

General view

Warning!

1. When the spindle power feed, it's forbidden to bump-stop at the upper and lower limit position of the spindle travel. When power feed approach the limit position, it's must be stopped by manual to avoid damage of machine.
2. Within the actual travel of the spindle (excluding the two limit positions), the power feed of the spindle is allowed to use mechanical travel unit and mechanically bump-stop.

Safety Notice

I . Safety Measure for Working Personnel

All the working personnel of the machine must have intimate knowledge of the operation technology , master the safety notice in the manual , and know the struction of all che parts of the machine.

II . Safety Notice During Transporting and Insta lling the Machine

1 . During transporting and installing the machine , he special handling ring and ho sting and installing equipments must be used and the user mus read the contents related to transporting and installing the machine in the operation manual please.

2. Before putting the machine on the foundation, the clamping of column must not be released to avoid the downup of the machine , The column can be only hoised under the clamping state and the power supply is not permitted to cum on until the ground bolts have been tightened.

III . Safety Notice During Preparing befor the Machine Running

1. Check the machine state and see if it is completely well, check the cutting tools and spare tools , check the reliability of the tools in the spindle and check the reliability of the standard action of the limit switches and safe clutches.

2. When something wrong with the machine and someabnormal noise comes from the hydraulic system, cut down the power supply to stop the running of the machine . There should not be strong vibra-

tion and dust source near the machine.

IV. Safety Notice during the Machine Running

1. Any people except the operator is not permitted to stay in the working spot and the working area. pedestrian is not permitted to go into the limit area.

2. The following action is forbidden during the running of the machine : the machine working under the condition of overloading (that over the cutting condition) checking the part in the machine and take away a breakdown ; changing the tool manually and getting rid of the chips . Gasoline kerosene and other material which is firing easily are all forbidden to use as cleanser. Do not clean the machine with the equipment from which compress air is produced.

3. When the operator want to turn the radial around after releasing the column, notice that if there is somebody or something nearby the dangerous area.

4. There is extruding point between the headstock and the limit block and there is extruding point between the radial arm and the end of the inner column also. the operator must take care of the safety when operating.

V. Safety Notice about Electricity

The machine adopts 3-phase AC power supply of 380V and any nonspecial person is forbidden to touch the power control unit to avoid danger. All operators and main

tainers are alarmed to notice highly the problem of safety because of the many of turning parts of the machine . Those who have not learned about this notice are forbidden to do any operation .

- 1 . Check if the ground . wire of the . power Supply is connecte solidly and if the diameter of the wire is wire is accordance with the requirements .
- 2 . Check if the phase - sequence of the machine power supply is correct .
- 3 . Check if the travel limit switch is reliable .
- 4 . Check if the operation buttons are corret and the emergency button is reliable .
- 5 . When the machine is getting inuo trouble or in imminent danger state , push down the emergency button firstly (the emergency button is at lower place of the operation station) and then push the red stop button on the general power supply switch (the general power supply switch is at lower place of the column) . Nobody is permitted to turn on the power supply until the wrong of the machine is overcome and the danger is eliminated .
- 6 . The electricity mainainer must wear the ele - ctricl absolute shoes to work according to the operation rule . During the mainainence of the machine electricity , someone must be assigned to take care of the power supply or an alarm plate must be hung at the position of the power supply . Usually the machine electricity should be

maintained under the condition of turning off the power supply , if the mainainence must be done with the power supply turning on , anything electrified is forbided to touch .

7 . The keys of the niche door and the power supply must be kept by a special person .

Note :

Sign of dangher of electricity .



Sing of the switch of the
general power supply



The machine operators and mainainers must obey the above safety notice strictly .

INFORMATION

The clamping forces of spindle head and column may be changed during the transportation of the machine, so the adjustment of the clamping forces of spindle head and column must be carried out according to "the eleventh chapter of OPERATION MANUAL" before the machine is put into operation.

CONTENTS

I . Applications and Characteristics	1—1
II . Main Specifications and Parameters	2—4
III . Transmission System	5—10
IV . Principal Construction	11—22
V . Hydraulic System and its Action	23—28
VI . Electrical Equipment	29—36
VII . Cooling	37—37
VIII . Lubrication	38—39
IX . Transportation and Installation of Machine	40—43
X . Operation of the Machine	44—46
XI . Adjustments and Maintenance	47—48

1. Applications and Characteristics

Radial Drilling Machine Models Z3040x16(I) and Z3040x16(II) improved
Z3050x16(I) and Z3050x16(II)

on the base of the new series products are the universal machine for general purposes, and suitable for drilling, counter-boring, reaming, spot facing and tapping on medium or large-sized parts. Boring operation is also possible where such technological equipment is available.

These machines possess the following features:

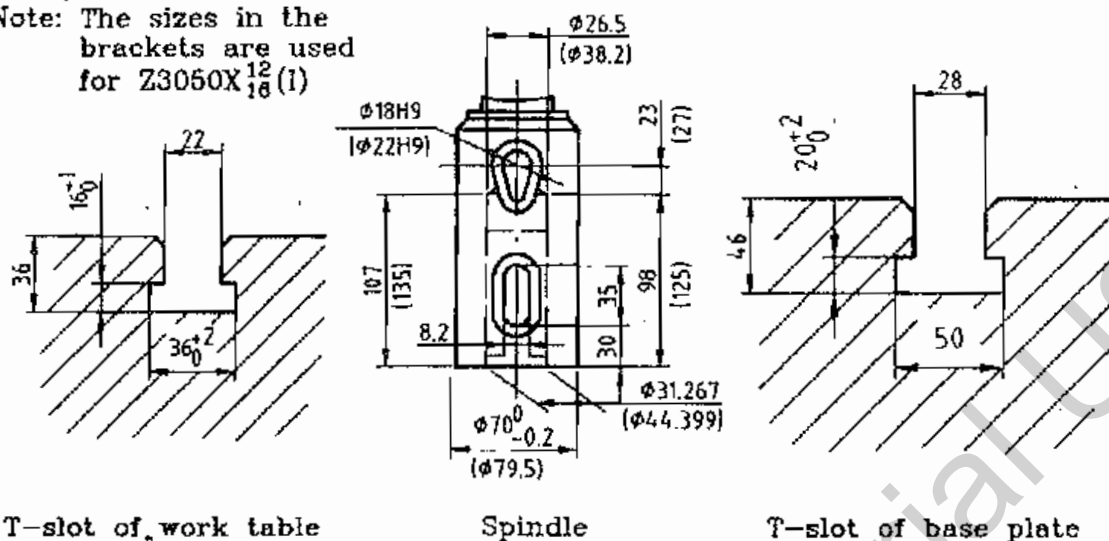
1. Their adoption of hydraulic pre-selected changed speed mechanism saves setting time.
2. Such motions as the forward and reverse rotation of the spindle, braking, speed changing, as well as its neutral position are controlled by hand lever. This facilitates easy operation.
3. A hydraulic driven rhombic block clamping mechanism is adopted for the spindle head, the arm, the inner and outer columns, which ensures reliable clamping.
4. Upper guide way on the arm, spindle and its sleeve as well as the rotary path of the inner and outer columns have undergone hardening treatment, so that the stability of the machine accuracy is retained for a long time and that the service lives of the machines are prolonged.
5. Complete safety device and outer column protective device are provided in these machines.
6. A series of effective measurements have been adopted in construction designing and manufacturing process, the durability of machine accuracy and service life of whole machine are thus prolonged.
7. Electric equipments used on these machines are reliable and ensure the personal security and are convenient for maintenance.

II . Main Specifications and Parameters

Description	Unit	Specifications	
		Z3040 × $\frac{1}{16}$ 2 (I) (II)	Z3050 × $\frac{1}{16}$ 2 (I) (II)
Maximum drilling diameter	mm	40	50
Distance from the center line of Spindle to column	mm	Max: 1600 Min: 350	
Horizontal traverse of spindle Head on arm	mm	1250	
Distance from spindle nose to Working surface of base plate	mm	Z3040 × $\frac{1}{16}$ 2 (I) Max: 1250mm Min: 350mm Z3050 × $\frac{1}{16}$ 2 (II) Max: 1250mm Min: 350mm Z3050 × $\frac{1}{16}$ 2 (I) Max: 1220mm Min: 320mm Z3040 × $\frac{1}{16}$ 2 (II) Max: 1280mm Min: 380mm	
vertical travel of arm on column	mm	580	
Elevating speed of arm	m/sec	0.02	
Swivel angle of arm	degree	360°	
Taper in spindle	Morse	No. 4	No. 5
Range of spindle speeds	rpm	25 - 2000	
Number of spindle speeds	steps	16	
Range of spindle feeds	mm/rev	0.04 - 3.2	
Number of spindle feeds	steps	16	
Spindle travel	mm	315	
Feed depth per revolution of graduated dial	mm	112	
Maximum permissible torque of spindle	N.m	400	500
Maximum permissible feed pressure of spindle	N	16000	18000
Power of the main drive motor	KN	3	4
Power of arm elevating motor	KW	1.5	
Power of hydraulic clamping motor	KW	0.75	
Power of coolant pump motor	KW	0.09	
Weight of the machine (approx)	Kg	3500; 3900: (with auxiliary column)	
Overall dimensions (L × W × H)	mm	2500 × 1060 × 2655	

Note: The sizes in the brackets are used for Z3040 × 16 (II) or Z3050 × 16 (II)

Note: The sizes in the brackets are used for Z3050X¹²₁₈ (I)



Note: The sizes in the brackets are used for Z3050X¹²₁₈ (II)

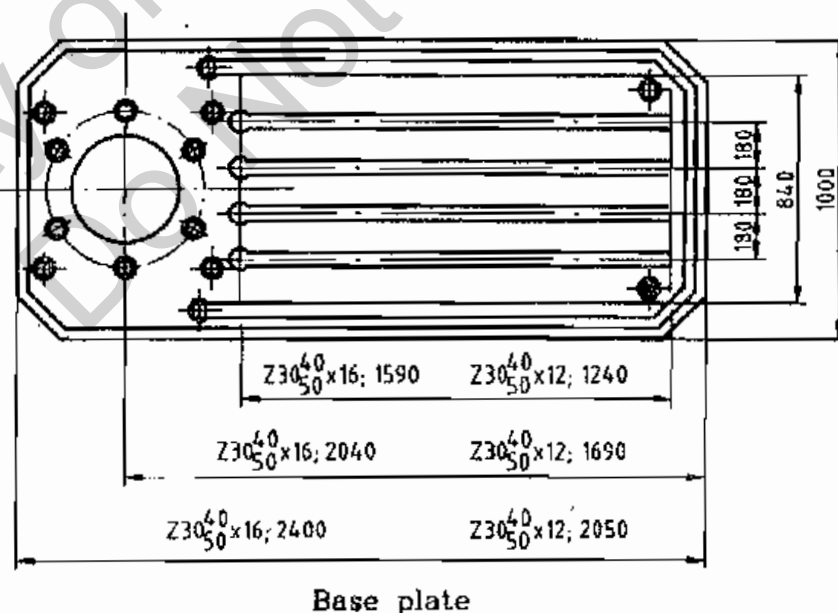
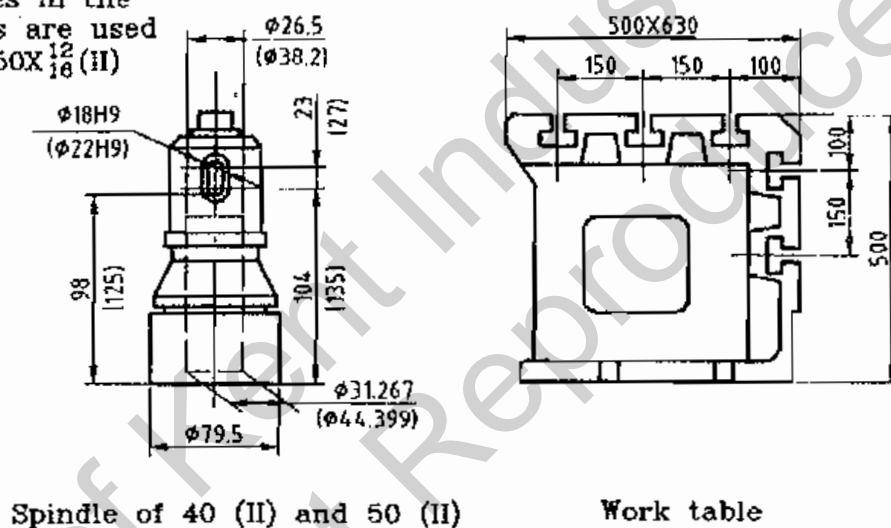
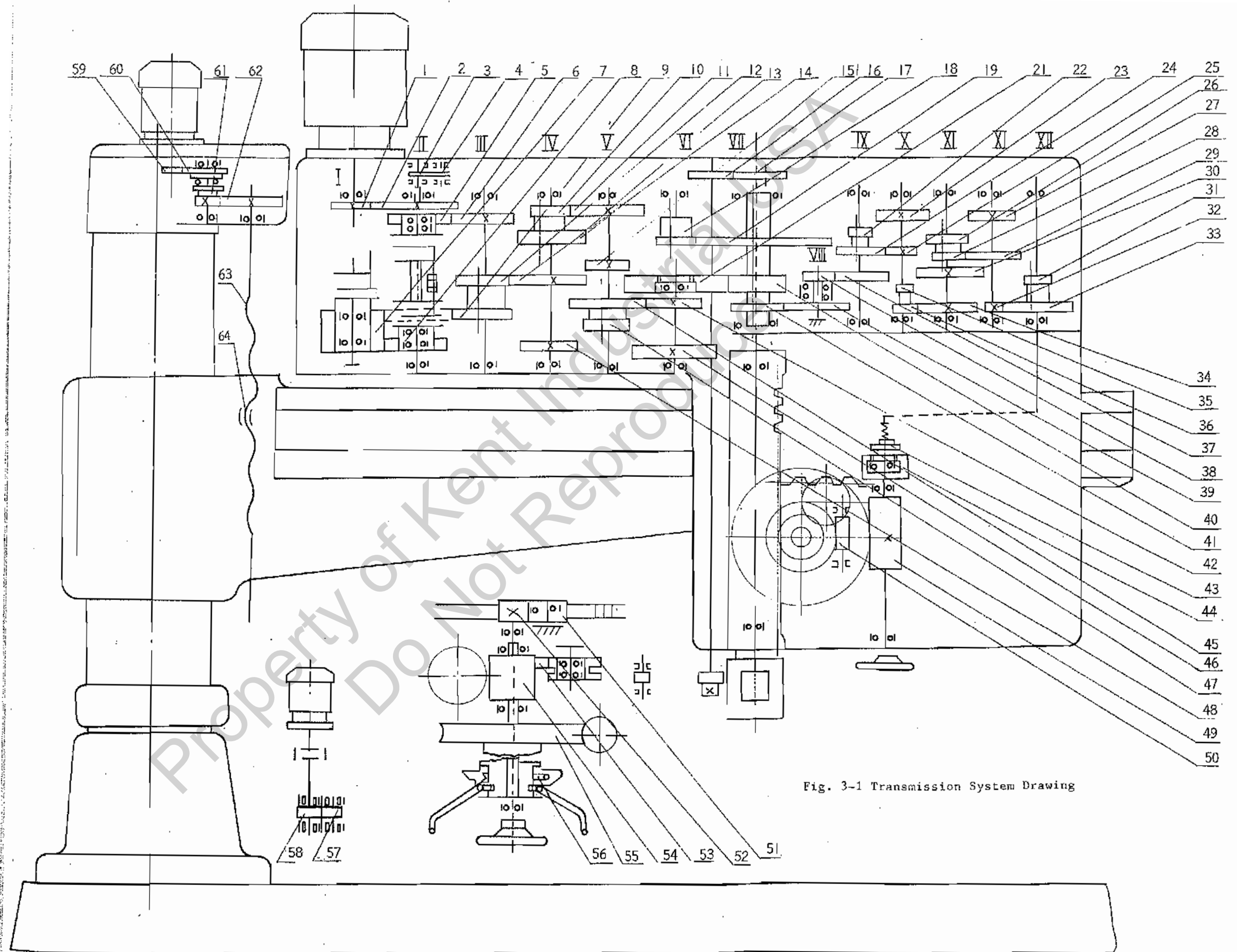


Fig.2-2 Main parameters of Spindle, Table & Base plate

III. Transmission System

Rotation of spindle, feed of spindle, lifting of arm and movement of spindle head on the arm are included in the transmission system. The following diagrams and charts will be found in this section:

1. Diagram of the transmission system (fig. 3-1)
2. Chart of spindle speeds (fig. 3-2)
3. Chart of spindle feeding speeds (fig. 3-3)
4. Table of gears, worm wheels, worms, lead screws and nuts (table 1)
5. Diagram of rolling bearing distribution (fig. 3-4)
6. Table of rolling bearings (Table 2)



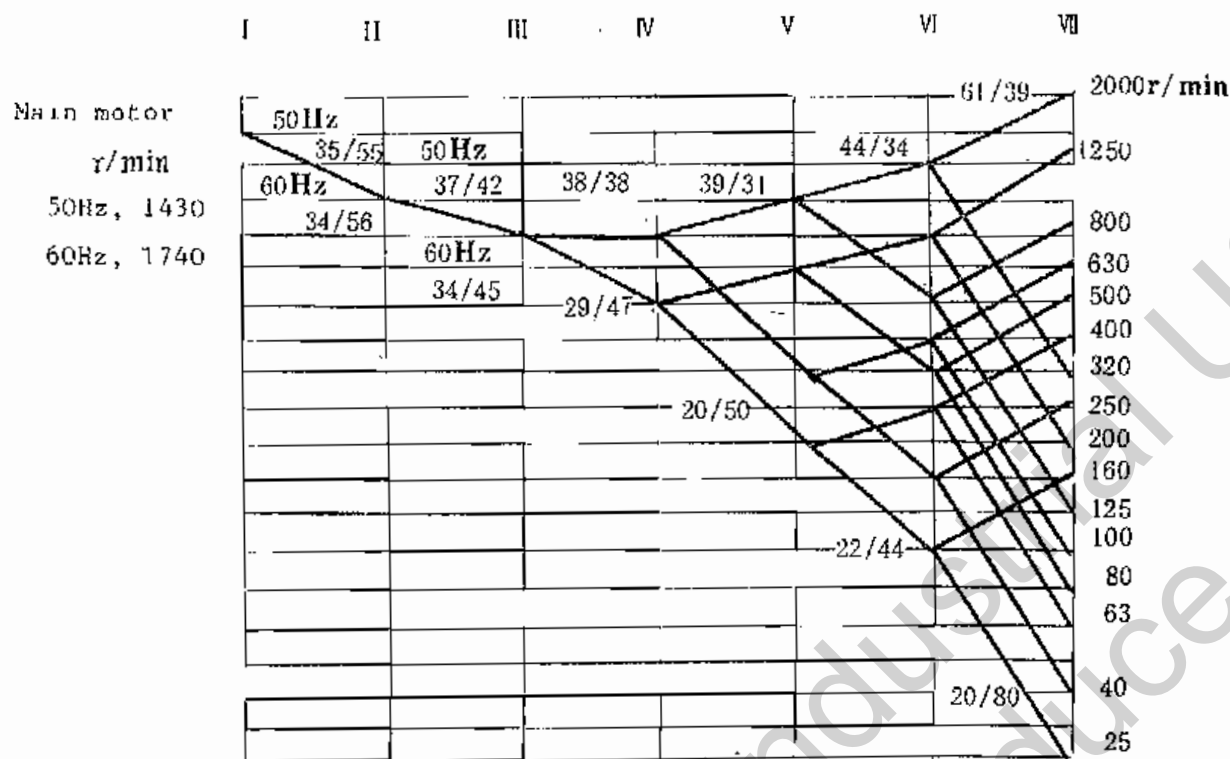


Fig. 3-2 Spindle Feed Graph

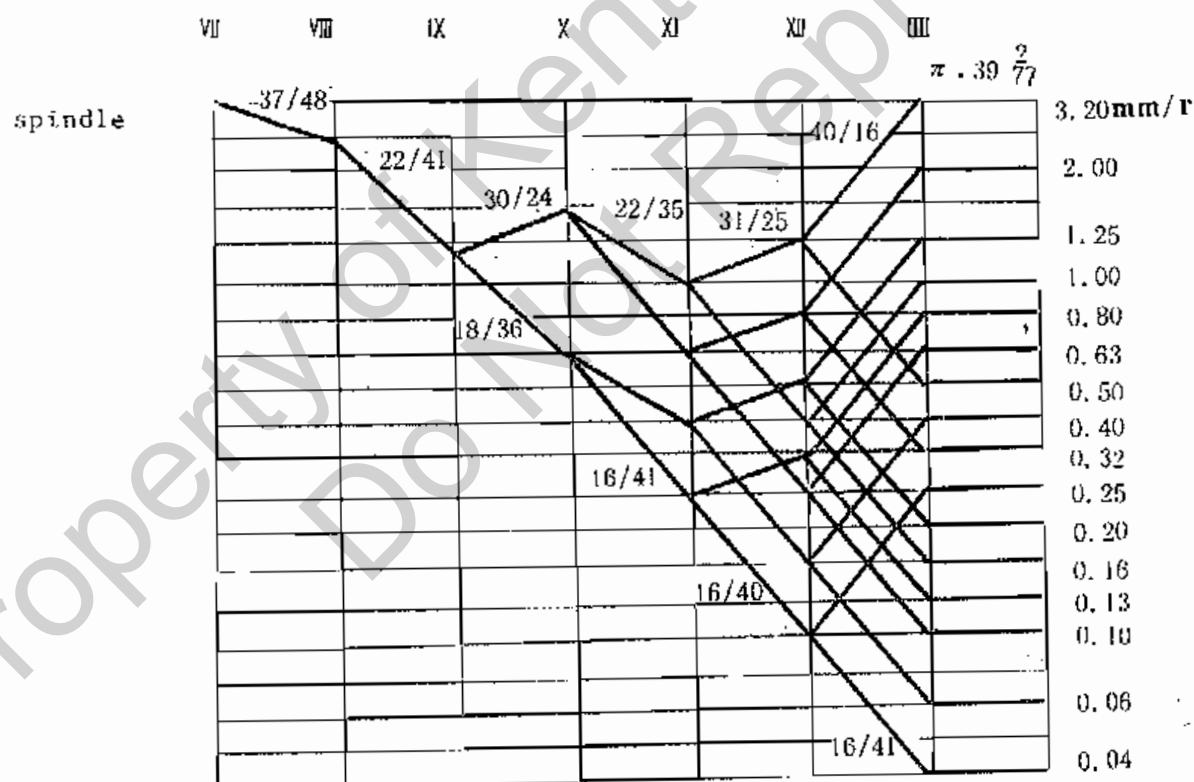


Fig. 3-3 Spindle Speed Graph

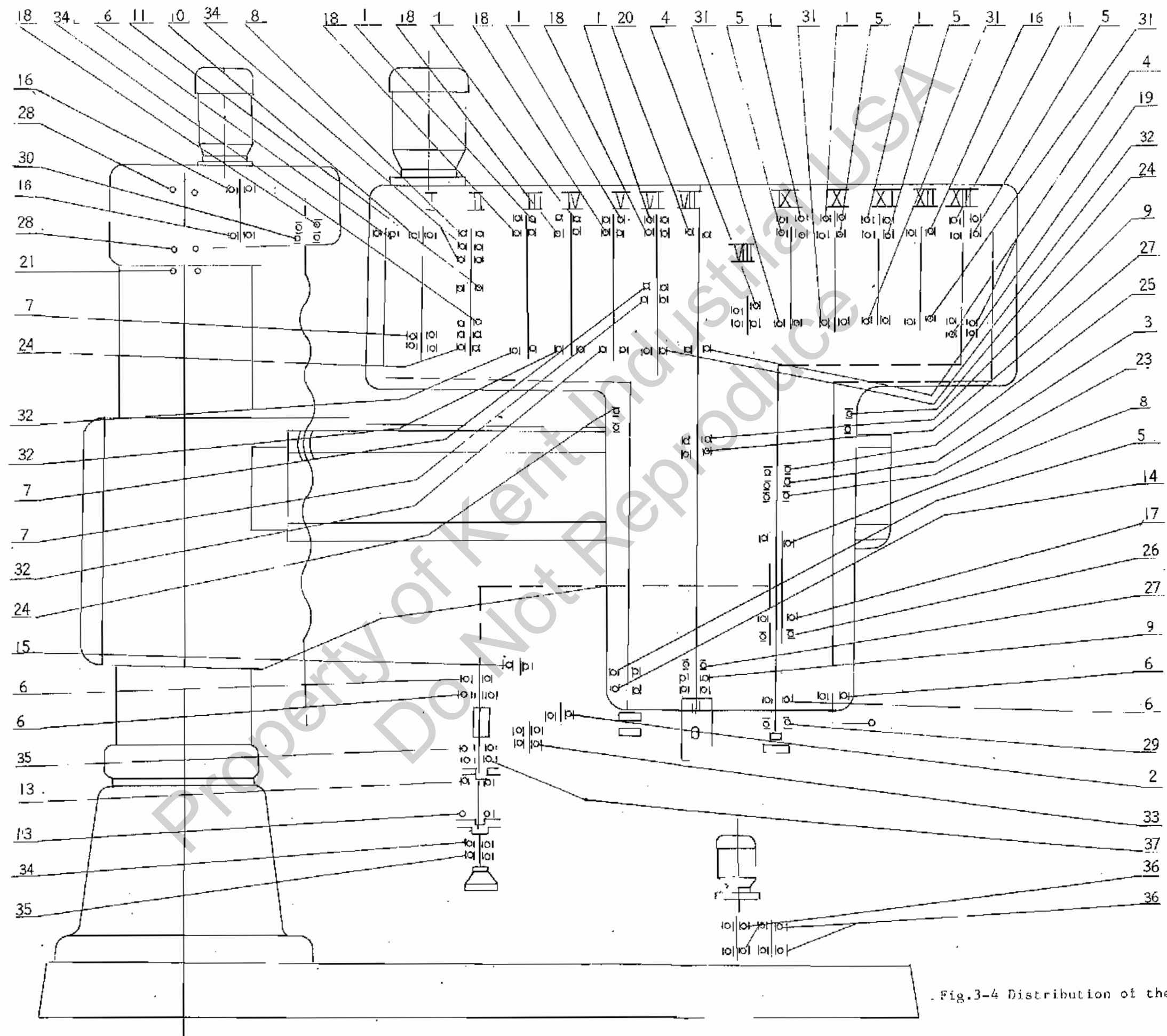
No. in Fig.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25		
No. of teeth or threads	50Hz:35 60Hz:34	50Hz:55 60Hz:56	17	17	50Hz:37 60Hz:34	50Hz:42 60Hz:45	36	36	38	20	50	29	47	39	31	28	28	20	80	61, int gear 20		18	36	30	24		
Module	2		2		2.5										2										2.5		
Helix angle & its direction																											
Grade of accuracy	7-7C		8-8C		7-7C										9-9C		7-7C		6-6C		8-8C						
Material	45		40C r		40C r	45	40C r		45	40C r	45			40C r	45			40C r			45						
Heat-treatment & hardness	G 54		G 48		G 52	G 54	G 52		G 54	G 52	G 54			G 52	G 54				G 52		G 48		G 54				

No. in Fig.	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	
No. of teeth or threads	31	25	16	40	41	16	16	41	35	16	22	41	22	48	39	37	34	38	38	44	44	22	38	2	2	
Module	2.5											2		2.5		2	2.5		1.5		2.5	3		2.5	2	1.5
Helix angle & its direction																							4°58' R.H.		5°42'38" R.H.	
Grade of accuracy	8-8C											7-7C		6-6C		7-7C		8-8C		7-7C			8-De			
Material	40C r	45	40C r	45	40C r	45	40C r	45							20C r	40C r	45	40C r	45	40C r	45					
Heat-treatment & hardness	T 235 G 48	G 54	T 235 G 48	G 54	T 235 G 48	G 54	T 235 G 48	G 54							S 0.7- C 59		C 48	G 54	G 52	G 54	T 235					

No. in Fig.	51	52	53	54	55	56	57	58	59	60	61	62	63	64
No. of teeth or threads	35	20	42	13	77	72	17		20	42	16	54	1	1
Module	2		3	3	2	1.5	2				2.5		T36×6	
Helix angle & its direction					4°58'	5°42'38"	R.R.							
					R.R.	R.R.								
Grade of accuracy	9-9C			8-8C	8-De	8-8C	8-8C							
Material	45		40C r	HT30-54	40C r	40C r	45	20Cr	45	45	45	45	45	45
Heat-treatment & hardness			T 235	T 235		T 235	G 48	G 54	80.5-~	C 59	G 54	G 48	T 235	45 ZnAl 10-5

Note:

- The meanings of the heat-treatment symbols are as follows
S___ carburizing G___ high-frequency induction hardening
C___ quenching D___ nitriding T___ quenching and high temperature tempering; Figures behind the symbols represent the depth of carburization or hardness.
- The heat-treatment and hardness that are filled in the table are suitable for the gear faces or the thread parts of the worms.



Bearing of spindle
nose 40(11)
50(11)

Fig.3-4 Distribution of the Antifriction Bearings

List of Anti-friction Bearings (Table 2)

Serial No.	1	2	3	4	5	6	7	8	9	10	11	12	13
	26	100	101	104	105	106	107	108	D108	109	110		116
Specifications	6 x 19 x 6	10 x 26 x 8	12 x 28 8	20 x 42 x 12	25 x 47 x 12	30 x 55 x 13	35 x 62 x 14	40 x 68 x 15	40 x 68 x 15	45 x 75 x 16	50 x 80 x 16		80 x 125 x 22
Grade of accuracy	G												
Pieces	8	1	1	4	5	5	4	2	3	1	1		2

Serial No.	14	15	16	17	18	19	20	21	22	23	24	25	26
Type	201	203	204	205	206	210	211	217		8101	305	8106	8107
Specifications	12 x 32 x 10	17 x 40 x 12	20 x 47 14	25 x 52 x 15	30 x 62 x 16	50 x 90 x 20	55 x 100 x 21	85 x 150 x 28		12 x 26 x 9	25 x 62 x 17	30 x 47 x 11	35 x 52 x 12
Grade of accuracy	G												
	1	1	3	1	5	1	1	1		1	3	1	1

Serial No.	27	28	29	30	31	32	33	34	35	36	37	38	39
Type	D8101	8117	8205	8207	50204	50206	7000105	7000106	7000110	941/15	7000111	F8112	D3182113
Specifications	40 x 60 x 13	85 x 110 x 19	25 x 47 14	35 x 62 x 18	20 x 47 x 14	30 x 62 x 16	25 x 47 x 8	30 x 55 x 9	50 x 80 x 10	15 x 20 x 12	55 x 90 x 11	60 x 85 x 17	65 x 100 x 26
Grade of accuracy	G												
Pieces	2	2	1	1	4	4	2	5	2	4	1	1	1

IV. Principal Construction

1. Spindle speeds transmission mechanism (fig. 4-1)

This spindle speeds transmission mechanism is mounted on the upper part of the spindle head. There are 8 transmission shafts. The 16 spindle speeds are obtained by means of the different ways of engagement of the 4 double sliding gears and the fixed gear. The friction clutch for spindle forward/reverse rotation is provided on shaft II. This enables the spindle to change its direction of rotation smoothly and without impact, and it also prevents the motor being overloaded. Neutral position of the spindle is obtained by means of the sliding gear fitted on shaft VI (refer to the section on neutral position of the spindle), which facilitates mounting and dismounting of tools and alignment of the hole to be machined.

2. Speed change mechanism for spindle feeds (fig. 4-2)

It is similar to the spindle speed change transmission mechanism in regard to its type of structure, mounting position and arrangement in construction.

3. Spindle feed and operation mechanism

The spindle feed mechanism consists of two parts: the worm shaft and the horizontal shaft. The driving force is transmitted by the spindle feed transmission mechanism to the worm shaft, then through the worm gear, and finally transmitted to the spindle sleeve by the horizontal shaft, so that the spindle may get its feed movement.

(1) The worm shaft (fig. 4-3)

When hand lever 8 is at its horizontal position, the safety steel ball clutch for feeding is made idle run by the spindle feed transmission mechanism. When hand lever 8 is depressed to mechanical operation position, the inner and outer gears on the steel ball clutch mesh. Thus accomplishes mechanical feeding. When the feed resistance exceeds its specified value, or when cutting at predetermined depth, the steel ball clutch will disengage automatically, and the mechanical feed is interrupted. To dismantle the clutch, remove the front cover of the spindle head, and dismantle worm shaft (move a distance out), thus the steel ball clutch assembly will be disconnected from the spindle head. To dismantle the worm shaft from the case, remove the pin 6 on the inner toothed sleeve 5, then remove the binding screw on the supporting sleeve 7. Then the supporting sleeve may be removed from the spindle head. Together with worm shaft

assembly.

(2) The horizontal shaft (fig.4-4)

Engagement and disengagement of the clutch on the horizontal shaft are controlled by the thirty three $\phi 12\text{mm}$ steel ball. Care must be taken not to lose any of them when dismantling. It must be pointed out that lacking of steel ball is not allowed when reassembling

and they may not be substituted by balls of other specification, or the clutch will be damaged. Adjustment of the clutch should be carried out with the clutch meshed. Tighten screw cap 3, so that the handle 5 may be pushed with ease. Then lock screw cap 3 with screw 4.

To dismantle the horizontal shaft, first move the spindle to its topmost position, then turn screw 2 on fig.4-6 clockwise, loosen the spindle balance spring. The spindle must be held in place with padding so that it does not fall off when the horizontal shaft is dismantled. Then unscrew screw 1 to withdraw the push button box together with its electric wire; unscrew nut 2. remove the hand wheel, and the horizontal shaft assembly may be dismantled. Note: When replacing the horizontal shaft, move the spindle to its topmost position, and the cam should be placed in accordance with the position shown in fig. 4-6 or the spindle will not remain balanced.

4. Spindle head clamping mechanism (fig.4-5)

The pressure oil of the hydraulic system in the clamping mechanism, enters the large cavity of the oil cylinder to push the piston, making the rhombic block stand upright with slight deflection and self-lock. Thus eliminates the clearance between the spindle head and arm guide way, clamping the spindle head onto the arm. The pressure oil enters the small cavity and pushes the rhombic block. The spindle head disengaged.

5. The spindle and its balancing (fig.4-6)

The spindle is of the two-point support type common structure. A cam-helical spring structure is adopted for spindle balancing. Balance between the gravity of the spindle elements and spring force is maintained by the cam. The balancing force may be adjusted by screw 2.

The semicircular hole in the spindle nose is for insertion of tool dismounting spanner. Cutting tools may be easily removed with the spanner without impact on the spindle, which helps to maintain accuracy of the spindle in a comparatively long period. To dismantle the spindle, first remove the horizontal shaft (refer to the section on horizontal shaft), then the spindle may be removed from the spindle head. If the spindle balance springs to be dismantled as well, first remove the chain from cam 3, then unscrew binding screw 4, and remove the screw on cover 5.

6. Clamping of the column (fig. 4 - 7)

Actions of the column clamping oil cylinder and the rhombic block are similar to those of the spindle head. The disengaging and matching of the taper faces of the inner and outer columns are effected by the lever. This loosens or clamps the columns.

Disengagement of the taper faces is accomplished by spring plate 3 on the upper part of the outer column which raises the outer column.

7. Lifting and clamping of the arm (fig. 4 - 7, fig. 4 - 8)

The motor on the top of the column drives the arm up and down.

In the transmission chain, a steel ball safety clutch is incorporated, and a safety nut 9 is fitted on the top end of lifting nut 8 (fig. 4 - 7), to avoid accidents caused by sudden drop of the arm, when nut 8 is worn.

The mechanism of the oil cylinder and rhombic block for arm clamping is similar to that of the spindle head clamping device.

Loosening or clamping of the arm is achieved by means of the lever.

The loosening prior to its lifting and the clamping after its lifting are controlled by the electrical switch on the base of the clamping oil cylinder.

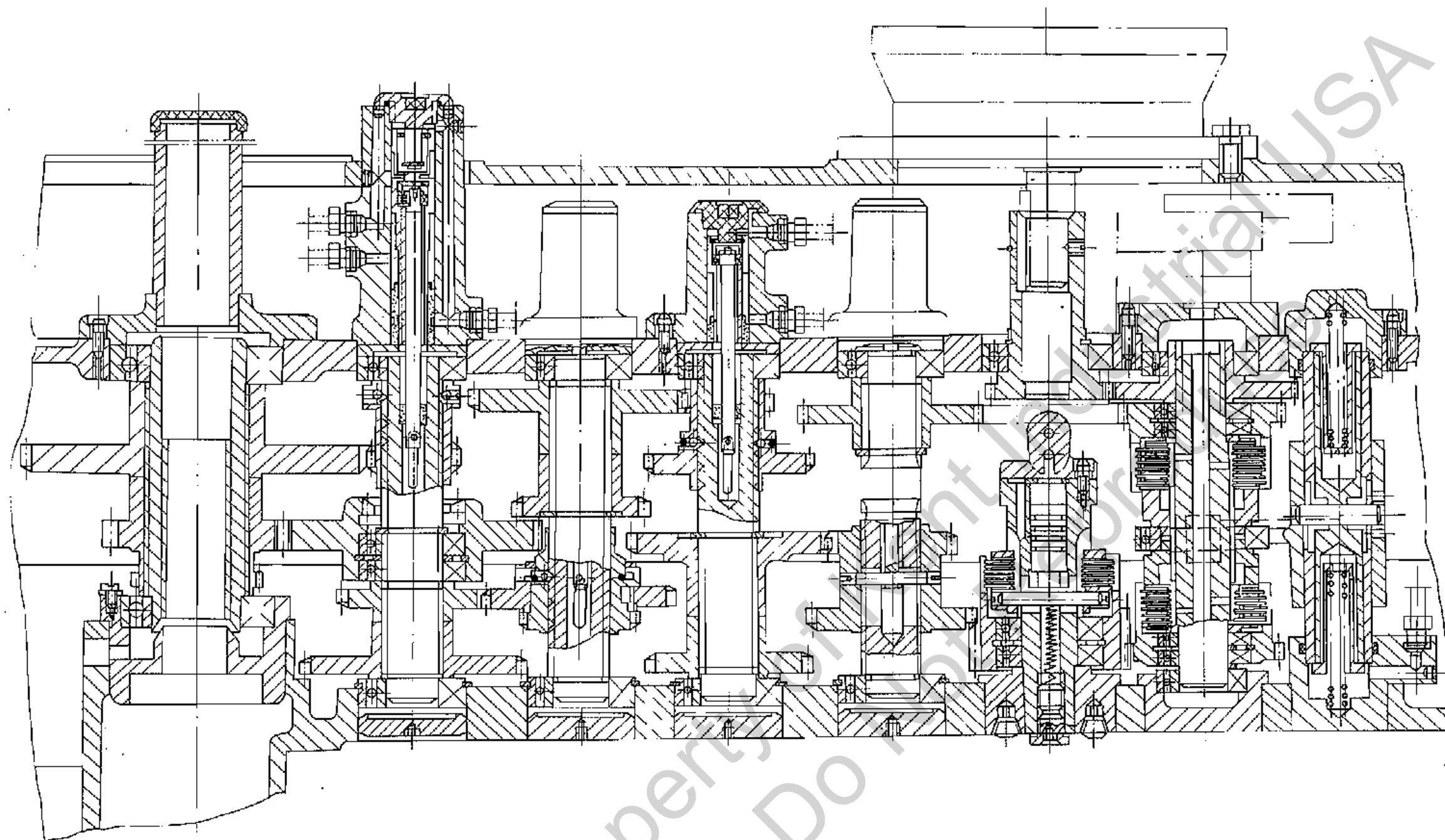


Fig. 4-1 Stretch Drawing of Spindle Speed Change Mechanism

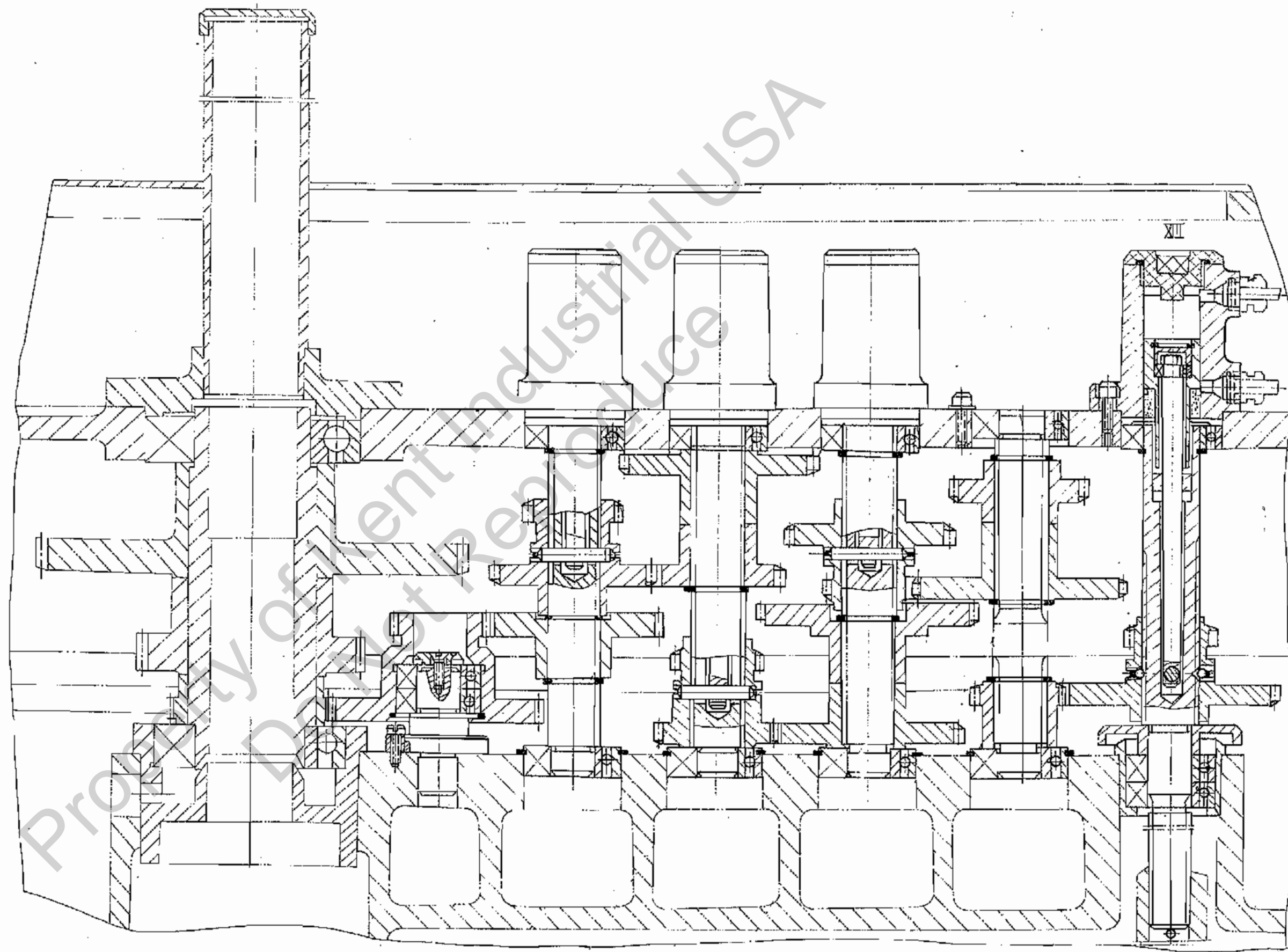


Fig. 4-2 Stretch Drawing of Spindle Feed Change Mechanism

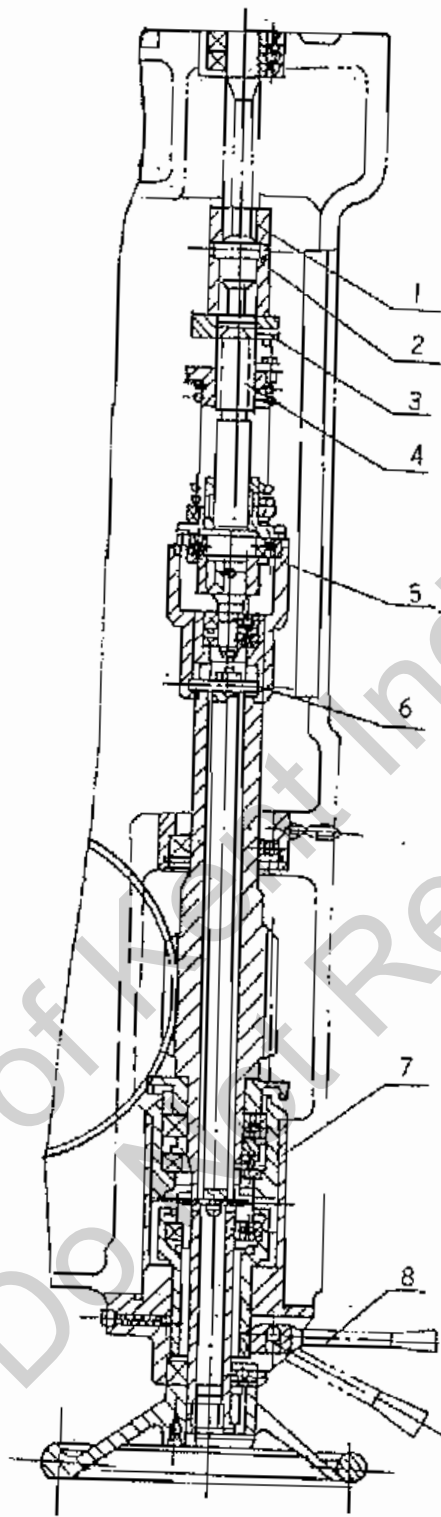


Fig. 4-3 Worm Shaft Drawing

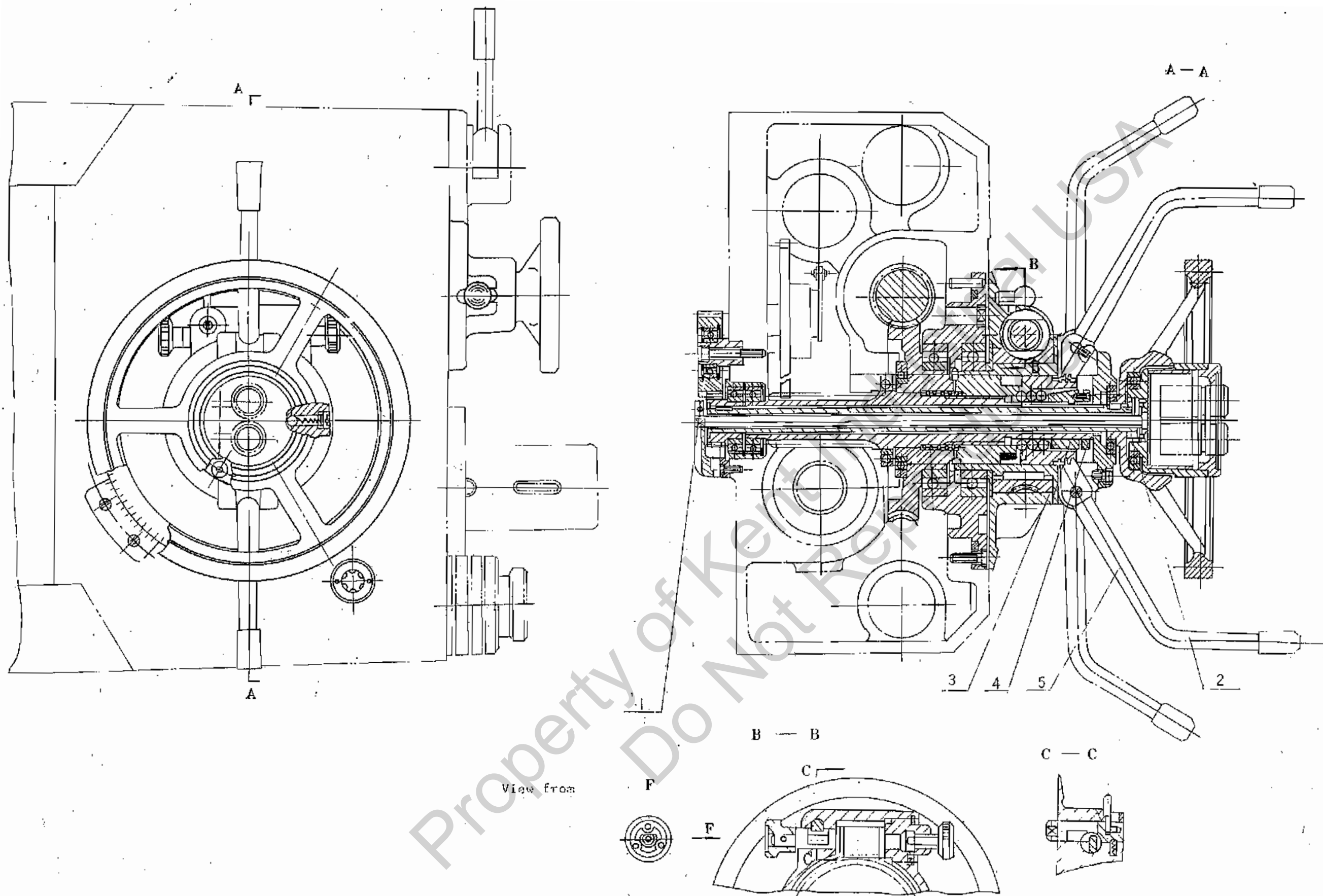


Fig. 4-4 Horizontal Shaft Drawing

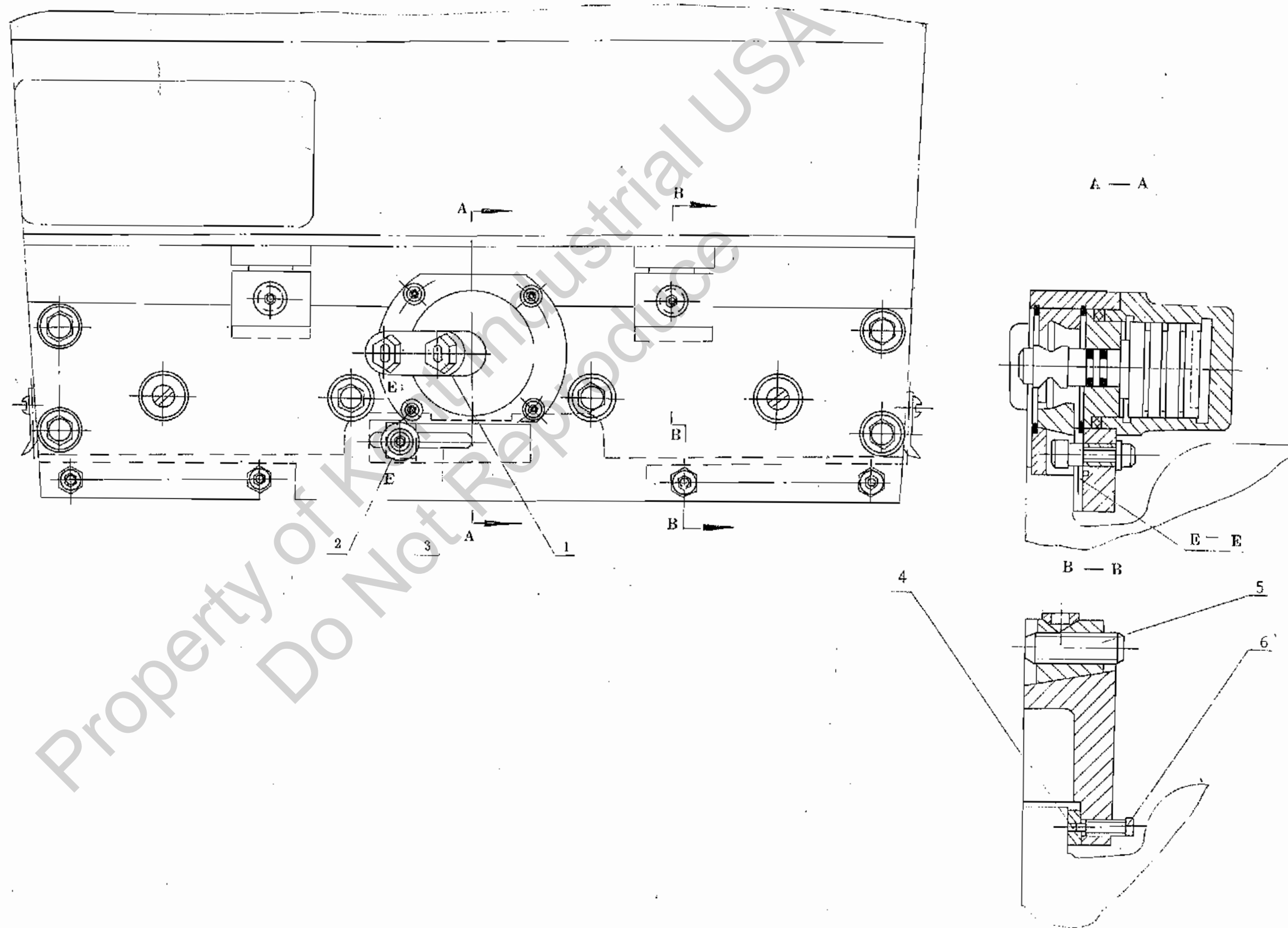


Fig. 4-5 Spindle Head Clamping Mechanism

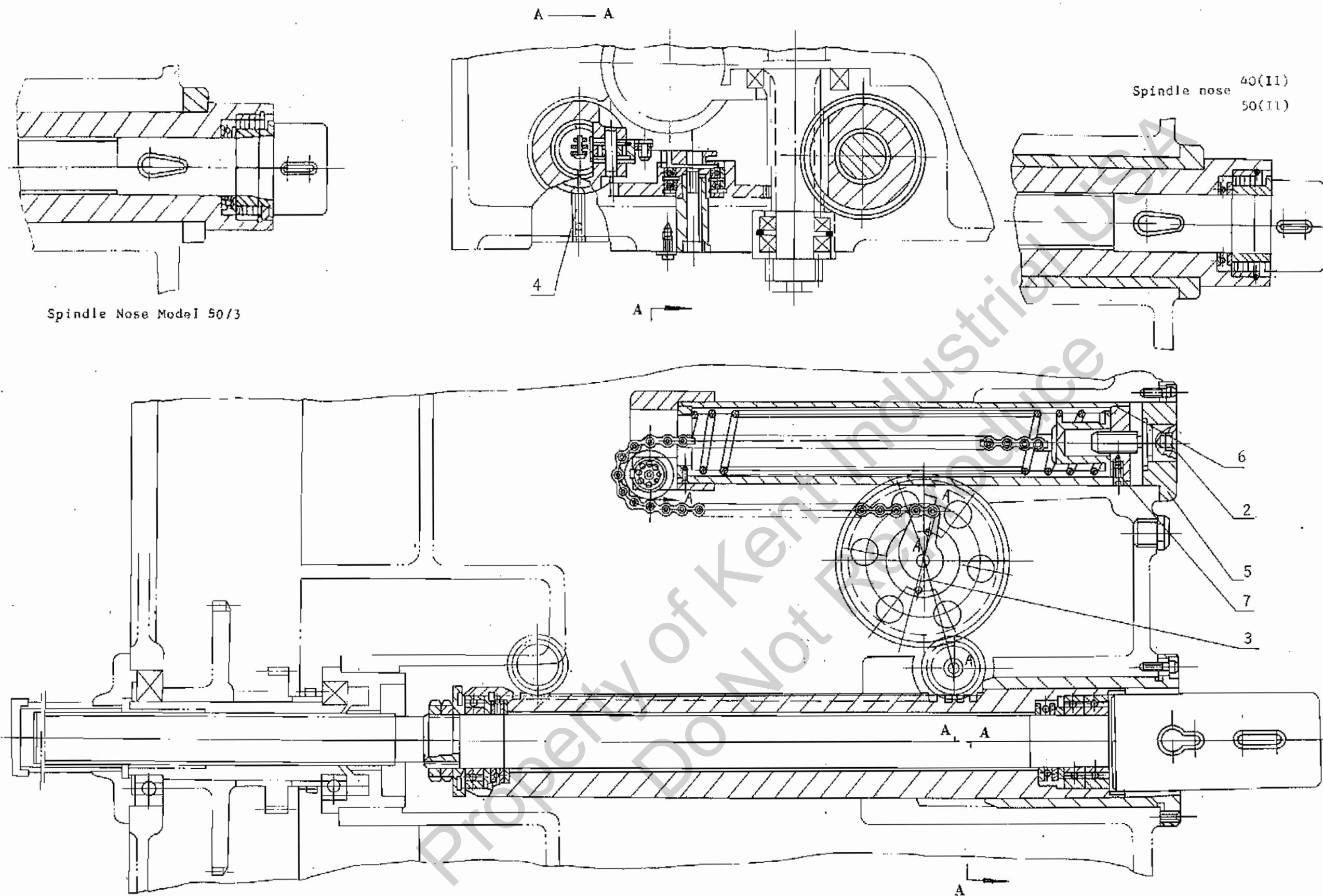


Fig. 4-6 Spindle and Its Balance

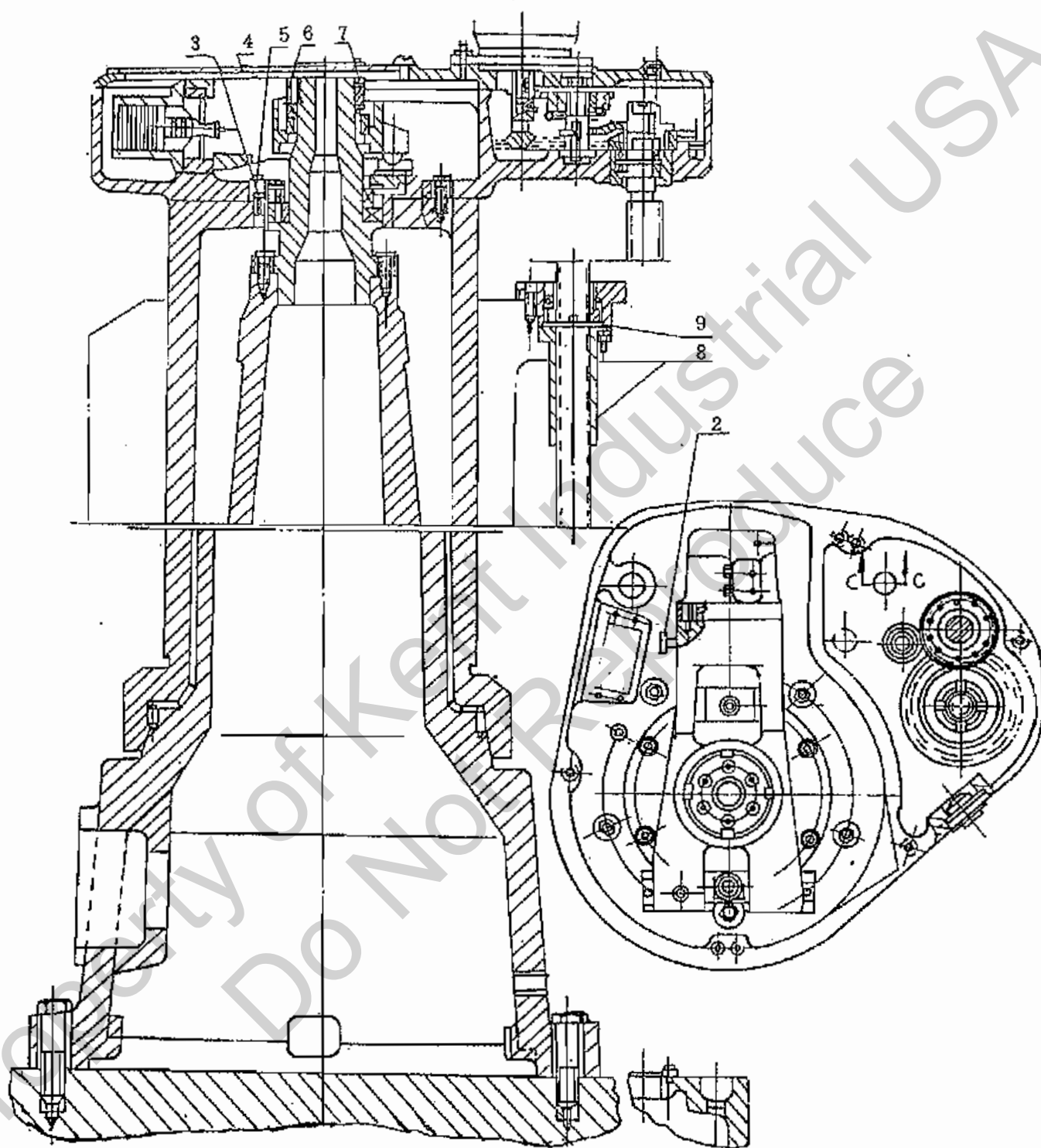


Fig. 4-7 Column Clamping & Arm Elevating Mechanism

M6×16; J12-6

(2 Pcs.)

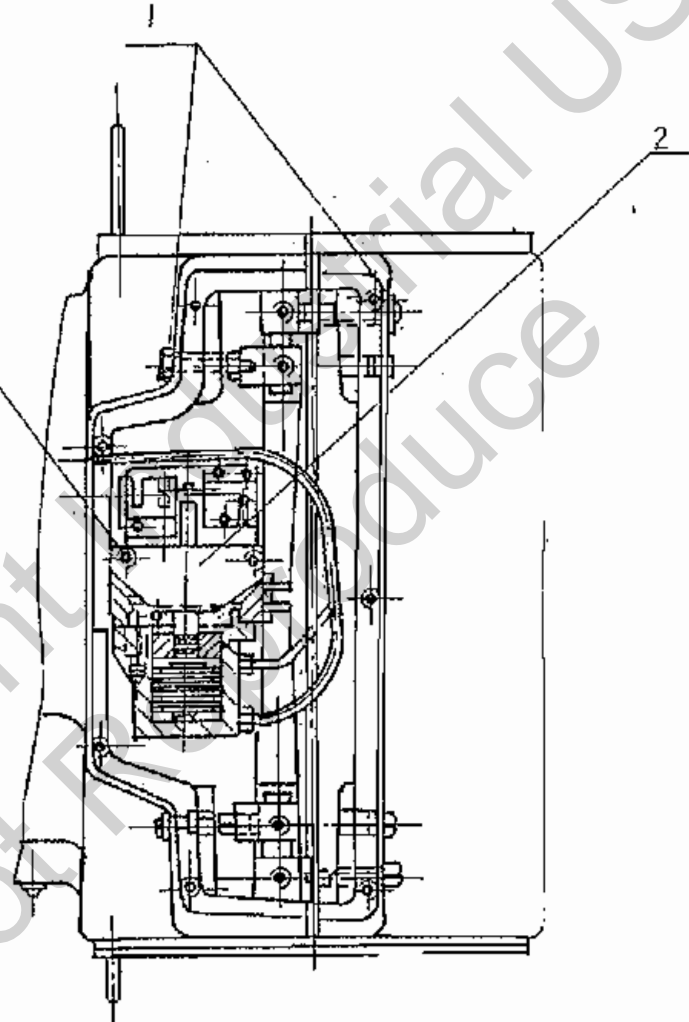


Fig. 4-8 Arm Clamping Drawing

V. The hydraulic system and its acting

The hydraulic system of this machine consists of two parts: the hydraulic system of the operating mechanism and the hydraulic system of the clamping device.

1. Hydraulic system of the operating mechanism (fig. 5 - 1)

The operating valve and the pre - selection valve are fitted on the top part of the spindle head. The spindle speeds pre - selection valve, and the feed pre - selection valve are 16 - position six way rotary valve. Four differential oil cylinders are controlled by each rotary valve, so as to accomplish the sixteen step speed changing.

The operating valve is a five - position six way rotary valve, controlling the forward rotary oil cylinder, the reverse rotary oil cylinder, the speed change oil cylinder, the "neutral position" oil cylinder, and the brake cylinder.

State of oil circuit of each position of operating valve:

Spindle action \ Oil circuit No.	1	2	3	4	5	6
Forward rotary	+	-	-	-	+	-
Reverse rotary	-	+	-	-	+	-
Speed change	+	+	+	-	+	-
Neutral position	-	-	-	+	+	-
Stop	-	-	-	-	-	-

Note: "+" means high pressure oil

"-" means low pressure oil

Each oil circuit is connected to:

1. Forward rotation oil cylinder
2. Reverse rotation oil cylinder
3. Pre - selection valve
4. Neutral position oil cylinder
5. Outlet port of oil pump
6. Port of return oil

In the course of speed changing, high pressure oil enters into pre selection valve, driving each of the change speed oil cylinders, which makes the sliding gears change speed. At the same time, high pressure oil also enters into the forward and reverse rotation

Oil cylinders respectively through the apertures. Due to the dimensions of the forward and reverse rotation oil cylinders are unequal (forward rotation oil cylinder is larger than the reverse rotation oil cylinder), the shifting fork on the clamping friction disc presses the forward rotation friction disc with a smaller force, making the transmission chain start.

With the operating valve on stop position, the oil in oil pump drains directly back to oil circuit 6 through oil circuit 5, and the entire system is at low pressure state. Due to a lack of pressure in oil circuit 5, the spring in the brake oil cylinder is released and presses on the friction disc, this brakes the transmission chain, and the spindle ceases to rotate.

To mount the oil pipes, connections must be according to the pipe numbers shown on fig 5-3. When inserting pipe 1 and cleaning the filter gauze, be sure to have end of oil pipe 1 put into the gauze or it may cause defect in the hydraulic system which will affect its normal operation.

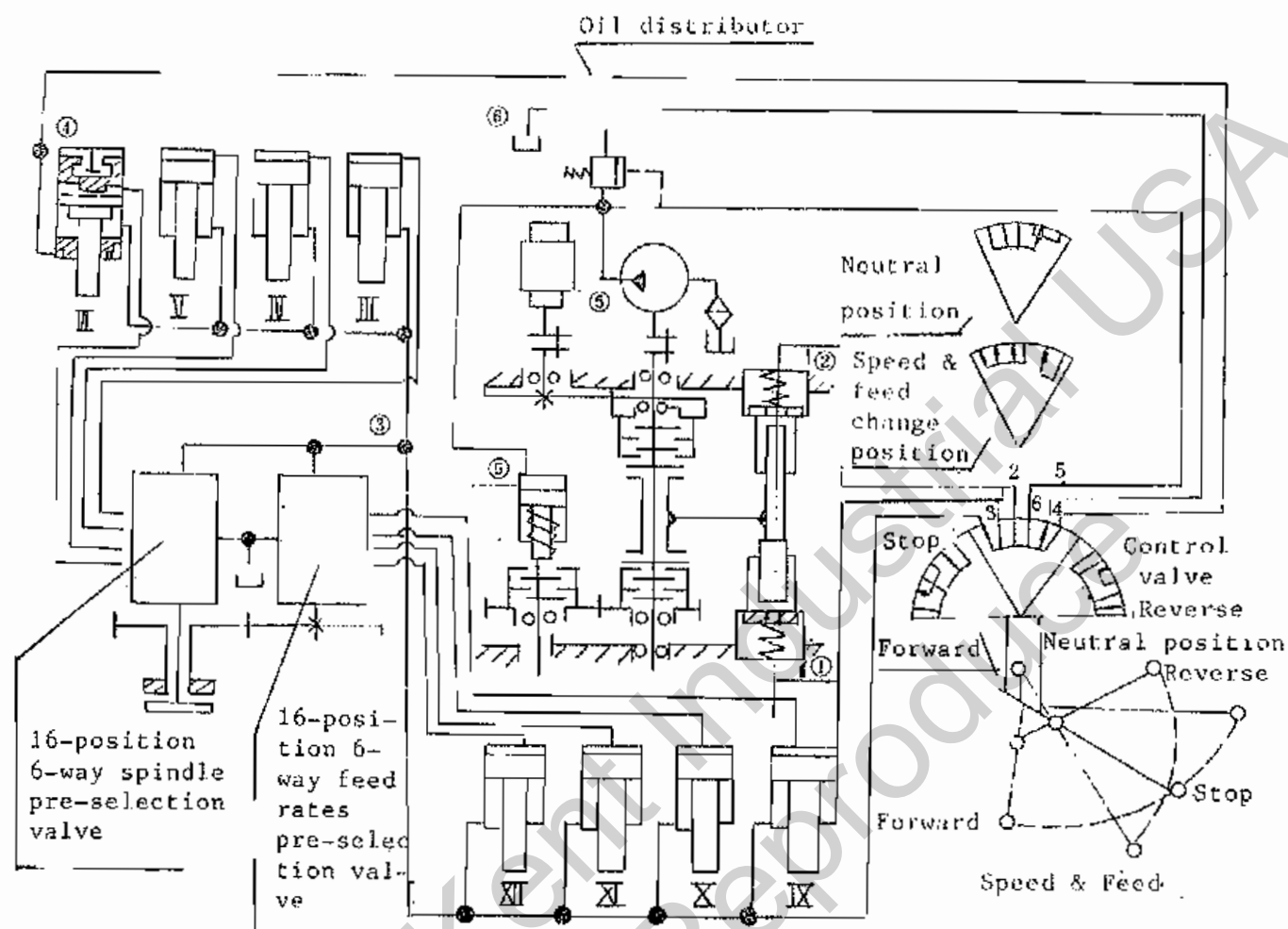
pressure in the hydraulic system is controlled by spring 3 (fig 5-3) in the overflow valve on the oil pump, its working pressure is $156.8 \times 10^4 - 196 \times 10^4$.

2. Hydraulic system of clamping mechanism (fig 5-2).

Clamping and releasing of the spindle head, column and arm are accomplished via the rhombic block after the pressure oil drives the piston. Among them, clamping and releasing of the arm are controlled independently by means of distributing valve, but releasing and clamping of the spindle head and column are carried out either simultaneously or independently. Selection of releasing and clamping simultaneously or independently is controlled by means of the change-over switch 21 on the right side of the spindle head. To clamp (or release) the spindle head and column, first turn the change-over switch 21 to the designated position. (Intermediate position - clamping and releasing simultaneously of both the spindle head and column; clockwise - turning the switch 21 through an angle 30° - - clamping and releasing independently of the spindle head; and counterclockwise - turning it through an angle 30° - - clamping and releasing independently of the column). Then start the clamping motor by depressing down the push button 18 (or 19) as shown in fig 10-4, as a result, oil supplied by the oil pump passes through the electromagnetic valve and enters into the clamping oil cylinder to drive the piston and rhombic block, therefore, clamping (or releasing) would be realized.

The hydraulic system of the clamping mechanism on the machine is of the closed cycle type. Since the sizes of the ends of clamping oil cylinder piston are not equal, part of the oil must be supplemented by oil suction pipe when oil enters the large cavity. But the surplus oil in the oil circuit transudes through the oil pump, and flows out through the return oil port when oil enters the small cavity. Volumetric efficiency of the pump is low, which means a small volumetric difference, so there will be no back pressure or over pressure in this system.

Fig. 5-1 Hydraulic Principal Drawing of Control Mechanism



Change oil circuits table of the speed and feed change oil cylinders

Cylin. NO. min	III	IV	V	VI
2000	+	+	-	+
1250	-	+	-	+
800	+	+	+	+
630	+	-	-	+
500	-	+	+	+
400	-	-	-	+
320	+	+	-	-
250	+	-	+	+
200	-	+	-	-
160	-	-	+	+
125	+	+	+	-
100	+	-	-	-
80	-	+	±	-
63	-	-	-	-
40	+	-	+	-
25	-	-	+	-

Cylin. NO. min	IX	X	XI	XII
3.20	+	+	-	-
2.00	+	-	-	-
1.25	-	+	-	-
1.00	+	+	+	-
0.80	-	-	-	-
0.63	+	-	+	-
0.50	+	+	-	+
0.40	-	+	+	-
0.32	+	-	-	+
0.25	-	-	+	-
0.20	-	+	-	+
0.16	+	+	+	+
0.13	-	-	-	+
0.10	+	-	+	+
0.06	-	+	+	+
0.04	-	-	+	+

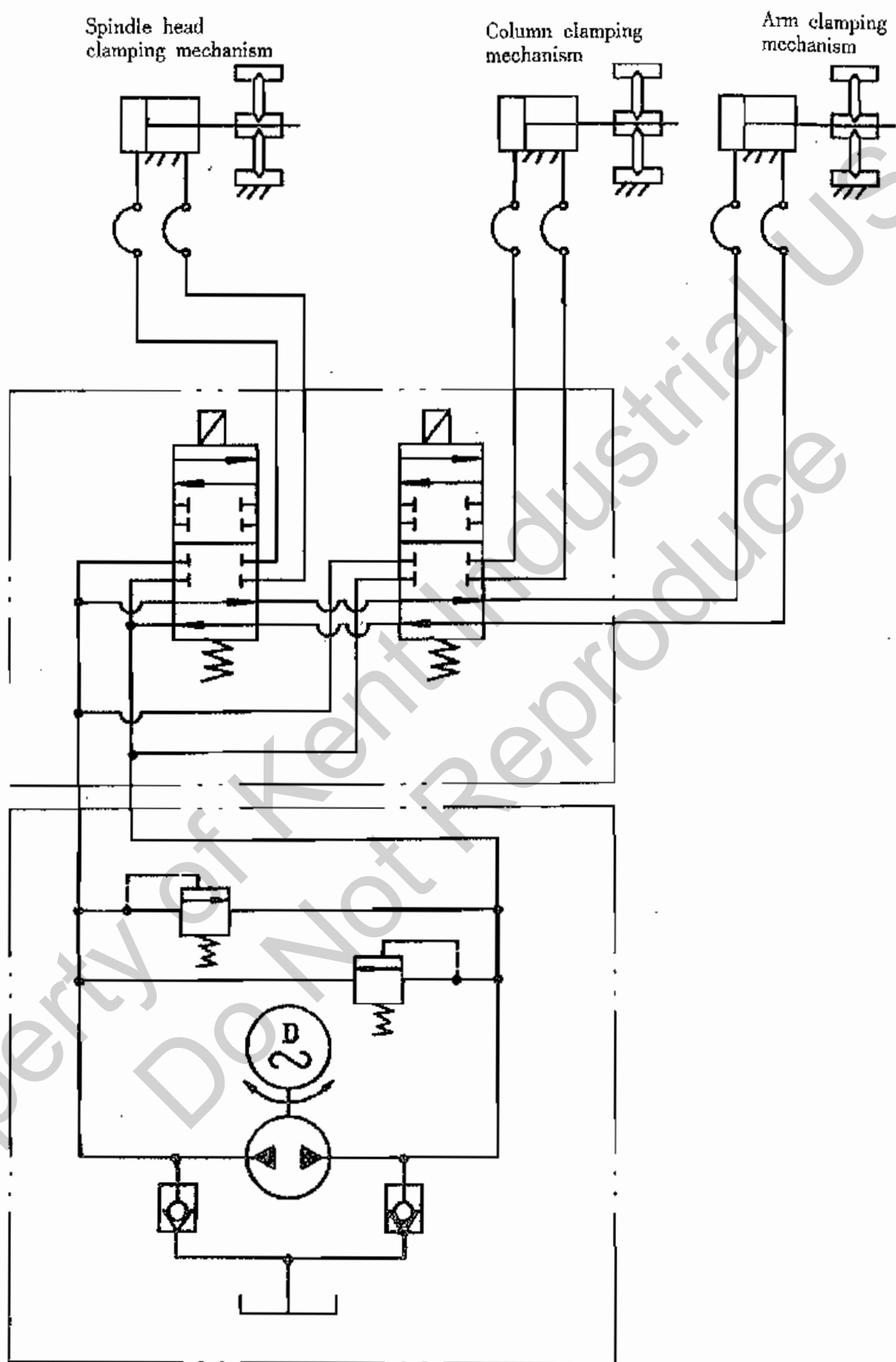


Fig.5-2The Circuit Diagram of the Hydraulic System for the Clamping Mechanism

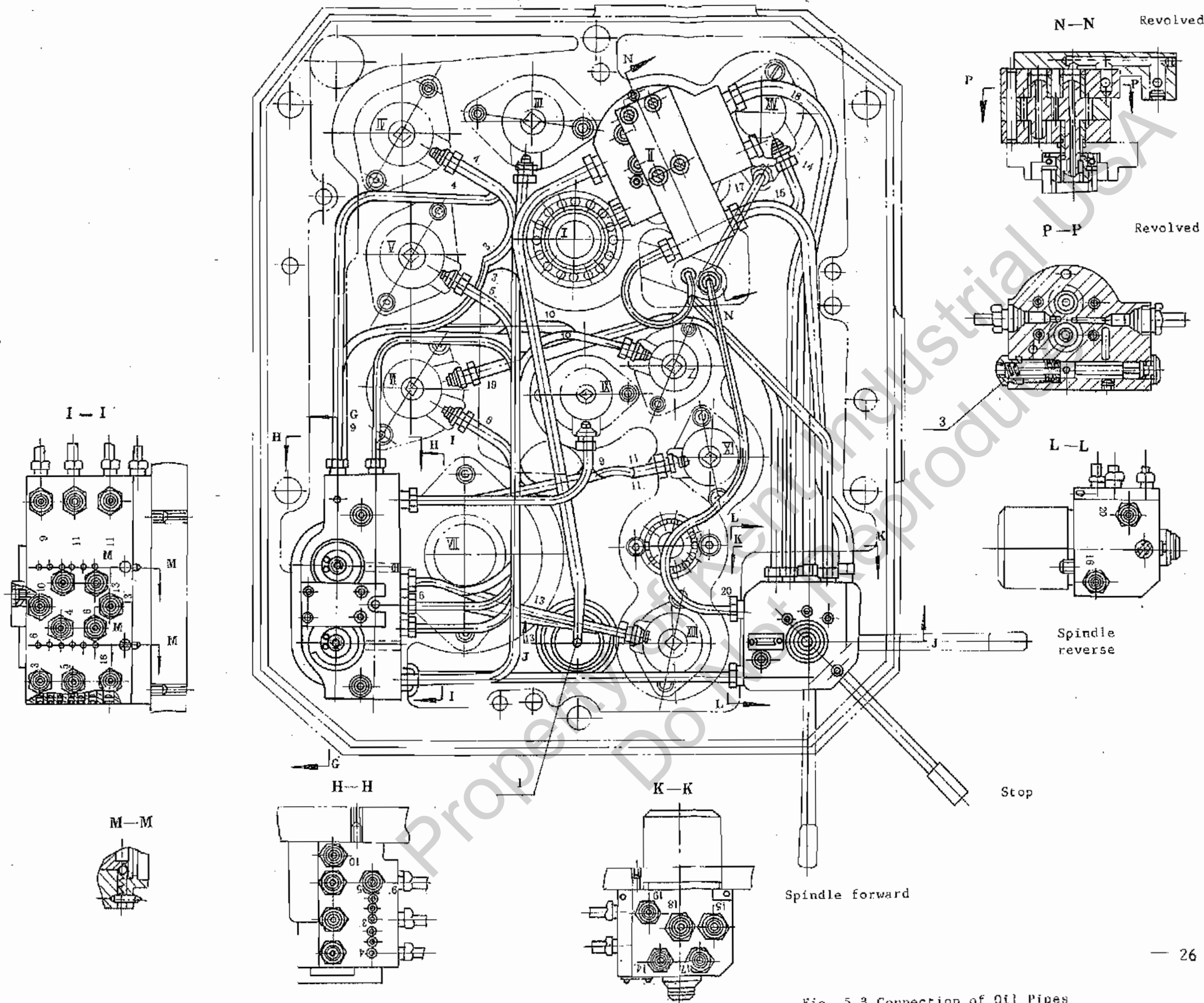


Fig. 5-3 Connection of Oil Pipes

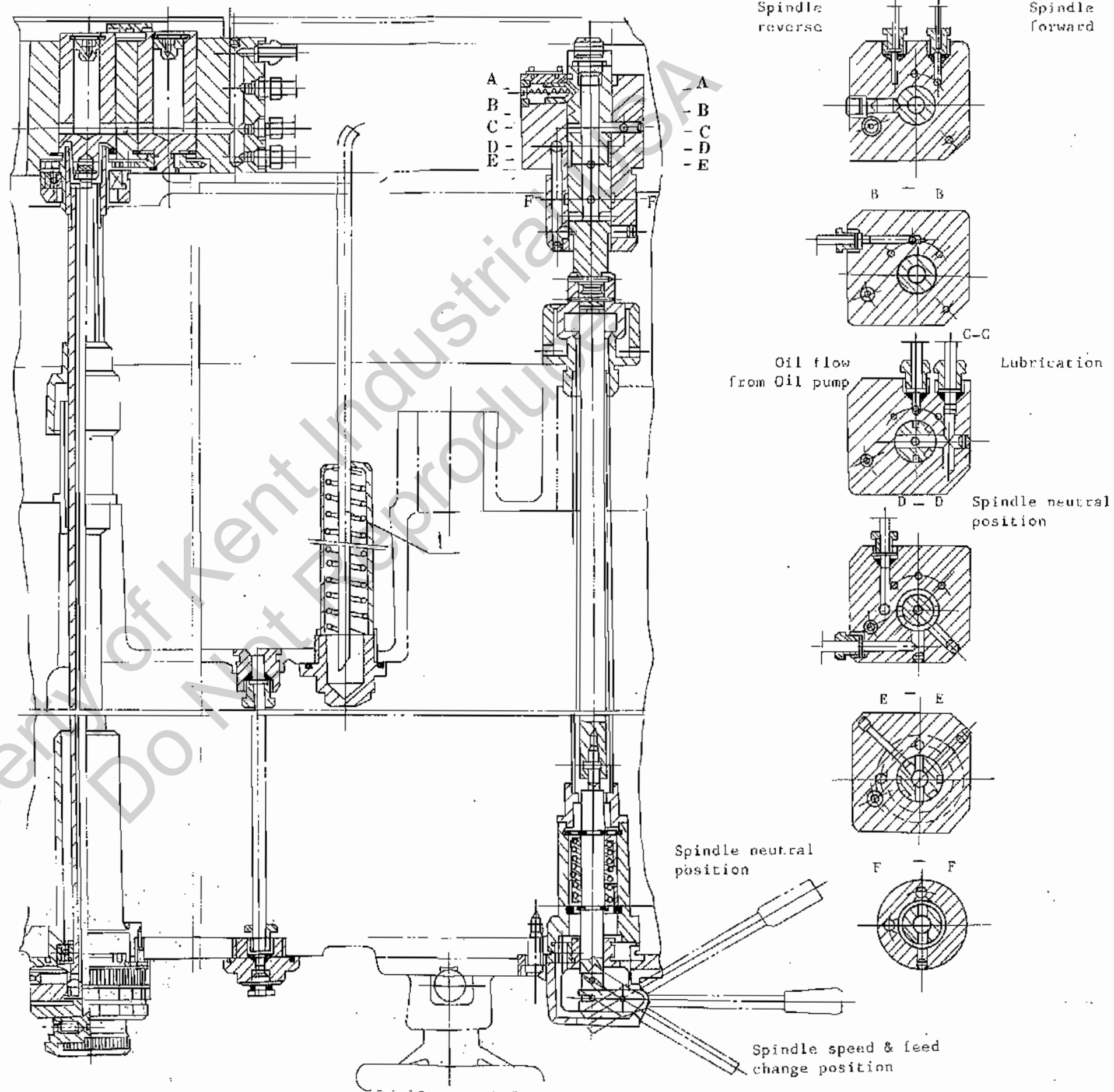


Fig.5-4 Control Mechanism

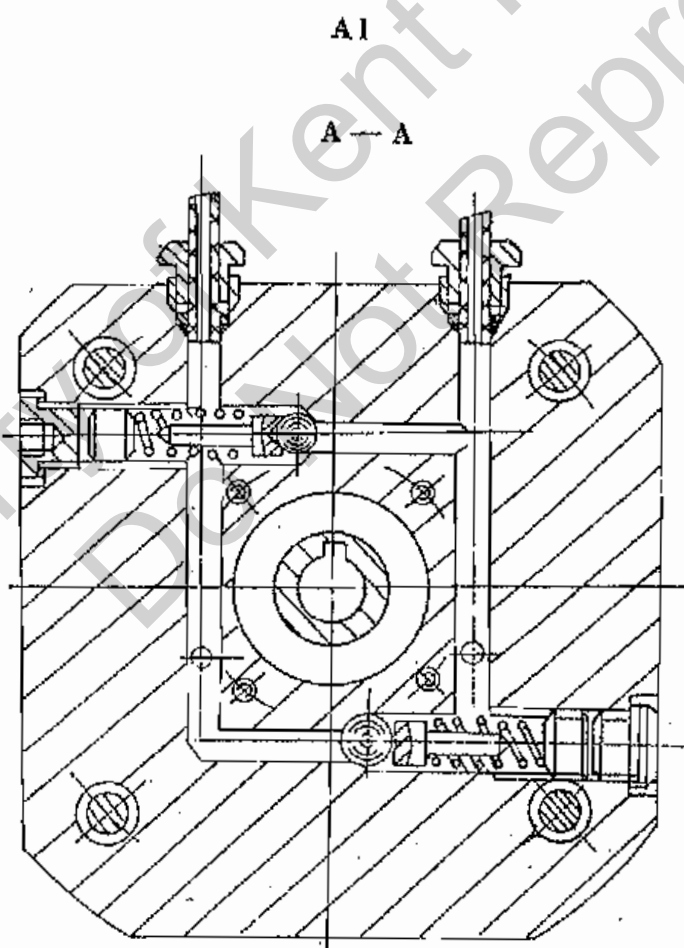
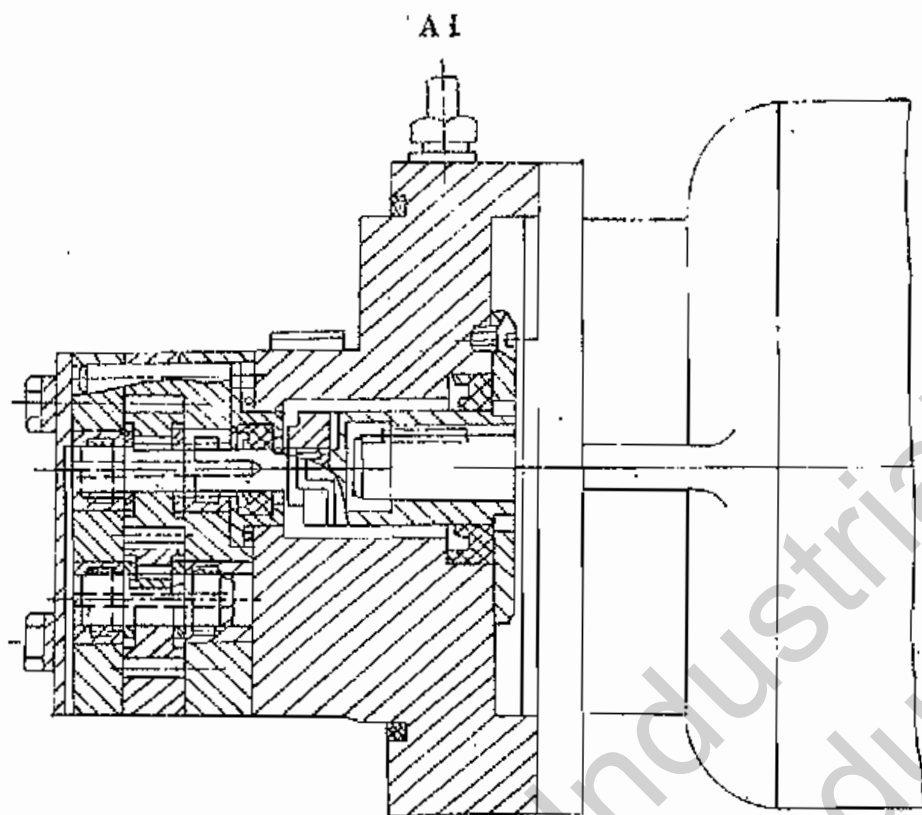


Fig. 5-5 Oil pump for Clamping

VI. ELECTRICAL PART

1. General description

The 380V, 50Hz three - phase A. C. power supply is used for this machine. The 220V, 50Hz; 380V, 60Hz; 420V, 50Hz; 220/440V, 60Hz three phase A. C. power supplies can also be used according to the special order. The control circuits, illumination circuit and indication lamps are supplied by control transformer, with 110V, 24V respectively. The electrical equipments suited for different types of power supply and frequency are listed in the relative list. The following motors are mounted on the machine for driving all the mechanisms.

- M1.....Main motor
- M2.....Elevating motor for radial arm
- M3.....Hydraulic pump motor
- M4.....Coolant pump motor

Power supply lead - in distribution is mounted in the lower forepart of the column; coolant pump motor stands on machine base; the elevating motor is installed at top of the column, and other electric appliances are all equipped in the rotary part of the machine.

As no using of collector ring on the top of column, the arm should not be turned in the same direction all the time during the operation so as to protect the main wire from breaking.

2. Description of circuit

1) The preparing work before starting the machine

Turn on the master supply switch QS1, and the indicator of power supply HLI lights up.

2) Rotation of main motor

The A. C. contactor KM1 will close and self - lock after pressing the starting push - button SB3. the main motor is working by pressing down the stop push - button SB2, the A. C. contactor KM1 releases, making the main motor stopped.

In order to protect the main motor from overload operation for a long period, the thermal relay FR1 has been used in the circuit; its set value can be adjusted according to the rated current of the main motor M1.

3) Lifting and lowering of the arm

After pressing down the lifting (or lowering) push - button SB4 (or SB5), the time relay KT1 closes, causing its normally open contact close. the A. C. contactor KM4 closes and the hydraulic pump motor M3 rotates to supply the pressure oil which flows into the oil cavity for releasing of the arm through distributing valve to push the piston and rhombic blocks,

enabling the arm to release. At the same time, the piston rod presses on the limit switch SQ2 by the reed to release the A. C. contactor KM4 and close the A. C. contactor KM2(or KM3), the hydraulic pump motor M3 stops rotating and elevating motor M2 will rotate to bring the arm up (or down).

When the arm isn't released, making of normally open contact of limit switch SQ2 and closing the A. C. contactor KM2(or KM3) could not be accomplished, so that the arm can't be lifted (or lowered). When the arm is lifted (or lowered) to the required position, the push - button SB4(or SB5) should be released, resulting the releasing of the A. C. contactor KM2(or KM3) and of the time relay KT1, as well as the stopping of elevating motor M2 and of arm elevating (or lowering). Due to the releasing of time relay KT1, its normally close delay make contact closes after a delay of 1 ~ 1.5sec. The A. C. contactor KM5 will close, the hydraulic pump motor M3 rotates in reverse direction to supply the pressure oil which flows into the oil cavity for clamping of the arm through the distributing valve, pushing the piston and rhombic block in reverse direction and clamping the arm. At this time, the piston rod depressed down the limit switch SQ3 through the reed to release the A. C. contactor KM5, thus the hydraulic pump motor M3 stops rotating.

The combination switches SQ1a and SQ1b are used to limit the traverse of the arm. When the arm is lifted(or lowered) to the extreme position, the A. C. contactor KM2(or KM3) releases to stop the rotating of the elevating motor, enabling the arm to stop lifting (or lowering). The automatic clamping of the arm is controlled by the limit switch SQ3. When something wrong with the hydraulic clamping system, the automatic clamping of the arm couldn't be carried out, or since the limit switch isn't adjusted so well, the normally closed contact of SQ3 can't be disconnected after the arm has been clamped, as a result, the hydraulic pump motor would be under overload operation for a long time to cause the damaging of it. In order to protect the hydraulic pump motor from damaging the thermal relay FR2 is used in the circuit, its setting value should be adjusted according to the rated current of the motor M3.

4) Not only can the clamping and unclamping of the column and spindle head be accomplished simultaneously, but also can be respectively.

A. Simultaneously accomplishment:

As the changeover switch SA1 is turned to the neutral position the time relay KT2 and KT3 can be synchronously engaged by pressing the release push - button SB6(or clamp push - button SB7), and consequently their normally open delay made contact is made and the electromagnets YA1 and YA2 become closed. After a delay of 1 ~ 1.5seconds, the normally open delay made contact of time relay KT3 will close, enabling the hydraulic pump motor to rotate and supply the pressured oil which will enter into the releasing(or clamping) cylinder of column and spindle head through the distribution valve, pushing the piston and rhombic blocks to release (or clamp) the column and spindle head.

B. Respective accomplishment

To accomplish the releasing and clamping of the column and spindle head respectively,

the changeover switch SA can shifting to the left position or to the right position, by depressing the release push - button SB6 (or clamp push - button SB7) which allows YA1 (or YA2) to make individually, the releasing (or clamping) of the column and spindle head can be carried out respectively according to the principle of simultaneously accomplished action.

5) Starting and stopping of coolant Starting or stopping of the coolant pump motor M4 can be realized by turning the power switch QS2, i. e. switching on or off the power supply.

3. Check on the phase sequence of power supply

After the machine has been installed, connect it with the main power supply and depress the unclamp push - button SB6, if the spindle head and column are released, it means that the power supply phase sequence is correct. Otherwise position of any two leads of the power supply line must be exchanged. When correct phase sequence is ensured, adjust the connection lines of elevating motor M2.

4. Maintenance of electric equipments

During electric inspection, PLS PAY ATTENTION to the power on combined switch, transformer contactor and wires for power leading in.

The electric equipments must be kept clean, so that the dust, dirt and impure substance must be removed periodically. The cleaning may be done by blowing. The coils should never be cleaned with kerosene or gasoline. The motor should be overhauled and cleaned once every year of service. Examine the bearings and change the lubrication oil at least once a year. Use calcium base grease NO. 2 or NO. 3 for the anti - friction bearings of motor.

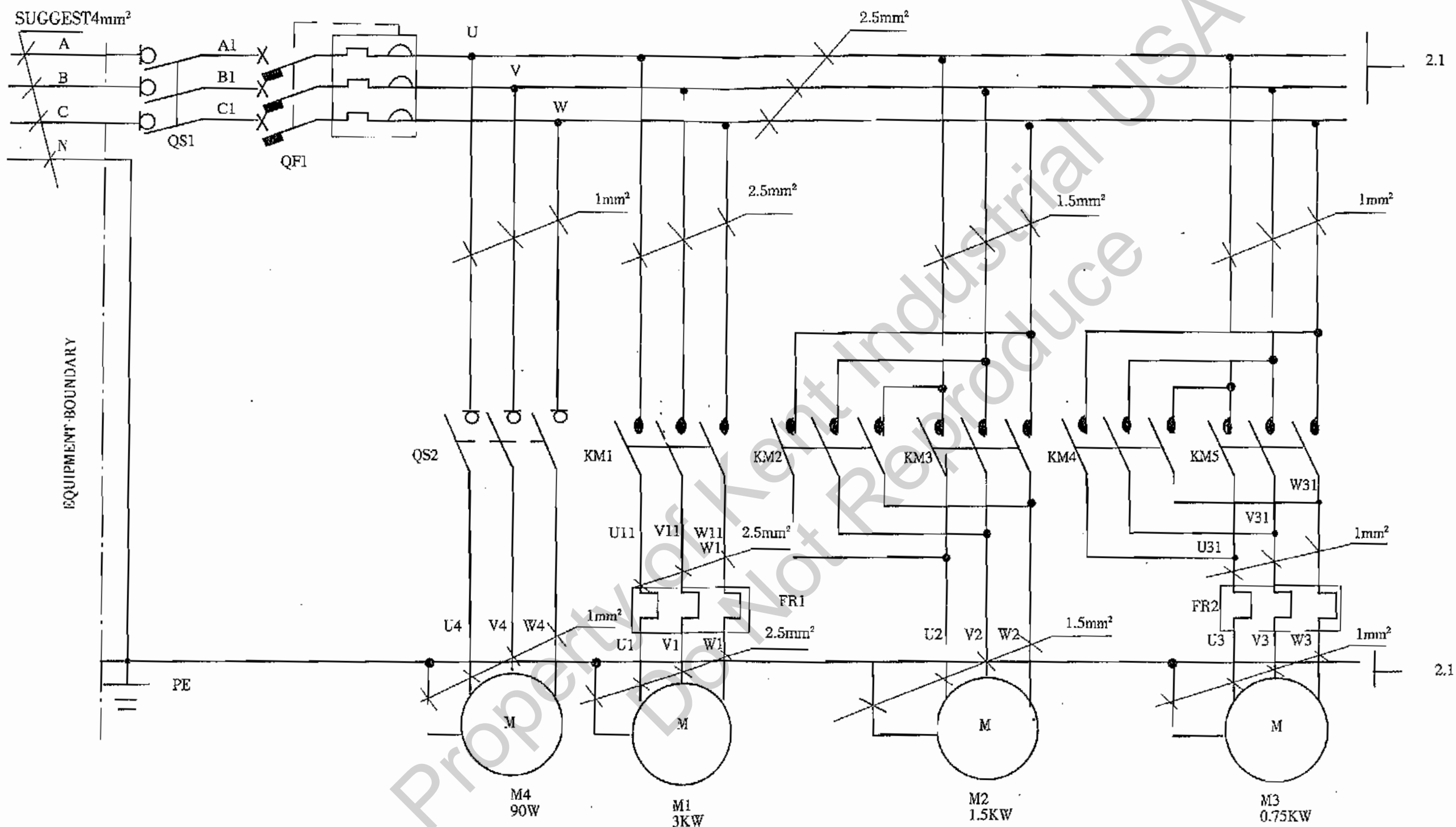
Clean off the dirt on all contacts carefully. Timely replace the worn contacts by new ones. Oil on contacts is not allowed. Burnt or oxidized contacts should be repaired by means of a fine file.

Be sure not use a voltage (frequency is rated) that exceeds the rated voltage by $\pm 10\%$.

5. The ex - works voltage of the machine can be changed as follows when the machine is wired for AC three phase bi - voltage 220/440V or 220/380V:

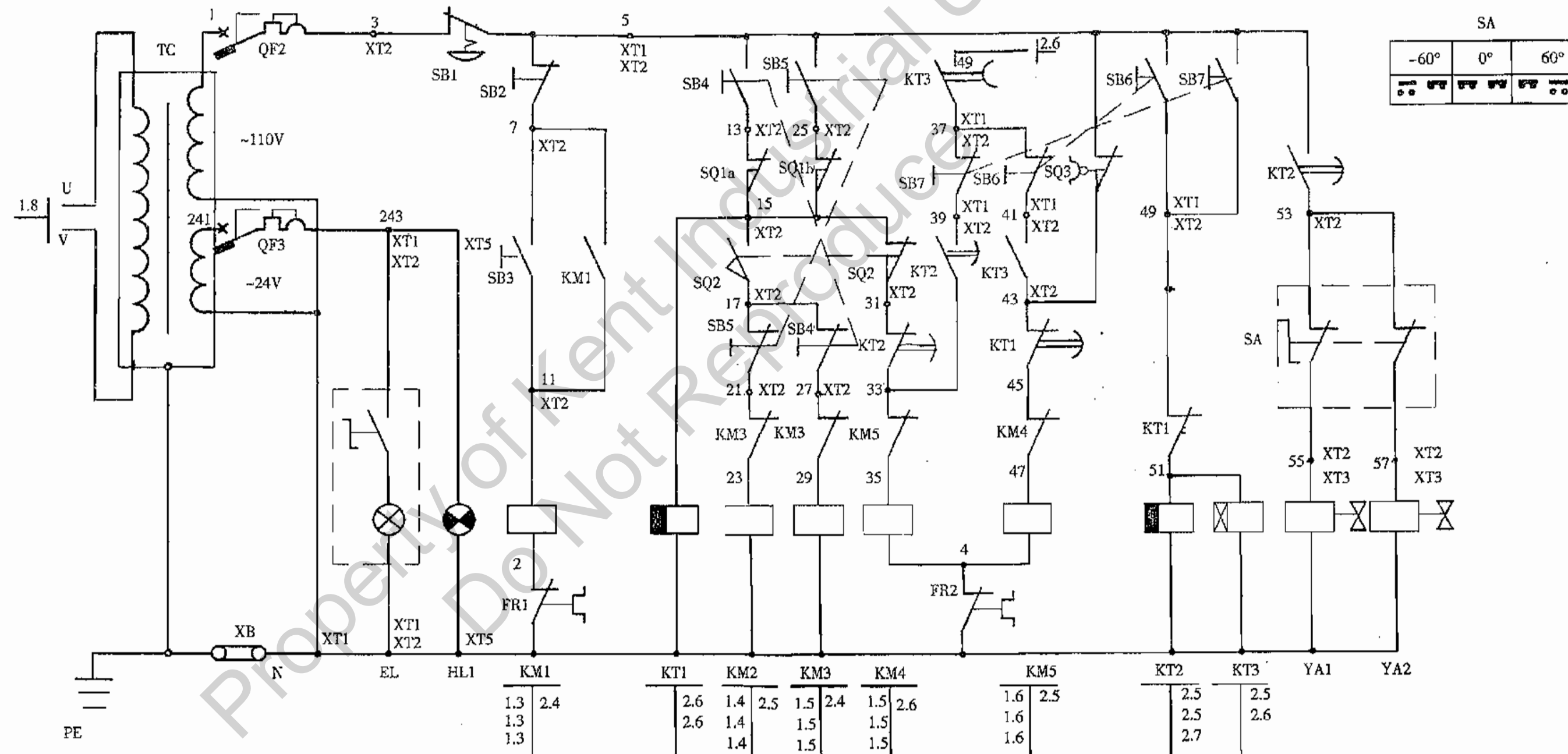
If the power for machine is AC three phase bi - voltage 220/440V or 220/380V. The ex - works voltage is marked on the nondrying glued mark plate attached to the arm cabinet door. If users desire to change the voltage, be sure to reconnect the leads of the four motors and transformer according to the wiring diagrams marked on the motors and transformer. Replace the thermal relays and breaker circuit according to the capacities given in the packing list with the spare parts supplied.

1	2		3	4	5	6
	POWER SWITCH			lift and lowering motor	clamping and release hydraulic motor	
POWER LEAD IN	LOAD SWITCH	PROTECT SWITCH	COOLANT PUMP	lift	lowering	release clamp



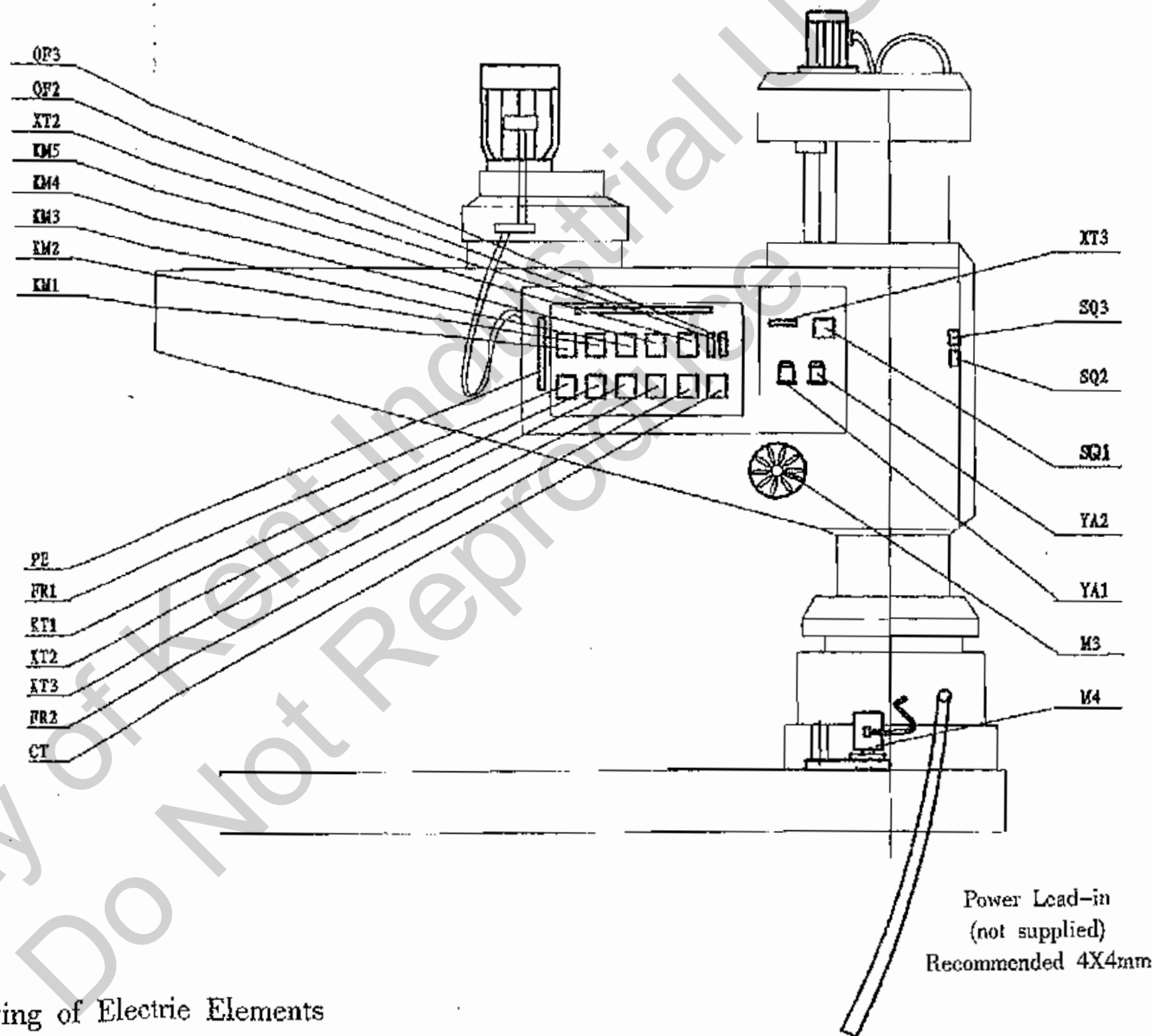
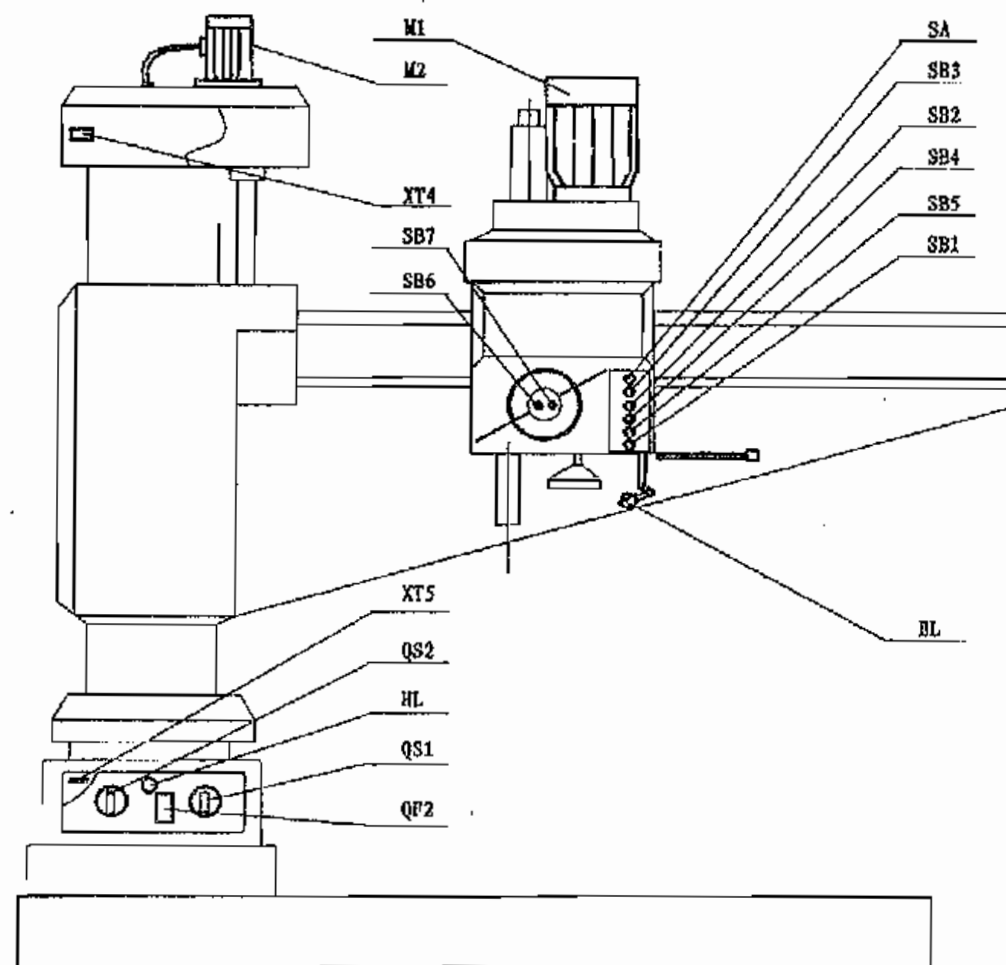
CIRCUIT CIAGRAN

1	2		3		4		5		6		7		8
		lighting and indicator			main motor control		lift and lowering of arm		hydraulic clamping and release			distribution valve	
Control transformer	PROTBCT	lighting	power indicator	emergency stop	start	stop	lift	lowering	release	clamp	delay	spindle box	column



MODLR	Z3040X ¹² / ₁₆ /1.2		Z3050X ¹² / ₁₆ /1.2	
MI CAPACITY	3KW		4KW	
220V 380V	SCOPE OF CURRENT(A)	SBTTING(A)	SCOPE OF CURRENT(A)	SBTTING(A)
QF1	10-15	10-15	15-20	10-15
FK1	9-12.5	4.5-7.2	12.5-18	6.8-11
FK2	2.5-4	1.6-2.5	2.5-4	1.6-2.5

CIRCUIT DIAGRAM



Location Drawing of Electric Elements

LIST OF ELECTRICAL EQUIPMENTS

QUANTITY																		SYMBOL	SPECIFICATION AND TYPE	SETTING CURRENT	DESCRIPTION			
Z3050X16/1 Z3050X16/2 Z3050X12/1									Z3040X16/1 Z3040X16/2 Z3040X12/1															
VOLTAGE (V) AND FREQUENCY (HZ)									VOLTAGE (V) AND FREQUENCY (HZ)															
60HZ						50HZ			60HZ						50HZ									
220 /440	440	420	220 /380	380	220		440	420	220 /380	380	220		220 /440	440	420	220 /380	380	220		440	420	220 /380	380	220
													1	1	1	1	1			1	1	1	1	1
1	1	1	1	1	1		1	1	1	1	1									1	1	1	1	1
1	1	1	1	1	1		1	1	1	1	1		1	1	1	1	1	1		1	1	1	1	1
1	1	1	1	1	1		1	1	1	1	1		1	1	1	1	1	1		1	1	1	1	1
1	1	1	1	1	1		1	1	1	1	1		1	1	1	1	1	1		1	1	1	1	1
1	1	1	1	1	1		1	1	1	1	1		1	1	1	1	1	1		1	1	1	1	1
													1	1						1				
																1								
																1	1							
													1			1						1		1
1	1						1																	
		1						1																
			1	1					1	1														
1			1		1				1		1													
1	1						1						1	1										
		1						1			1					1								
			1	1					1	1							1	1				1	1	
1			1		1				1		1		1			1						1		1
	1	1		1			1	1		1						1	1		1					
4	4	4	4	4	4		4	4	4	4	4		4	4	4	4	4	4						
2	2	2	2	2	2		2	2	2	2	2		2	2	2	2	2	2						
1	1	1	1	1	1		1	1	1	1	1		1	1	1	1	1	1		1	1	1	1	1
1	1	1	1	1	1		1	1	1	1	1		1	1	1	1	1	1		1	1	1	1	1
1	1	1	1	1	1		1	1	1	1	1		1	1	1	1	1	1		1	1	1	1	1

LIST OF ELECTRICAL EQUIPMENTS

QUANTITY																								SYMBOL	SPECIFICATION AND TYPE	SETTING CURRENT	DESCRIPTION	
Z3050X16/1 Z3050X16/2 Z3050X12/1																												
VOLTAGE (V) AND FREQUENCY (HZ)												VOLTAGE (V) AND FREQUENCY (HZ)																
60HZ						50HZ						60HZ						50HZ										
220 /440	440	420	220 /380	380	220	440	420	220 /380	380	220		220 /440	440	420	220 /380	380	220	440	420	220 /380	380	220						
1			1		1			1		1														QF1	DZ47 - 63; 3P 20A		CIRCUIT BREAKER	
	1	1		1		1	1		1			1	1	1	1	1	1		1	1	1	1	1		QF1	DZ47 - 63; 3P 15A		CIRCUIT BREAKER
1	1	1	1	1	1			1	1	1	1	1	1	1	1	1	1		1	1	1	1	1		QF2	DZ47 - 63; 1P 2A		CIRCUIT BREAKER
2	2	2	2	2	2			2	2	2	2	2	2	2	2	2	2		2	2	2	2	2		YA1 YA2	MFJ1 - 3; 110A		AC ELECTROMAGNET
1	1	1	1	1	1			1	1	1	1	1		1	1	1	1	1	1	1	1	1	1		SB1	XB2 - BS542(RED)		PUSH - BUTTON
1	1	1	1	1	1			1	1	1	1	1		1	1	1	1	1	1	1	1	1	1		SB2	ZB2 - BA1C + BZ102C(white)		PUSH - BUTTON
1	1	1	1	1	1			1	1	1	1	1		1	1	1	1	1	1	1	1	1	1		SB3	ZB2 - BA3C + BZ101C (GREEN)		PUSH - BUTTON
4	4	4	4	4	4			4	4	4	4	4		4	4	4	4	4	4	4	4	4	4		SB4 - SB7	ZB2 - BA2C + BZ105C (BLACK)		PUSH - BUTTON
1	1	1	1	1	1			1	1	1	1	1		1	1	1	1	1	1	1	1	1	1		SA	ZB2 - BD3C + BZ104C		ROTATION SWITCH
1	1	1	1	1	1			1	1	1	1	1		1	1	1	1	1	1	1	1	1	1		SQ1	HZ4 - 22 TH		LIMIT SWITCH
2	2	2	2	2	2			2	2	2	2	2		2	2	2	2	2	2	2	2	2	2		SQ2,SQ3	LX5 - 11 TH		LIMIT SWITCH
1	1	1	1	1	1			1	1	1	1	1		1	1	1	1	1	1	1	1	1	1		HL	LED1 - 10/21 (WHITE)		INDICATION LAMP
1	1	1	1	1	1			1	1	1	1	1		1	1	1	1	1	1	1	1	1	1		EL	JC38 - A; 40W,24V		WORK LAMP
1	1	1	1	1	1			1	1	1	1	1		1	1	1	1	1	1	1	1	1	1		QF3	DZ47 - 63 IP 3A		
3	3	3	3	3	3			3	3	3	3	3		3	3	3	3	3	3	3	3	3	3		KT ₁ ~ KT ₃	K22E AC110V		

VII . Gooling

When cooling the cutting tools, first turn switch 1, fig. 10-1 to start the coolant pump. Flow of the coolant is regulated by cook 20. The coolant tank is in the rear part of the base.

VIII Lubrication

1 . Automatic Lubrication

(1) The friction disc shaft and the brake shaft: Lubrication by control valve low pressure oil circuit and the oil flowing out from stated pressure valve on the oil pump..

(2) Gears and bearings on the upper part of spindle head: Splash lubrication.

(3) Worms and worm wheels on feed mechanism: The worms and worm wheels are lubricated by the oil sent to all parts through rotation of the worm wheels.

(4) Lifting mechanism speed change device: Splash Lubrication.

(5) Column guideway: oil is supplied by a special automatic lubrication pump.

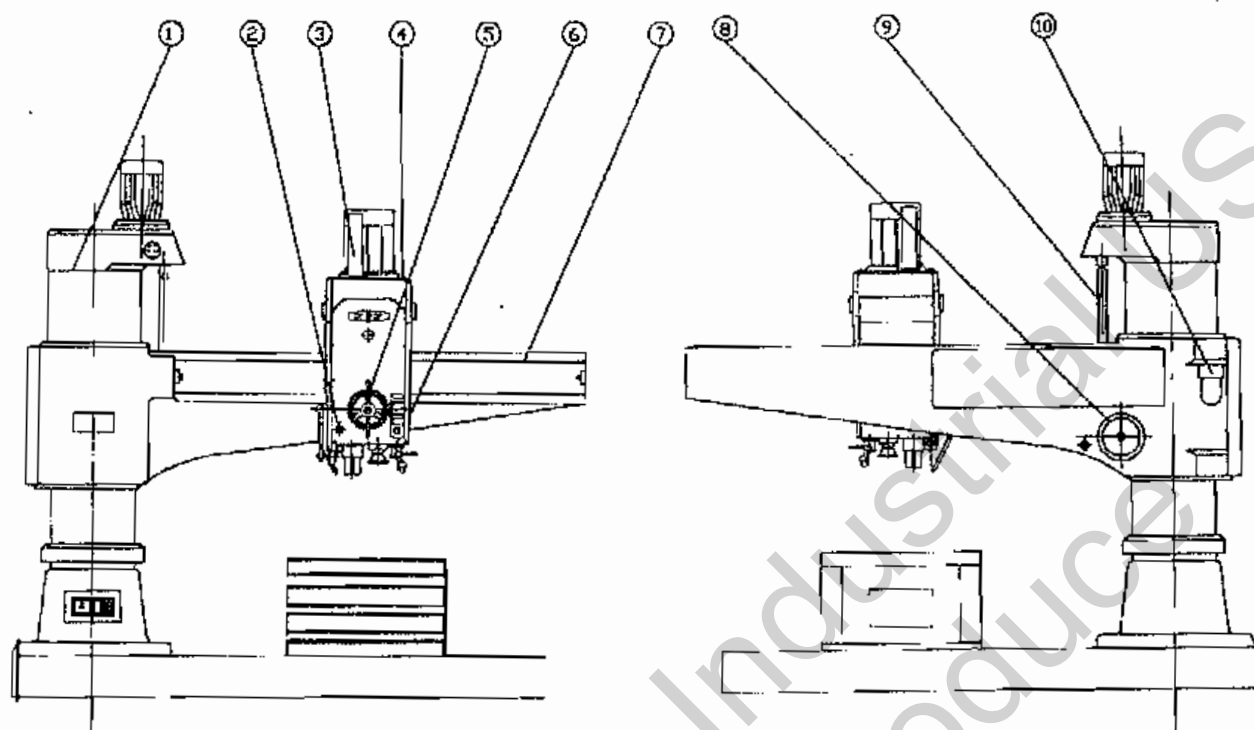
2 . Manual Lubrication

Arm guide way, lead screw, spindle bearing, micro - adjustment worm are lubricated according to the requirements on fig.8-1, using an oil can or an oil gun.

3 . Filling and Draining of the oil Tank

This should be carried out according to the requirement indicated on the fig.8-1. The operator should check the oil level on the oil leveler frequently. The maximum height of oil level should not exceed the center of the oil leveler.

Fig. 8-1 Machine Lubrication Diagram



Item No.	Lubrication Point	Lube Oil	Lubrication Circle	Remark
1	arm rising - falling mechanism	Refined mineral oil viscosity 32	Change oil once per 3 months	Unscrew the threaded plug when fill oil (about 1000ml)
2	Gear head lower oil pool	Refined mineral oil Viscosity 32	Change oil once per 3 months	Open label on gear head for filling oil (about 1600ml)
3	Spindle spline	Refined mineral oil viscosity 32	Fill oil once per week	Do not overfill
4	Gear head upper oil pool	Refined mineral oil viscosity 32	Change oil once per 3 months	
5	Fine adjustment worm	Refined mineral oil viscosity 32	Fill oil once per month	Do not overfill
6	Spindle upper & lower bearings	Animal & plant oil calcium soap 12 - 17 % mineral oil 83 - 87 %	Fill oil once per month	Open label on gear head for filling oil
7	Rock arm guide	Refined mineral oil viscosity 68	Always keep oily	
8	Clamping oil pump oil pool	Refined mineral oil viscosity 32	Change oil once per 3 months	Open the cover of door of electric appliance cabinet for filling oil
9	arm rising - falling guide screw	Refined mineral oil viscosity 68	Fill oil once per week	Do not overfill
10	Column lube oil pump oil pool	Refined mineral oil viscosity	Always keep oil	

IX. Transportation and Installation of Machine

1. Transportation (Fig.9-1)

Excessive tilting, especially turing the case upside down are not allowed during transit. After unpacking the case, shift the table along the longitudinal plane of the machine to adjust the center of gravity and then secure it for handling. Soft materials should be padded at places where the ropes and the surfaces of the machine come into contact to prevent damage to the machine.

2. Installation (Fig. 9-2)

Before the machine is secured to the foundation, never unclamp the column, otherwise the machine might tipover. When installing the machine, fix the foundation bolts on the base plate first and then set the machine on the foundation. After this, place steel pads under the base plate. The levelling of the machine is mainly carried out by adjusting three pairs of steel pads 1,2 and 3. Each of the readings taken by the spirit level in transverse and longitudinal planes of the machine should not exceed 0.04/1000mm. Thereafter adjust each of the remaining accuracies, and each of the readings taken should not exceed the actual errors recorded in the Test Certificate. The holes for the foundation bolts are filled with concrete mortar after the machine has been carefully levelled, grout also the foundation round the base plate and the pads with concrete mortar so as to set them securely. When the concrete gets quiter dry, the foundation bolts should be tightened, then finally check by spirit level to avoid the deformations of the machine. Only after the preparations for trial run of the machine have been done, the machine can then be put into operation. Before operation, the spindle protective cover should be tightened by screws at the top of the flange cover.

Before trial-running of the machine, two antilooping plates 2 for therhombic blocks in Fig.408 must be removed, thereafter tighten up the two screws (M6x16; J21-6).

Range of the arm rotation in transverse plane: 2140 mm, which keep Min. distance 800 mm from motion limit of its adjacent equipment.

3. Preparations for Trial Running

After the machine has been installed, connect it to the electric mains, then depress the unlamp push-button as well as swivel the column to make sure whether the wires are connected correctly so as to get ready for the proper elevation of the arm. The rust preventives which are coated on the external machined surfaces of the machine should be cleaned by means of kerosene soaked clean cotton yarn. When cleaning the guiding surface of the column, the kerosene must be prevented from flowing into the surface of the arm sleeve. After the cleaning drop some machine oil No. 30 into the column guide surface, then lower the arm by 50mm and after the exposed part of the column guide surface has been cleaned and lubricated, elevate the arm for about 100mm, afterwards clean again and fully lubricate the exposed parts of the column, the arm can now be allowed to ascend or descend for a large distance. Method of operation as described above has to be followed or it will cause the danger of scoring the guiding surface of the column. Remove screw and joint at place 1 according to fig. 4-5, then connect oil pipe for clamping spindle head on the arm, fill the oil according to fig. 8-1, check the lubrication condition. The machine can be started to run only when it is assured that every thing is normal. The moving parts of the machine have to be checked at the same time to make sure they are operating normally. If that is so, run the machine idle for 30 minutes, and when it is found satisfactory, the machine can then be delivered for regular operation.

Note: With regard to ventilation and anticorrosion, seal ring under arm quill and cover of arm are abnormally attached to the machine. They ought to be exactly fitted up when installing.

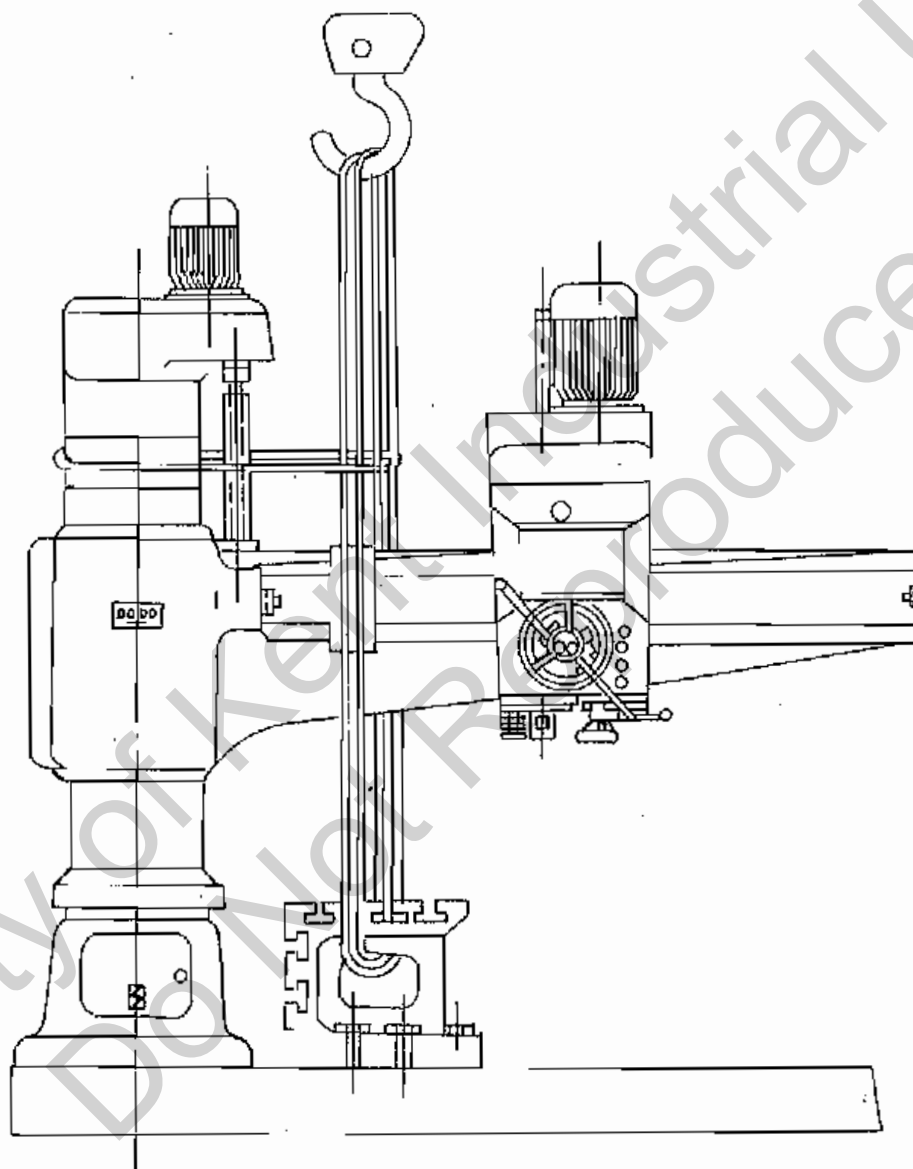
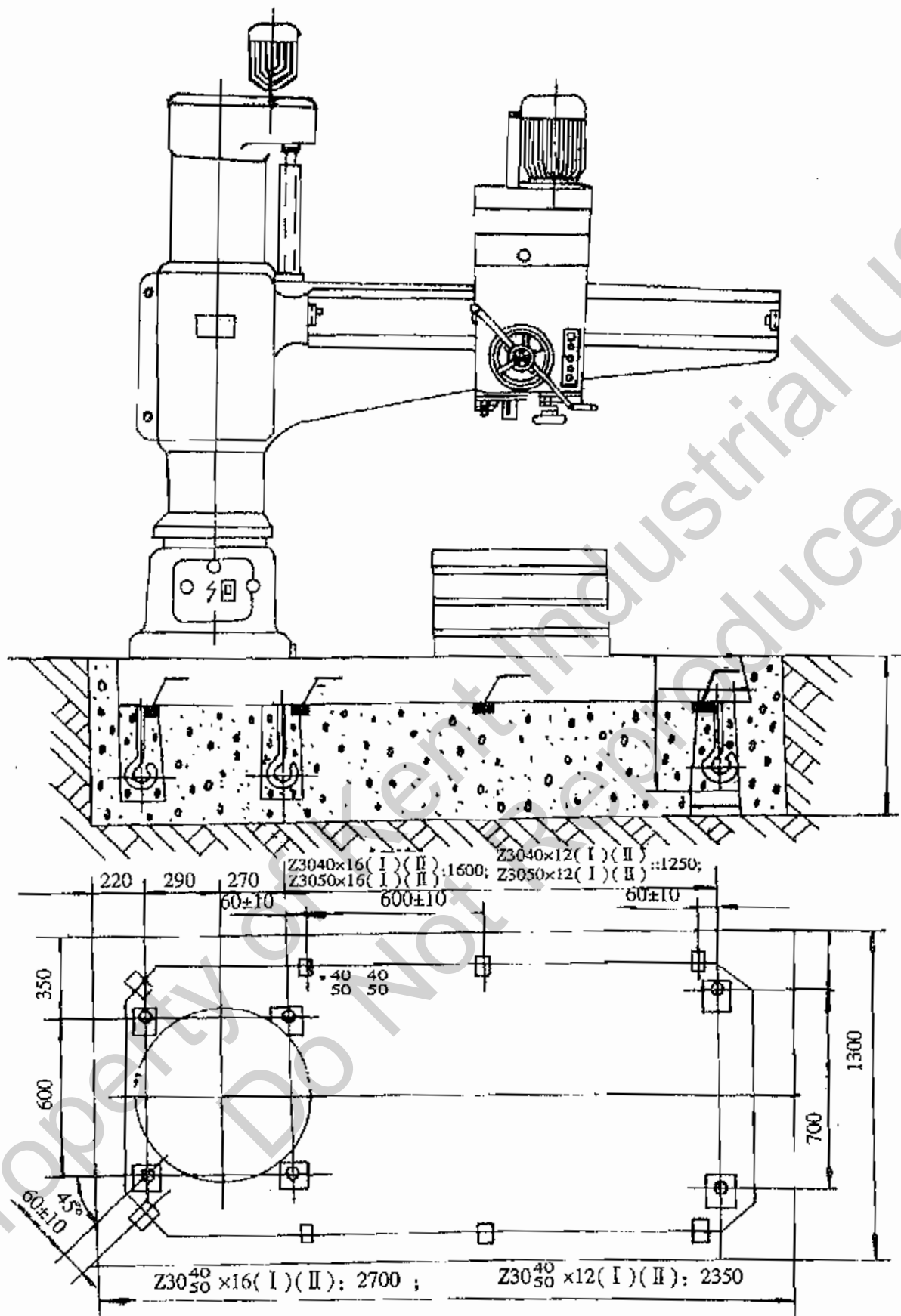


Fig. 9-1 Handling Diagram of the Machine



Depth of foundation depends on the soil condition

Fig. 9-2 Foundation Plan

X. Operation of the machine

For operation of the machine, please refer to fig. 10 - 4 and the list of function of control handles, handlewheels and push - button.

1. Starting the spindle

Press push - button 9, and when the indication lamp lights up, rotation handle 13 forward - turn or reverse - turn position as shown in fig. 10 - 1, then spindle will turn clockwise or counterclockwise.

2. Neutral position of the spindle

Lift handle 13 as shown in fig. 10 - 1, then the spindle can be easily rotated by hand. If the spindle were to be restarted, depress handle 13 before starting.

3. Change of spindle speeds and feeds

Rotate the pre - selection knob 3 or knob 4 to the speed and feed desired, then just press handle 13 down to the speed change position according to fig. 10 - 1 pre - selection is also possible in the course of spindle operation. There are three steps of high rotational speeds and three coarse feeds provided for the spindle. Since they are inter - locking, simultaneous selection of more than one step is impossible.

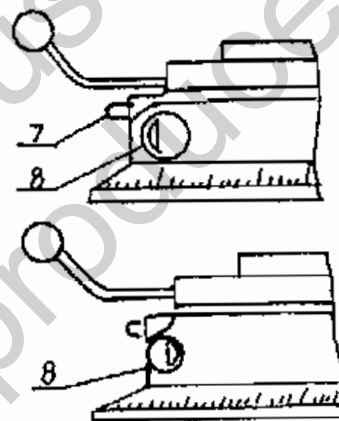
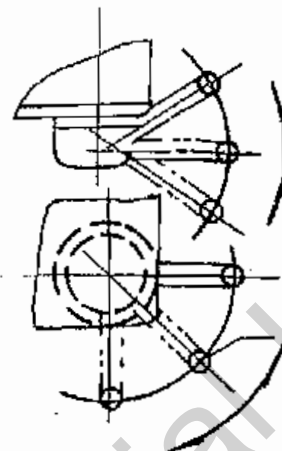
4. Feeds of spindle

Automatic feed: press down handle 15 and 13, then pull out handle 5, thus the automatic feed is on.

Manual feed: push in handle 6 and give it a turn. This will make the spindle feed upward or downward.

Micro - feed: raise handle 15, pull out handle 6, then turn handlewheel 17, and micro - feed is obtainable.

Pre - determined depth cutting: pull out handle 7, rotate turn - handle 8 to the position indicated on fig. 10 - 2, turn the graduated dial to the value of depth desired, approximately aligned with the "0" line of the counterscale on the spindle head, turn handle 8 to the position indicated on fig. 10 - 3 micro - adjust it until it is aligned with the "0" line. Tighten handle 8 with the lock knob



Handle 8 with the lock knob on the other end, push in handle 7 to engage the feed, When the cutting depth reaches the predetermined depth valve, handle 15 raise automatically, and the predetermined depth cutting procedure is accomplished.

Tapping: Tapping is carried out in the same manner as manual feeding.

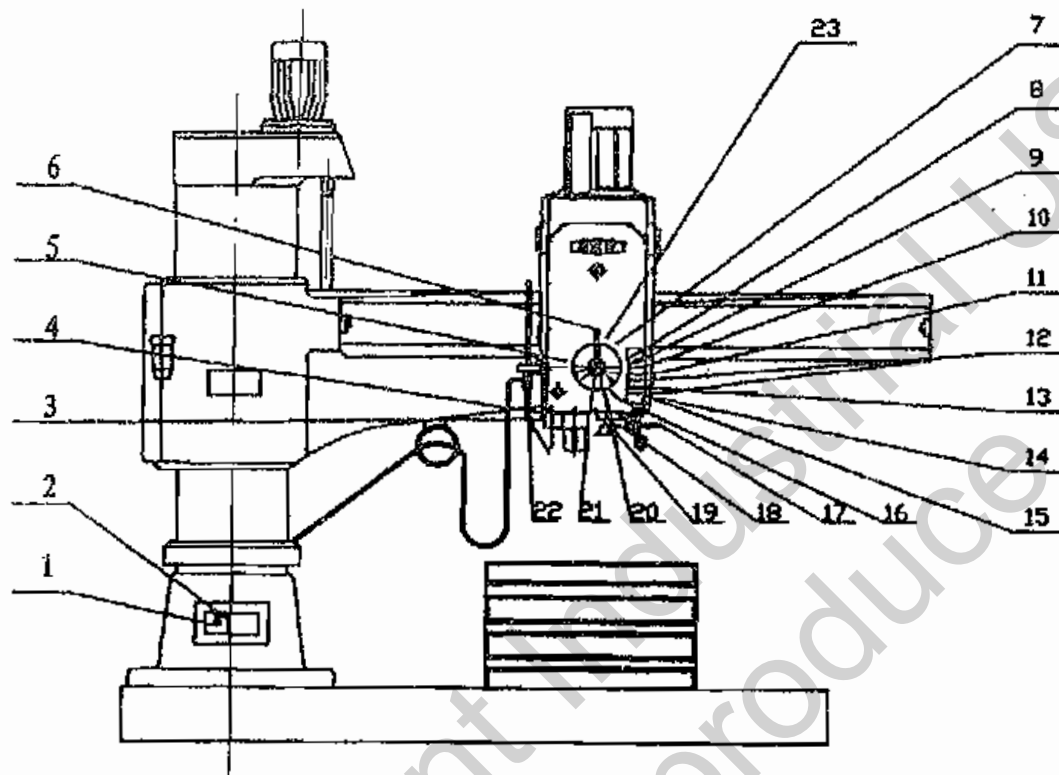
5. Clamping and releasing of the spindle head and the column:

clamping or releasing of the spindle head and the column is carried out either simultaneously or individually. When the change - over switch 21 is set on the intermediate position, simultaneous clamping or releasing of the spindle head and the column is obtained. But the spindle head can be clamped and released independently by clockwise - turning the switch 21 through an angle 30° and the column can be also clamped and released independently by counterclockwise turning the switch 21 through an angle 30° . After the position of the change - over switch is determined, the clamping(or releasing) would be accomplished only by depressing down the push - button 18(or 19).

6. lifting and lowering of the arm:

Push - button 11 and 12 are used for the lifting and lowering of the arm.

Fig 10 - 4 Diagram of Controls



List of the use of control levers, handwheel & push - button

Location	Name of controls	Location	Name of controls
1	Switch for coolant pump motor	13	Master starting Push - button
2	Main switch	14	Master stopping push - button
3	Spindle speeds pre - selection knob	15	Lever for spindle speed or feed change, forward, reverse, breaking, and for setting the spindle in a neutral position
4	Spindle feed rate pre - selection knob		
5	Handwheel for spindle head traverse	16	Adjusting rod for balancing the spindle
6	Winged levers for spindle traverse	17	Switch for illuminating lamp
7	Lever for pre - determined depth cutting	18	Lever for engaging or disengaging power feed
8	Push - button for starting the main drive motor	19	Handwheel for fine hand feed
9	push - button for stopping the main drive motor	20	Push - button for clamping the spindle head and column
10	Push - button for arm ascent	21	Push - button for releasing the spindle head and column
11	Push - button for arm descent	22	Knob for coolant supply
12	Change over switch	23	Micro adjusting knob for feed depth dial

1. Adjustment of the machine

(1) Adjustment of spindle head clamping force (fig.4-5)

To adjust the clamping force, loosen screw 2 and shift part. The clamping force is adjusted so that when a peripheral force of 392N is applied to the rim of the spindle head shifting handwheel, the spindle head will not waddle. Adjust the clearance between the contact faces of the arm and the spindle guide way with screws 5 and 6. When tested with a 0.04 mm plug gage, insertion of the gage over 20 mm should not be possible, and so that the spindle head could be shifted when a peripheral force of not over 58N is applied to the spindle head shifting handwheel. Lock the adjustment screw when the adjustment is completed.

(2) Adjustment of the column clamping force (fig. 4-7)

Screw 5 is used for adjustment of the clearance of inner and outer column taper faces. When adjusting, inner and outer column taper faces. When adjusting, the force on the six screws should be uniform. The column clamping force is adjusted with the screw cap 7. It should be adjusted to such a degree that when a 1568N horizontal force is applied to the end of the arm, the column will not rotate, and rotates when a horizontal force not more than 29N is applied after it is released. Tighten screw 6 and lock screw cap 7.

(3) Adjusting of arm clamping force (fig. 4-8)

When adjusting, the main power supply may be cut off during the screw 1 properly, so that a 0.04 mm plug gage could not be inserted while the arm is in its clamped state.

(4) Adjust the spindle balancing force (fig. 4-6)

To adjust the spindle balancing, turn screw 2 clockwise to reduce the balancing force, and counter clockwise to increase it.

(5) Adjustment of feed resistance (fig.4-3)

Feed resistance can be adjusted by turning screw 2 to loosen the spring. The spring force required as follows:

Model	Feeding resistance(N)	Clutch status	Model	Feeding resistance(N)	Clutch status
Z3040x16	≤ 19200	Engaged	Z3050x16	≤ 21600	engaged
Z3040x16	> 23200	disengaged	Z3050x16	> 26100	disengaged
(1)(11)			1)(11)		

(6) Adjustment of pressure of hydraulic system on clamping mechanism (fig.5-5)

The hydraulic clamping device of the clamping mechanism is mounted in the electric cabinet, and under the electric cabinet. The pressure of the hydraulic system is $245 \times 10^4 - 294 \times 10^4$ pa.

It should be pointed out that the typical construction of rhombic block is adopted for the clamping of the spindle head, column and arm. Such circumstances may occur in the course of servicing or operation: Clamping is possible when the clamping push-button is being pressed, but as soon as the hand is removed from the button, the clamping is released.

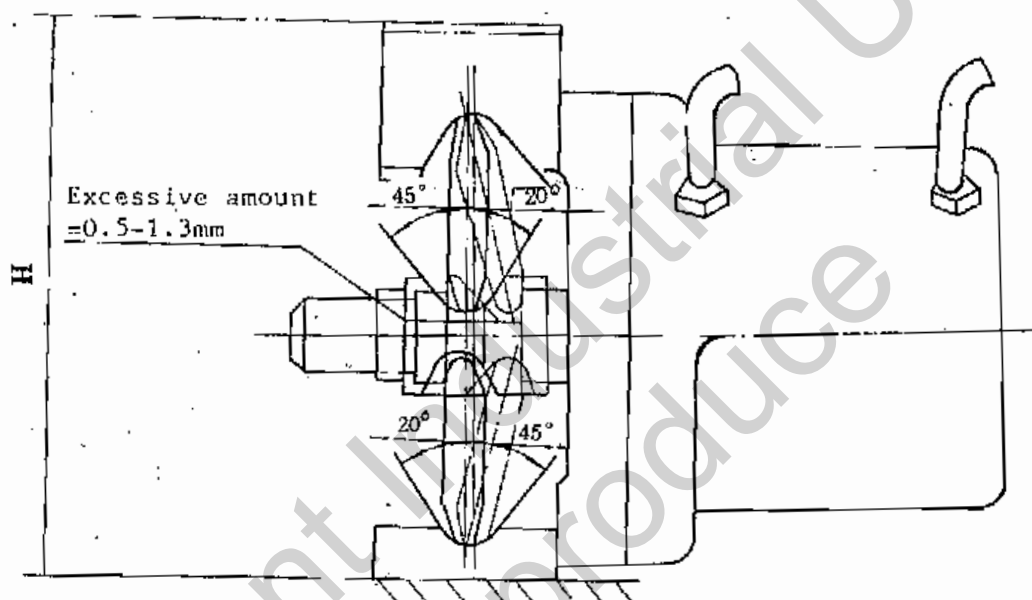


Fig. 11-1 Assembling Diagram of Rhombic Blocks

The cause for this defect could be the incorrect direction of the rhombic block and pressure block angles or because of the clamping force being too large, or the pressure of the hydraulic system in the clamping mechanism being insufficient, which causes the distance H to be inadequate (fig.1-1), and the rhombic block to be unable to stand upright.

2. Maintenance of the machine

- (1) When the machine is put into operation, it should be lubricated according to the specifications given in the instruction manual. Wash the filter gauze periodically so as to keep the oil clean.
- (2) Wipe the arm and the column guide ways with a piece of fine gauze, and lubricate frequently in order to avoid abrasion.
- (3) Care should be taken when removing counter-balance spring of spindle. Depress the top cover 6 (fig. 4-6) and gently unscrew the set screw 7. Then lift up the top cover 6 and remove the spring.