Manual CEC-37

OPERATOR'S MANUAL

KEARNEY & TRECKER MILWAUKEE

3hp No. 2

7½hp No. 3

MODEL CE

plain and universal

Milling Machines

KEARNEY & TRECKER CORPORATION

MILWAUKEE 14, WISCONSIN, U.S.A.

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One copy of this manual is furnished with each new machine. Additional copies may be obtained by writing direct to Kearney & Trecker Corporation.

Kearney & Trecker Corporation

Milwaukee 14, Wisconsin

U. S. A.

Index

LIST OF ILLUSTRATIONS

FOREWORD

This manual contains instructions for operating the plain and universal styles of the following Kearney & Trecker—Milwaukee milling machines:

3hp No. 2 CE
7½ hp No. 3 CE

This manual has been prepared to familiarize you with these machines and to help you operate them properly. The first three sections of the manual briefly describe the electrical, coolant and lubrication systems. Section IV describes conventional operation in which table travel is manually controlled by the table feed lever. Section V, a unit on machine adjustments gives a step by step method in making adjustments on gibs, table brackets, etc. "Do's" and "Dont's" in milling practices can be found in Section VI.

NOTE

THIS IS AN OPERATOR'S MANUAL ONLY. For installation instructions refer to the Installation Manual No. CEI-10. For replacement parts information refer to Catalog CER-3 for 2CE machines, and CER-7 for 3CE machines.

IMPORTANT Read before Studying Manual

Figures 1 and 2 identify the units with which the operator should be familiar. Refer to these illustrations when studying the manual. Each unit is called out just once, and so if the desired unit cannot be found on one view, try the other one. All references to the machine such as right and left, front and rear, etc. are made from the operator's normal position while facing the machine.

It is our intention to continually improve the service you receive from Kearney & Trecker—Milwaukee milling machines and to make their operation as simple as possible. In accordance with this policy, we invite you to bring any questions and problems to the attention of the Service Department, Kearney & Trecker Corporation, Milwaukee 14, Wisconsin, U.S.A. For service by telephone, call GReenfield 6-8300.

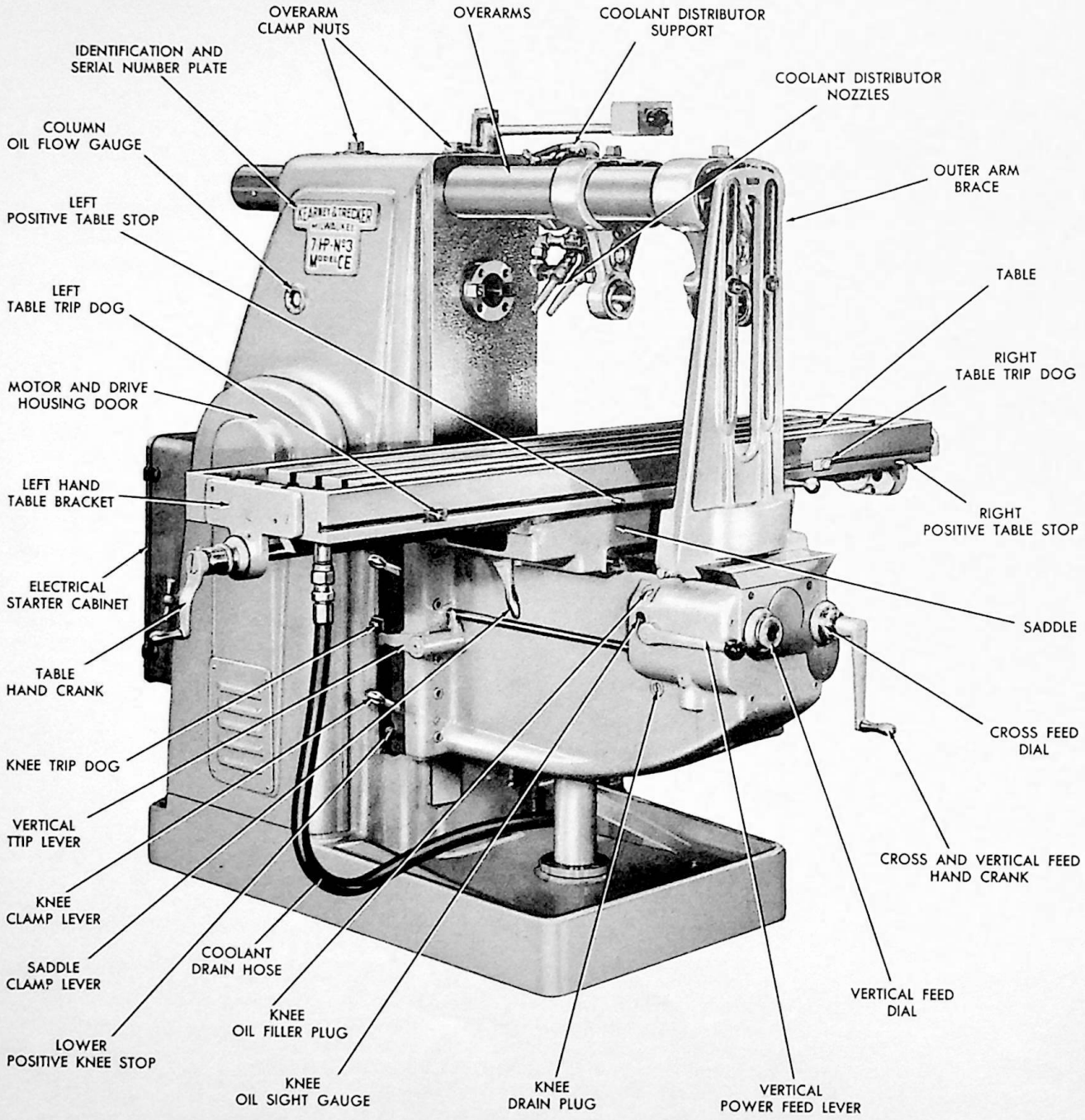


Fig. 1 7½hp No. 3 Model CE Plain Machine — left front view

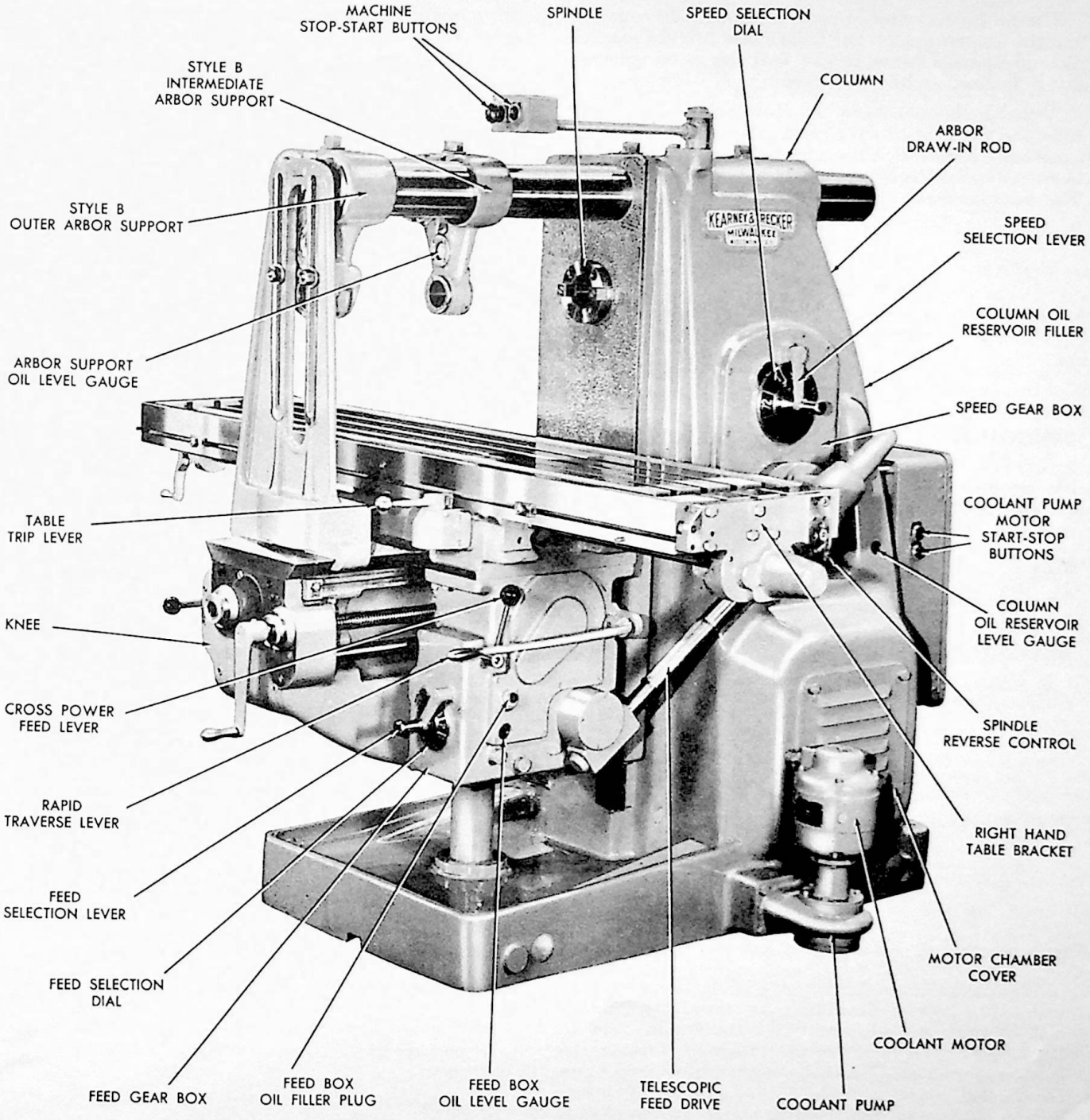


Fig. 2 7½hp No. 3 Model CE Plain Machine — right front view

SECTION I

ELECTRICAL SYSTEM

The electrical system consists of the main drive motor and the necessary controls. This motor drives the spindle and supplies power for the feed and rapid traverse drives to knee, saddle, and table on all machines.

A master disconnect switch which controls all current from the main line to the electrical starter cabinet is actuated by a lever on the cabinet. The lever must be in the ON position before power operation is possible. The machine start and stop buttons control the main drive motor. This motor must be running in order to move the knee, saddle and table by power.

A control fuse and heater elements are incorporated in the electrical system to provide the maximum protection for the motor and controls. Because of the complexity of the electrical system, we recommend that only a competent electrician be permitted to work on any of the equipment.

SECTION II

LUBRICATION SYSTEM

DESCRIPTION

Individual oiling systems lubricate moving parts in the column, knee, and feed gear box. Each of these systems is provided with an oil level gauge, and the necessary filler and drain plugs. Flow of oil in the column is shown by the column oil flow gauge. Oil flows in these units whenever the motor is running. All other moving parts of the machine must be oiled manually.

INSTRUCTIONS

1. Follow all directions given in the Lubrication Charts on page 13.

2. Periodically check the oil sight gauges. The oil should be at the high point in the level gauges when the machine is not in operation and should drop during operation. If oil is not passing through the flow gauges during operation, stop the motor and check the oil level.

3. Wipe the accumulated dirt from the exposed sections of the overarms and apply a thin coat of oil once each day.

4. Periodically grease the motor if it is provided with two zerk fittings. If the motor is equipped with sealed-for-life bearings, refer to the manufacturer's recommendations.

SECTION III

COOLANT SYSTEM

DESCRIPTION

The coolant pump distributes coolant from the reservoir in the base of the column up through pipes and nozzles to the cutter. From here the coolant falls to the table and returns to the reservoir through the coolant drain hose. The coolant distributor nozzles can be swiveled to distribute the flow to all types of cutters and are equipped with valves for regulating the coolant flow. The distributor can be attached to either overarm by means of the coolant distributor support.

INSTRUCTIONS

1. Keep the screen cover on the opening in the column base when the machine is used without coolant.

2. Periodically remove and clean the drain screens and pockets in the column base and at the left end of the table.

3. Use light cutting oils or soluble oil mixtures; they are equally as efficient as heavy oils.

4. Periodically check the level of coolant in the reservoir. Fill the reservoir by removing the cover in the base of the column beneath the knee, and adding coolant until the level rises to the screens.

SECTION IV

CONVENTIONAL OPERATION

GENERAL

This section describes conventional operation of the plain and universal machines. Operation of plain and universal machines is identical except in applications which require swiveling of the table. For such applications the table on universal machines can be swiveled approximately 47 degrees in either direction from the normal position. The table can be locked in position with four clamp screws, two on each end of the saddle.

Instructions for using the dividing head and lead attachments in spiral milling and indexing operations will be found in catalog UHS-10.

The main drive motor must be running before any power movement is possible. To start this motor, see that the lever on the electrical starter cabinet is set to the ON position, then push the master start button. Be sure to push the master stop button whenever the machine is not to be used for some time.

The spindle is controlled through the start-stop buttons on the arm which extends forward from the top of the column. The starting button arm can be swiveled to the right or left to bring it into the operator's reach wherever he stands.

SPINDLE REVERSE CONTROL

The direction of spindle rotation can be reversed as follows:

1. Stop the spindle. Jog the spindle with the machine start-stop buttons and push or pull the reverse knob for the desired rotation. Do not reverse the rotation while the spindle is running.

2. To disengage the drive to the spindle, set the knob to the center or neutral position.

SPINDLE SPEED CHANGE CONTROL

(See Fig. 3)

The spindle speed is changed as follows:

1. Stop the spindle and withdraw the speed selection knob on the speed gear box. Do not change speed while the spindle is running.

2. Rotate the lever and knob until the desired speed as shown on the speed selection dial lines up with the RPM plate. Do not use force in rotating the lever. Jog the spindle with the machine start-stop buttons while rotating the lever if the lever does not rotate freely.

3. Insert the knob plunger in the hole provided to lock the lever in position.

COOLANT PUMP CONTROL

The coolant system is driven by the coolant pump motor at the right rear of the column near the floor (See Fig. 2). The pump is controlled by the coolant start-stop buttons on the right side of the electrical control cabinet. Coolant will flow continuously until the coolant stop button is depressed.

POWER FEED CONTROLS

These machines are equipped with levers for engaging power feed (when the spindle is running) to all movable units. When power feed is not desired, move the control lever to the center or neutral position.

To prevent expensive repairs and lost time, develop the habit of seeing that the correct speed and feed is being used, that overhanging fixtures do not interfere with the movement and the cutter does not engage the workpiece at the rapid traverse rate.

Power movement of the knee is obtained by means of the vertical power feed lever. The knee is fed downward by moving the lever downward.

Power movement of the saddle is obtained by means of the cross power feed lever. The saddle is fed to the rear, or inward, by moving the lever inward.

Power movement of the table is obtained by means of the table trip lever. The table is fed to the right by moving the lever to the right.

HAND FEED CONTROLS

These machines are also equipped with hand cranks for moving the various units by hand. Safety disengage springs are incorporated in these cranks to disengage them when not in use.

Hand movement of the knee is obtained by means of the cross and vertical feed hand crank. The knee is fed downward by turning the crank counterclockwise.

Hand movement of the saddle is also obtained by means of the hand crank. The saddle is fed to the rear, or inward, by rotating the hand crank clockwise.

Hand movement of the table is obtained by means of the table hand crank. The table is fed to the right by rotating the hand crank clockwise.

MICROMETER DIALS

The graduated micrometer dials make it possible to make movements of the table, saddle, and knee in thousandths of an inch. They also make it possible to

quickly and accurately re-locate the table, saddle and knee settings especially in production milling.

Typical use of the dials is shown in the following example:

Let us assume that a particular job requires the milling of a key slot in a number of shafts, and each shaft will be clamped in exactly the same place on the table. Assuming the length of the cut has been determined, a method must now be used which will accurately stop the table movement at exactly the same spot for every piece.

1. Run the table to the exact spot at which the cut is to be stopped.
2. Using a dark crayon or chalk, make a vertical mark that extends down the front of the table and onto the saddle.
3. Without moving the table handcrank, loosen the set screw in the graduated table micrometer dial and set the dial to zero.

To return to the same position each time, simply return the table to a point where the chalk mark on the table coincides with the mark on the saddle. Now, using the table handcrank, move the table slowly until the micrometer dial reads exactly zero.

FEED CHANGE CONTROL

(See Fig. 3)

The rate of feed movement for the knee, saddle, and table is indicated in inches per minute and is controlled by the feed selection lever and knob. To change the feed rate be sure the spindle is running. Withdraw the feed selection knob, rotate the lever in either direction until the desired feed rate on the dial lines up with the arrow on the rim of the dial. Release the lever so that the plunger enters the hole provided and locks the lever in position.

The feed rates and the range of feed rates for the knee are one-half of those shown on the dial. That is, if the arrow is lined up with $\frac{3}{8}$, the saddle and table will feed at $\frac{3}{8}$ inches per minute, but the knee will feed at $\frac{3}{16}$ inches per minute.

RAPID TRAVERSE CONTROL

The knee, saddle, and table can be moved at the rapid traverse rate when the motor is running by first engaging the respective feed lever and then moving the rapid traverse lever to the right.

TRIP DOGS AND LIMIT STOPS

Adjustable trip dogs are supplied to stop the travel of the movable units at any point within their range of travel. The two dogs for the knee are located at the left rear end of the knee. The two dogs for the saddle are located at the front and rear of the saddle to the right of the way. Two dogs are used with the table. Positive limit stops are also provided to restrict the total travel of each movable unit.

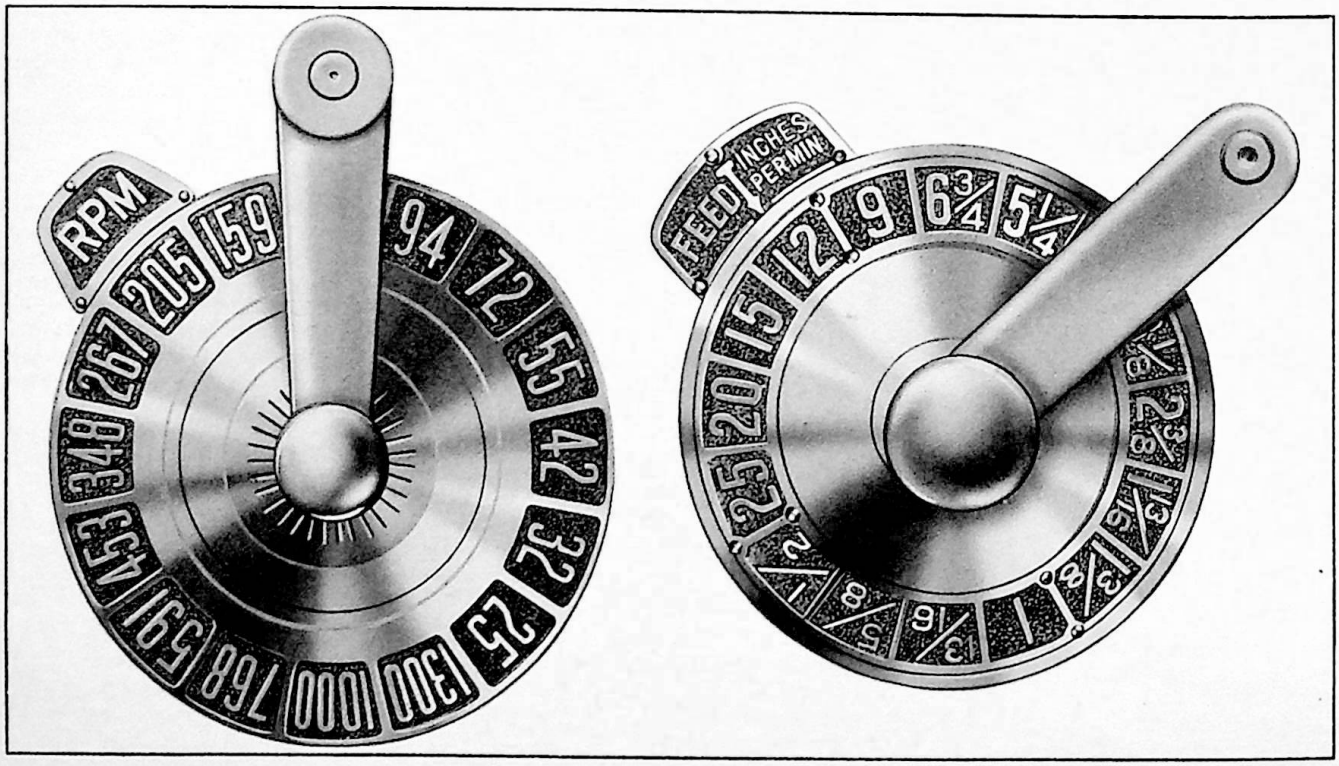


Fig. 3 Speed and Feed Selection Dials

CLAMPS

Clamps are provided to lock the movable units in any position within their range of travel. The knee and saddle clamp levers are serrated so that they can be removed and repositioned if necessary. The table clamp is a screw type and needs no re-positioning. The knee is locked by moving the knee clamp lever outward. The saddle is locked by moving the saddle clamp lever inward. The table is locked by moving the table clamp lever clockwise.

Be sure to clamp all units which will not be moved during the setup. For example, if a job requires only table travel, lock the knee and the saddle. Release all clamp levers when the job is finished.

SPEED AND FEED CALCULATION

The chart on page 16 titled "Rules for Determining Correct Speeds and Feeds" can be used as an aid in the proper selection of speeds and feeds. Also, carefully study the instructions on the use of the enclosed Speed and Feed Calculator.

ARBOR SUPPORTS AND ARBORS

The arbor supports provide additional support for extended arbor and arbor assemblies. If the setup permits the use of only one arbor support, additional rigidity can be obtained by inverting the other support and mounting it midway between the column and the support being used.

When removing or applying arbor supports, extend one overarm approximately 6 inches beyond the other. Slide the arbor support first onto the extended overarm and then onto the other. Position the arbor supports and overarms, and then clamp them with the lock nuts. The adjustable arm feature permits arbor supports to be handled with a minimum of effort.

The spindle on 3CE machines is equipped with a No. 50 standard non-sticking steel taper. The spindles on 2CE machines are equipped with a No. 40 standard taper. The spindle is also equipped with two keys for driving arbors and cutters. When removing arbors, first loosen the nut on the arbor draw-in bolt at the rear of the column. Then hold the arbor and tap the draw-in bolt with a soft hammer until the arbor is loose. Screw the bolt out of the arbor and then remove it. When installing an arbor, hold it in place in the spindle taper, engage the draw-in bolt, then tighten the lock nut.

Observe the following rules when working with arbors and arbor supports:

1. Tighten or loosen the arbor nut with the arbor support in place.

2. Be sure arbor nuts are always tight during operation.

3. Adjust the arbor support bushings to provide a running fit for arbor bearings. (See Fig. 5)

4. Be sure the arbor diameter is large enough to withstand the cutting forces which will be encountered.

5. Be sure the cutter-arbor setup runs true over its entire length.

6. Be sure both spindle keys are seated properly.

7. Keep the spindle, arbors and cutters clean. Even a particle of dirt can affect the accurate alignment of the precision ground surfaces.

8. When face mill cutters are mounted to the spindle draw up the retaining screws evenly before tightening them.

9. Periodically check the oil level in the arbor support oil sight gauge.

OVERARMS

The arbor supports are mounted on two parallel overarms which provide accurate alignment and maximum rigidity for the arbor and cutter assembly. Self-equalizing overarm clamps are locked and unlocked by means of clamp nuts.

The position of the overarms can be adjusted by releasing the clamp nuts and pushing them to the desired position.

The double overarms eliminate the necessity of completely removing the arbor support when replacing arbors and cutters. When this is necessary, merely slide the support onto an extended overarm, swing the support upward and let it rest on the other overarm.

OUTER ARM BRACE

The outer arm brace is used to tie the overarms and the knee together for heavy milling operations. The slots in the brace permit it to be used at various settings of the knee. To install the brace, proceed as follows:

1. Mount the arbor supports so that the outer face is flush with the end of the overarms.

2. Position the overarms so that the arm brace can be located as close to the saddle as possible.

3. Mount the brace on the knee, bring it into contact with the arbor support and secure it to the arbor support and knee.

4. Always be sure to loosen the arm brace from the overarm supports before raising or lowering the knee.

SECTION V

MACHINE ADJUSTMENTS

After a period of use, it may become necessary to make adjustments to some of the moving units to keep them working properly. Listed here are a set of step by step adjustments which can be done simply and quickly by the operator.

We ask that any adjustments or repairs other than those mentioned here be handled by qualified maintenance personnel, or by a Kearney & Trecker serviceman. Repair parts books on these machines, catalogs CER-3 for 2CE, and CER-7 for 3CE, are available.

SADDLE GIB ADJUSTMENT

The left saddle dovetail has a full length taper gib with adjusting screws at both ends. To make gib adjustment, loosen the screw at the small gib end approximately one-quarter turn, then bring up the opposing screw the same amount. This process must be repeated until a slight drag is felt when moving the saddle by hand.

KNEE GIB ADJUSTMENT

A straight, full length gib is bolted to left rear of knee in contact with the column dovetail. When adjustment is required, tighten the knee clamp lever, then bring up the six fillister head screws slightly (about 1/10th turn). Then release knee clamp levers and check movement.

Proper knee gib adjustment can be checked with an arbor or test bar mounted into the spindle. A dial indicator fastened to the table in contact with the side of the arbor or test bar should not register more than .001" when the knee clamp levers are tightened.

All gib adjustments are extremely important in maintaining overall machine accuracy. Loose gibs will cause chatter and vibration. Further, they will permit entry of dirt or grit which will impair the sliding ways. Gibs should be examined frequently and adjusted when necessary.

TABLE GIB ADJUSTMENT

The table is equipped with a full length taper gib which has adjusting screws at both ends.

When gib adjustment is required, loosen the screw at the small end one-quarter turn, then tighten the screw on the opposite end the same amount. Repeat this process until a slight drag is noticeable when moving the table over the entire range of travel by hand. Caution must be taken not to bring the opposing screws up too tightly or a bow in the gib will result.

NOTE: *To maintain even wear on table ways and table screw, place fixtures, vises and workpieces in various positions as jobs permit. During idle periods the table should be centered on the saddle to prevent deflection due to weight.*

ADJUSTMENT OF TABLE SCREW THRUST BEARINGS

The table screw is mounted in brackets secured to table ends. The left table bracket bearing is of the radial type and requires no adjustment. The right table bracket is constructed so as to permit the use of opposed tapered roller bearings with an adjusting nut for end thrust take-up.

Table screw thrust bearing adjustment can be made as follows:

1. Remove the cover from the right table bracket.
2. For 2CE: Loosen 2 set screws in the adjusting nut and tap the nut with a soft hammer to release the bronze shoes under the set screws.

   For 3CE: Bend up the tab on the gurney lock washer which secures the adjusting nut.
3. Use a spanner wrench or insert a 3/8" rod in the hole provided to turn the nut.
4. Adjustment will be evident when opposed bearings are properly seated and end play is removed.
5. Secure the adjusting nut with set screws and attach the cover.

NOTE: *After making adjustment, on 2CE observe the position of the set screws in relation to the keyway milled in the table screw end. Should one of the set screws be positioned directly over the keyway, secure only the other set screw. This precaution will prevent the bronze locking shoe from being forced into the keyway slot.*

PULLEY BELT ADJUSTMENT

(See Fig. 4)

1. Loosen clamp nuts (A), lift up and remove cover (B).
2. Turn nuts (D) and (F) counterclockwise to loosen.
3. Turn screw (C) counterclockwise to obtain proper pulley belt tension. Correct belt tension is when

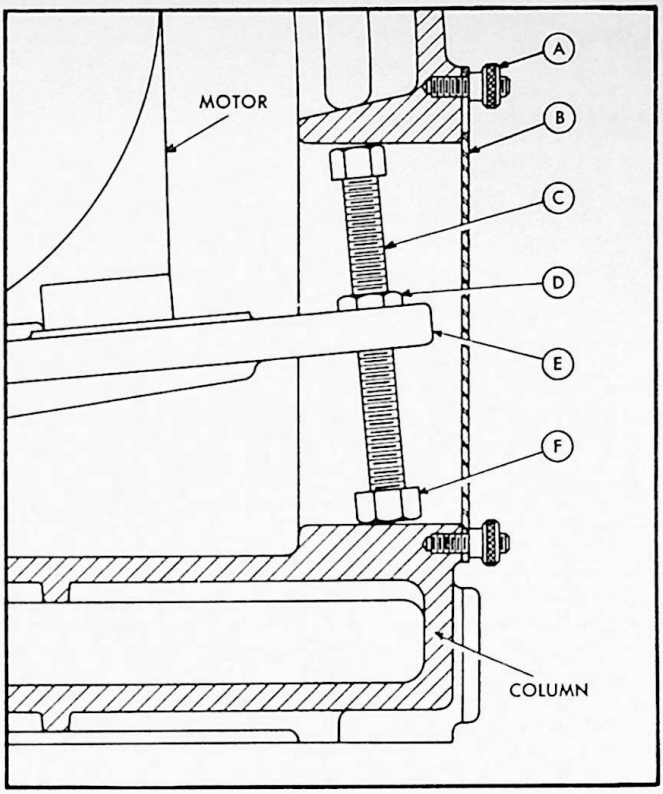


Fig. 4 Pulley Belt Installation and Adjustment

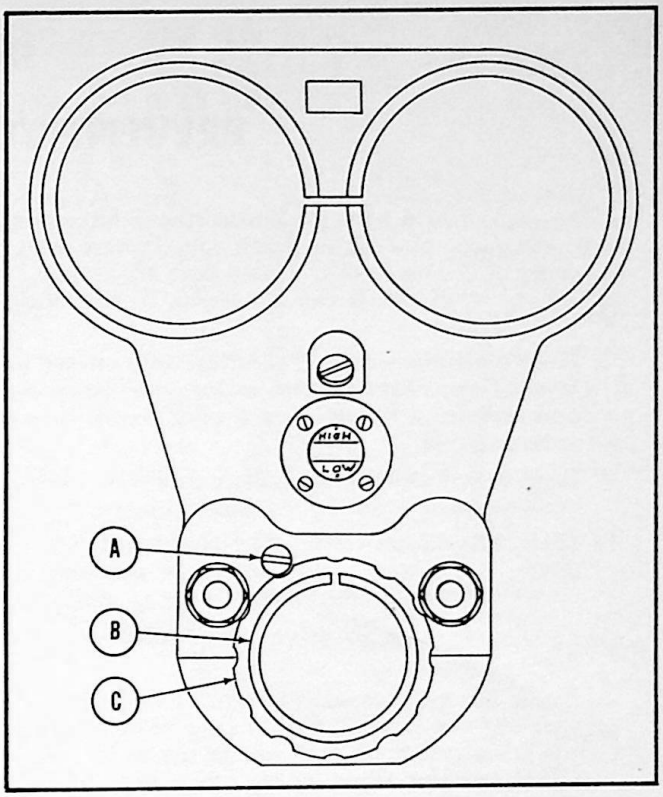


Fig. 5 Arbor Bearing Adjustment

belt can be deflected approximately ¾ inch by hand from its normal position.

4. Turn nuts (D) and (F) clockwise to tighten.
5. Install cover (B) and secure with nuts (A).

ARBOR BEARING ADJUSTMENT

When it becomes necessary to adjust arbor bearings, follow these steps. (See Fig. 5.)

1. Unscrew lock screw (A) until it is free of adjusting ring (C).
2. To tighten the bearing (B), tap the adjusting ring (C) in a clockwise direction until the next notch in the ring is directly behind the head of the lock screw.
3. Turn the lock screw back into position.
4. Gently tap the adjusting ring and the arbor bearing against the face of the arbor support.
5. Tighten the lock screw again.

If the bearing is still too loose, repeat above procedure. If the bearing gets too hot, it is too tight. Repeat above procedure, tapping adjusting ring in a counterclockwise direction, and tapping the ring and the bearing against the back face of the support.

SECTION VI

PREVENTIVE MAINTENANCE

The neglect of a very elemental step is often found to be the cause of a major repair job. It may even be the cause of serious injury. Listed here are several precautionary steps which can add years to the efficient life of a machine.

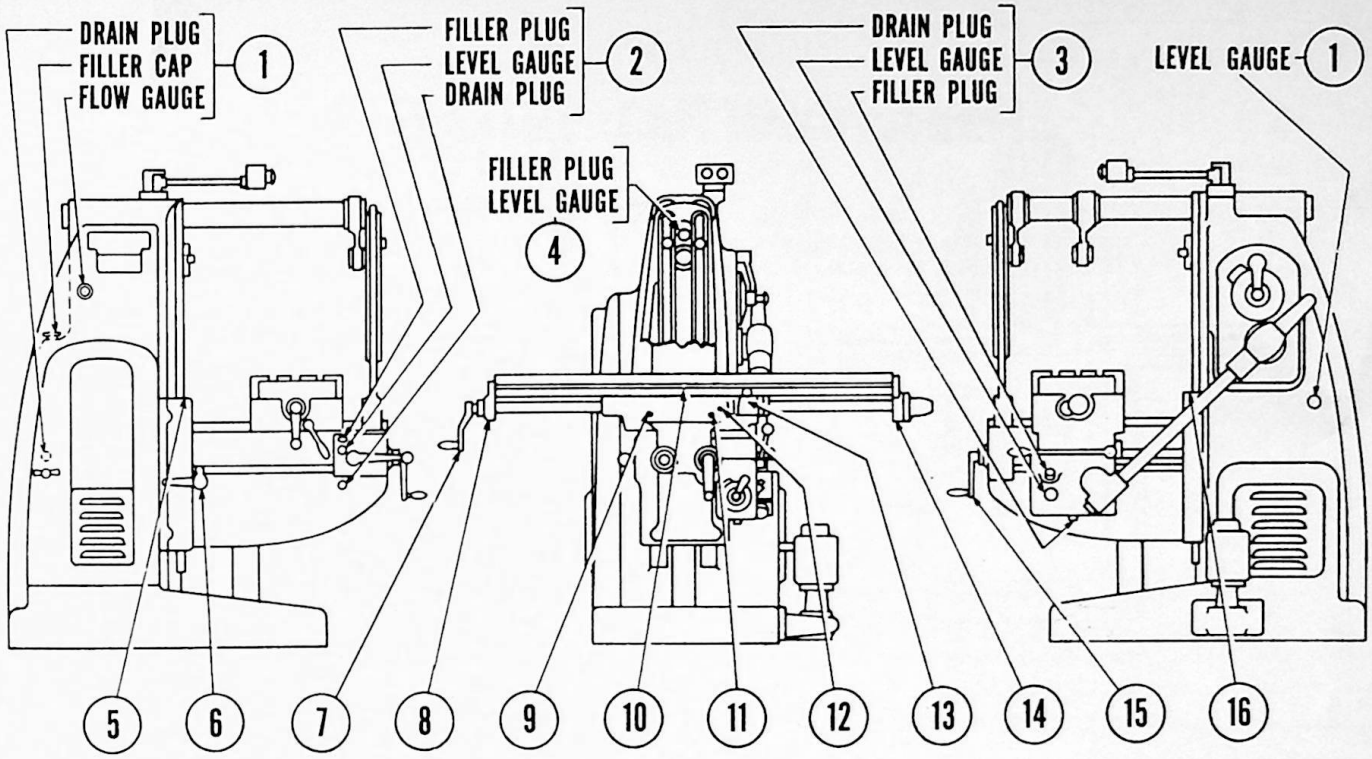
1. Keep machines clean. If possible, keep unused portions of ways covered with a clean rag. Keep chips and dirt from being clogged or jammed between moving parts.
2. Keep floor areas free from chips and oils. They are extreme hazards to the machine operator.
3. Do not lay tools on finished surfaces of the machine. If a cabinet or tool box is not available, first cover machined surfaces with a rag or shop towel.
4. Do not attempt to drive arbors without spindle drive keys.
5. Never use a cutter without a drive key. Use a key that fits the keyway and is long enough to drive the arbor collars on each side of the cutter. Before tightening the arbor, be sure that the cutter has been rotated against the key.
6. Never use a lead block or hammer to tighten a wrench. Sufficient tightness can be gotten when tightening by hand.
7. Always use washers beneath nuts, and use a wrench that fits the nut.
8. Always use a rag when handling or mounting cutters.
9. Do not force cutters onto arbors. If the cutter binds, it probably is due to a nick or scratch in the arbor. In most cases, a piece of emery cloth will remove any high spots on the arbor and permit the cutter to slide freely into place.
10. When milling without coolant, place the coolant covers over the screened coolant wells in the table to prevent grit and dust from clogging the coolant channels.
11. As a precautionary measure, always use trip dogs to safely limit travel of the table, knee, saddle, and vertical head.
12. To protect the table lay rough castings on a subbase.
13. Finished surfaces of the workpiece should be protected by placing shim stock between the workpiece and the clamps.
14. Before beginning a job, check to see that sufficient clearances have been allowed between moving and stationary units.
15. To prevent dust and dirt from entering the machine, always keep the motor and pulley bracket doors closed.

It is our belief that although the items listed above are quite elementary, they are items which will aid greatly in producing better work faster and more safely.

A more complete summary of the Do's and Dont's in milling practices can be obtained by contacting your Kearney & Trecker representative or dealer, or by contacting the Kearney & Trecker Corporation. Ask for "Milling Practice Series" Book I. Also helpful would be "Milling Practice Series" Book II, which explains the inner workings of the milling machine. A booklet titled "Methods of Cam Milling" on Kearney & Trecker machines, is also available.

Efficiency of a machine is judged by the amount of work it produces and the finish and accuracy of the pieces produced. At times, especially when taking heavy cuts, excessive vibration or "chatter" causes a poor finish. In most cases a few simple checks can eliminate chatter. Following is a check list which can be used to point out a few of the main causes of chatter.

1. Is the workpiece clamped properly?
2. Are overhanging portions of workpiece rigidly supported from the bottom?
3. Is the cutting force directed against rather than away from the fixture or holding device?
4. Are the proper speeds being used? (See chart on p. 16.)
5. Are the proper feeds being used? (See chart on p. 16.)
6. Have all movable units, other than the one being used, been properly locked?
7. Is the arbor large enough for the job it is expected to do?
8. Is the cutter as close to the face of the column as the workpiece permits?
9. Is the arbor support as close to the cutter as possible?
10. Are both arbor supports being used?
11. Is the overarm brace being used?
12. Does the cutter have too many teeth for proper chip clearance?
13. Is a proper depth of cut being taken?
14. Is the arbor bearing set properly?
15. Are the overarms sticking out more than is necessary?
16. Is the cutter sharp?
17. Is the cutter diameter as small as possible?
18. Is the coolant flow properly regulated?
19. Have the gibs been properly adjusted?

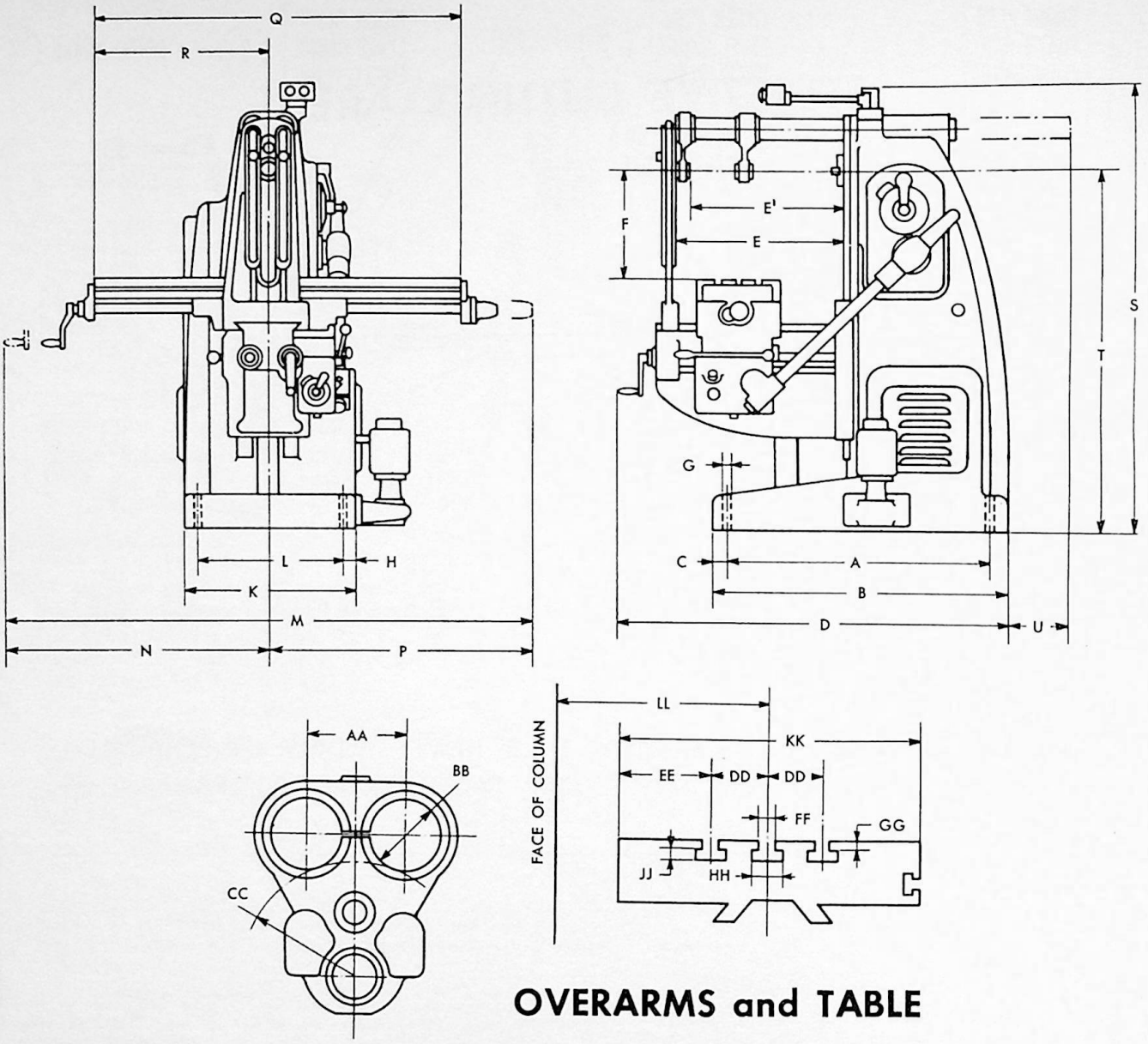


OIL RECOMMENDED: GARGOYLE D.T.E. HEAVY MEDIUM OR EQUIVALENT (SAYBOLT UNIVERSAL VISCOSITY 300-325 SECONDS AT 100° FAHRENHEIT)

		PARTS LUBRICATED	RESERVOIR CAPACITY 2CE	RESERVOIR CAPACITY 3CE	INSTRUCTIONS	INTERVAL
AUTOMATIC OILING	1	Spindle Drive Speed Gear Box Pulley Assembly	2 Gallons	2½ Gallons	Stop motor and add oil to maintain level at upper line on level gauge.	As required.
	2	Knee Drive	5 Quarts	1½ Gallons	Drain reservoir. Flush with liquid flushing solvent for ten minutes with motor running. Drain and refill reservoir.	Every four months or each 500 hours of machine operation, whichever occurs first.
	3	Feed Gear Box Rapid Traverse Drive	3 Pints	1 Gallon		
	4	Arbor Support			Add oil to maintain level at upper line on level gauge.	Daily.
HAND OILING	5	Left Column and Knee Way	Spring or screw cap oil cups.		Fill oil cups.	Daily.
	6	Knee Trip Lever				
	7	Table Hand Crank				
	8	Left Bracket Bearing				
	9	Left Knee and Saddle Way				
	10	Table and Saddle Ways				
	11	Right Knee and Saddle Way				
	12	Saddle Mechanism*				
	13	Table Trip Lever				
	14	Right Bracket Bearings				
	15	Elevating and Cross Feed Hand Crank				
	16	Right Column and Knee Way				

*Omitted on Universal Style machines. Lubricate saddle mechanism through oilers 9 and 11.

Fig. 6 Lubrication Chart—2CE and 3CE— Plain and Universal



OVERARMS and TABLE

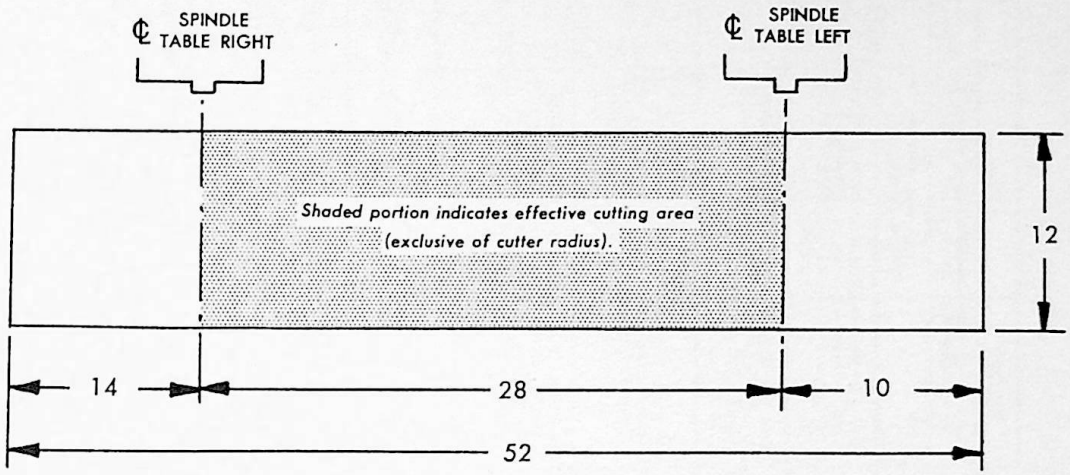
Note: Upper figures are in inches; lower fiaures are in metric system.

	A	B	C	D	E	E'	F Min	F Max Plain	F Max Univ.	G	H Front	H Rear	K	L Front	L Rear	M
3hp No. 2 Model CE Plain and Universal	37¾	41	1¾	56	24½	22¼	0	17	16	13/16	1¾	1½	24	20½	21	65⅜
	959	1041	44	1422	622	565	0	432	406	21	44	38	610	521	533	1661
7½hp No. 3 Model CE Plain and Universal	45¾	49	1¾	65	29¾	26½	0	18	17	13/16	1¾	1½	28	24½	25	81
	1162	1245	44	1651	756	673	0	457	432	21	44	38	711	622	635	2057

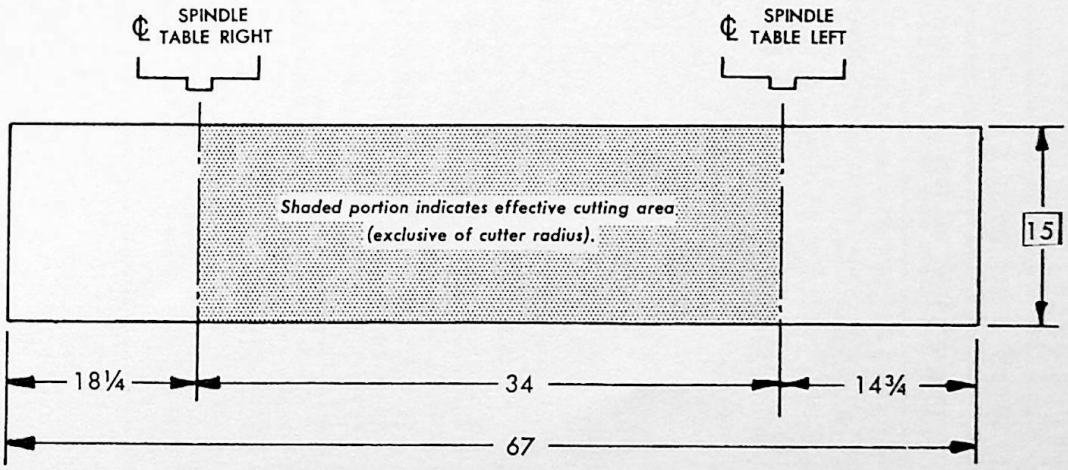
N	P	Q	R Max	S	T	U	AA	BB	CC	DD	EE	FF	GG	HH	JJ	KK	LL Min	LL Max
50¼	43⅛	52	42	61¾	50	15½	4	2⅞	4 9/16	2¼	3¾	1/16	9/16	1¼	31/64	12	7⅜	17⅜
1276	1095	1321	1067	1568	1270	394	102	73	116	57	95	17	14	32	12	305	187	441
61	54	67	52¼	65¼	50	26	5⅜	4¼	6⅜	2¾	5¼	1/16	¾	1¼	31/64	15	9⅜	21¾
1549	1372	1702	1327	1654	1270	660	137	108	162	70	133	17	19	32	12	381	238	552

Fig. 7 Plan Dimensions—2CE and 3CE—Plain and Universal

EFFECTIVE CUTTING AREAS



2CE PLAIN and UNIVERSAL



3CE PLAIN and UNIVERSAL

Fig. 8 Effective Cutting Areas

SAMPLE SPEED AND FEED CALCULATION.

PROBLEM: Determine proper SPEED and FEED of a 5" diameter face mill with 10 High Speed Steel blades, milling cast iron.

A) TO DETERMINE SPEED DIAL SETTING (Cutter R.P.M.):

RULE: Divide the feet per minute (F.P.M.) by the circumference of the cutter, expressed in feet.

FORMULA: $F.P.M. \div \frac{\text{Dia. of cutter} \times \pi}{12} = R.P.M.$

From Chart 2 under H.S. in Cast Iron, 80 F.P.M. (range 50-80) is selected.

Therefore: $80 \div \frac{5 \times 3.1416}{12} = R.P.M.$

$$\begin{array}{r} 3.1416 \\ 5 \text{ in. dia.} \\ \hline 15.7080 \end{array} \qquad \begin{array}{r} 1.31 \\ 12 \overline{)\,15.71} \end{array} \qquad \begin{array}{r} 61.1 = R.P.M. \\ 61.1\ R.P.M. \\ \hline 1.31 \overline{)\,80.00} \end{array}$$

SHORT FORMULA FOR SPEED:

$$\frac{4 \times F.P.M.}{\text{Diam. of Cutter}} = R.P.M. \text{ or } \frac{4 \times 80}{5} = 64\ R.P.M.$$

B) TO DETERMINE FEED DIAL SETTING (Feed in inches per minute = F):

RULE: Multiply feed per tooth per revolution by number of teeth in cutter and by the speed (number of revolutions per minute.)

FORMULA: F.T.R. x T. x R.P.M. = F (Feed)

From Chart 3 under Face Mill H.S. in Cast Iron a F.T.R. (chip load) of .012 is selected (range .010-.025). R.P.M. is 61 from speed calculation.

Therefore: .012 x 10 x 61 = Feed.
7.32 = Feed.

RESULT: For the 5" diameter face mill cutter with 10 High Speed blades, milling cast iron—

The SPEED dial setting is 61 R.P.M.
The FEED dial setting is 7.32 I.P.M.

NOTE: The speeds and feeds determined by mathematical computation are approximate and dial settings closest to these results (either higher or lower) are normally satisfactory as a starting point.

TO FIND	HAVING	RULE	FORMULA
Speed of Cutter in Feet per Minute (F.P.M.)	Diameter of Cutter and Revolutions per Minute	Diameter of Cutter (In.) Multiplied by 3.1416, Multiplied by Revolutions per Minute, Divided by 12	$\frac{D \times \pi \times R.P.M.}{12} = F.P.M.$
Revolutions per Minute (R.P.M.)	Feet per Minute and Diameter of Cutter	Feet per Minute, Divided by Circumference of Cutter in Feet (Diameter x 3.1416 ÷ 12)	$\frac{F.P.M. \div D \times \pi}{12} = R.P.M.$
Feed per Revolution (F.R.)	Feed per Minute and Revolutions per Minute	Feed per Minute, Divided by Revolutions per Minute	F. ÷ R.P.M. = F.R.
Feed per Tooth per Revolution (F.T.R.)	Feed per Minute and Number of Teeth in Cutter	Feed per Minute (In.), Divided by Number of Teeth per Minute (Number of Teeth in Cutter x Revolutions per Minute)	F. ÷ (T. x R.P.M.) = F.T.R.
Feed per Minute (F.)	Feed per Tooth per Revolution, Number of Teeth in Cutter, and Revolutions per Minute	Feed per Tooth per Revolutions Multiplied by Number of Teeth in Cutter, Multiplied by Revolutions per Minute	F.T.R.xT.xR.P.M. = F.
Feed per Minute (F.)	Feed per Revolutions and Revolutions per Minute	Feed per Revolution Multiplied by Revolutions per Minute	F.R. x R.P.M. = F.
Number of Teeth per Minute (T.M.)	Number of Teeth in Cutter and Revolutions per Minute	Number of Teeth in Cutter Multiplied by Revolutions per Minute	T. x R.P.M. = T.M.

R.P.M. = Revolutions per Minute
T. = Teeth in Cutter
D. = Diameter of Cutter
π = 3.1416 (Pi)
T.M. = Teeth per Minute
F. = Feed per Minute
F.R. = Feed per Revolution
F.T.R. = Feed per Tooth per Revolution
F.P.M. = Speed of Cutter in Feet per Minute

Fig. 9 Rules for Determining Speeds and Feeds.