



Since 1979

CM-2 Tool & Cutter Grinder *Operation Manual*



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Appendix 1:

Chapter 1 CM-A Machine Information

Read this manual carefully before your operation.

$$\boxed{\text{CM-A}} = \boxed{\text{CM-2}} + \boxed{\text{The Inspection System}} + \boxed{\text{Optical Ruler}}$$

1-1 Introduction

The Kent USA Cutter and Tool Grinder is a precision machine that could be applied for sharpening, reconditioning and generating certain types of cutting tools. The machine can grind straight, tapered and curved surfaces including helical leads. It can also grind externally as well as internally; can grind convex and concave radii; and produce a complete new cutter from solid stock. All grinding operations can generally be performed in a single setting or chucking of the work-piece.

This chapter begins with information about the CM2 machine – such as features, equipment, specifications etc. The machine CM-A = (The CM2 Machine) + (The CCD Inspecting System) + (The optical ruler). The feature and maintenance of CM-2 was described from chap 1 to chap 5 and the inspecting system was then described in chap 6 in this manual. The optical ruler was set in CM-A to measure the slide movement of wheel-head and the angle of the turntable of work-head. The measured data could be read easily in the digital display of CM-A.

1-2 General Description

The Kent USA CM-A Grinder consists of a fixed bed and two basic units – the wheel-head unit (right side of the machine) and the work-head unit (left side) – strategically located on the pedestal/base. These units provide 10 axes of motion (5 linear, 1 swivel, 2 tilt, and 2 rotary) that involve 10 separate machine elements as follows (Refer to Fig 1-1 and Fig.4-1):

1. Work-head turntable swivels through 235 degrees in the horizontal plane.
2. Work-head offset slide moves 133mm in a horizontal plane.
3. Work-head main slide moves 140mm in a horizontal plane.
4. Work-head tilt pivots through 40 degrees in a vertical plane above center.
5. Work-head spindle rotates through 360 degrees about its axis.
6. Wheel-head cross slide moves 183mm in a horizontal plane.
7. Wheel-head longitudinal slide moves 120mm in a horizontal plane.
8. Wheel-head vertical slide moves 220mm in a vertical plane.
9. Wheel-head tilt pivots through 15 degrees in a vertical plane above center.
10. Wheel-head spindle rotates through 360 degrees about its axis.

tip of workhead

workhead tilt

work-head
main slide
(3)

work-head offset
Slide (2)

(1) turntable

grinding wheel seat
(8)

wheel longitudinal

main(cross) slide
of grinding wheel
(6)

Fig 1-1 Outline of Kent USA CM-2 Cutter and Tool Grinder

All these elements are capable of independent, individual, operator control that covers a wide range of routine cutter grinding assignments – from simple small tools to large intricate shapes with multiple operations – accurately and efficiently.

This general information, along with the machine specifications and dimensional drawing on the following pages, is to familiarize all personnel concerned about the machine, with the basic capabilities of the Kent USA Cutter and Tool Grinder. Further, it enables them to be better prepared for the detailed instructions that follow.

1-3 Specification of the machine

Capacity

Work-head:

Swing over main slide , max dia _____ 12" (300mm)

Collet work dia , max _____ 1.25" (32mm)

Mix _____ 0.12" (3mm)

Lead generated by spiral lead mechanism

Minimum 0° Maximum 45°

Length between spindle nose and tail center

Max _____ 6" (152mm)

Wheel-head:

Grinding wheel dia , max _____ 4" (101mm)

Range

Work-head:

Main slide travel _____ 5.75" (140mm)

Offset slide travel , total _____ 5.25" (133mm)

- front of center , 3" (76mm)
- rear of center , 2.25" (57mm)

Work-head angular adjustment:

Horizontal plane (turntable base) _____ 235°

Vertical plane , above center _____ 40°

Below center _____ 40°

Wheel-head:

Longitudinal slide travel _____ 4.72" (120mm)

Vertical slide travel , total _____ 8.66(220mm)

- above center , 4.1" (104mm)
- below center , 4.5" (116mm)

cross slide travel , total _____ 7.20" (183mm)

- front of center , 2.87" (73mm)
- rear of center , 4.33" (110mm)

Spindle speeds

(± 0% , -8% variation allowable)

Work-head , one speed _____ 436 rpm

Wheel-head , three speeds _____ 3850, 5560 and 7200 R.P.M

(Motor speed @ 3405 rpm)

Chapter 2 Description of the machine (CM-A)

2-1 The outline of CM-A

The outline of CM-A and the nomenclature was shown in Fig 2-1

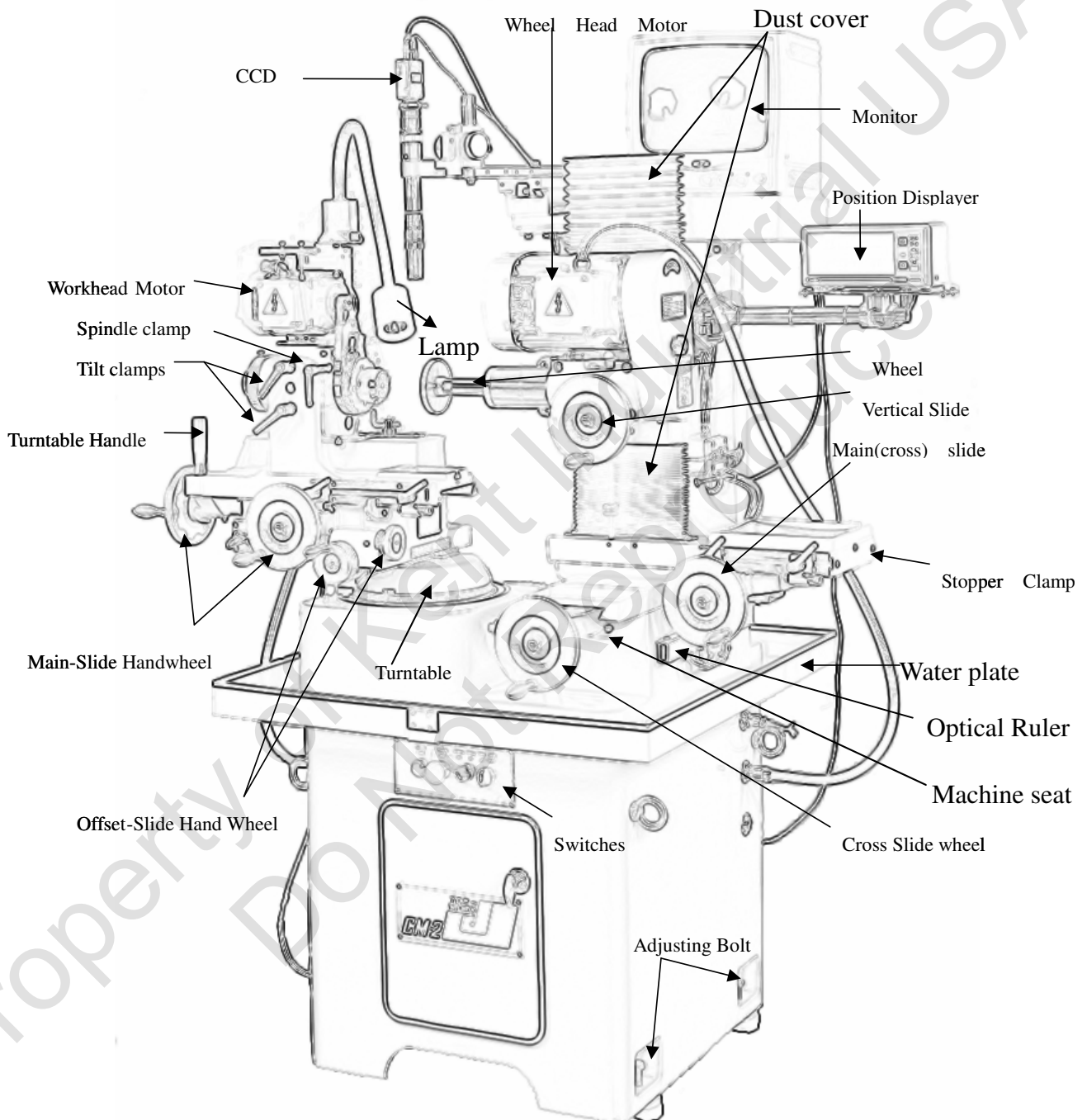


Fig 2-1 CM-A Machine nomenclature

2-2 The axial controllers

As you first view the grinder machine, there are many metal hand-wheels (movement controllers), plastic clamps (clamping / unclamping the axes), and stoppers (set the distance /angle). These 3 kinds of elements are shown in Fig 2-1. All clamps are following the right –hand rules (clockwise to clamp) except the **work head** main slide clamp (C.C.W to clamp view from the top). The elements will be described detail in Chap 4.

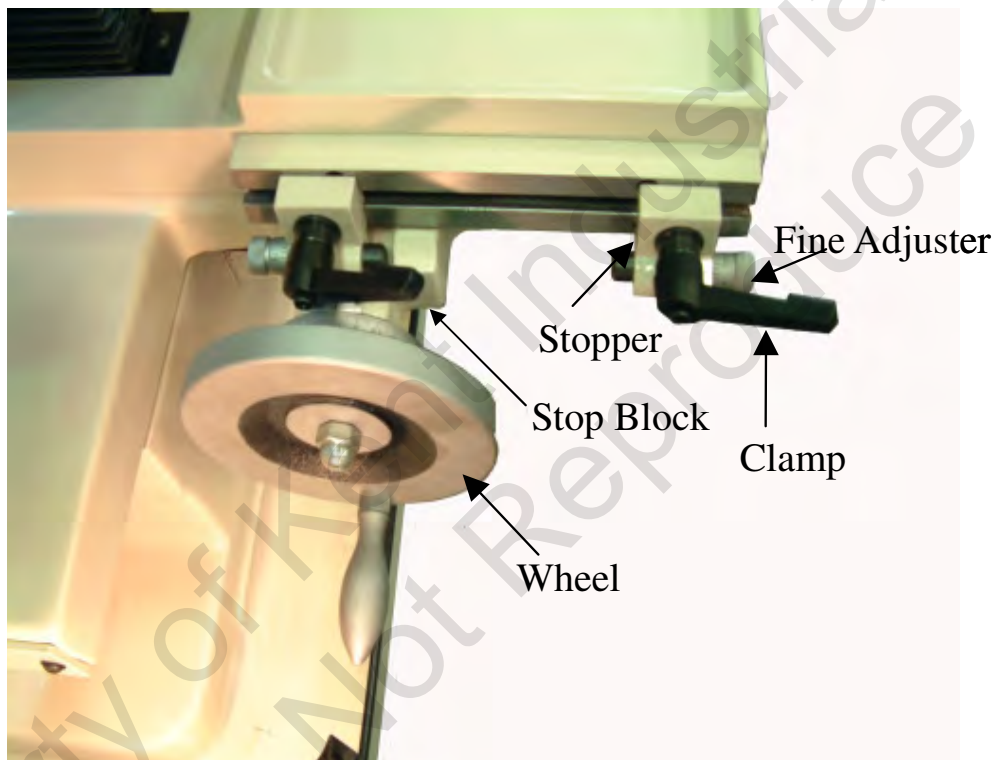


Fig 2-2 The controlling device

The hand-wheels, clamps and stoppers are shown in Fig 2-2 and the detail of their function will be described in chap 4.

2-3 Hand-wheels for controlling the movement

There are 7 metallic hand-wheels to control the motion of slide. The detail will be

described in the following section. The function of these hand-wheels are:

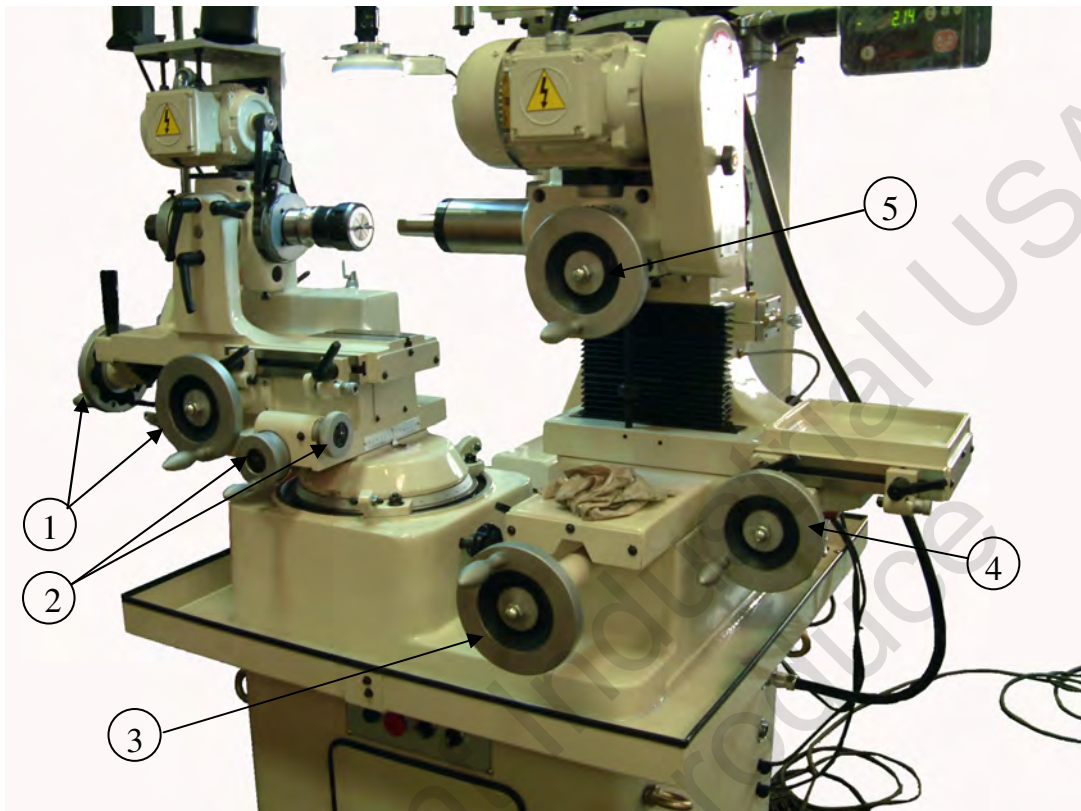


Fig 2-3 Hand wheels of slide

Work-head (Left side of the machine)

1. Hand-wheels of main slide : There are 2 hand wheel to control the main slide , one is called the “Front” and the other one is called the “End” .
2. Hand-wheels of offset slide : 2 hand-wheels are used for the “Fast” (In the front of the machine) and the “Slow” (Right side of the machine) offset movement of the work-head .

Wheel-head (Right side of the machine)

3. Hand-wheel of main (cross, Y Axis) slide.
4. Hand-wheel of longitudinal slide (X Axis).
5. Hand-wheel of vertical slide.

Caution: The value of Z Axis shown in the **position display** is not the vertical slide value. The **Z value** shown on the digital displayer is the **swivel angle** of the work-head **turntable**.

2-4 Clamps

There are 2 kinds of clamps on the machine. One is the bigger plastic handle to lock /unlock the axis, the other one is the smaller plastic handle to lock /unlock the stopper .The axis clamps were be described in this section. The clamp of stopper will be described in the 4th chapter in detail.

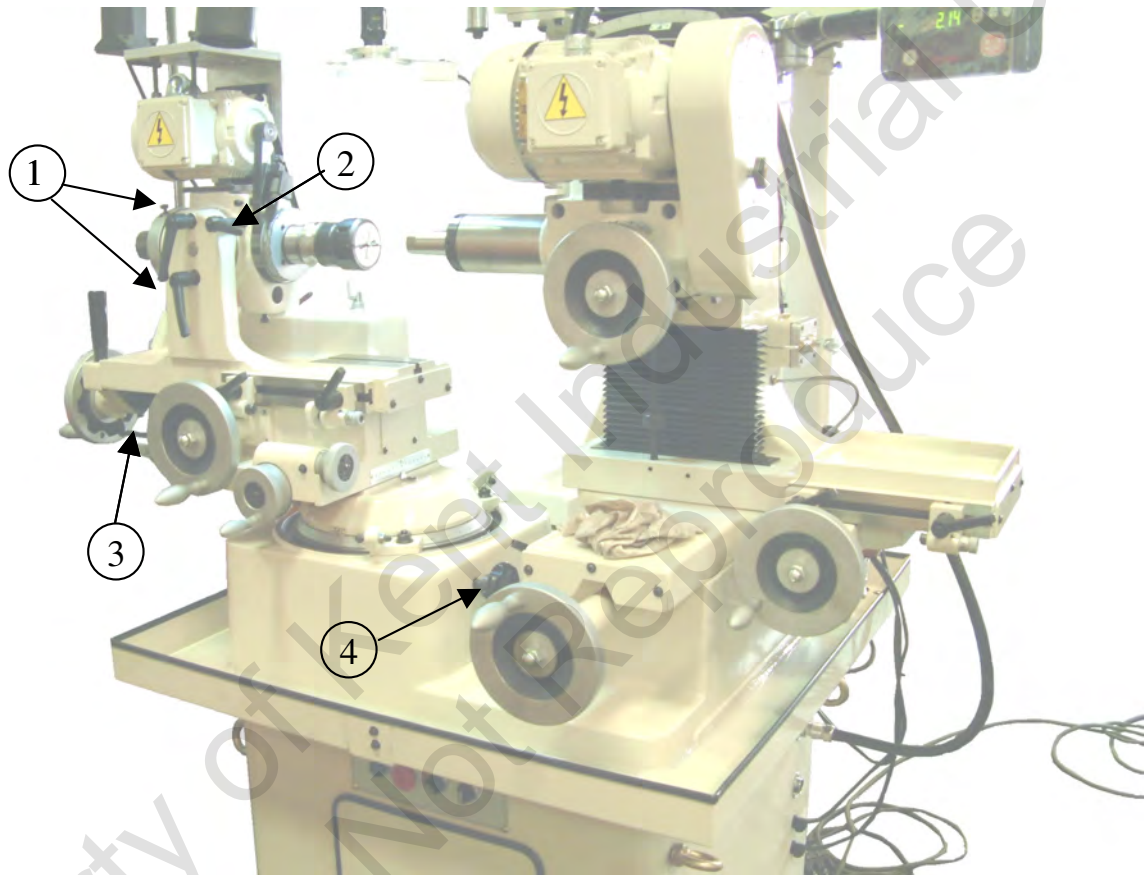


Fig 2-4 Clamps of work-head axis

Work-head:

1. 2 clamps for spindle tilt .-----C.W to lock.
2. 1 clamps for spindle rotation .---C.W to lock.
3. 1 clamp for main slide. -----C.C.W to lock(Viewed from the top of the machine).
4. 1 clamp for turntable.
 - ※ The clamp for the “Front” hand-wheel of offset slide is a Hex. screw .
It is located just before the front wheel and is not shown in the picture.
 - ※ There is no clamp on the wheel-head unit.

Chapter 3 Installation Instructions

3-1 General

To obtain and maintain accurate results from the Kent USA Cutter and Tool Grinder, over a long period of time, several external requirements must be met. The requirements are outlined below with suggestions for their accomplishment.

3-2 Location

For the best over-all performance, install the machine in a location which is clean and well lighted. Do not place the machine in an area subjected to heavy vibrations as this will affect the accuracy of the machine. Provide sufficient space in all directions around the machine to permit full use of the machine's maximum ranges. (See Figure 3-1) The surrounding area should be large enough to permit easy access to all parts of the machine and electrical control panel by servicemen as well as operating personnel. Allow ample room for the safety of the operator, and for servicing, adjusting and maintaining the equipment.

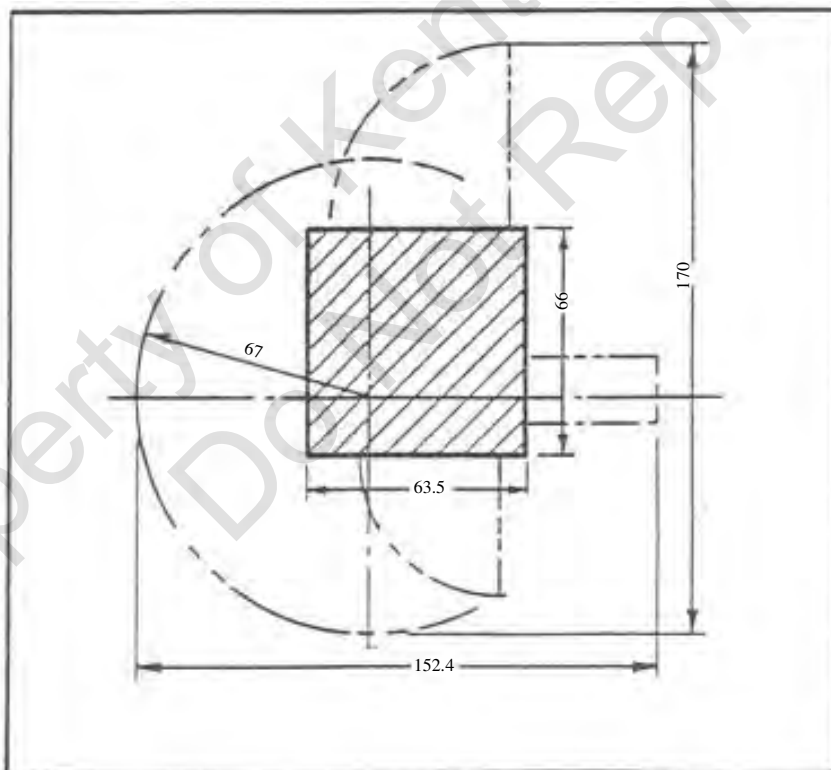


Fig 3-1 The sufficient space of the machine

3-3 Foundation

A special foundation is not required. Any substantial floor, fairly flat, and sufficiently heavy to withstand the weight of the machine , will be satisfactory . However, do not locate the machine close to vibrating equipment. Vibration transmitted to the machine will result in a poor finish on the cutting edge of the tool being sharpened.

3-4 Uncrating

When uncrating, handle all parts with care. Inspect all packing material so that parts and literature are not inadvertently throwaway. Usually, small parts are in cloth containers fastened to the machine and other unattached parts are packed in a wooden compartment on the skid. Observe all warning tags and plates attached to the machine. After uncrating, prepare to lift machine off of skid. Four clamp bolts hold machine to skid.

3-5 Lifting

The machine may be easily lifted, by a crane, with a four-point chain or wire cable hook-up, as shown in Figure 3-2. Insert 1.2”(30mm) diameter , 4.7”(1.4m) long steel rods (not pipes) through the holes provided and place the hooks securely around them .

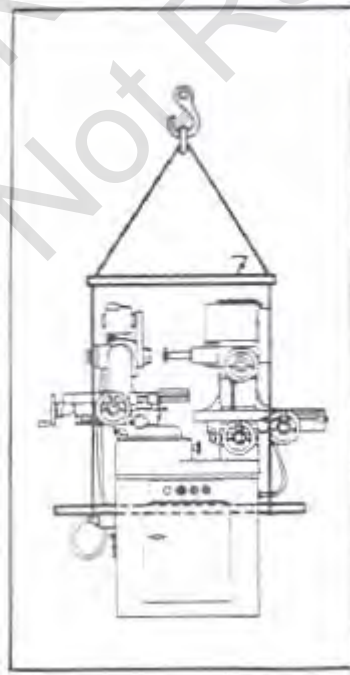


Fig 3-2 Machine Lifting

Padding should protect any point where the chain or cable contacts the machine .Be

sure that the chains or cables used for lifting are strong enough to support the weight of the machine. It is a good idea to use protection spacer (wood or plastic) to spread the lifting ropes wide enough to prevent scraping or crushing against the sides of the machine. Keep the machine level during lifting.

When it becomes necessary to move an installed machine from one location to another, position all slides in the center of their travel and move the stop dogs to help retain this position. Then use the four-point hook-up as described above.

3-6 Cleaning

Do not move any until the machine is thoroughly cleaned. A protective coating over certain areas was applied before shipment to protect the machine from dirt, accumulated during transit. Use a good grease solvent to remove the dirt and protective compound. Do not use caustic type cleaners! Wipe the machine with clean lint-free cloths. A stiff bristle brush may be used to clean corners. Do not use compressed air to blow off the machine! Compressed air could force grit between sliding surfaces and result in rapid wear.

Do not start the machine at this time. Wait until it is completely assembled and leveled. Then follow the operating instructions presented in a later chapter. The machine is now ready for assembling.

3-7 Assembling

Attach all parts that were shipped loose, such as end pans, guards, handles, etc. Make a thorough and complete visual inspection of all parts that can be seen, without removing gasket-sealed cover plates, for damage and do not attempt to operate machine if damage is evident.

Electrical Connections – Have a competent electrician hook up the electrical power source to the machine in accordance with the local code and the electrical schematic diagram shipped with the machine. Be sure the correct voltage is applied. At the completion of the electrical hookup, the electrical cabinet door should be closed and switch placed in the **OFF** position.

3-8 Leveling

After the machine has been placed in position and cleaned, it must be leveled. Use an accurate reliable level. The machine can be checked for level by placing the leveling instrument on the finished top surface of the T-slot pad, on top of the main slide. Be sure that the finished pad is clean and the leveling instrument free from burrs. The swivel may then be rotated to check for level both longitudinally and transversely.

Chapter 4 Operating Instructions

4-1 General

Never operate the Kent USA Tool and Cutter Grinder until you are familiar with all the slides, their controls, directions of movement and functions. Familiarize yourself with the auxiliary equipment (collets, adapters, arbors, attachments, etc.), their nomenclature, and the basic grinding knowledge are really necessary. Then study the operating instructions carefully before proceeding with an actual grinding or sharpening procedure.

This chapter is to discuss your standard features and standard equipment of the machine. There are 2 main sections in this chapter.

Introduction

Machine Units

Each of the 2 sections are then sub-divided in a logical sequence – “building block approach”- so that a new operator may gain confidence as he reads and understands the instructions.

4-2 Introduction

The section consists of machine nomenclature and orientation of axes and their motions. The operator’s normal operating position is standing and facing the front of the machine with the work-head on his left and the wheel-head on his right.

Machine nomenclature is shown in Fig 2-1. The relation of axes and motion is shown in Fig 4-1.

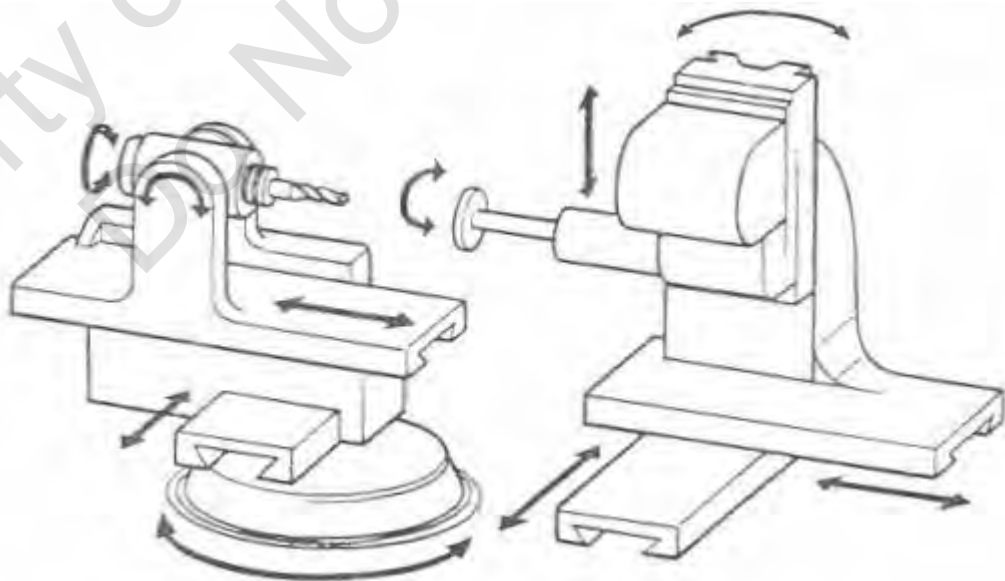


Fig 4-1 Axes of CM-A

Discussion of the machine units is in the following sequence:

Pedestal/base

Work-head

- Turntable
- Work-head offset slide
- Work-head main slide
- Work-head tilt
- Work-head index
- Work-head lead mechanism
- Work-head rotation

Wheel-head

- Cross slide
- Wheel-head longitudinal slide
- Wheel-head vertical slide
- Wheel-head drive, the motor, and the tilt of the wheel-head.

The Grinder machine **CM-A** has 10 axes of motion (1 swivel, 2 tilt, 2 rotary, and 5 linear axes) which may be used independently or in combination to produce a wide variety of work-piece shapes. The work-head tilts vertically, rotates (for lead generation or cylindrical grinding) and may be swiveled by rotating the turntable. The work-head is mounted on the main slide for longitudinal movement and on the offset slide to offset the work-head for grinding concave and convex radii. The work-head slide control hand-wheels (dual hand-wheels on main slide) are grouped for the convenience of the operator. The wheel-head has three linear axes (longitudinal, cross and vertical). All of which are independent of the work-head. The wheel-head slide control hand-wheels are also closely grouped at a convenient height and face the operator at his normal working position.

The description of axes:

Work-head:

1. Turntable swivel
2. Offset slide
3. Spindle rotation
4. Spindle tilt
5. Main slide

Wheel-head

6. Vertical slide
7. Spindle tilt
8. Longitudinal slide

9. Main slide (Cross)
10. Spindle rotation

4-3 General of machine units

The worktop Cutter and Tool Grinder is a multi-axis machine completely self-contained to perform its duty efficiently. The machine units are grouped so as to accommodate the work-piece at the left side of the machine, and the grinding wheel at the right. Therefore the units on the left-hand side of the machine, as the operator faces the machine, comprise the work-head unit and those on the right, the wheel-head unit. The work-head unit is independent of , and has no mechanical attachment to, the wheel-head unit. Both units are supported on a common pedestal base.

4-4 Pedestal/Base

The pedestal is a rigid steel structure to permanently place the machine in location and compartments for electrical compartment (at the rear) houses the starter, transformer, etc. and disconnect device, with a book rack on the inside of the door. There are two compartments at the front: one enclosed containing the electrical push buttons, etc., and the other with a hinged door for storage of tools, accessories, wheels and miscellaneous items. For safety reason, keep this door closed when access is unnecessary.

On top of the pedestal is the cast iron base for the work-head and the wheel-head units. The base is bolted in seven places to the pedestal for maximum rigidity. The switches of CM-2 are shown in Fig 4-2. The function of each button is “Master Start”, “Master Stop”, “Grinding Spindle off”, “Grinding Spindle On”, “Work-head Left”, and “Work-head right”(from left to right) in sequence.



Fig 4-2 Push buttons on the Base of machine

4-5 Work-head Turntable

The entire work-head assembly is mounted on large antifriction bearings that are rigidly supported within the machine base. The antifriction characteristics of the bearings permit an almost effortless swivel of the work-head assembly through 235 degrees of movement. Movement of the turntable is done by the operator by physically pulling or pushing on the work-head handle. The swivel motion provides a convenient and accurate method of generating radii on a work-piece. If the turntable works too freely, a slight amount of “drag” may be applied by tightening the turntable swivel clamp knob (refer to Fig 4-3). The swivel may be securely clamped in any angular position with this same knob. In addition, two adjustable turntable stops may be set to limit the swivel motion. These stops are in a circular T-slot around the base of the turntable. Location and accurate positioning of the turntable are accomplished by:

A circular scale on the turntable base, which facilitates swivel settings. It is graduated 180° in both directions from the zero position of the turntable. Adjusting screws carried by the turntable stops, which facilitate fine swivel stop settings.

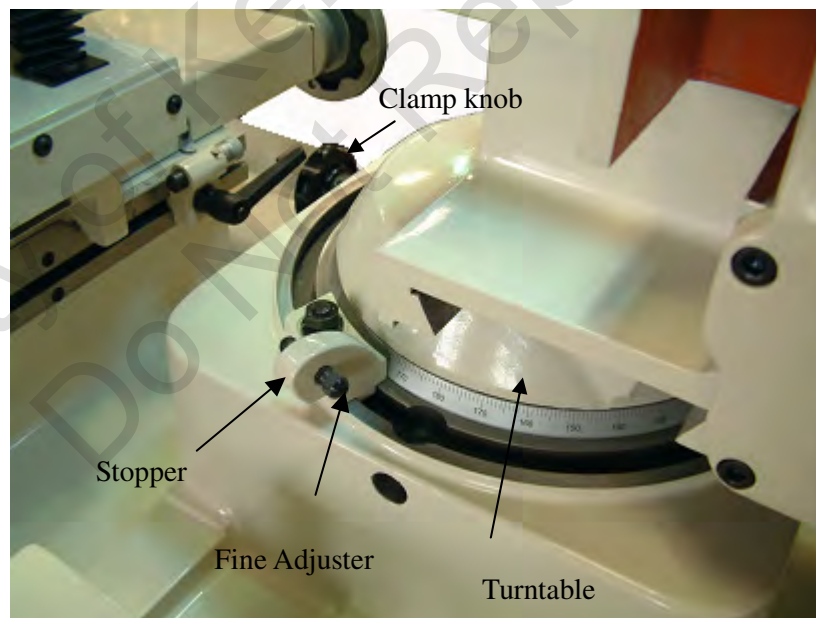


Fig 4-3 Turntable swivel

4-6 Work-head Offset Slide

On top of the turntable is the offset slide. Its name is derived from its function-which provides for offsetting the centerline of the work-head spindle in relation to the center of the turntable swivel. The work-head spindle centerline can be moved to either side of the turntable pivot point-from **76mm** in front to **57mm** behind-for a full **133mm** range of travel. Movement, by the operator, is controlled by either of two hand-wheels.

The **fast-feed** hand-wheel, located at the front of the slide, moves the slide **1.5mm** per turn. The hand-wheel dial is calibrated in **0.02mm** increments, and clockwise rotation adjusts the slide away from the operator.

The **fine-feed** knob, located at the right side of the slide, moves the offset **0.3mm** per turn. The dial is calibrated in **0.002mm** increments. And clockwise rotation adjusts the slide away from the operator.

The approximate position of the offset slide is read from a linear scale on the lower right-hand end of the slide. A zero line on the turntable registers with this scale.

The scale, together with the two dials above, serves not only to set an initial offset slide position, but also to indicate the exact slide position at all times.

Thus the centerline of the work-head/work-piece may be quickly and accurately set in relation to the turntable pivot point for generating concave or convex radii.

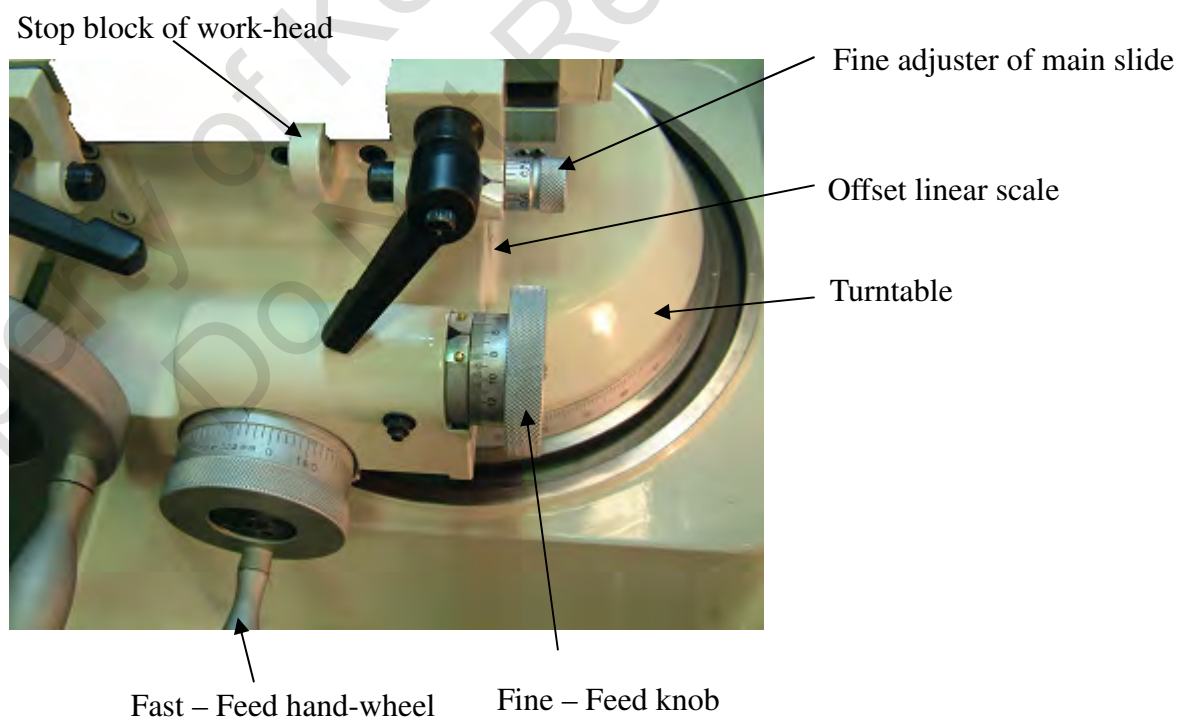


Fig 4-4 Work-head Offset Slide

4-7 Work-head Main Slide

The main slide of the work-head is mounted on top of the offset slide and moves at a right angle to it. The main slide is adjustable from either one of the dual hand-wheel controls. This pair of hand-wheels, one at the front and one at the left end of the slide, allows the operator to choose the most convenient position for adjusting the main slide depending upon the nature of the job being performed. Normally, the front hand-wheel is used for the majority of operations, but when the turntable is swiveled to the front to an extreme position, the end hand-wheel becomes more convenient for the operation. See Fig 4-5.

A hand clamping screw is located directly behind each hand-wheel to lock it in position after an adjustment has been made. If the operator wants to move the main slide with the front hand-wheel, he must loosen the clamping screw of this hand-wheel and tighten the clamping screw behind the end hand-wheel, and vice versa. Clockwise rotation of either hand-wheel moves the main slide toward the grinding wheel spindle.

※ The direction for clamping the **end** hand-wheel is **C.C.W (Viewed from the top of the clamp)**.

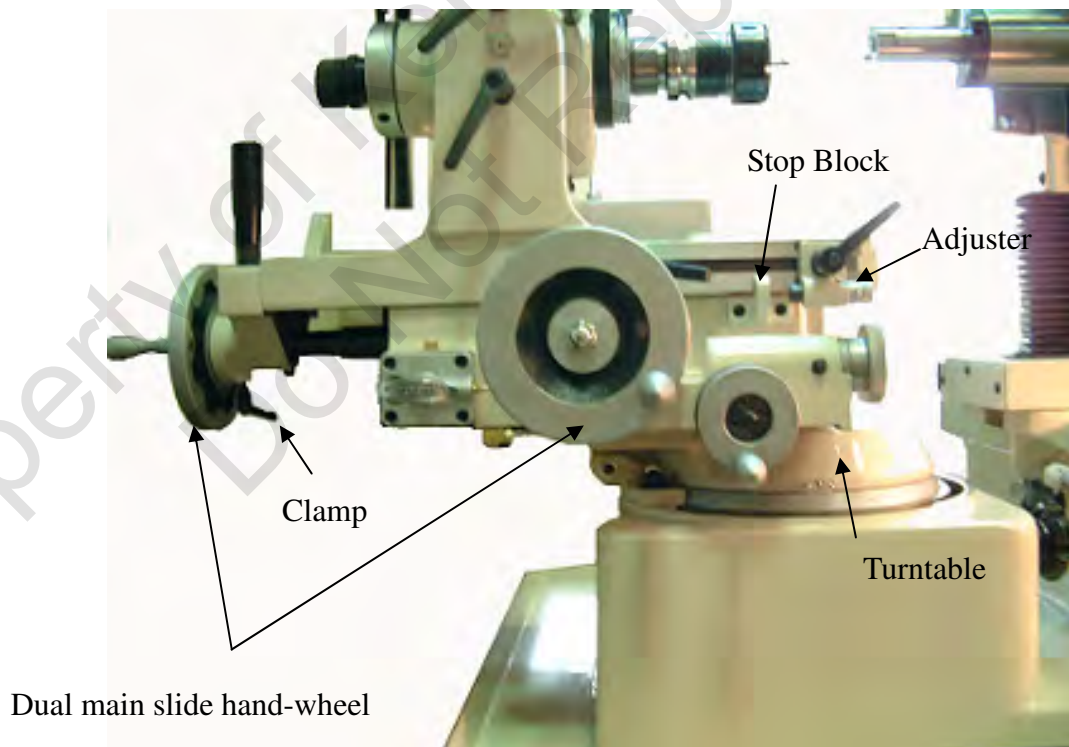


Fig 4-5 Work-head Main Slide

4-8 work-head Tilt

Tilting of the work-head is provided by the unique location of the work-head spindle housing, between two uprights one of which is cast integral with the main slide. Between these uprights the work-head will tilt 40° above or below the horizontal centerline, and may be clamped firmly - by two “work-head tilt clamp nuts” - in any position within this range. Refer this to Fig 2-1. To tilt the work-head spindle, loosen the clamping nuts, tilt the work-head by hand to the desired position, and tighten the clamping nuts. Returning the work-head spindle to the “zero” or horizontal position is simplified by using the centering gage.

4-9 work-head Index

The work-head spindle is equipped with two types of indexing devices:

-A ratchet type indexing device located on the front of the work-head. See Fig 4-6.

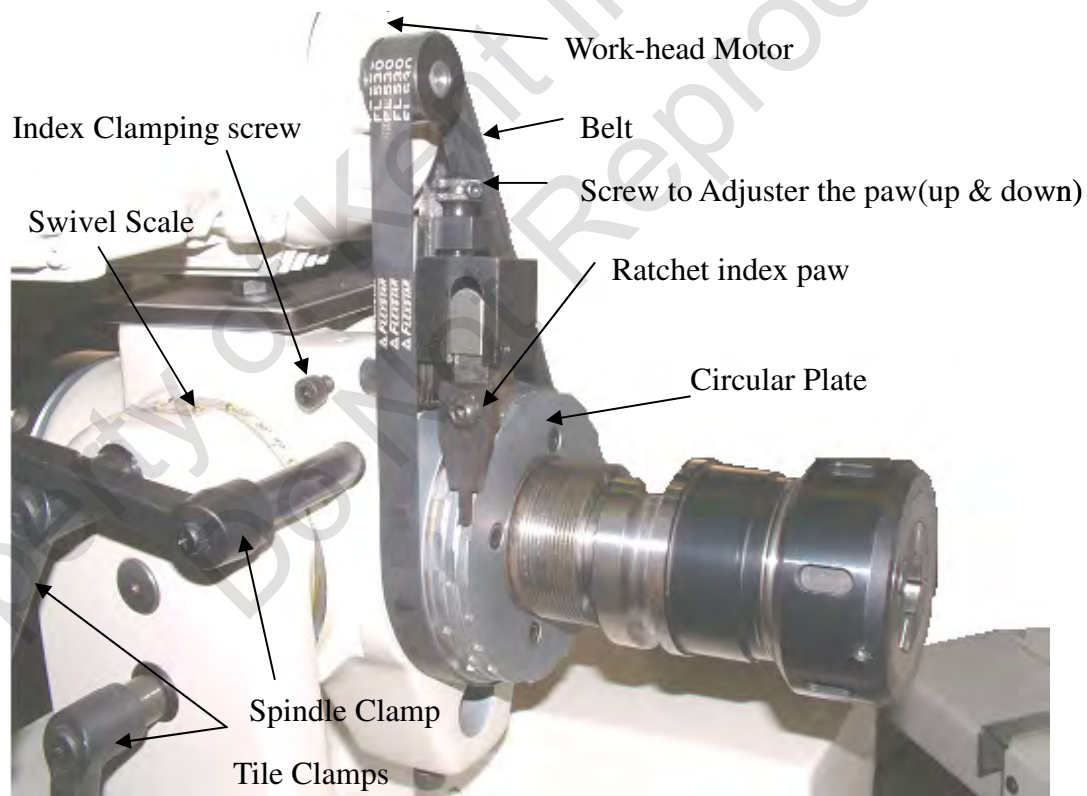


Fig 4-6 The work-head Ratchet Indexing Device

-A detent type indexing device, used in conjunction with the lead mechanism, located on the rear of the work-head.

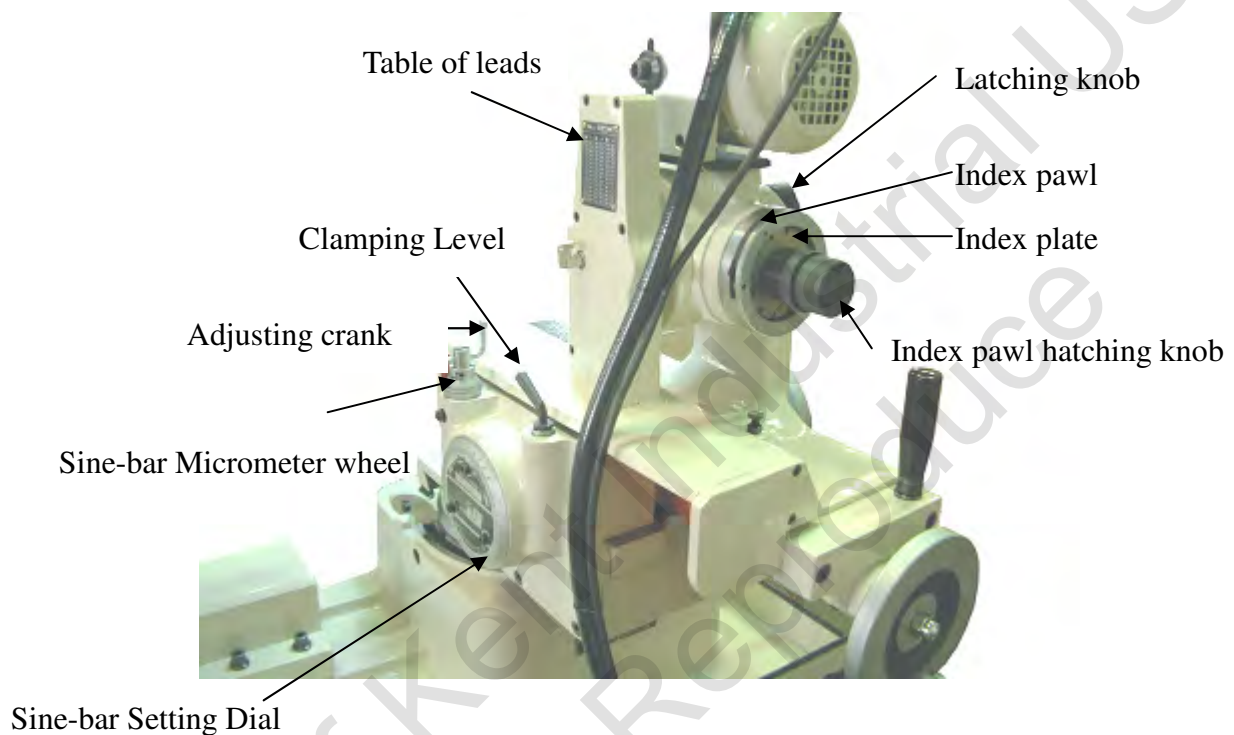


Fig 4-7 The Detent Indexing Device

4-9-1 The ratchet type of indexing

The ratchet type indexing device (Fig 4-6) consists of three rows of notches machined in the periphery of the circular plate on the front of the work-head spindle, and a spring-loaded index blade which pivots in a block. This block itself is moveable on guide ways on a holder body whose shank, in turn, is adjustable in its mounting hole in the work-head housing. This indexing device is used for grinding straight cutter teeth and ordinary indexing. The three rows of notches offer a choice of 10, 12 or 14 equally spaced divisions. The 12 notch row include four additional notches for indexing of cutters with eight teeth.

The index blade may be aligned with any row of notches by simply loosening the clamping screw in the work-head, repositioning the index blade assembly until the blade tip is aligned with the proper row of notches and retightening the clamping

screw. The vertical movement of the blade holder block may be used to “roll” the work-head spindle to place a cutter tooth in a desired position relative to the grinding wheel.

✖The top screw on the paw of ratchet is used to adjust the paw UP/DOWN vertically and the screw behind the paw is used to move the paw to / fro in horizontal direction

✖The whole ratchet device could be remove by loosening the indexing clamp screw in Fig 4-5. The method to move the paw away from the plate is to push the upper of the metal paw and then rotate the screw (behind the paw) by hand. The spring inside the ratchet device will work and make the paw isolated with the plate.

4-9-2 The detent type of indexing

The detent type indexing mechanism consists of an index plate on the rear of the work-head spindle and a spring loaded index pawl on a pivot in the cutter ring. See Fig 4-8.

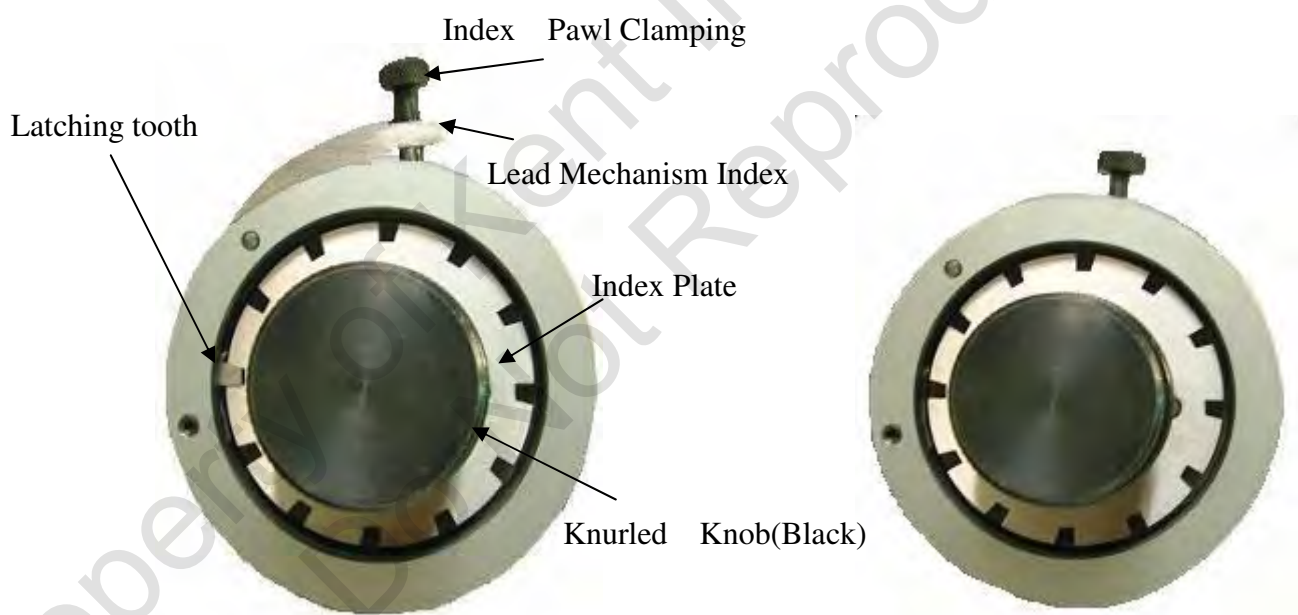


Fig 4-8 Index Latching/Unlatching

This indexing/driving arrangement permits the spindle to be accurately indexed in relation to the lead generating mechanism for grinding multi-toothed helical fluted cutters. Besides indexing, it is also the driving member between the lead mechanism and the work-head spindle. A set of three interchangeable index plates

(0,8, 10 and 12 equally spaced notches are supplied with the machine, additional plates with 15, 18, 20, 22, 24 or 28 positions are available at extra cost). The **zero plate** is used for cutting the special tool depends on customer design. To interchange plates, unscrew the knurled clamping knob on the rear of the work-head spindle and remove it and the plate. See Fig 4-8. Replace with desired plate. For jobs on which the lead generating mechanism will not be used, the index pawl must be disengaged from the notched plate. This disengages the work-head spindle from the lead generating mechanism and permits the spindle to be freely rotated. Simply depress the knob on the exposed end of the pawl; rotate the knob a quarter of a turn, and release. The pawl will remain disengaged.

4-9-3 The step to change the detent plate.

1. Lock the spindle.
2. Loosen the black knurl knob.
3. Put the flat screwdriver into the hole (2 holes on the O.D of the plate) and forced the plate outside. The plate will be removed.
4. Rotate the plate 180° and redo step 3 once the plate could not be removed in step 3 .

Use only one index method in the operation.

4-10 Work-head Lead Mechanism

The standard lead mechanism provides leads for grinding helices. Basically, the lead mechanism is means of transmitting rotational movement to the work-head spindle by directional movement of the main slide of work-head. The mechanism consists of an adjustable sine-bar arrangement (with anti-friction rollers between the guiding surface of the sine-bar, as shown in Fig 4-9) linked to the work-head spindle and the work-head main slide. When the mechanism is engaged, longitudinal movement of the slide-with the sine-bar tilted causes vertical movement to the rack and rotational movement to the spindle through the bevel gears. The combination of movements generates the lead. By changing the angle of the sine-bar, infinitely variable leads can be obtained over the entire range of the mechanism.

Engagement of the lead mechanism occurs when the index pawl, on the rear of the work-head spindle, is engaged in a notch of the index plate(Fig 4-10). This is the driving member between the lead mechanism and the work-head spindle.

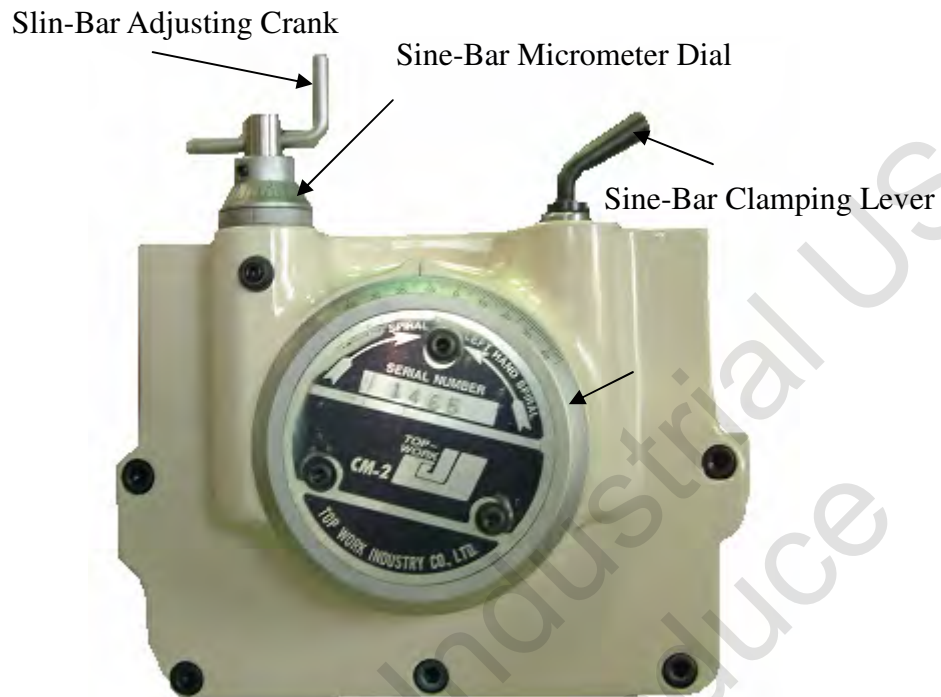


Fig 4-9 Sine-bar Adjusting device

Actually, the lead mechanism rotates the outer ring on the spindle, which carries the index pawl, and, when the pawl is engaged in a notch in the index plate, the spindle is rotated. Disengagement of the index pawl removes any influence of the sine-bar on the spindle. In fact, when not using the lead mechanism, always disengage the index pawl from the index plate and latch it in this position by rotating the knurled pawl – latching - knob a quarter turn.

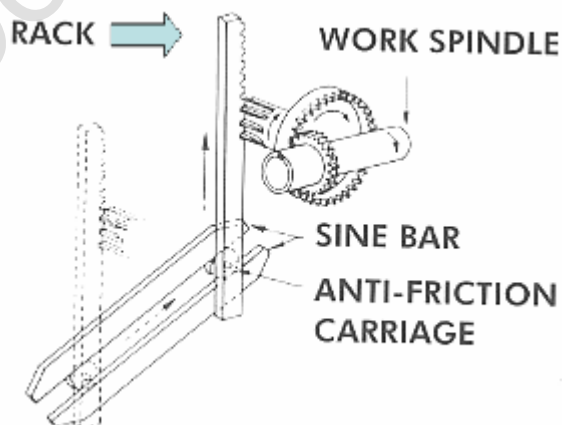


Fig 4-10

Angular setting of the sine-bar is made by the adjusting crank with its micrometer dial in conjunction with the large graduated setting dial at the back of the offset slide.

The sine-bar setting dial is graduated in degrees and may be adjusted so as to obtain tight – hand or left –hand leads. The adjusting crank dial is calibrated in two-minute increments, and, one turn of the crank moves the setting dial six degrees. Before making any adjustments, always release the sine-bar clamping lever, by moving it counterclockwise when looking down on it, and re-clamp after the adjustment has been made. See Fig 4-9. For left-hand leads, rotate the adjusting crank counterclockwise when looking down on it. For right-hand leads, after the clamping lever has been released, turn the adjusting crank counterclockwise a small amount in order to release the wedging action of the clamp, then make the clockwise adjustment. Re-clamp the sine-bar after the adjustment.

It must be remembered that the readings obtained from the sine-bar setting dial, and the micrometer dial on the adjusting crank, refer only to the angular position of the sine-bar and not to the angle of the helix. The setting of the sine-bar for any desired lead may be determined by the table 1.

A table of leads, with the corresponding sine-bar settings sufficient for most jobs is located on the housing above the sine-bar adjusting crank. Interpolation for intermediate leads will be sufficiently accurate for practical purposes. Yet, it is not easy for operators to know. In practice, please refer to table 1 of this manual.

| CM-2 $\theta = \tan^{-1} (31.75 * \tan \beta \div D) \div 2$ | | | | | |
|--|---------|----------|-----------|---------|----------|
| D | β | θ | D | β | θ |
| ϕ 8 | 30° | 33.2 | ϕ 14 | 45° | 33.1 |
| ϕ 8 | 35° | 35.1 | ϕ 14 | 60° | 37.85 |
| ϕ 8 | 45° | 37.9 | ϕ 15 | 30° | 25.35 |
| ϕ 8 | 60° | 40.86 | ϕ 15 | 35° | 28 |
| ϕ 9 | 30° | 31.9 | ϕ 15 | 45° | 32.35 |
| ϕ 9 | 35° | 34 | ϕ 15 | 60° | 37.37 |
| ϕ 9 | 45° | 37 | ϕ 16 | 30° | 24.4 |
| ϕ 9 | 60° | 40.35 | ϕ 16 | 35° | 27.1 |
| ϕ 10 | 30° | 30.7 | ϕ 16 | 45° | 31.6 |
| ϕ 10 | 35° | 32.89 | ϕ 16 | 60° | 36.9 |
| ϕ 10 | 45° | 36.25 | ϕ 20 | 30° | 21.2 |
| ϕ 10 | 60° | 39.84 | ϕ 20 | 35° | 24 |
| ϕ 11 | 30° | 29.51 | ϕ 20 | 45° | 28.8 |
| ϕ 11 | 35° | 31.8 | ϕ 20 | 60° | 35 |
| ϕ 11 | 45° | 35.44 | ϕ 25 | 30° | 18.1 |

| | | | | | |
|-----------|-----|-------|-----------|-----|-------|
| ϕ 11 | 60° | 39.34 | ϕ 25 | 35° | 20.8 |
| ϕ 12 | 30° | 28.4 | ϕ 25 | 45° | 25.9 |
| ϕ 12 | 35° | 30.8 | ϕ 25 | 60° | 32.77 |
| ϕ 12 | 45° | 34.6 | ϕ 32 | 30° | 14.9 |
| ϕ 12 | 60° | 38.8 | ϕ 32 | 35° | 17.4 |
| ϕ 14 | 30° | 26.3 | ϕ 32 | 45° | 22.4 |
| ϕ 14 | 35° | 28.9 | ϕ 32 | 60° | 29.9 |

Table 1 The relation ship between helical angle and Sin-bar angle

Where:

D: Diameter of tool to be ground

β : Helical angle of tool

θ : Sine-bar tilt angle

4-10-1 Example for getting the sine-bar tilting angle by the calculator

case:

Helical angle (β) = 30°

Tool Diameter (D) = 8mm

Find θ ?

Since $\theta = \tan^{-1}(31.75 \cdot \tan \beta / D) \div 2$, the step for the calculator to get θ is

$\boxed{31.75} \boxed{*} \boxed{30} \boxed{\tan} \boxed{=} \boxed{\div} \boxed{8} \boxed{=} \boxed{\text{shift}} \boxed{\tan} \boxed{\div} \boxed{2} \boxed{=}$

The result = 33.21°

4-10-2 Grinding the helical angle

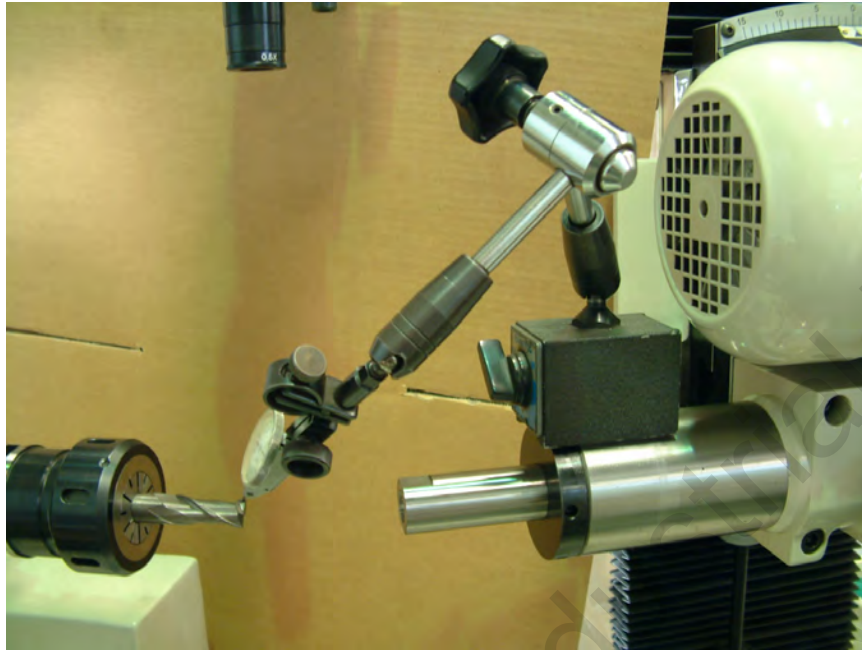
When cutting the helical angle:

1. Set the tool on the spindle.
2. Measure the approximate helical angle (β) of tool and the O.D (D) of the tool.
3. Check table1 and find the approximate θ .
4. Loosen the index pawl latch knob and latch the index plate. Refer to Fig 4-8 and section 4-9-2.
5. Follow the steps described in appendix 1 to adjust the helical angle and get the correct θ .
6. Latchet the tooth.
7. Unclamp the work-head spindle.
4. Move the main slide of work-head.

4-10-3 Get the correct helical angle

How to find the real helical angle of the tool in re-sharpening operation?

Refer to the picture below



Steps:

1. Set the tool on the work-head and the dial meter (with a magnetic seat) on the spindle of the wheel-head.
2. Let the probe of meter touch with the O.D of tool.
3. Adjust the sine-bar angle by following the steps of section ※View the approximate helical angle of tool with your experience .Don't lock the crank
now !
4. Move the main slide of work-head and watch the movement of the probe along the helical angle.
5. Watch the position (relative to the tool) of the probe.
6. Adjust the sin-bar until the probe matched the O.D completely.
7. Lock the crank NOW and do the grinding operation!

4-11 Work-head rotation

The work-head spindle may be rotated by hand or power. Hand rotation is commonly used during set-up; for checking purposes, indexing and variety of cutter sharpening operations. Power rotation is used for cylindrical grinding operations such as “circle” grinding O.D. of cutter teeth prior to the clearance grind, cut-off operations, necking, grooving, and multi-diameter cylindrical grinding.

When **power** rotation is desires:

1. Disengage the index pawl from the index plate at the rear of the work-head

spindle.

2. Unclamp the spindle clamping knob near the front of the work-head and remove the entire blade holder assembly of ratchet from the front of the work-head.

When the **hand** is used:

1. Unclamp the spindle
2. Disengage the ratchet index paw if not used.
3. Disengage the detent index tooth

Now, place the drive belt (supplied with the machine) over the work-head motor pulley and round the front spindle cap. Adjust the belt tension by adjusting the motor bracket on top of the work-head by moving the motor up & down. Lock the bracket in position with the hex bolt in base of bracket. Then replace belt guard before starting spindle rotation. The procedure is like that described in the wheel-head drive and motor (Section 4-15).

The operator controls the starting, and direction of spindle rotation with the pushbuttons and selector switches on the pushbutton control panel on the front of the machine pedestal.

The work-head spindle is driven (power rotation only) by a 1/4 HP motor at approximately 436 RPM.

4-12 Wheel-head Cross Slide

The wheel-head cross slide is supported by the pedestal/bade and is a means of adjusting the grinding wheel in relation to the work. The centerline of the grinding wheel spindle may be moved 183mm in a horizontal plane with the cross slide – from 73mm in front of the center of the work-head turntable pivot point to **110mm** behind it. Each full turn clockwise of the hand-wheel moves the slide **5mm** to the rear (away from the operator). The hand-wheel dial is calibrated in **0.02mm** increments.

An adjustable positive stop is located on the left side of the wheel-head cross slide. After moving the stop to an approximate location, the micrometer adjustment provides an accurate setting for repetitive cross slide positioning. This simplifies returning the slide to its original position whenever it has been moved, or retracted, to the rear.

The cross slide value could be read from the scale (set on the CM2) or the position displayer (CM-A).



Fig 4-11 Stopper of wheelhead cross slide & scale

4-13 Wheel-head Longitudinal Slide

The longitudinal slide is mounted on top of the cross slide and moves at a right angle to it. This slide provides **120mm** of horizontal movement of the grinding wheel – toward or away from the work-head. Control of the slide is by the longitudinal slide hand-wheel whereby each full turn clockwise moves the slide **7.5mm** to the right. The hand-wheel dial is calibrated in **0.03mm** increment.

Two adjustable positive stops are located on the front of the slide. After moving these stops to an approximate location, the micrometer adjustment provides an accurate setting for repetitive positioning and also for accurately limiting the movement in both directions.

The distance moved by the slide could be read on the x-axis of the digital display.

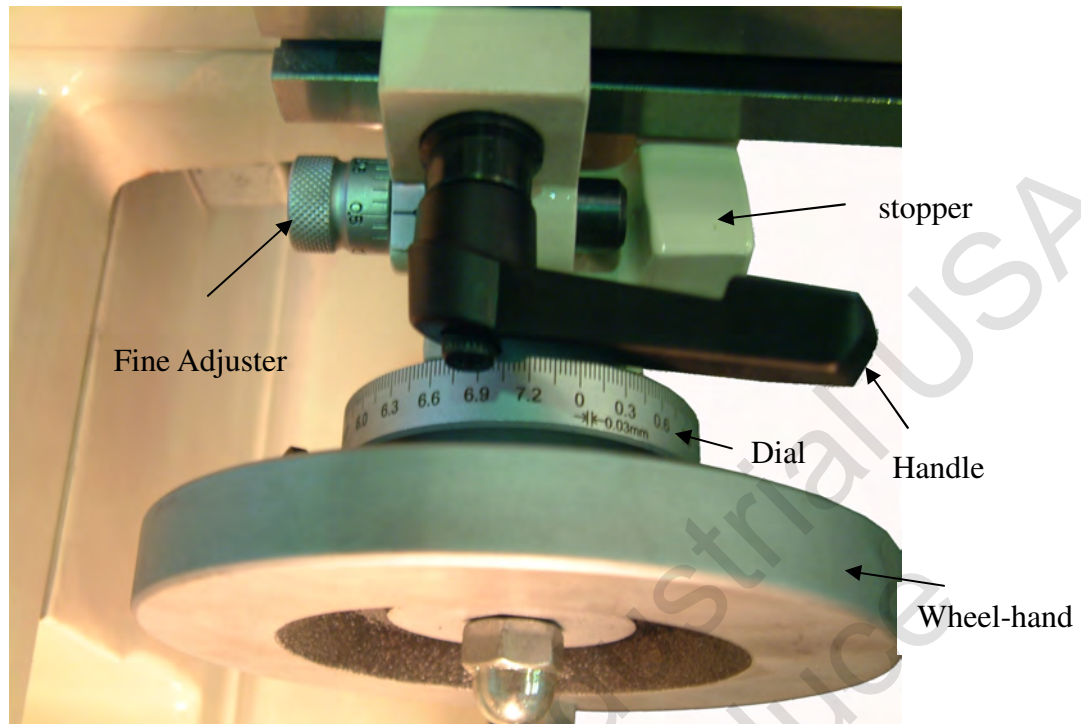


Fig 4-12 Stopper & Hand-wheel of wheel-head longitudinal slide

4-14 Wheel-head Vertical Slide

The vertical slide is mounted on the column portion of the longitudinal slide unit. This slide carries the grinding wheel spindle drive motor and spindle housing complete with spindle has **220mm** of movement on the face of the column. This movement is **104mm** above and **116mm** below, the centerline of the work-head spindle. Control is by the vertical slide hand-wheel whereby each full turn clockwise moves the slide upward **2mm** the hand-wheel dial is calibrated in **0.02mm** increments. See Fig 4-13.

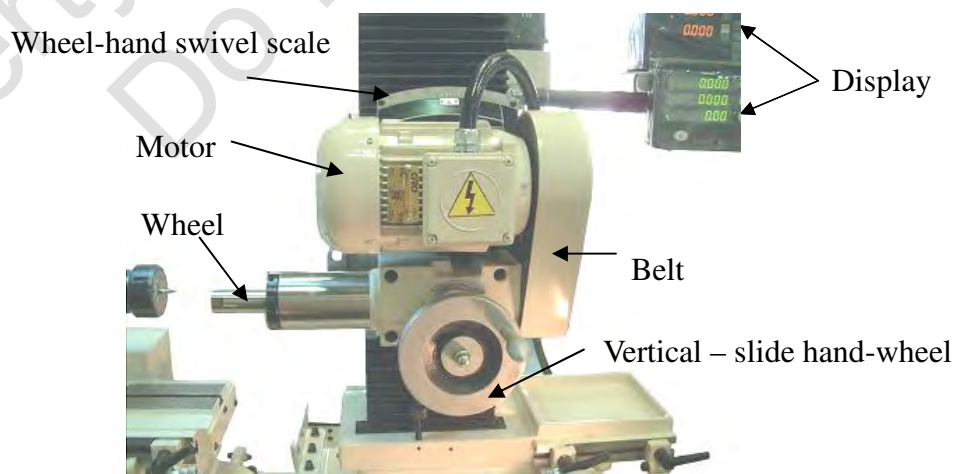


Fig 4-13 Motor and spindle of wheelhead

A micrometer stop, for accurately positioning the vertical slide is located beneath the spindle housing. Rough setting is by a pair of adjustable knurled nuts on the stationary vertical screw. See Fig 4-14.



Fig 4-14 Vertical slide adjusting nut

The upper nut is the stop nut, and the lower nut locks the stop nut in position. The final setting and accurate adjustments are made by the adjustable sleeve, fitted with a **0.02mm** graduated micrometer dial, attached to the bottom of the spindle housing. When the vertical slide is positioned. Adjust the stop nuts within 1/4 inch of the micrometer as a safety precaution. (See warning.)

Warning

When adjustment of the vertical slide is achieved during set-up. The micrometer stop nuts should be positioned within 6mm or less of the micrometer dial (see Fig 4-14).

By keeping the stop nuts close to the micrometer dial, they tend to catch the wheel-head. Should the elevating mechanism fail for any reason.

The up-down label was shown in Fig 4-15 and the vertical scale was shown in Fig 4-16.



Fig 4-15 Vertical slide up – down label.
C.W to UP and C.C.W to DOWN



Fig 4-16 Vertical slid scale

The step to set the distance of vertical slide:

1. Turn the micrometer sleeve(a hollow cylinder with scale) C.C.W to make the stopper extruded a little and make the sleeve be on the base line. Use the stopper and the nut to set the distance , not the sleeve.
 2. Set the rough distance with the hand-wheel. The distance could be read from the scale.
 3. Adjust the sleeve for the precision distance.
 4. Tighten the 2 nuts on the lead screw.
- ※The fine adjustment may not be over **6mm**. It must be less than the amount of the micrometer sleeve.

4-15 Wheel-head Drive and Motor

The grinding wheel spindle is driven by a single “V” belt between the pulleys of the spindle and motor. Each pulley has 3 steps that provide a selection of spindle speeds – 3850, 5560, or 7200 R.P.M. Loosening the hex bolts on the motor seat in changing/adjusting the belt.

4-16 Wheel-head tilt (CM-A only)

It is really helpful for tilting the wheel-head in some grinding operation—especially in helical angle grinding. The reason is this kind of grinding is like the lathe cutting---move the tool with the work-piece chucked.

In tilting operation, you must loosen the hexagonal socket-head bolt first and then tilt the wheel-head by hand. Be careful to hold the wheel-head by the hand to prevent it from falling down .The tilt angle is 15 degrees. See Fig. 4-17and 4-18.

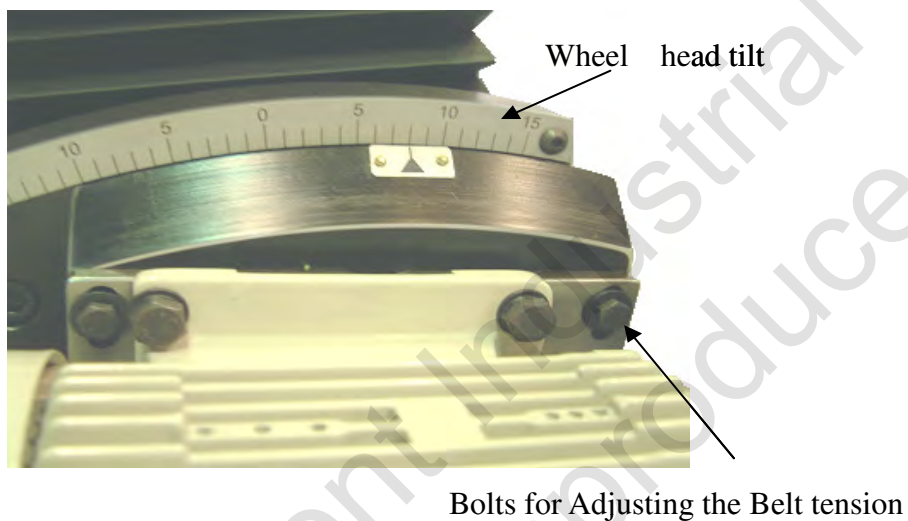


Fig 4-17 Wheel-head tilt device

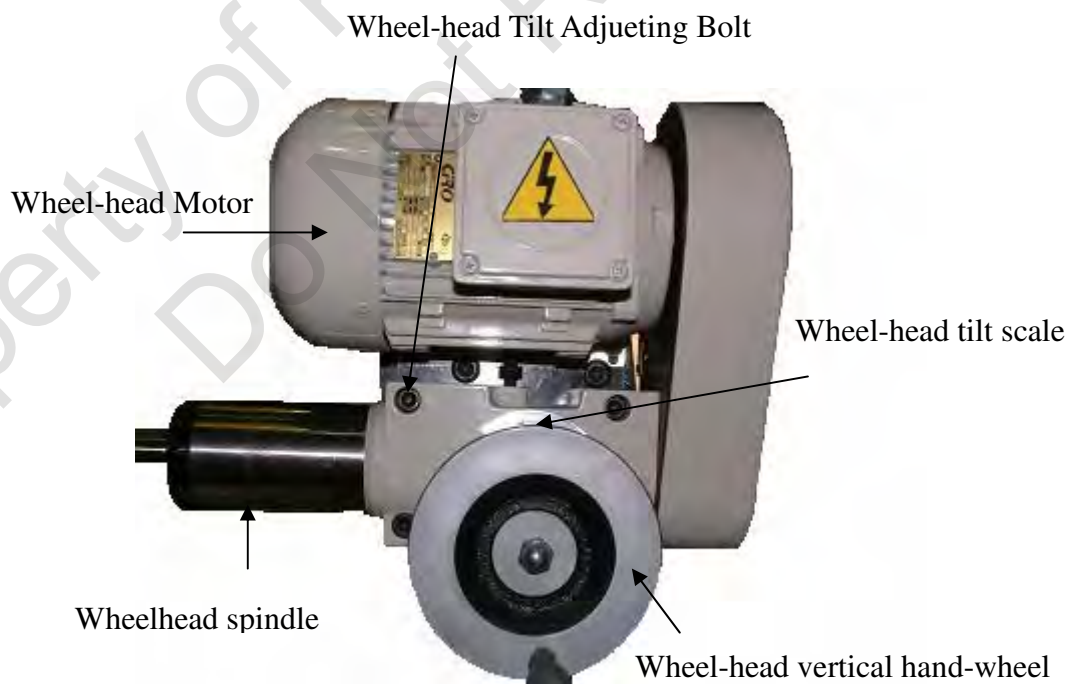


Fig 4-18 Wheel-head tilting

4-17 Synthesis of axis control

Work-head:

| | Motion | Range | One turn movement & increment | Direction of clamp |
|---|--------------|-------------|--|--------------------|
| 1 | Tilt | -40° ~ +40° | 1° | C.W (2 clampers) |
| 2 | Main - slide | 140mm | Front wheel End wheel | C.W C.C.W |
| 3 | Off – set | 133mm | Fest wheel: 1.5mm, 0.02mm Micro wheel: 0.3mm, 0.002mm | C.W C.W |
| 4 | Turn table | 235° | 1° | C.W |
| 5 | Spindle | 436 R.P.M | | C.W |

Wheel-head:

| | | | | |
|---|-------------------------------|-------------|---------------|-----|
| 1 | tilt | -15° ~ +15° | 2mm, 0.02mm | C.W |
| 2 | Longitudinal (x axis) | 120mm | 7.5mm, 0.03mm | |
| 3 | Main – slide (cross) (y axis) | 183mm | 5mm, 0.02mm | |
| 4 | Vertical – slide | 220mm | 2mm, 0.02mm | |
| 5 | Tilt | -15° ~ +15° | 1° | |

※ one of the main-slide clamping screws of work-head must be locked for sliding. If both of them are loosen, the slide will not be moved and both of hand-wheels will be rotated.

※※How to move the work-head/wheel-head to the horizontal level?

Steps:

1. Set the micrometer as section 4-10-3.
2. Set a steel rod (120mm long with 0.003mm roundness accuracy) on the work-head/wheel-head.
3. Slide the wheel-head left and right, back and forth to measure the horizontal level on the both ends of the rod.

Chapter 5 Lubrication instructions & maintenance

5-1 Introduction

Long, useful machine life and continued accuracy of performance rely largely upon dependable lubrication. So it is essential that the operator be familiar with the requirements of the lubrication system and be sure the machine is lubricated routinely according to recommendations. Of course, initial lubrication when machine is installed is very important and must not be neglected.

5-2 Lubrication information

Below is a chart of the service areas that must be attended and supplied with the grades of lubricant which meet recommended specifications. Also refer to the Figure 5-1 that shows the lubrication service device

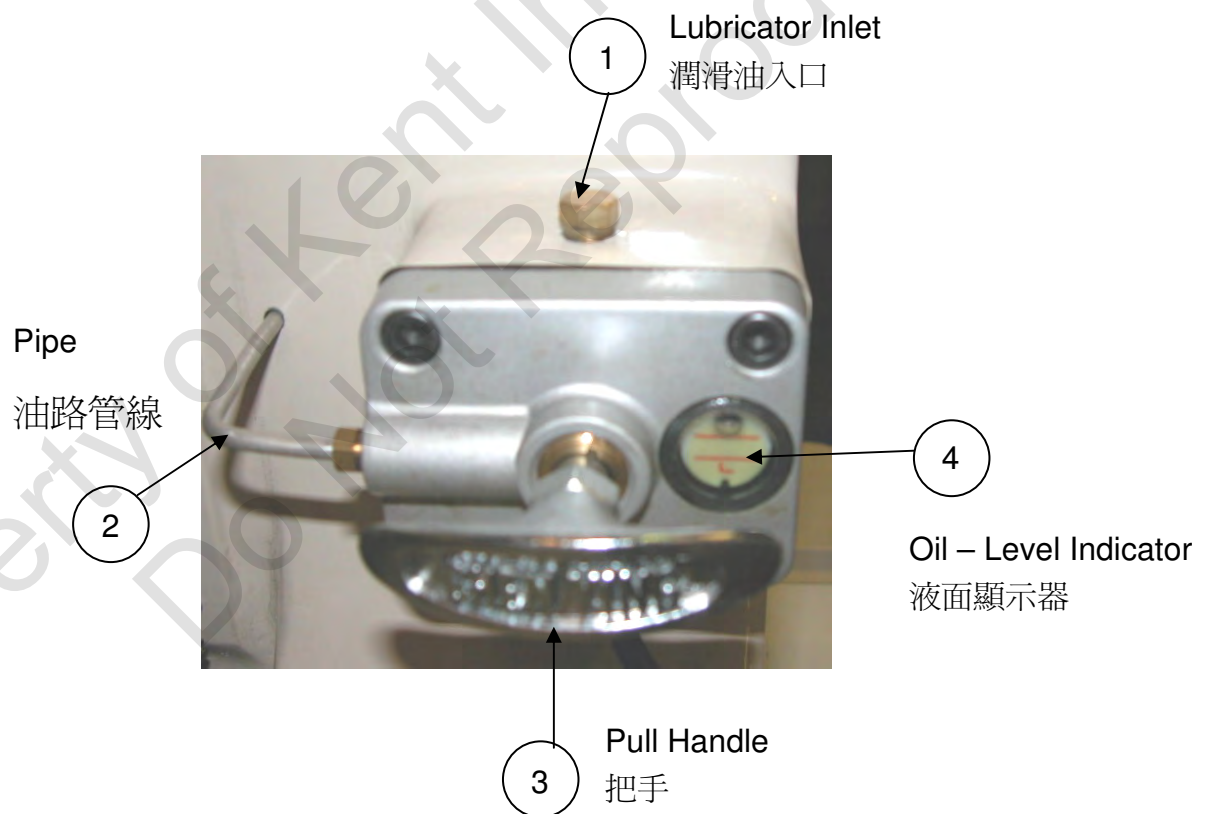


Figure 5-1 The lubrication service device

There are 2 lubricating inlets in the CM-2 machine. One is used for lubricating the

work-head and the other one is for the wheel-head. The work-head inlet is located in the lower-left (front side) of the machine and the wheel-head inlet is located in the right side of the machine. All moving slides of the machine will be lubricated automatically through the lubricating system. The specified lubricator could be injected to the reservoirs by the inlet. For a longer life of the machine, be sure the lubricator is new and clean. The oil level must be between two horizontal lines of the level indicator. Check the oil level before your daily operation.

For additional information on lubrication specifications see the latest issue of China petroleum Corp. Lubricant manual.

| Interval | Parts lubricated | Instructions |
|---------------------|--|---|
| Daily (8 hours) | All wheel-head slides and lead screws. | Pull handle out to limit of stroke, allow to return by itself. Keep reservoir filled. |
| | All work-head slides and lead screws. | Same as station 1. |
| Monthly (160 hours) | Work-head spindle. | Add 10 drops only with bench oiler. |

Lubrication information (Continued)

When filling the reservoirs, and when lubrication the various lube stations, be sure to use new, clean oil. Fill with perfect clean oil from a clean container and use only clean equipment. Fill with oil that meets #68 of Chinese Petroleum Corp. specifications.

| Inspection items | | Per day | Per week | Per month | Per 3 month | Half year | Per year |
|------------------|---|---------|----------|-----------|-------------|-----------|----------|
| lubrication | Injective lubrication handle | ○ | | | | | |
| | Turning part of work-head | | ○ | | | | |
| | Work-head pinion gear & gear rack | | | ○ | | | |
| | Angle-adjusting seat worm gear & bearing | | | | ○ | | |
| | Wheel-head pinion gear & gear rack | | | ○ | | | |
| | Sand wheel seat spindle transmission part | | ○ | | | | |
| | Turntable (cotter, fixed handle) | | | | ○ | | |
| | Hand wheel tuning part | | ○ | | | | |

| | | | | | | | |
|-----------|---|---|---|---|---|---|---|
| | Oil level inspection | ○ | | | | | |
| Cleaning | Working table (slide surface) | | ○ | | | | |
| | Interior parts (leading screw, bearing) | | | | | ○ | |
| Mechanism | Slide block & slide rail loosening inspection | | ○ | | | | |
| | Transmission belt loosening inspection | | | ○ | | | |
| | Spindle loosening inspection | | | ○ | | | |
| | Pinion gear & gear rack of work-head | | | | | ○ | |
| | Leading screw loosening inspection | | ○ | | | | |
| | Pinion gear & gear rack pf work-head | | | ○ | | | |
| | Slide scraper wearing inspection | | | | ○ | | |
| | Slide gib & surface wearing inspection | | | | ○ | | |
| Electrics | Electric apparatus inspection | | | | | ○ | |
| | Wiring (joints) inspection | | | | | | ○ |

Table 2 Machine Inspection Table

Chap 6 The Inspecting system of CM-A

The inspecting system includes: microscope, CCD camera, and monitor. The microscope was used to enlarge the image, the CCD camera was used to capture the image and the enlarged image was show on the monitor .the system made it convenient in are checking, cutting edge detection, and tool-cracking once the tool was ground. Also, it could be applied in searching the center of the tool before grinding.

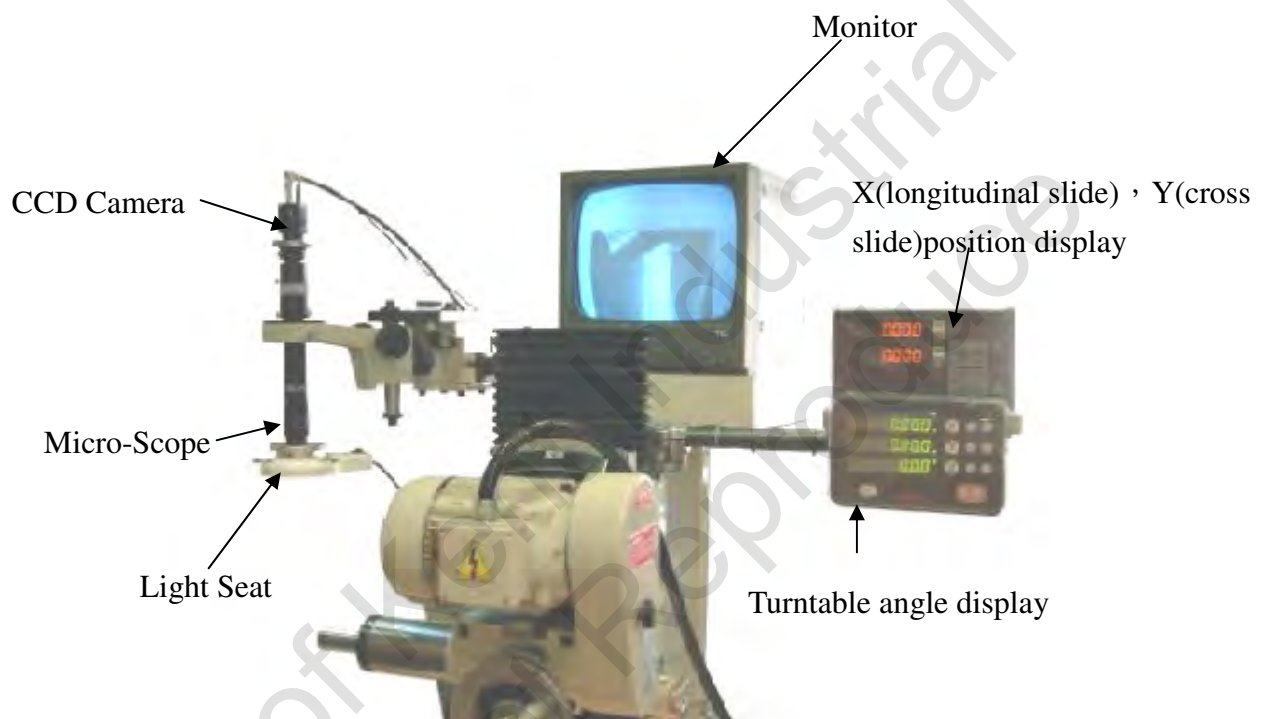


Fig 6-1 The Inspecting system of CM-A

6-1 The Capturing Device & Elements

The capturing Device includes:

- ① The CCD camera: Capture the enlarged image.
- ② The scale line adjuster (3 pieces): Adjust the focus and left-right position of scale line (semi-circle concentric) .
- ③ Tool (work-part) image adjuster (3 pieces): Focused and positioned the left-right & up-down of the tool (work-part) image only.
- ④ Lumen Adjuster: Sleeve for adjusting the lumen of image.
- ⑤ Microscope Len: The Len to enlarge the picture and protects the telescope.
- ⑥ Lens Zooming: To enlarge the image.

- ⑦ Focus adjustment clamp of scale line: Adjust the width of the scale line only by loosening the screw line and then moving it up and down.
- ⑧ Up-Down assembling set: The device for adjusting and holding the whole column of the inspecting system. It also connected the inspecting system with the CM-2 frame.
- ⑨ The linking sleeve: To link the upper parts and the lower parts and the inspect system.
- ⑩ Scale changer: Rotate to open and to change the scale lens.

Please refer to Fig 6-2 .The number indexed in the picture is accordance with the number described above.

The detail of the device could refer to Fig 6-3.The function of the number is the same as described in Fig 6-2.

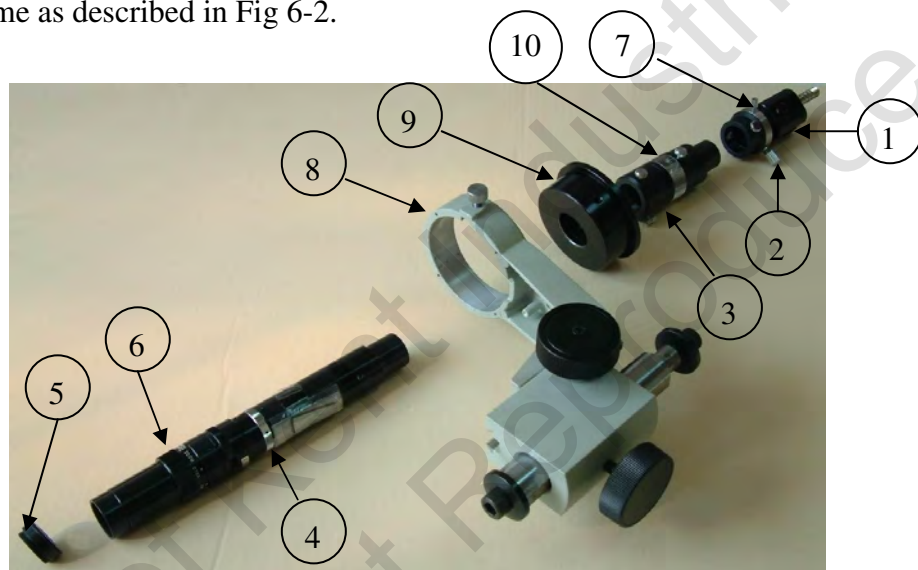


Fig 6-2 The individual part of the inspecting system

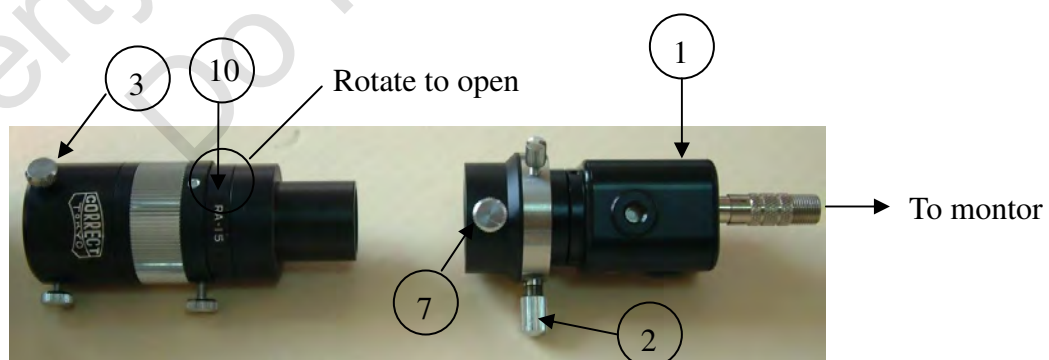


Fig 6-3 The upper unit of the inspecting system

The half-assembled picture is shown in Fig 6-4.

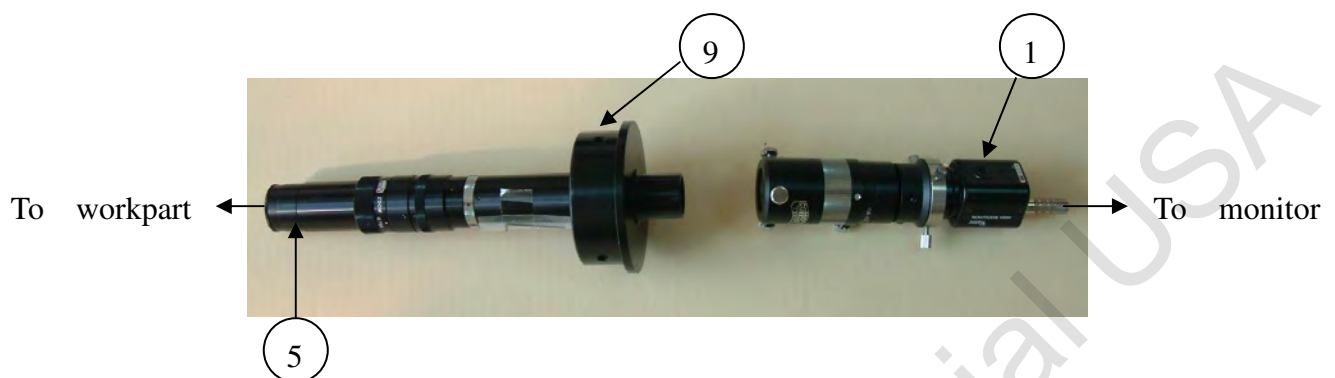


Fig 6-4 Half-assembled of the capturing system

The detailed picture of part ⑧ in Fig 6-2 is showed in Fig6-5

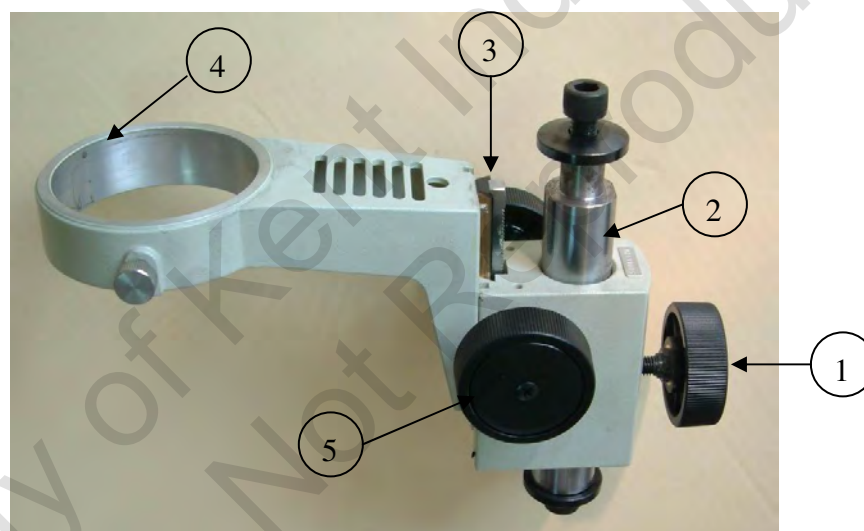


Fig 6-5 Up-Down assembling set

The function of each part of the assembling set is:

- ① Knob1: To clamp part ② when the height of part ② was set.
- ② Major up-down column: To connect the inspecting system with the machine frame.
- ③ Rack: To move the set slowly.
- ④ Sleeve: To hold the capturing system (Part 9 in Fig 6-4).
- ⑤ Knob2: To clamp part ③ of Fig 6-5 when the height of the device is set already .

The entire assembly of Fig 6-2 was shown in Fig 6-6

※ The lowest element in Fig 6-6 is a light seat. It is used to set the light on for illuminating the work-part.



Fig 6-6 The entire assemble of the capturing system.

The detailed function of each part of the inspecting system is discussed in the following section.

6-1-1 CCD camera

The function of CCD camera was to capture the image enlarged by the telescope. There are 3 sizes for CCD camera: 2/3", 1/2", and 1/3".

The zoom ratio of them is:

2/3 ": 28

1/2": 39

1/3": 51

6-1-2 The entire picture Adjustment

The adjusting of the semi-circle scale line to the center of monitor is :

Adjust (left and right, up and down) the whole picture by adjusting the 3 adjuster (part ② in Fig 6-3). Until the image is on the center of the monitor.

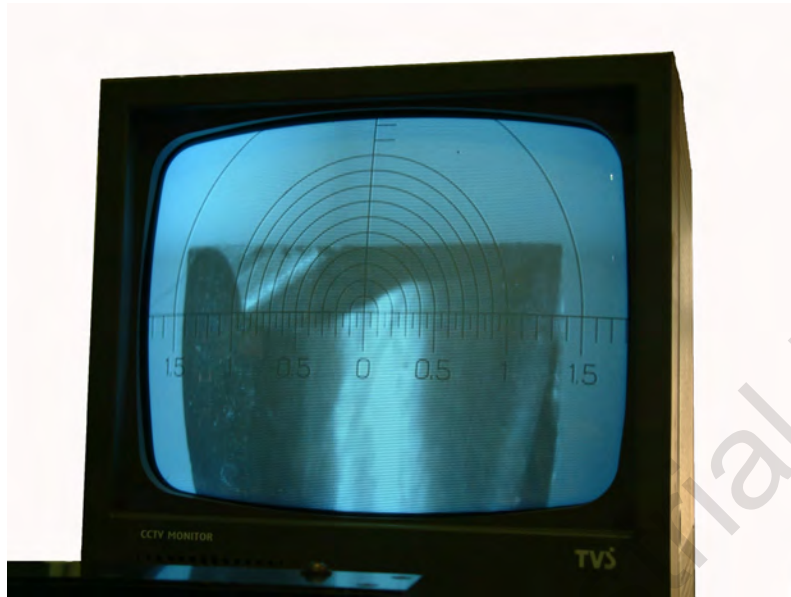


Fig 6-7 The whole picture on the monitor

6-1-3 Adjusting the tool image

The adjuster could be used to adjust “only” the tool position on the monitor.

6-1-4 Lumen Adjustment

The metallic ring was used to Adjust the lumen of image.

6-1-5 Microscope Lens:

The lens to get the image with its unique enlarge ratio. The enlarge ratio of CV_0.5 is 0.5.

6-1-6 Zoom & Focus of the lens

The Focus and enlarging ratio of the tool could be adjusted by this ring. The zoom ratio for ms-501 is 0.75~4.5.

6-1-7 Scale line Focus adjusting

The steps for this adjustment are:

1. Loosen part ⑦ of Fig 6-2.
2. Pull the whole upper column(part ①) up and down to adjust the focus of the scale Line.
3. Clamp part ⑦ of Fig 6-2

6-1-8 The calculator of the enlarged ratio

The total enlarged ratio (R) equal:

$$R = (\text{electronic Ratio}) \times (\text{optical ratio})$$

The optical Ratio includes: ⑤ Lens ratio, ⑥ Zooming Ratio, and ⑦ Scale Line Focus Adjusting.

※ ⑤,⑥,⑦ are the number in Fig 6-2

The electronic ratio is the CCD ratio. Its ratio depends on the size of CCD camera we use .the relationship between the CCD size and the ratio is:

$$1/2"= 39$$

$$2/3"= 28$$

$$1/3"= 51$$

If we use ⑤ CV-0.5(Ratio 0.5), ⑥ MS-501(Ratio 0.75~4.5) and ⑦ RA-15(ratio 1.5) for microscope and the CCD will be 1/2". The result ratio (R) is:

$$\text{Min R}=[(0.5) \times (0.75) \times (1.5)] \times (39)=21.84$$

$$\text{Max R}=[(0.5) \times (4.5) \times (1.5)] \times (39)=131.6$$

6-2 The display of the image

The image captured by the inspecting system will be displayed on the monitor. **Steps to install the display are:**

1. Connect the electric wire for the inspecting system and the monitor. The connectors are located at the back of the monitor and are all shown in Fig 6-8.



Fig 6-8 The inspecting system connectors

The enlarged picture of the 2 connectors located in the middle of Fig 6-8 is shown in Fig 6-9.

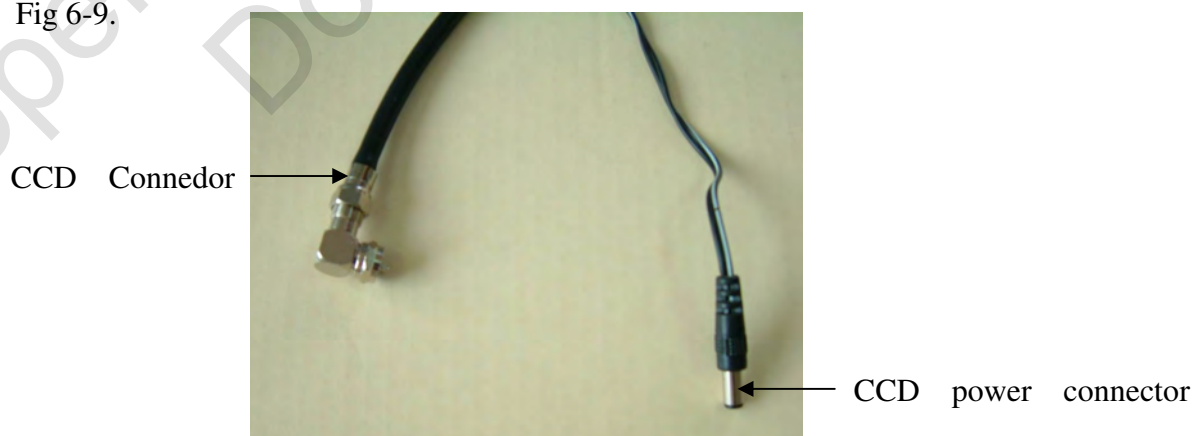


Fig 6-9 The CCD connector & the CCD power connector

The left connector is connected to the CCD camera the other end is connected to the “IN” socket of the monitor. The right one is connected to the CCD power (DC 12v) .The enlarged picture of the connectors of monitor is showed in Fig 6-10.



Fig 6-10 The connectors of monitor

The function of each connector in the picture is (From left to right): monitor power source (INPUT) and CCD image transferred to the monitor (IN).

※ The “OUT” and the “AUDIO” connectors are neglected.

3. Turn the monitor source power ON, and the scale line (semi-circle) will be shown as Fig 6-7.

4. Adjust the focus of image.

6-3 The adjusting of the entire image (scale line & the tool) on the screen.

Refer to Fig 6-3

Steps:

1. Loosen part ⑦.
2. Pull part ① up & down to focus the scale line. Fasten part ⑦ if the line is clear enough.
3. Rotate the 3 bolts of part ② to adjust the scale line at the appropriate position for inspecting the tool.
4. Loosen part ③ and rotate the column. The tool image will be also rotated.
5. Set the image of the tool cutting edge parallel with the X axis of scale line.

6. Fasten part ③.
7. The correct position of the tool relative to the scale line could refer to Fig 6-7.

6-4 Adjusting the center of tool at the center of the inspecting system

The purpose for adjusting the center of tool at the center of inspecting system is to make the grinding task easier in the first cut. Yet the adjusting is quite different in the different operation. The general principle is just described in this section.

6-4-1 Principle for adjusting the center of the tool: -**Lath tool** sampled
Refer to Fig 6-11----the mechanism of the inspecting system.

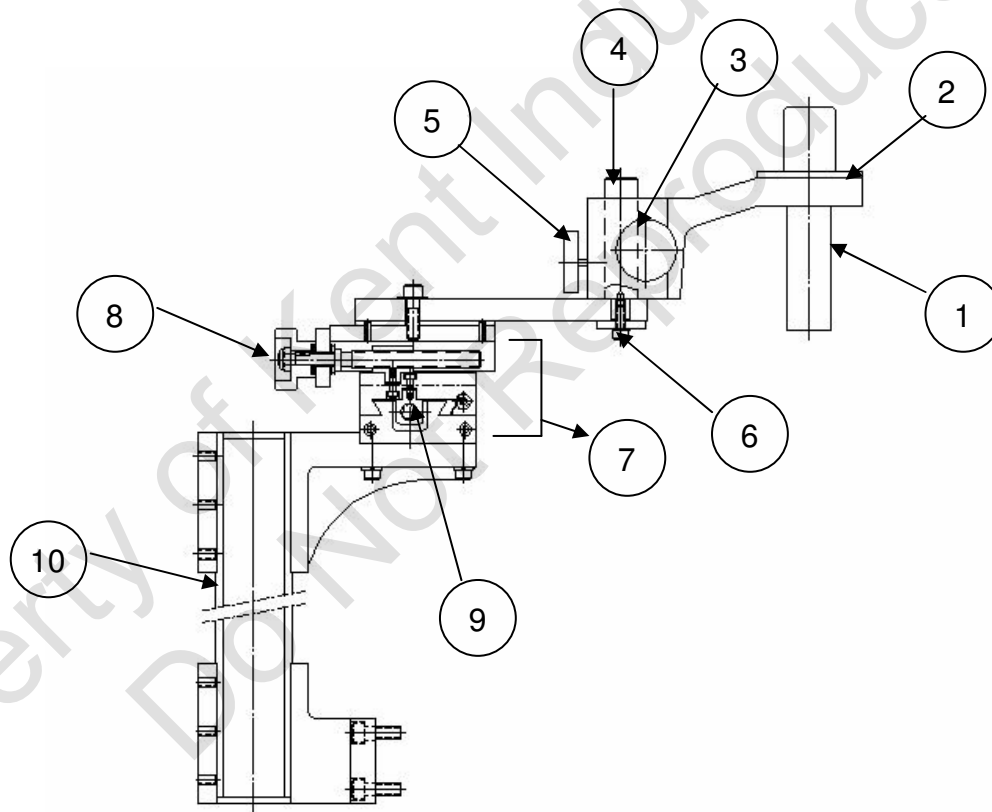


Fig 6-11 The whole structure of inspection system

The parts of Fig 6-11 is described below:

1. Inspecting device: CCD camera with the microscope and lens.
2. Holder: To hold part 1 and link itself with part 7 by the part 4 and part 6. The part 1 here is the same as part 8 in Fig 6-2.

3. Adjusting knob: Adjust the rack to move part 2 up and down.
4. Stepped column: Link part 2 with part 7. The same as part 2 in Fig 6-5.
5. Adjusting knob: Loosen part 5 may move and rotate part 2 quickly.
6. Bolt: Fasten/loosen part 4.
7. Joint set: Set the rough position of part 1 easily and quickly.
8. Adjusting knob: Fine adjust of the whole image.
9. Adjusting knob: Fine adjust of the whole image.
10. Column: Joint the whole mechanism of the inspection system with the CM-2 machine frame.

6-4-2 **The steps for Assembling the whole inspecting system**

1. Assemble the CCD camera and the microscope as described in section 6-1.
2. Put part 4 (stepped column) into part 2 (holder) and then fasten part 6 (bolt) in Fig 6-11.
3. Put part 1 (inspecting device) into part 2 (holder) by loosening the screw located on part 4 (sleeve) of Fig 6-5 and then fasten the screw.

6-4-3 **The steps for Adjusting the center of tool at the center of the inspecting system**

1. Set the lens of inspecting system to be above the tool by moving the part 7 of Fig 6-11.
2. Locate the tool at the approximate center of scale line by following the steps of section 6-3
3. Move the turntable C.W & C.C.W to see the rotation center of tool and the distance between the tool and the X axis of scale line. See (A) and (B) in Fig 6-12.

In this case, the distance between the horizontal line and the X is not the same in (A) and (B).

4. Adjust the tool position by the turntable until the distance is the same. Picture (D) and (E) shows that the center is set O.K already. Picture (C) shows that the tool is biased along axis Y, yet it is O.K in this set-up.

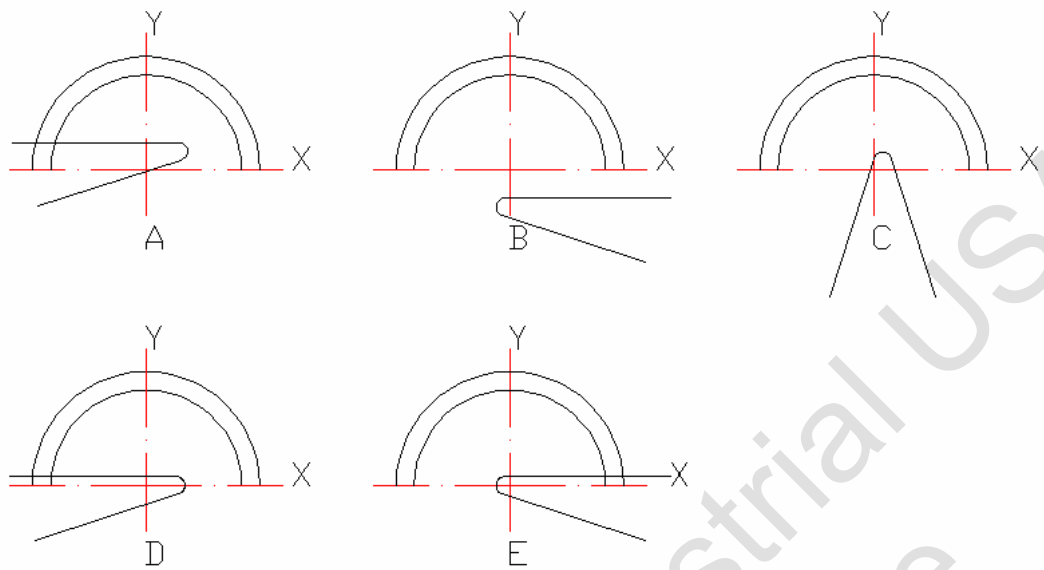


Fig 6-12 Adjust the center of tool

The incorrect center of the lathing tool is shown in A and B of Fig 6-12. The distance between the cutter edge and the axis X is not the same in these 2 pictures and the distance is the same as shown in picture (D) and (E).

6-4-4 **The steps for Adjusting the center of CCD camera at the center of the inspecting system**

1. The tool is not balanced in axis Y (picture F of Fig 6-12), adjust the tool to the approximate center by rotating knobs located on the seat until the tool looks like picture G (balanced in axis Y) of Fig 6-13 .

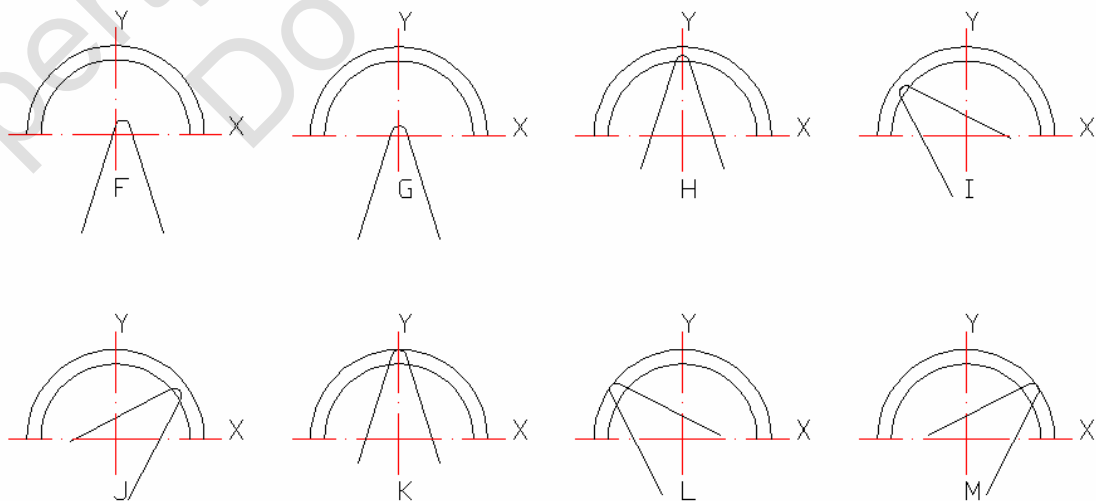


Fig 6-13 The CCD center adjusting

The adjusting knobs could be referred to part 8 and 9 of Fig 6-11.

2. Adjust the cross slide and the main slide of work-head until the center of tool looks like picture H of Fig 6-13. The tip of tool is extruded a little in picture H and the distance is balanced in axis Y.
3. Swivel the turntable to see if the tool is balanced in the inner circle. Refer this to J and K of Fig 6-13.
4. Adjust the cross slide and the main slide of work-head until the arc of tool contact the outer circle. Swivel the turntable to see if the tool is balanced in the outer circle. Refer this to L and M of Fig 6-13. The Source power socket and the adjusting knobs are shown in Fig 6-14.

Fig 6-14 shows the picture of the connectors and the adjusting knobs. It is displayed here for readers to recognize the inspecting device easier.

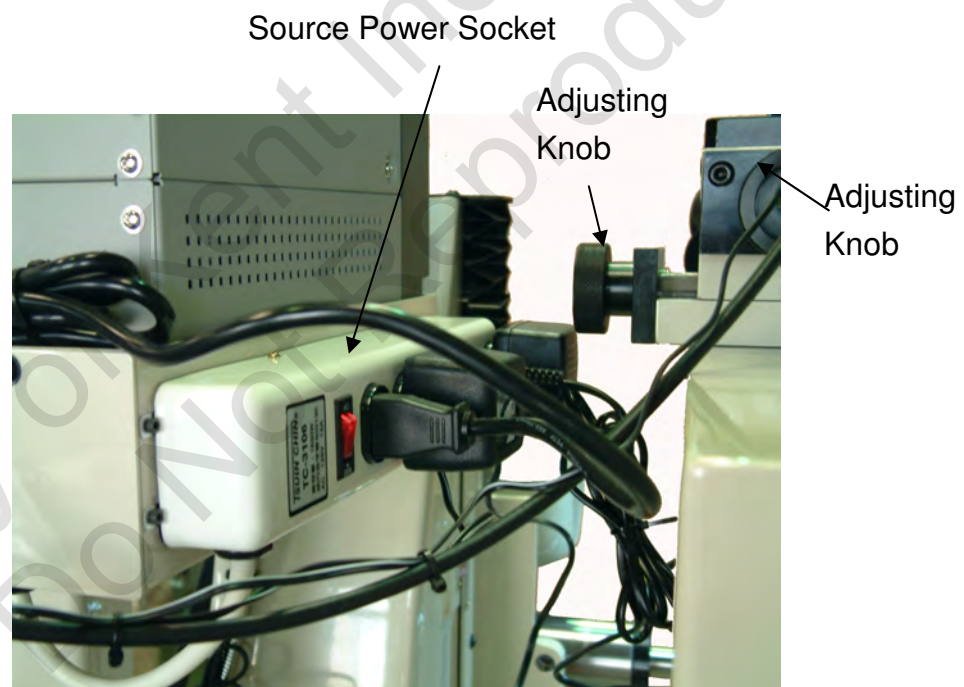


Fig 6-14 Image adjusting knob

Appendix 1 Part-list of CM-A

| (CM-A) A. Workhead (1/2) | | | | | | | |
|--------------------------|----------|-------------------------|------|---------|----------|---------------------|------|
| Ref No. | Part No. | Part Name | Q'ty | Ref No. | Part No. | Part Name | Q'ty |
| 1 | C-5025 | Spindle screw nut | 1 | 33 | | Hex. socket screw | 4 |
| 2 | | Pin | 1 | 34 | C-5006 | Collet head ring | 1 |
| 3 | C-6041 | Index ring | 3 | 35 | C-5005 | Chuck screw nut | 1 |
| 4 | C-5024 | Index ring coupled seat | 1 | 36 | C-5028 | Belt wheel guard | 1 |
| | | | | 37 | | Round head screw | 2 |
| 5 | | Hex. socket screw | 4 | 38 | C-6017-a | Adjusting screw nut | 1 |
| 6 | C-5018 | Index ring seat | 1 | 39 | | Pin | 1 |
| 7 | C-5017 | Bearing screw nut | 1 | 40 | C-6116 | Slide seat | 1 |
| 8 | | Pin | 1 | 41 | C-6017-b | Adjusting screw | 1 |
| 9 | C-5019 | Spring | 1 | 42 | C-6118 | Upper r slide seat | 1 |
| 10 | C-5020 | Pawl | 1 | 43 | C-6119 | Cutter rack | 1 |
| 11 | C-5023 | Pawl fixing screw seat | 1 | 44 | C-6121 | Controls plate | 1 |
| | | | | 45 | | Fixing screw | 1 |
| 12 | C-5022 | Pawl fixing screw | 1 | 46 | | Workhead motor | 1 |
| 13 | | Bearing | 3 | 47 | | Fixed screw | 1 |
| 14 | C-5016 | Bevel gear | 1 | 48 | C-5030 | Belt wheel | 1 |
| 15 | C-5001 | Workhead | 1 | 49 | | Belt(15FLS30) | 1 |
| 16 | C-5026-a | Workhead fixing block | 2 | 50 | | Hex. bolt | 1 |
| | | | | 51 | | Flat washer | 1 |
| 17 | | Clamping lever | 2 | 52 | C-5027 | Motor support | 1 |
| 18 | | Flat washer | 2 | 53 | | Hex. bolt | 3 |
| 19 | C-5026-b | Workhead fixing level | 2 | 54 | | Flat washer | 3 |
| | | | | 55 | C-5014 | Bevel gear shaft | 1 |
| 20 | C-5009 | Clamping lever | 1 | 56 | C-5015 | Bevel gear | 1 |
| 21 | | Hex. socket screw | 1 | 57 | C-5002 | Workhead cover | 1 |
| 22 | | Oil cover | 2 | 58 | | Hex. socket screw | 4 |
| 23 | C-5012 | Lock nut | 1 | 59 | | Round head screw | 3 |
| 24 | | Bearing | 1 | 60 | C-5029 | Lock rod | 1 |
| 25 | C-5011 | Bearing washer | 1 | 61 | C-6040 | Workhead strut | 1 |
| 26 | | Spring | 6 | 62 | | C-ring | 1 |
| 27 | C-5008-b | Fixed ring | 1 | 63 | | Hex. socket screw | 2 |
| 28 | C-5007 | Spindle fixed ring | 1 | 64 | C-5013 | Collar | 1 |
| 29 | C-5008-a | Fixed nut | 1 | 65 | C-5021 | Collar | 1 |

| | | | | | | | |
|----|--------|------------------|---|----|----------|-------------------|---|
| 30 | C-5003 | Workhead spindle | 1 | 66 | | Pin | 1 |
| 31 | | Key | 1 | 67 | C-5027-2 | Motor fixed plate | 1 |
| 32 | C-5004 | Index ring | 1 | 68 | | Washer | 1 |

| (CM-A) A. Workhead (2/2) | | | | | | | |
|--------------------------|----------|-------------------|------|---------|----------|-----------|------|
| Ref No. | Part No. | Part Name | Q'ty | Ref No. | Part No. | Part Name | Q'ty |
| 69 | | Hex. socket screw | 1 | | | | |
| 70 | C-5027-1 | Motor fixed plate | 1 | | | | |
| 71 | C-6041 | Index ring | 1 | | | | |
| 72 | | Hex. socket screw | 1 | | | | |
| 73 | | Hex. head nut | | | | | |
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(CM-A) B. Turntable and middle seat

| Ref No. | Part No. | Part Name | Q'ty | Ref No. | Part No. | Part Name | Q'ty |
|---------|----------|---|------|---------|----------|------------------------------|------|
| 1 | C-2003 | Turntable base | 1 | 32 | | Bearing | 2 |
| 2 | | Fixed ring | 1 | 33 | C-3107 | Fixing screw nut | 1 |
| 3 | | Bearing | 3 | 34 | | Fixing screw | 1 |
| 4 | C-2005 | Turntable shaft | 1 | 35 | C-3106 | Leading screw | 1 |
| 5 | C-2002 | Index ring | 1 | 36 | | C-ring | 1 |
| 6 | C-2001 | Turntable | 1 | 37 | | Set screw | 2 |
| 7 | C-3101 | Middle seat of turntable | 1 | 38 | | Oil Cover | 1 |
| | | | | 39 | C-5126 | Slide pin | 2 |
| 8 | C-3104 | Bevel gear | 1 | 40 | | Adjusting screw of slide pin | 4 |
| 9 | C-3102 | Gear fixed rack | 1 | | | | |
| 10 | C-3107 | Shaft | 1 | 41 | | Guard | 1 |
| 11 | | Bearing | 4 | 42 | | Hex. socket screw | 12 |
| 12 | C-4015 | Hand wheel | 2 | 43 | | Hex. socket screw | 2 |
| 13 | C-3110 | Screw rod | 1 | 44 | C-2010 | Locating pin stop block | 2 |
| 14 | C-3112 | Worm gear | 1 | | | | |
| 15 | | Bearing bush | 2 | 45 | C-2012 | Locating block | 2 |
| 16 | C-3113 | Thrust block seating | 1 | 46 | | Fixing screw | 1 |
| 17 | C-3115 | Hinge speed forward & backward Index ring | 1 | 47 | C-2011 | Adjusting screw | 2 |
| | | | | 48 | | Hex. socket nut | 4 |
| 18 | C-3114 | Hinge speed forward Backward hand wheel | 1 | 49 | C-2009 | Fixing rod | 1 |
| | | | | 50 | | Pin | |
| 19 | C-3116 | Cover | 2 | 51 | C-2008 | Fixing handle | 1 |
| 20 | C-3117 | Handle | 1 | 52 | C-2007 | Bearing cover | 1 |
| 21 | C-4017 | Handle | 2 | 53 | C-2006 | Bearing fixing nut | 2 |
| 22 | C-3119 | Worm gear | 1 | 54 | | Bearing | 1 |
| 23 | | Key | 1 | 55 | | Fixing screw | 2 |
| 24 | | Bearing | 2 | 56 | | Key | 1 |
| 25 | C-3118 | Fixing toggle | 1 | 57 | | Screw nut | 2 |
| 26 | C-3120 | Index ring | 1 | 58 | | Hex. socket screw | 4 |
| 27 | C-3121 | Micro adjusting | 1 | 59 | | Hex. socket screw | 4 |

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|----|--------|--------------------|---|----|--------|------------------|---|
| | | hand wheel | | 60 | | Key | 2 |
| 28 | C-3031 | Handle fixed screw | 1 | 61 | C-3122 | Slide stop block | 1 |
| 29 | | Bearing | 1 | 62 | C-3111 | Screw nut | 1 |
| 30 | | Oil filler | 1 | 63 | | Fixing screw | 1 |
| 31 | C-3105 | Bevel gear | 1 | | | | |
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(CM-A) C. Angle-adjusting seat and upper seat

| Ref No. | Part No. | Part Name | Q'ty | Ref No. | Part No. | Part Name | Q'ty |
|---------|----------|------------------------------|------|---------|----------|--------------------|------|
| 1 | C-5101 | Workhead base | 1 | 25 | C-5110 | Rake guide plate | 2 |
| 2 | C-5128 | Rake guide plate | 1 | 26 | C-5109 | Rake guide plate | 1 |
| 3 | C-5130 | Teeth rake guide plate | 1 | 27 | | Key | 1 |
| | | | | 28 | C-5109 | Worm gear | 1 |
| 4 | | Set screw | 1 | 29 | C-5107 | Workhead rake seat | 1 |
| 5 | | Hex. socket screw | 6 | 30 | C-5117 | Fixing rod | 1 |
| 6 | | Pin | 4 | 31 | C-5118 | Handle | 1 |
| 7 | C-5105 | Gear rack | 1 | 32 | C-5112 | Turning worm gear | 1 |
| 8 | | Bearing | 1 | 33 | C-5114 | The joint | 1 |
| 9 | | Bearing | 1 | 34 | | Pin | 1 |
| 10 | C-5106 | Slide block shaft | 1 | 35 | C-5115 | Handle | 1 |
| 11 | | Needle bearing stat | 2 | 36 | | Fixed screw | 1 |
| 12 | | Packing piece | 1 | 37 | C-5116 | Index table | 1 |
| 13 | | Screw nut | 1 | 38 | | Fixed screw | 1 |
| 14 | C-5129 | Guard | 1 | 39 | | Fixed screw | 1 |
| 15 | | Hex. socket screw | 4 | 40 | C-5111 | Index table | 1 |
| 16 | C-5104 | Handle | 1 | 41 | | Screw | 3 |
| 17 | C-5103 | Cover | 1 | 42 | C-5125 | Slide block | 1 |
| 18 | | Hex. socket screw | 2 | 43 | C-2012 | T-bolt | 2 |
| 19 | C-2012 | Adjusting screw | 1 | 44 | C-5102 | Handle base | 1 |
| 20 | C-3026 | Slide length adjusting screw | 1 | 45 | C-5113 | Worm gear base | 1 |
| | | | | 46 | | Hex. socket screw | 4 |
| 21 | | Clamping lever | 1 | 47 | C-5119 | Shaft | 1 |
| 22 | C-3029 | Adjusting ring | 1 | 48 | | Set screw | 1 |
| 23 | | Hex. socket screw | 6 | 49 | | Hex. socket screw | 2 |
| 24 | | Pin | 4 | 50 | C-3018-3 | Cover plate | 1 |
| | | | | 51 | | Screw | 3 |
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(CM-A) D. Grinding wheelhead (1/2)

| Ref No. | Part No. | Part Name | Q'ty | Ref No. | Part No. | Part Name | Q'ty |
|---------|----------|-------------------------------|------|---------|----------|-------------------------|------|
| 1 | C-4001 | Grinder base | 1 | 32 | C-4002 | Spindle | 1 |
| 2 | C-3201 | Upper & lower slide seat | 1 | 33 | | Bearing | 1 |
| 3 | C-3207 | Nut toggle | 1 | 34 | C-4006 | Spindle bush | 1 |
| 4 | | Key | 1 | 35 | C-4007 | Bearing protective seat | 1 |
| 5 | C-3206 | Micro- adjusting index seat | 1 | 36 | C-4009 | Pully | 1 |
| 6 | C-3205 | Micro- adjusting screw | 1 | 37 | | Belt | 1 |
| 7 | C-3204 | Fixing nut | 2 | 38 | | Knob | 1 |
| 8 | C-4014 | Cover | 1 | 39 | C-4021 | Motor protective shield | 1 |
| 9 | C-3203 | Height adj. screw | 2 | 40 | 4010 | Motor Pully | 1 |
| 10 | | Hex. socket bolt | 1 | 41 | | Motor | 1 |
| 11 | | Bearing | 2 | 42 | | Hex. socket screw | 4 |
| 12 | DC-7308 | Gear wheel fixing seat | 1 | 43 | | Hex. socket screw | 2 |
| 13 | C-4016 | Index table | 1 | 44 | C-4011 | Fixing block | 2 |
| 14 | C-4017 | Handle | 1 | 45 | | Set screw | 1 |
| 15 | | Screw nut | 1 | 46 | | Set screw | 1 |
| 16 | | Clamping lever | 1 | 47 | | Pin | 1 |
| 17 | | Hand wheel | 1 | 48 | | Hex. nut | 1 |
| 18 | DC-7307 | Lifting pinion | 1 | 49 | | Hex. socket screw | 1 |
| 19 | | Key | 1 | 50 | | Hex. socket screw | 1 |
| 20 | | Bearing | 2 | 51 | | Hex. socket screw | 1 |
| 21 | C-4003 | Sleeve | 1 | 52 | | Hex. socket screw | 3 |
| 22 | | Locking nut | 1 | 53 | C-4019 | Locking rod | 1 |
| 23 | C-4005 | Bearing protective seat | 1 | 54 | | Flat washer | 1 |
| 24 | C-4008 | Spring | 8 | 55 | | Sand wheel | 1 |
| 25 | | Hex. head screw | 1 | 56 | | Hex. socket screw | 1 |
| 26 | C-6009 | Protective shield fixing ring | 1 | 57 | C-4018 | Pully protective plate | 1 |
| 27 | C-6007 | Safety shield | 1 | 58 | | Flat washer | 1 |
| | | | | 59 | | Hex. socket screw | 1 |
| | | | | 60 | | Motor plate | 1 |
| | | | | 61 | | Flat washer | 4 |
| | | | | 62 | | Hex. socket screw | 4 |
| | | | | 63 | | Hex. nut | 1 |
| | | | | 64 | | Set screw | 1 |

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|----|--------|---------------------------------------|---|----|---------|-------------------|---|
| 28 | C-6029 | Sand wheel locking nut | 1 | 65 | | loose-leaf | 2 |
| 29 | C-6020 | Sand wheel packing | 1 | 66 | | Screw | 4 |
| 30 | C-6023 | Fixing shaft (short) of sand wheel | 1 | 67 | DC-7303 | Swivel plate | 1 |
| | | | | 68 | | Hex. socket screw | 2 |
| 31 | C-6008 | Protective shield rod | 1 | 69 | DC-7305 | T-nut | 2 |

(CM-A) D. Grinding wheelhead (2/2)

| Ref No. | Part No. | Part Name | Q'ty | Ref No. | Part No. | Part Name | Q'ty |
|---------|----------|-------------------|------|---------|----------|-----------|------|
| 70 | DC-7306 | Index plate | 1 | | | | |
| 71 | | Round head screw | 2 | | | | |
| 72 | DC-7302 | Base plate | 1 | | | | |
| 73 | | Hex. socket screw | 4 | | | | |
| 74 | DC-7304 | Bushing | 1 | | | | |
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(CM-A) E. Middle column and horizontal slide stop (1/2)

| Ref No. | Part No. | Part Name | Q'ty | Ref No. | Part No. | Part Name | Q'ty |
|---------|----------|------------------------|------|---------|----------|------------------------|------|
| 1 | C-5127 | Slide pin adj. screw | 2 | 41 | C-2012 | T-bolt | 1 |
| 2 | C-3023 | Slide pin | 1 | 42 | C-3010 | Screw | 3 |
| 3 | | Flat washer | 1 | 43 | C-3218-1 | Cover plate | 1 |
| 4 | | Hex. socket screw | 1 | 44 | | Bearing | 1 |
| 5 | | Pin | 1 | 45 | C-3002 | Transmission screw | 1 |
| 6 | | Set screw | 1 | 46 | | Key | 1 |
| 7 | C-3029 | Adj. screw | 1 | 47 | C-3001 | Horizontal slide plate | 1 |
| 8 | C-3013 | Leading screw nut | 2 | 48 | | Hex. socket screw | 6 |
| 9 | | Hex. socket screw | 1 | 49 | | Stop block | 1 |
| 10 | C-3028 | Adjusting ring | 2 | 50 | | Screw | 4 |
| 11 | | Hex. socket screw | 2 | 51 | C-4025 | Protective cover | 1 |
| 12 | C-3025 | Slide length adj. seat | 3 | 52 | | Hex. socket screw | 2 |
| 13 | | Clamping lever | 2 | 53 | | Bearing | 1 |
| 14 | C-2012 | T-bolt | 2 | 54 | | Thimble | 1 |
| 15 | C-3016 | Locating pin seat | 2 | 55 | | Thrust bearing | 1 |
| 16 | C-4017 | Hand wheel handle | 1 | 56 | C-3008 | Screw gear | 1 |
| 17 | | Hand wheel Fixing nut | 2 | 57 | | Hex. nut | 2 |
| 18 | C-4015 | Index hand wheel | 2 | 58 | | Needle bearing | 2 |
| 19 | C-3015 | Index fixing screw | 2 | 59 | C-3003 | Lead-screw | 1 |
| 20 | C-3014 | Index table | 2 | 60 | | Key | 1 |
| 21 | | Bearing | 2 | 61 | C-3005 | Lead-screw nut | 1 |
| 22 | C-3009 | Leadscrew bracket | 1 | 62 | C-3208 | Lifting lead-screw nut | 1 |
| 23 | | Bearing | 1 | 63 | C-3209 | Lifting gear | 1 |
| 24 | | Cover plate | 1 | 64 | | Hex. socket screw | 1 |
| 25 | | Key | 6 | 65 | | Thrust bearing | 1 |
| 26 | | Hex. socket screw | 4 | 66 | | Oil passway black | 1 |
| 27 | | screw | 1 | 67 | | Thrust bearing | 1 |
| 28 | | Bearing | 1 | 68 | C-3210 | Locking ring | 1 |
| 29 | | Slide plate pin | 1 | 69 | | Set screw | 1 |
| 30 | | Slide pin Adj .screw | 2 | 70 | C-3211 | Lifting leadscrew | 1 |
| 31 | C-3006 | Screw seat | 1 | 71 | | Flat washer | 1 |

| | | | | | | | |
|----|----------|------------------------|---|----|--------|--------------------------|---|
| 32 | C-3218-2 | Cover plate | 1 | 72 | | Hex. screw | 1 |
| 33 | | Screw | 3 | 73 | C-4016 | Protective cover | 1 |
| 34 | C-3011 | Leadscrew | 1 | 74 | | Hex. socket screw | 2 |
| 35 | | Clamping lever | 1 | 75 | C-3213 | Protective cover seat | 1 |
| 36 | | Set screw | 1 | 76 | | Hex. socket screw | 2 |
| 37 | C-3028 | Adj. ring | 1 | 77 | | Oil cover | 1 |
| 38 | | Pin | 1 | 78 | | Key | 1 |
| 39 | C-3026 | Slide length adj. seat | 1 | 79 | C-3202 | Upper & lower slide seat | 1 |
| 40 | C-3029 | Adjusting screw | 1 | 80 | | Hex. socket screw | 4 |

(CM-A) E. Middle column and horizontal slide stop (2/2)

| Ref No. | Part No. | Part Name | Q'ty | Ref No. | Part No. | Part Name | Q'ty |
|---------|----------|-----------------|------|---------|----------|-----------|------|
| 81 | | Oil fille | 1 | | | | |
| 82 | C-3022 | Slide plate pin | 1 | | | | |
| 83 | C-5127 | Adj. screw | 2 | | | | |
| 84 | C-3016 | Slide seat | 1 | | | | |
| 85 | C-4027 | Side cover | 1 | | | | |
| 86 | C-3018-2 | Cover plate | 1 | | | | |
| 87 | | Screw | 3 | | | | |
| 88 | | Screw | 3 | | | | |
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| (CM-A) F. Base and foot stand |
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(CM-A) G. Bracket of lens

| Ref No. | Part No. | Part Name | Q'ty | Ref No. | Part No. | Part Name | Q'ty |
|---------|----------|-------------------|------|---------|----------|-----------|------|
| 1 | C-5201 | Bracket of lens | 1 | | | | |
| 2 | | Hex. socket screw | 4 | | | | |
| 3 | DF-4104 | Lower seat | 1 | | | | |
| 4 | DF-4109 | Fixing plate | 2 | | | | |
| 5 | | Hex. socket screw | 4 | | | | |
| 6 | DF-4110 | Handle wheel | 2 | | | | |
| 7 | | Key | 2 | | | | |
| 8 | DF-4108 | Adjusting screw | 2 | | | | |
| 9 | DF-4107 | Nut | 2 | | | | |
| 10 | | Hex. socket screw | 2 | | | | |
| 11 | C-5127 | Adjusting screw | 4 | | | | |
| 12 | DF-4106 | Slide gib | 2 | | | | |
| 13 | | Hex. nut | 2 | | | | |
| 14 | | Hex. socket screw | 2 | | | | |
| 15 | DF-4112 | Upper seat | 1 | | | | |
| 16 | | Hex. socket screw | 2 | | | | |
| 17 | | Flat washer | 2 | | | | |
| 18 | | Hex. socket screw | 1 | | | | |
| 19 | DF-4116 | Washer | 1 | | | | |
| 20 | DF-4115 | Extend plate | 1 | | | | |
| 21 | | Fixing shaft | 1 | | | | |
| 22 | | Lens | 1 | | | | |
| 23 | | Lens seat set | 1 | | | | |
| 24 | DF-4116 | Washer | 1 | | | | |
| 25 | | Hex. socket screw | 1 | | | | |
| 26 | | Hex. socket screw | 6 | | | | |
| 27 | DF-4105 | Middle seat | 1 | | | | |
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(CM-A) J. Accessories list

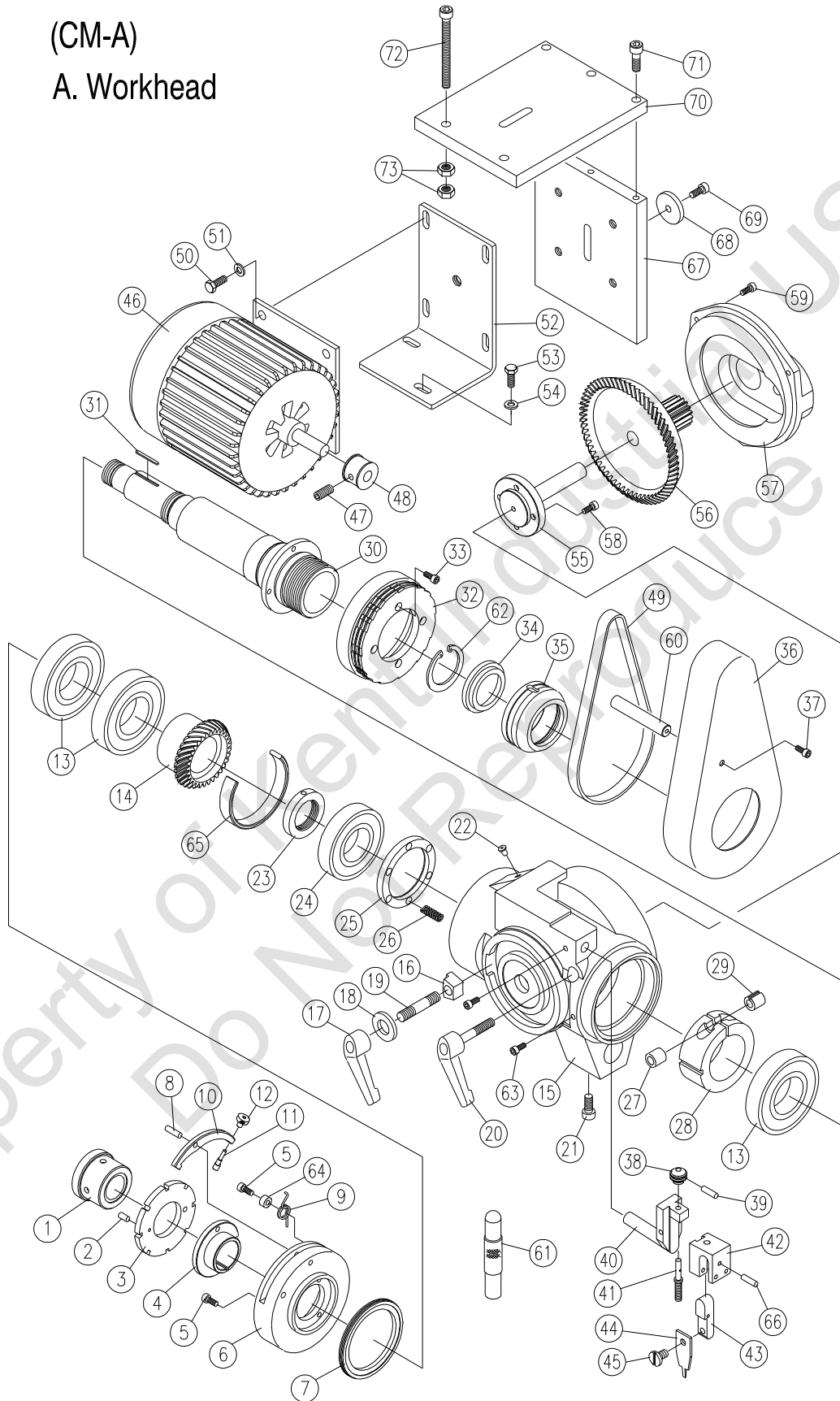
| Ref No. | Part No. | Part Name | Q'ty | Ref No. | Part No. | Part Name | Q'ty |
|---------|----------|--------------------------------|------|---------|----------|-------------------------|------|
| 1 | C-6101 | Spindle of milling cutter rack | 1 | 38 | C-6011 | Diamond cutter seat | 1 |
| | | | | 39 | | Pin | 1 |
| 2 | | Hex. head screw | 1 | 40 | M-6031 | Spring | 1 |
| 3 | | Hex. nut | 1 | 41 | C-6025 | Spring seat pin | 1 |
| 4 | C-6104 | Packing piece | 1 | 42 | C-6012 | Support bracket | 1 |
| 5 | | Hex. head screw | 1 | 43 | | Hex. socket screw | 1 |
| 6 | | Hex. nut | 1 | 44 | | chuck | 1 |
| 7 | C-6102 | Cutter grinding seat | 1 | 45 | C-6113 | Screw | 1 |
| 8 | | Flat washer | 1 | 46 | C-5006 | Chuck washer | 1 |
| 9 | | Hex. nut | 1 | 47 | C-6114 | Packing piece | 1 |
| 10 | C-6103 | Milling Cutte shaft | 1 | 48 | C-5005 | Chuck screw nut | 1 |
| 11 | C-6104 | Packing piece | 1 | 49 | | Sand wheel | 1 |
| 12 | C-6105 | Cutter housing | 1 | 50 | C-6122 | Pawl chuck fixing plate | 1 |
| 13 | C-6106 | Cutter nut | 1 | | | | |
| 14 | | Hex. socket screw | 1 | 51 | C-6115 | Sand wheel shaft | 1 |
| 15 | C-6107 | Strut | 1 | 52 | | Set screw | 1 |
| 16 | | Hex. socket screw | 1 | 53 | C-6032 | Gear plate seat | 1 |
| 17 | C-6108 | Support bracket | 1 | 54 | C-6033 | Gear column | 1 |
| 18 | | Flat washer | 1 | 55 | C-6034 | Gear | 1 |
| 19 | | Hex. socket screw | 1 | 56 | | Round head screw | 1 |
| 20 | | Hex. socket screw | 1 | 57 | | Hex. nut | 1 |
| 21 | C-6110 | Pad | 1 | 58 | | Hex. screw nut | 1 |
| 22 | C-6111 | Pad rack | 1 | 59 | C-6006 | Wheel head seat | 1 |
| 23 | C-6031 | Spring | 1 | 60 | C-6015 | Extended chuck | 1 |
| 24 | | Pin | 1 | 61 | | Spring chuck | 6 |
| 25 | C-6112 | Cutter pad seat | 1 | 62 | C-6016 | Extended chuck ring | 1 |
| 26 | C-6035 | Supporting shaft | 1 | 63 | C-6017 | Extended chuck nut | 1 |
| 27 | C-6037 | Center needle | 1 | 64 | C-6005 | Wheel head rod | 1 |

| | | | | | | | |
|----|--------|-----------------------------|---|----|--------|------------------------|---|
| 28 | C-6036 | Center rack | 1 | 65 | C-6002 | Adjusting screw nut | 1 |
| 29 | | Hex. socket screw | 1 | 66 | C-6001 | Wheel head padt sea | 1 |
| 30 | | Key | 1 | 67 | | Key | 1 |
| 31 | | Hex. socket screw | 1 | 68 | C-6003 | Adjusting screw | 1 |
| 32 | C-6027 | Strut 0f support bracket | 1 | 69 | C-6004 | Wheel head pad | 1 |
| | | | | 70 | | Hex. socket screw | 1 |
| 33 | | Pin | 1 | | | | |
| 34 | C-6028 | Support bracket | 1 | | | | |
| 35 | | Hex. head screw | 1 | | | | |
| 36 | | Hex. nut | 1 | | | | |
| 37 | C-6124 | Diamond cutter rack | 1 | | | | |

Appendix 2 Exploding diagram of CM-A

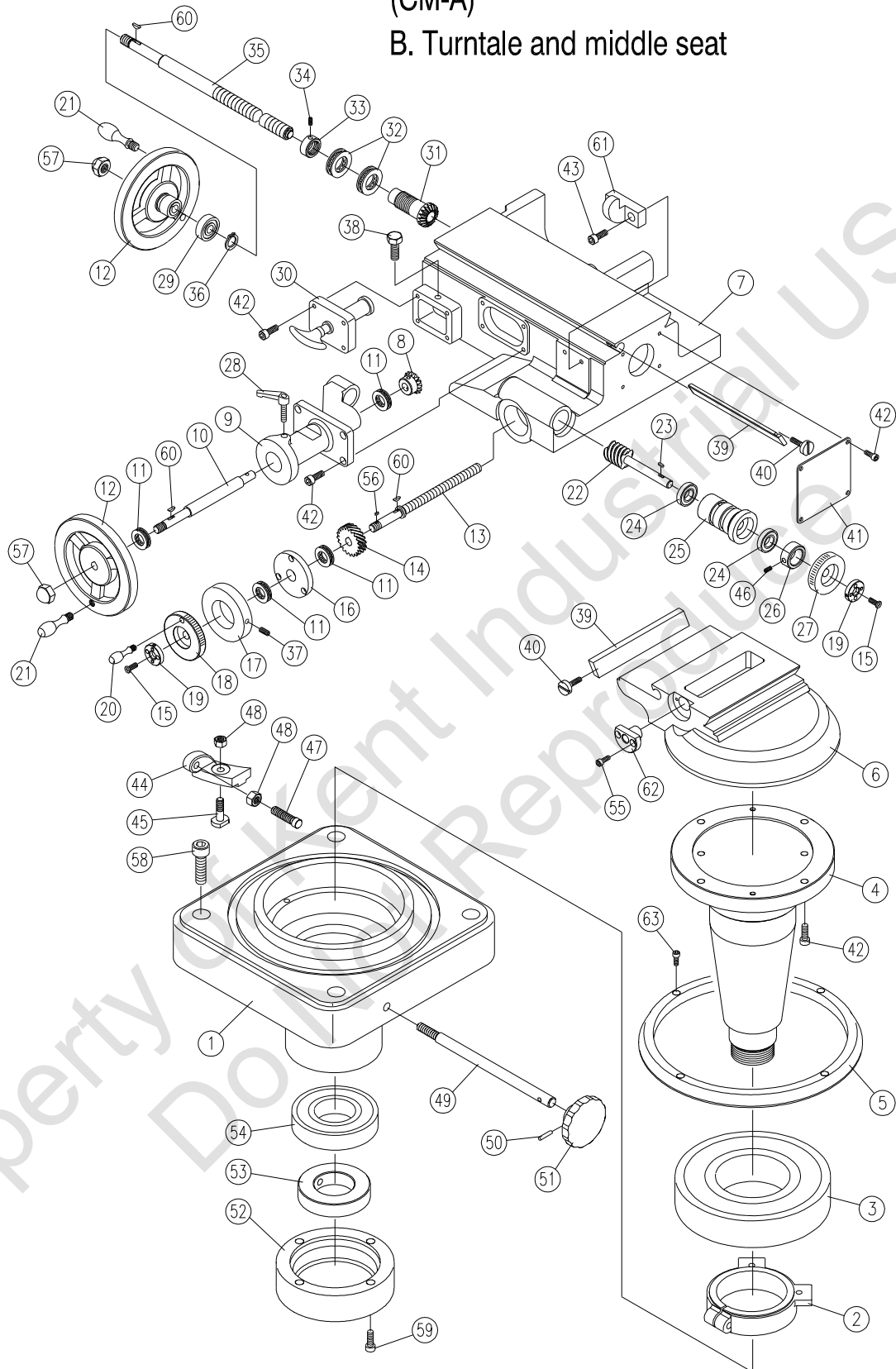
(CM-A)

A. Workhead



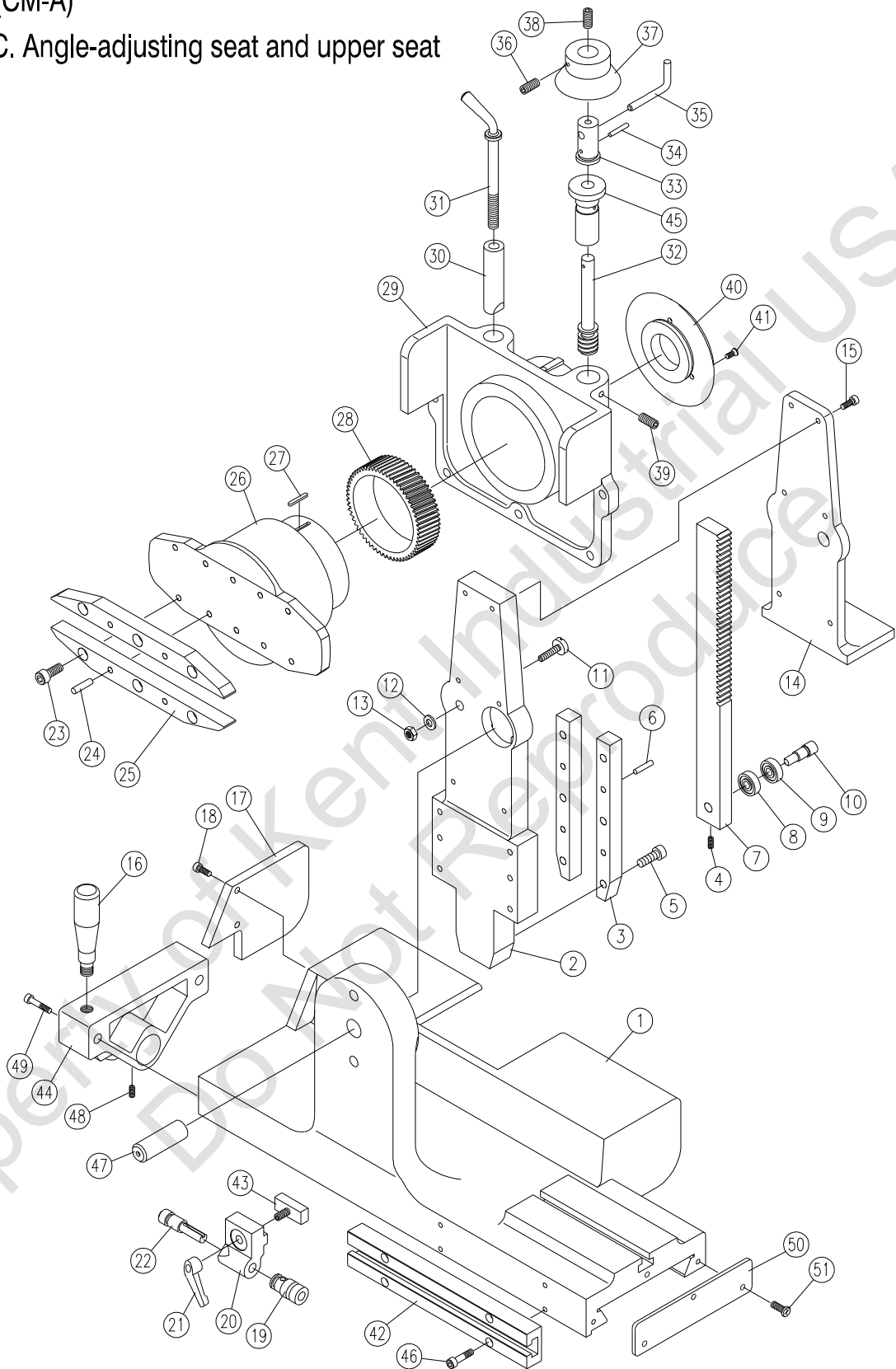
(CM-A)

B. Turntale and middle seat



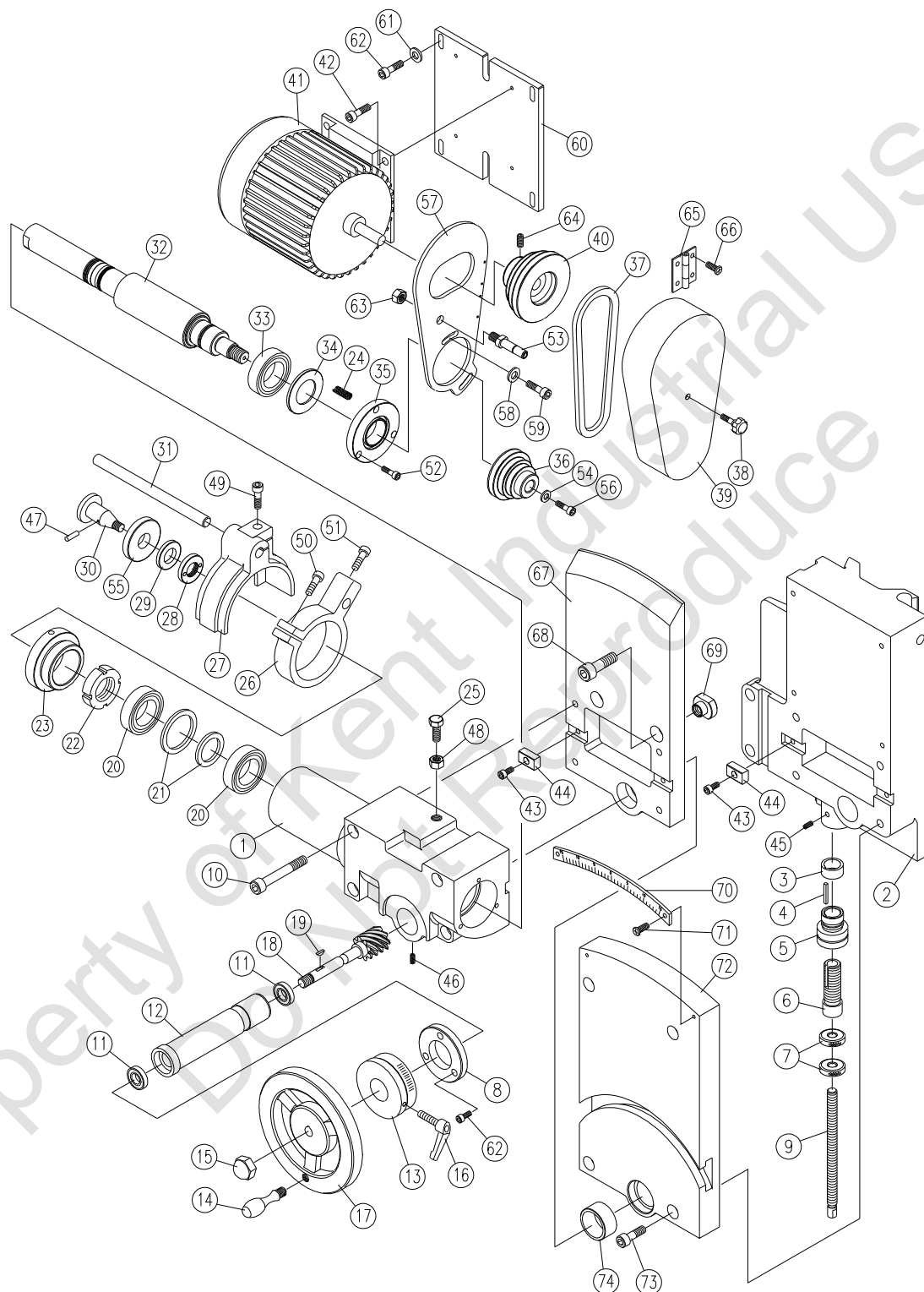
(CM-A)

C. Angle-adjusting seat and upper seat

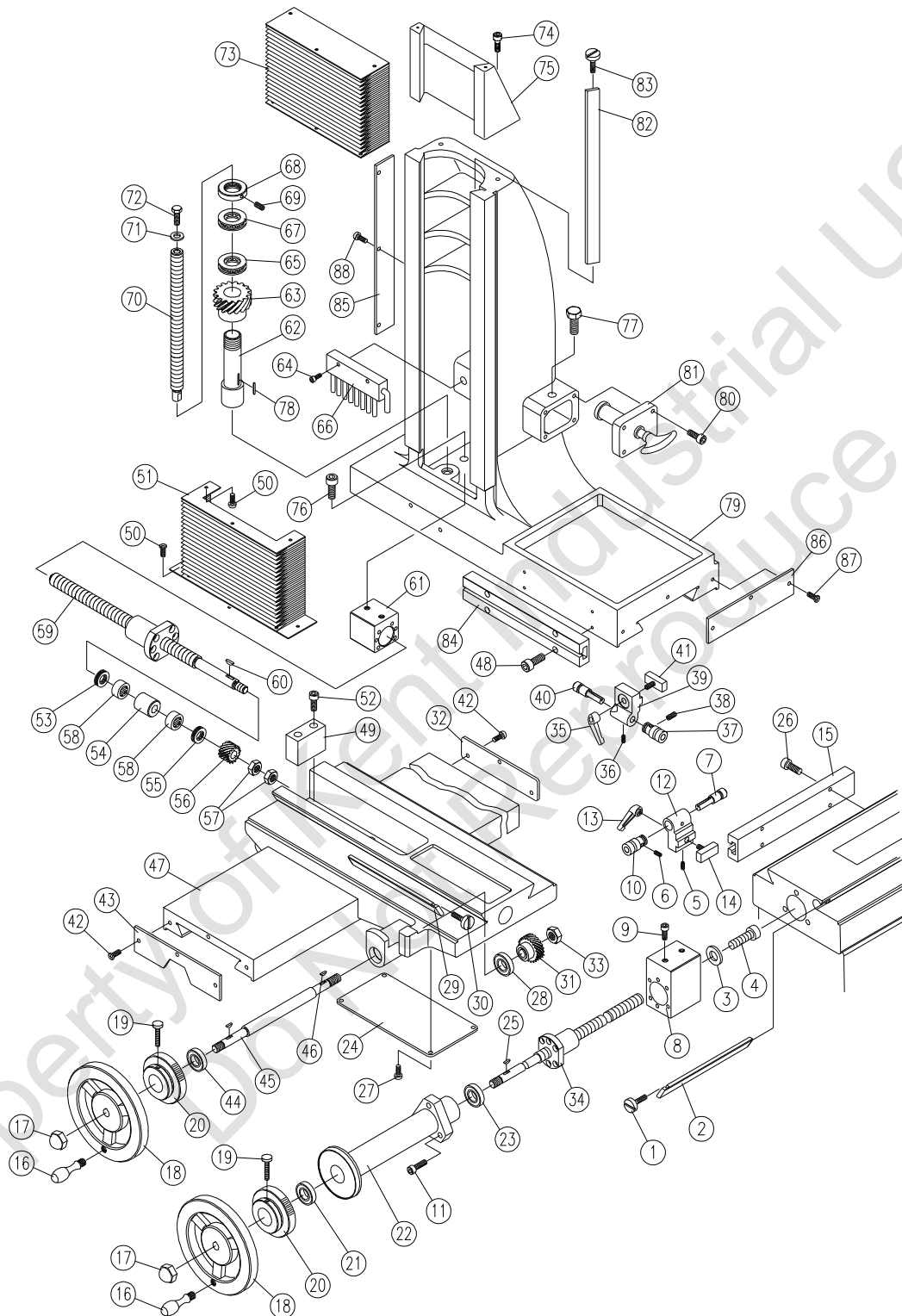


(CM-A)

D. Grinding wheelhead

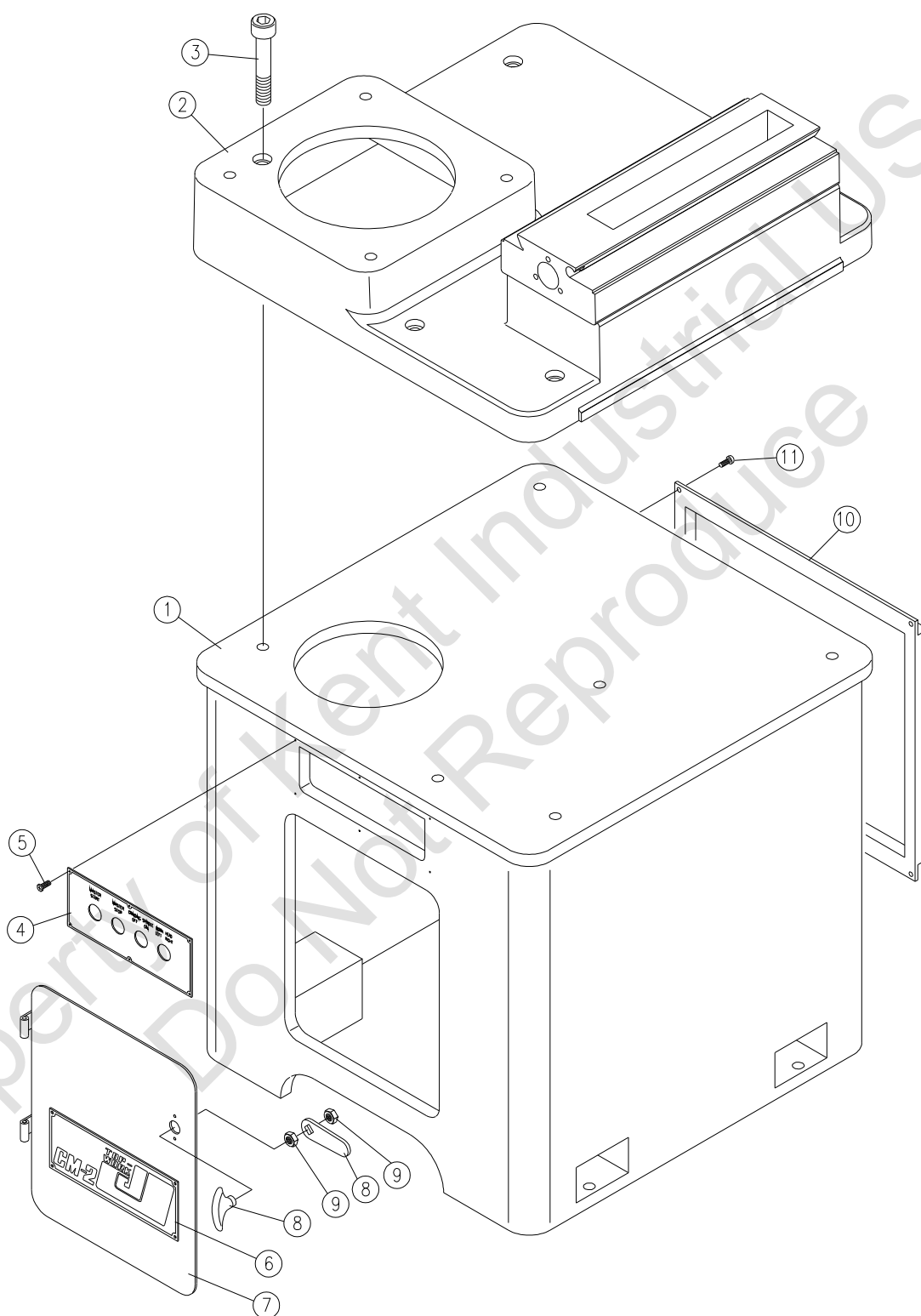


(CM-A) E. Middle column and horizontal slide stop



(CM-A)

F. Base and foot stand

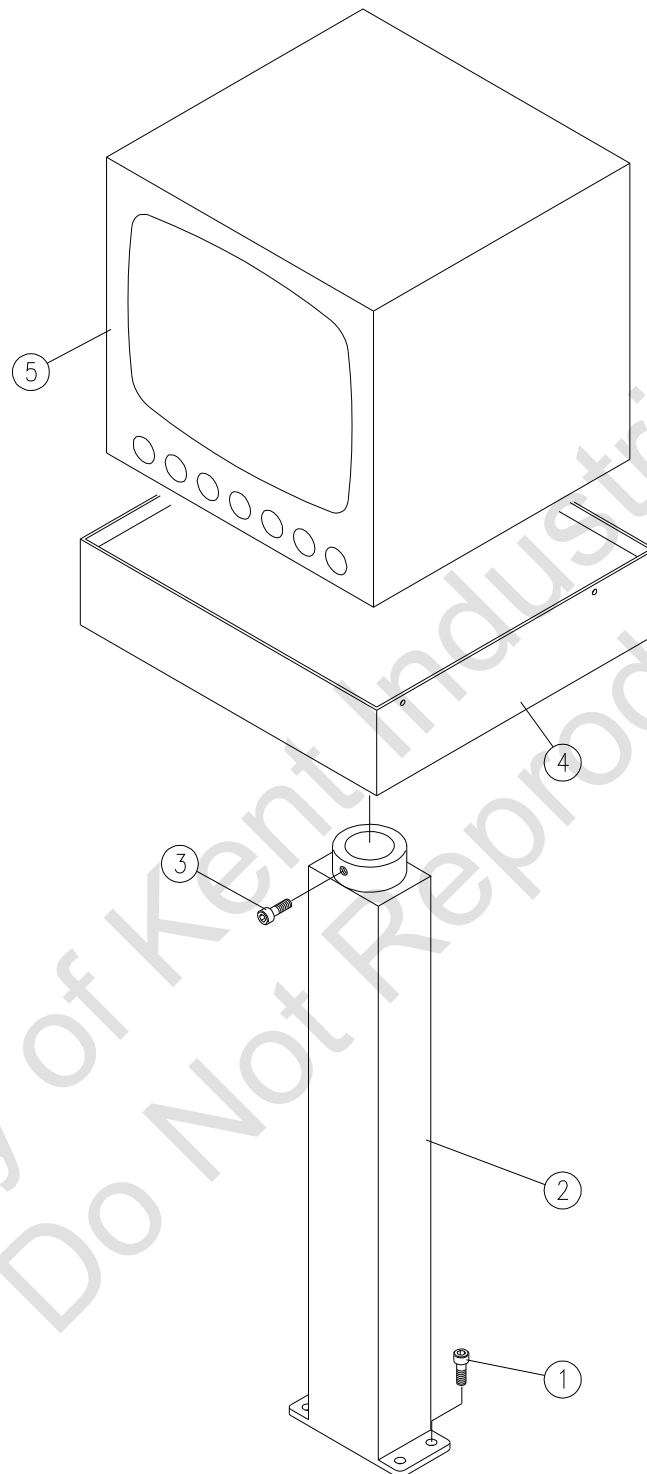


G. Bracket of lens



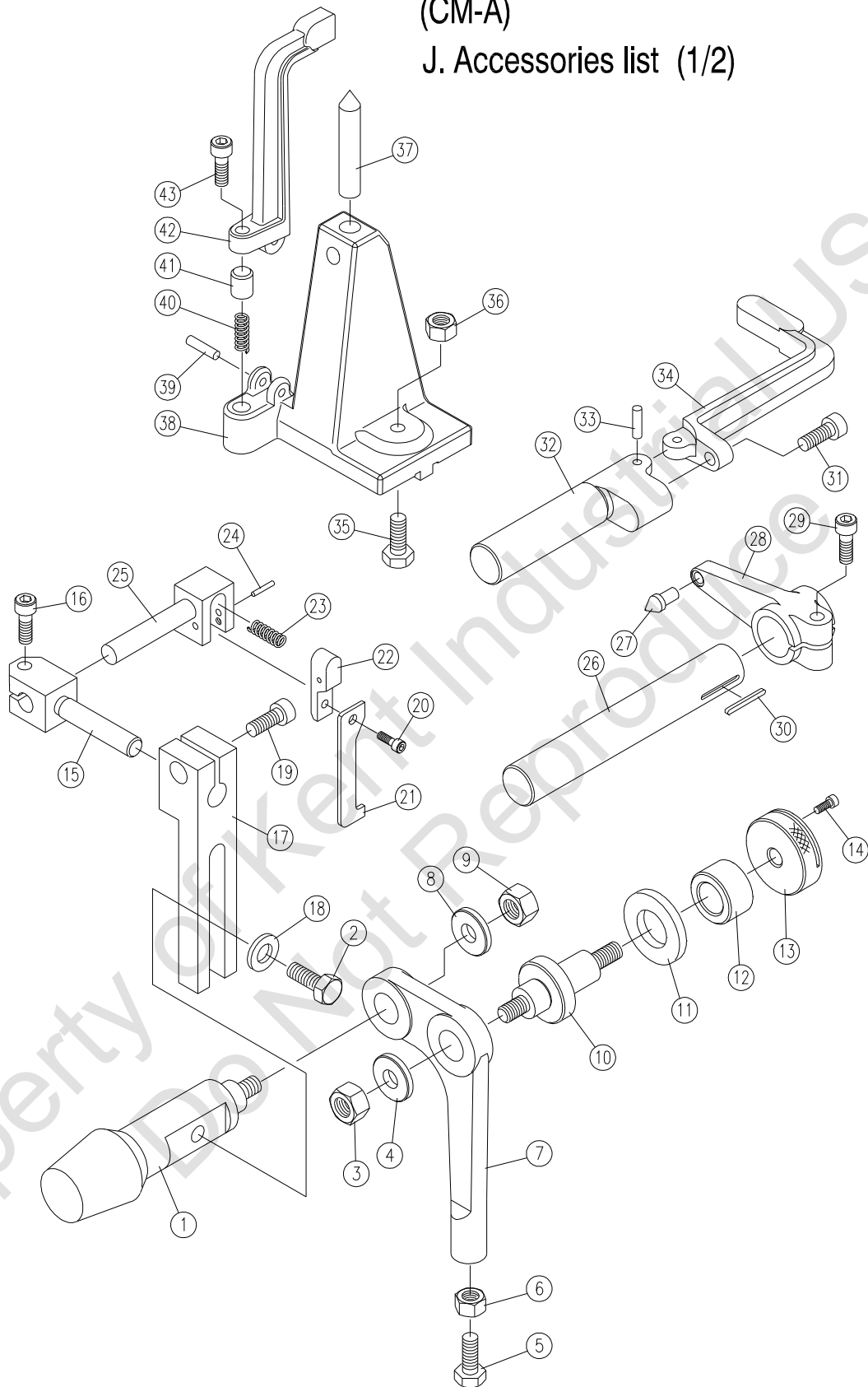
(CM-A)

H. Bracket of monitor



(CM-A)

J. Accessories list (1/2)



(CM-A)

J. Accessories list (2/2)

