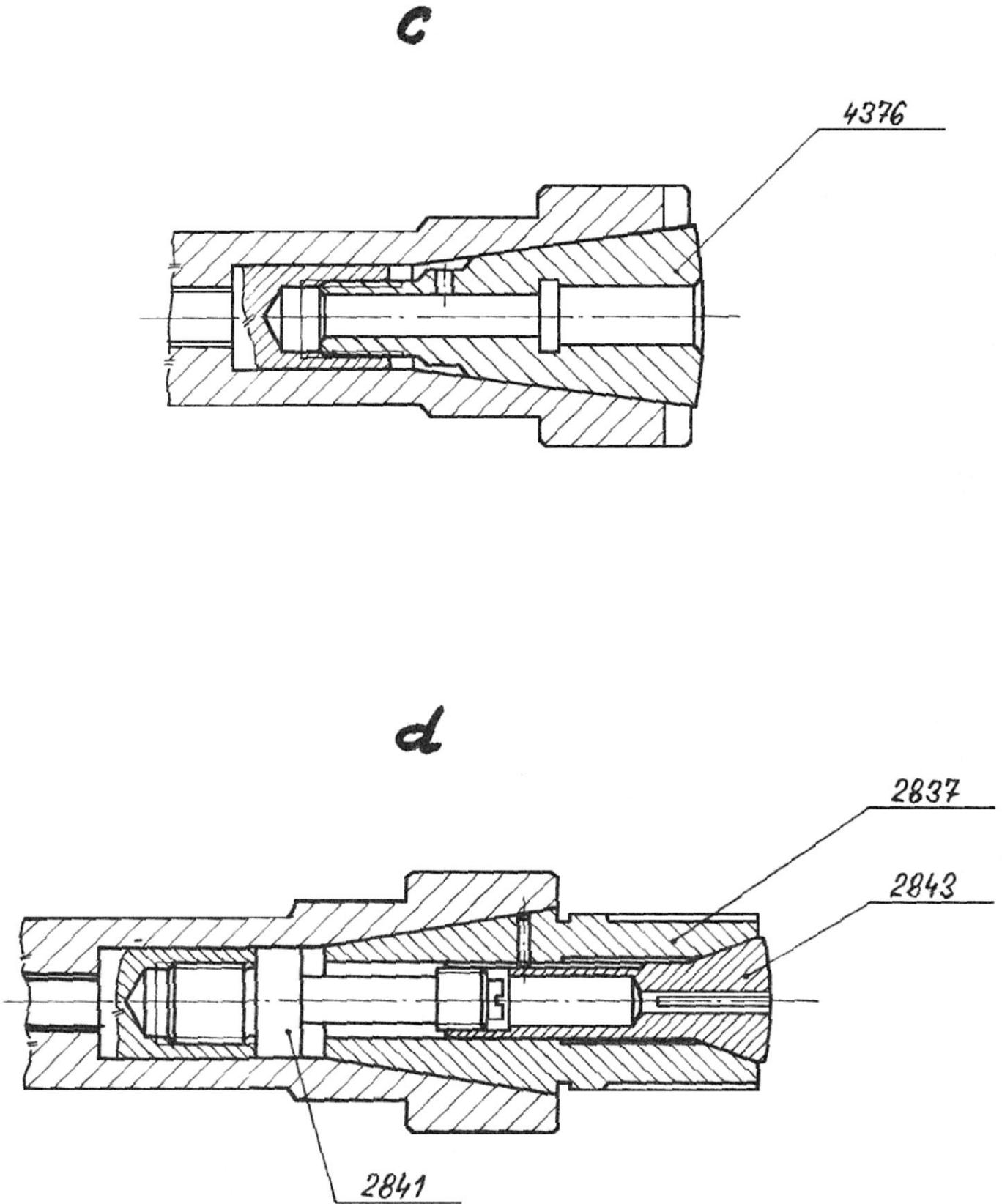


Fig. 15

