DEPARTMENT
OF THE ARMY TECHNICAL MANUAL

OPERATOR, ORGANIZATIONAL, DIRECT SUPPORT

AND GENERAL SUPPORT MAINTENANCE

MANUAL INCLUDING REPAIR PARTS LIST

FOR

ENGRAVING MACHINE, PANTOGRAPH

MODEL P1-2
(3417-00-973-9928)

LARS MACHINE, INC.

HEADQUARTERS,
DEPARTMENT OF THE ARMY

APRIL 1984

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, DC, 6 April 1984

REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS

You can help improve this manual. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Mail your letter, DA Form 2028 (Recommended Changes to Publications and Blank Forms), or DA Form 2028-2, located in the back of this manual direct to: Commander, US Army Armament, Munitions and Chemical Command, ATTN: DRSMC-MAS, Rock Island, IL 61299. A reply will be furnished directly to you.

Operator, Organizational, Direct Support and General Support Maintenance Manual Including Repair Parts List for:

ENGRAVING MACHINE, PANTOGRAPH

Model P1-2

(3417-00-973-9928)

NOTE

This manual is published for the purpose of identifying an authorized commercial manual for the use of the personnel to whom this equipment is issued.

Manufactured by: Lars Machine, Inc.
1925 Roosevelt Avenue
Racine, WI 53406

Procured under Contract No. DAA09-79-M-6888

INSTRUCTIONS FOR REQUISITIONING PARTS

NOT IDENTIFIED BY NSN

When requisitioning parts not identified by National Stock Number, it is mandatory that the following information be furnished the supply officer.

1 - Manufacturer's Federal Supply Code Number - 54994

2 - Manufacturer's Part Number exactly as listed herein.

3 - Nomenclature exactly as listed herein, including dimensions, if necessary.

4 - Manufacturer's Model Number - Model P1-2

5 - Manufacturer's Serial Number (End Item)

6 - Any other information such as Type, Frame Number, and Electrical Characteristics, if applicable.

7 - If DD Form 1348 is used, fill in all blocks except 4, 5, 6, and Remarks field in accordance with AR 725-50.

Complete Form as Follows:

(a) In blocks 4, 5, 6, list manufacturer's Federal Supply Code Number - 54994 followed by a colon and manufacturer's Part Number for the repair part.

(b) Complete Remarks field as follows:
Noun: nomenclature of repair part)
For: NSN: 3417-00-973-9928
Manufacturer: Lars Machine, Inc.
1925 Roosevelt Avenue
Racine, WI 53406
Model: P1-2
Serial: (of end item)

Any other pertinent information such as Frame Number, Type, Dimensions, etc.

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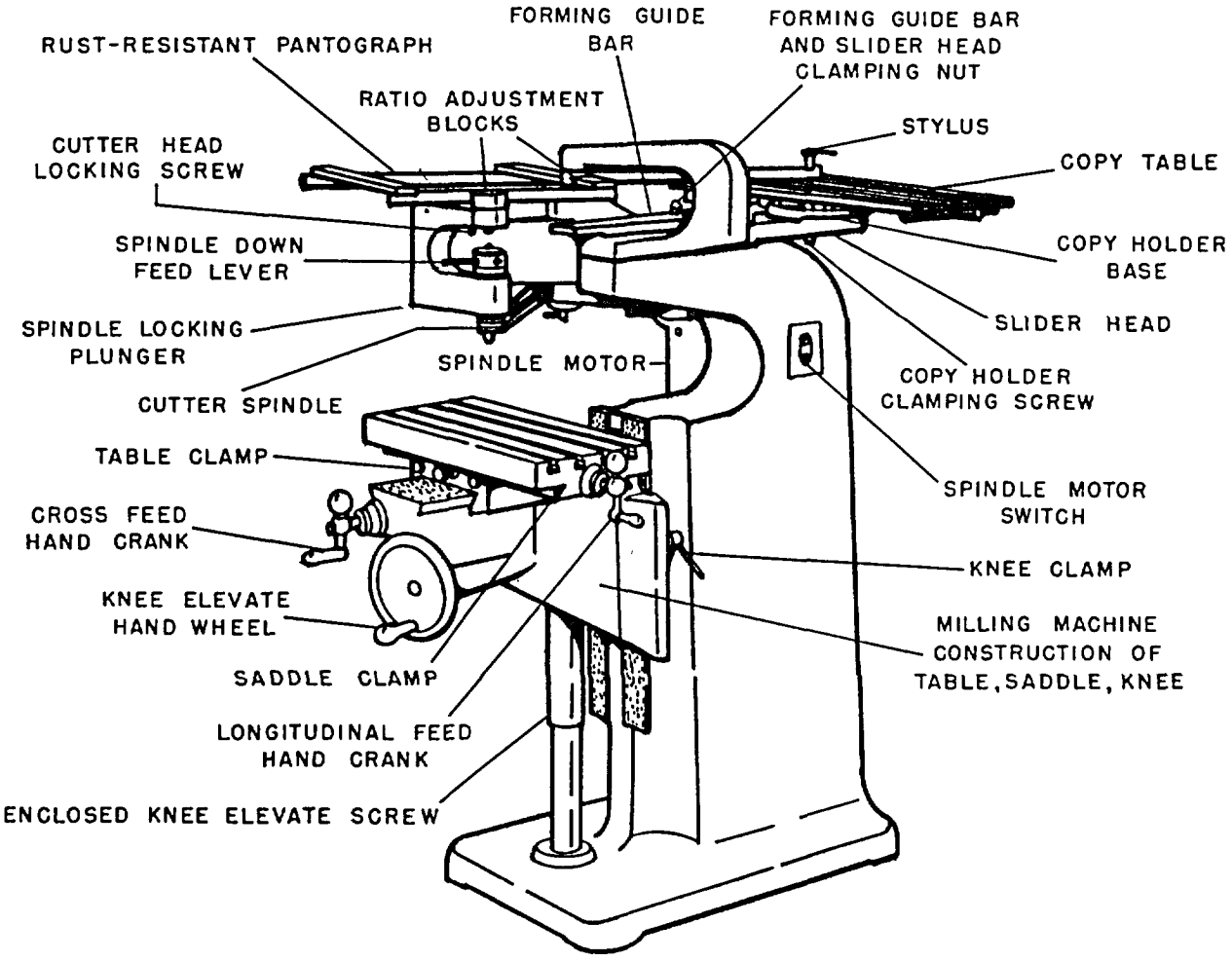
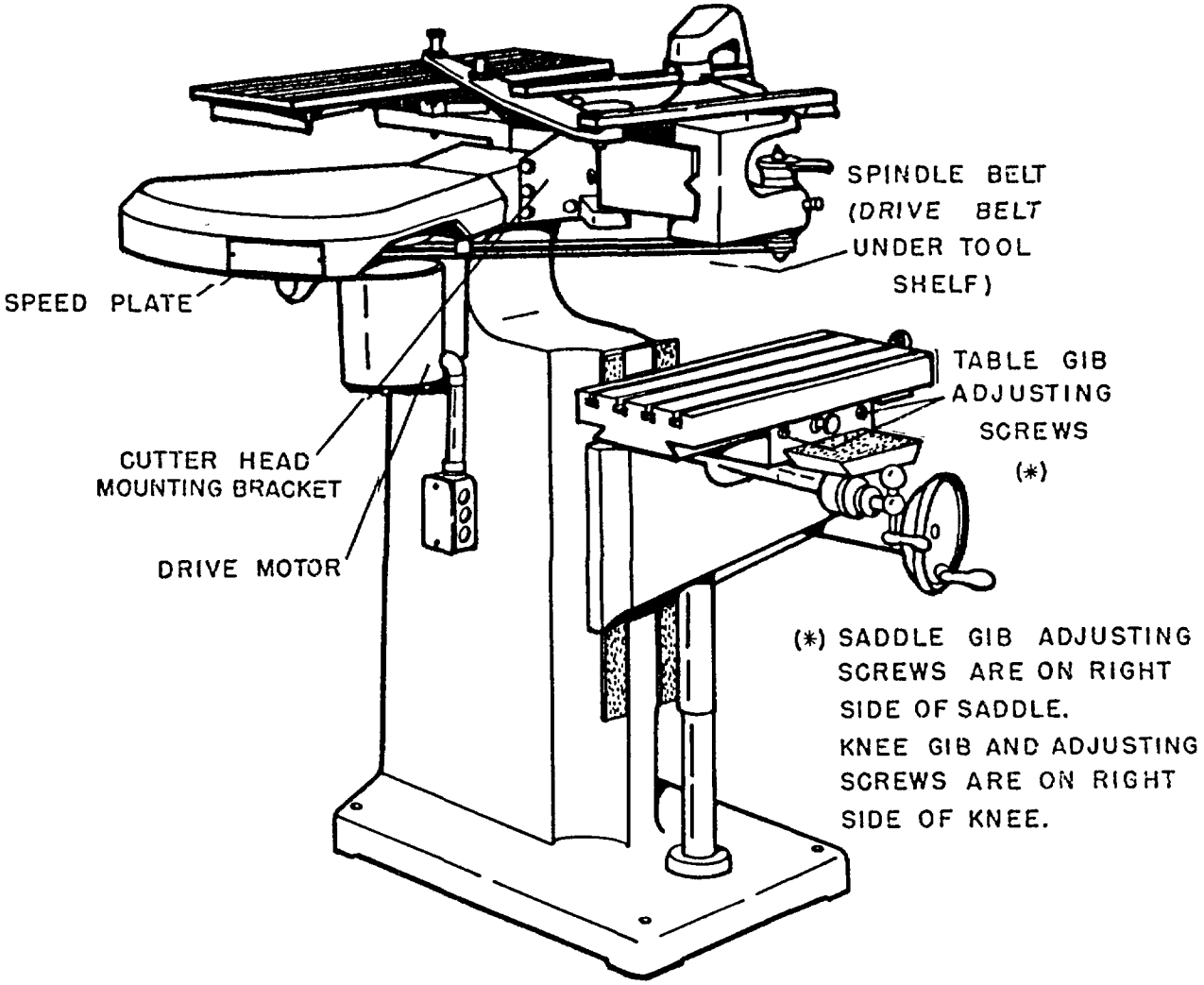
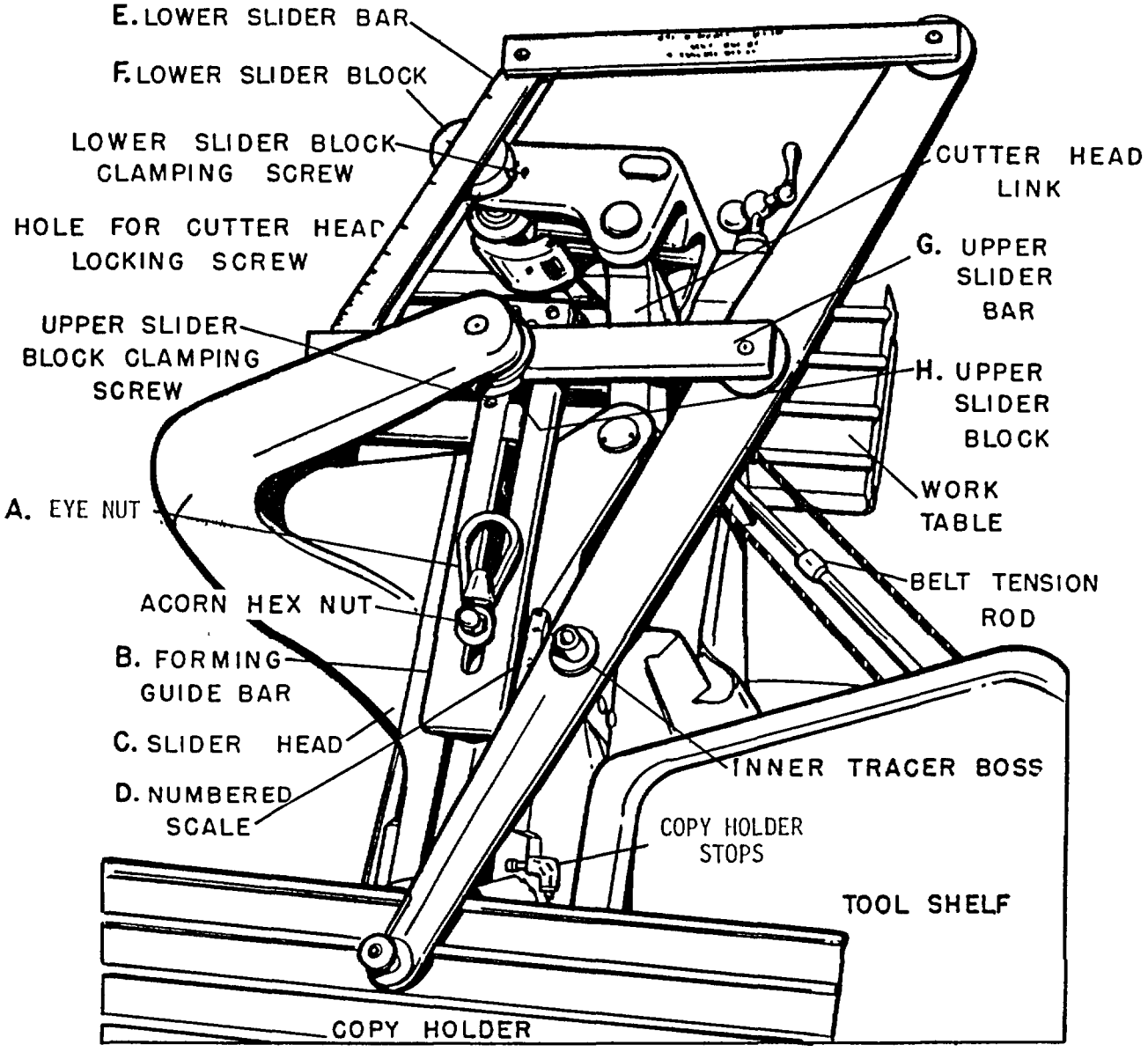
P1-2 PANTOGRAPH (2-Dimensional)
from Right

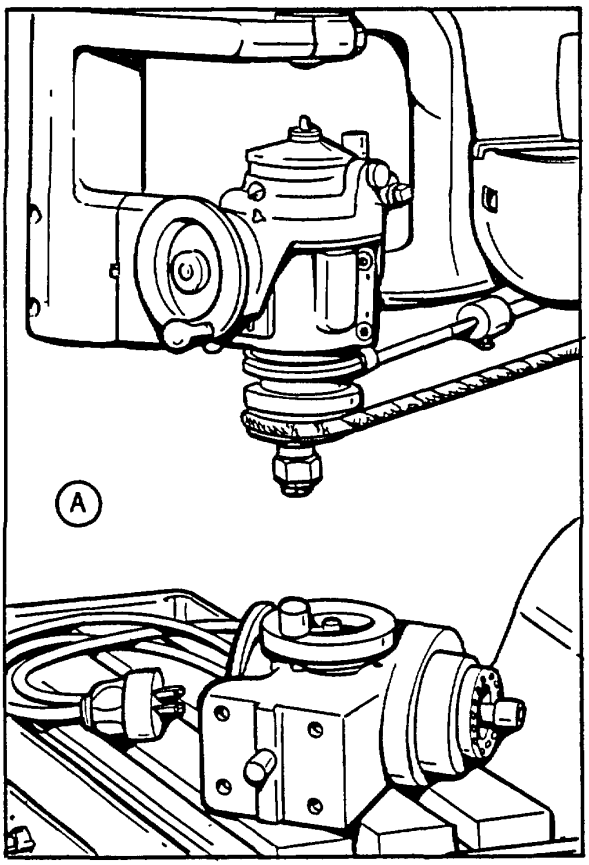


P1-2 PANTOGRAPH (2-Dimensional)
from Left

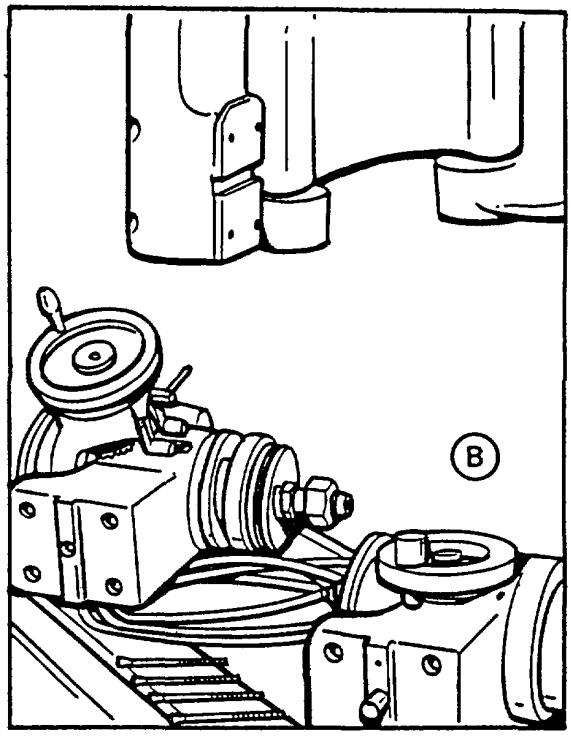


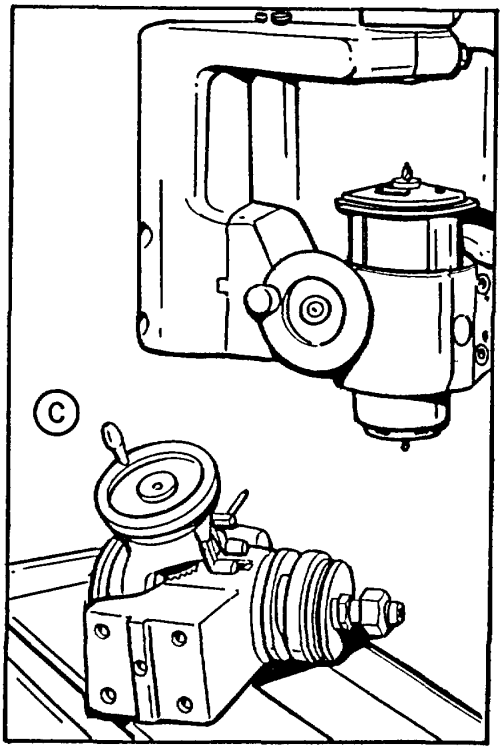
P1-2 PANTOGRAPH (2-Dimensional)
from Above





COMBINATION CUTTER HEAD, P1-2 HEAVY DUTY SPINDLE AND SUPER-SPEED ELECTRIC SPINDLE



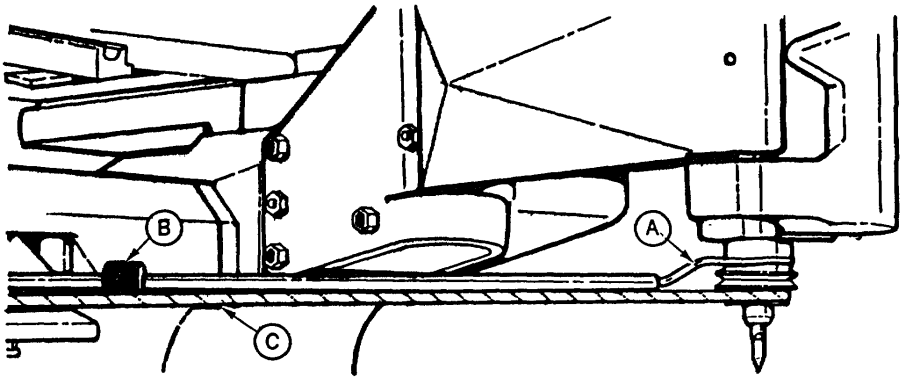


The Combination Cutter Head permits rapid change-over from belt-driven spindle to 45,000 R.P.M. Super-Speed Electric Spindle.

A. Upper left illustration shows belt-driven spindle in place and Super-Speed Electric Spindle and Cutter Head Bracket ready for installation on machine table.

B. Belt-Driven Spindle has now been removed by taking out four bolts shown lying on machine table.

C. Super-Speed Electric Spindle is now installed with same four bolts, mentioned in "B".

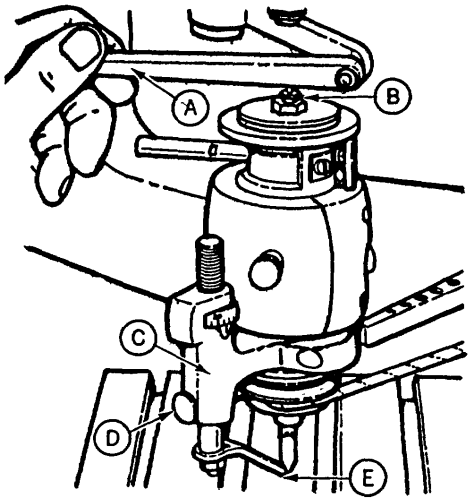


BELT TENSION ROD

A. Belt tension adjustment rod fork which engages machined groove at lower end of cutter head.

B. Belt tension adjustment collar; moves belt tension rod in and out of tension rod sleeve.

C. Endless fabric spindle belt.



706-4 DEPTH REGULATOR SINGLE FOOT

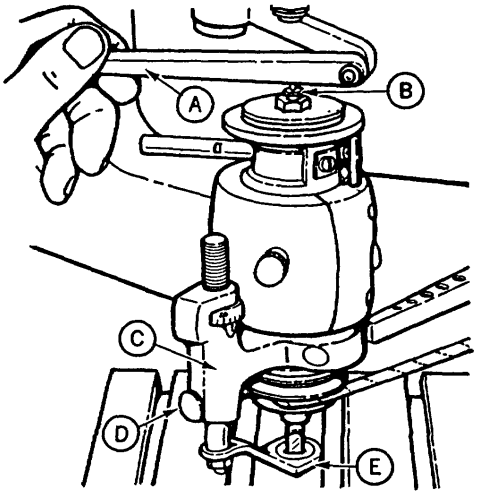
A. Hand feed lever for use with depth regulator.

B. Former point on top of spindle.

C. Depth regulator bracket with micrometer adjustment knob at upper end. Bracket clamps around lower end of spindle between belt tension rod fork and spindle pulley.

D. Depth regulator clamping screw.

E. Single foot rests on top of work close to cutter point.



1243-1 DEPTH REGULATOR UNI-BALL

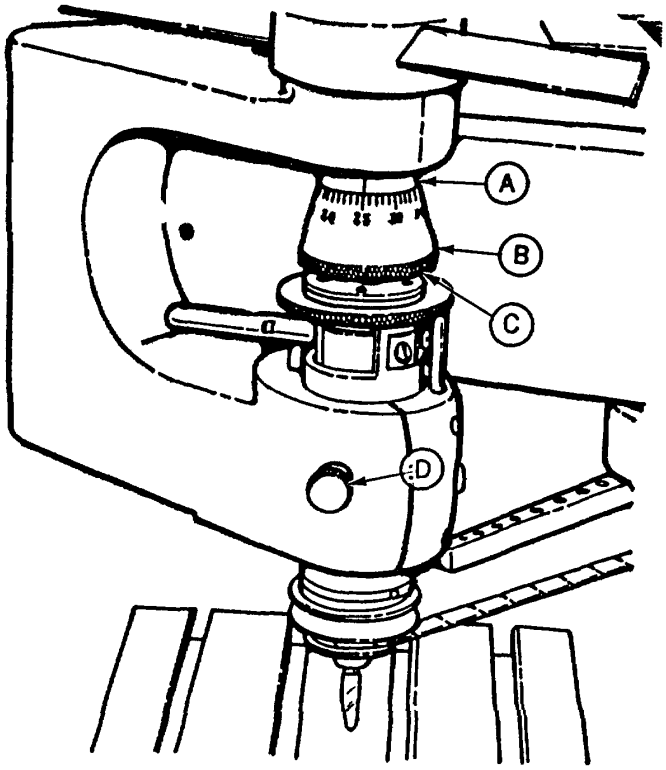
A. Hand feed lever for use with depth regulator.

B. Former point on top of spindle.

C. Depth regulator bracket with micrometer adjustment knob at upper end. Bracket clamps around lower end of spindle between belt tension rod fork and spindle pulley.

D. Depth regulator clamping screw.

E. Uni-ball foot rests on top of work and encircles cutters



MICROMETER DOWN FEED UNIT 1242-1

A. Upper end of unit has recess which fits snugly around hex-head nut below upper member of cutter head.

B. Micrometer down feed unit graduated in thousandths with maximum range of .200" down feed.

C. Unit rests over former point on top of spindle.

D. Former Sleeve Lock Screw which locks spindle in place for conventional engraving work or, when loosened, releases spindle free floating movement for work with Forming Guide.

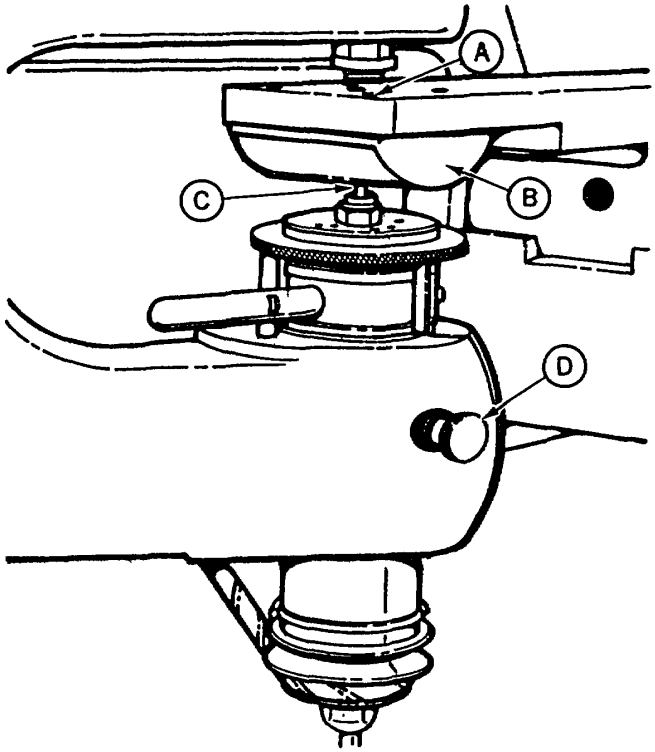
FORMING GUIDE IN USE

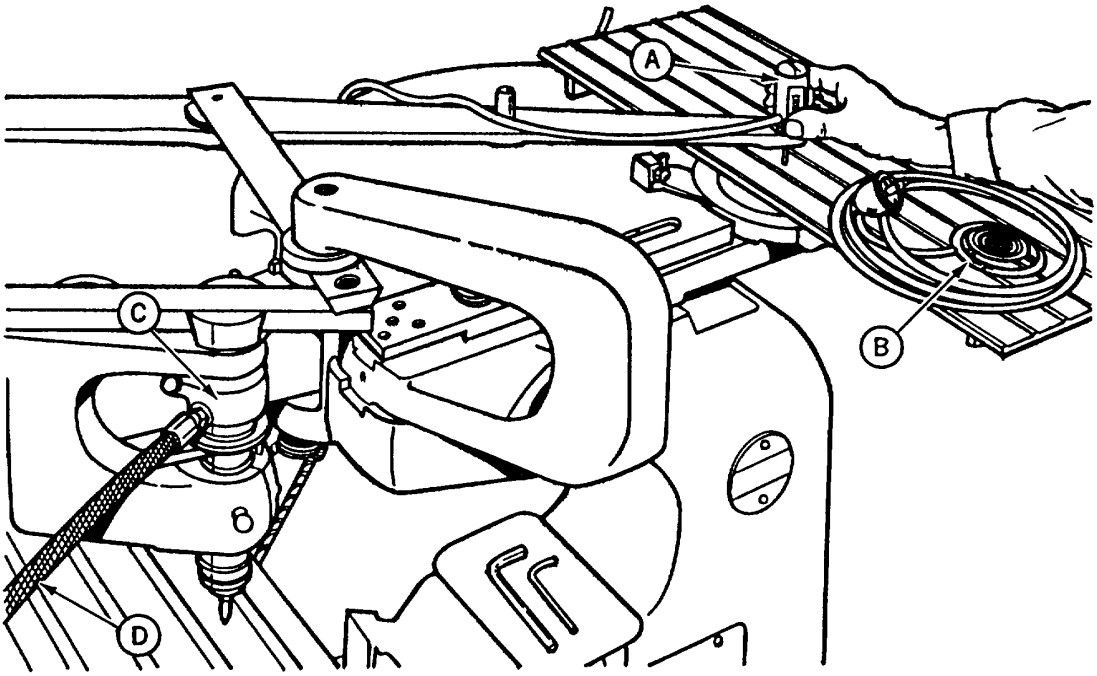
A. Former Bar extended over spindle and four Cap Screws which hold Forming Guide to Former Bar.

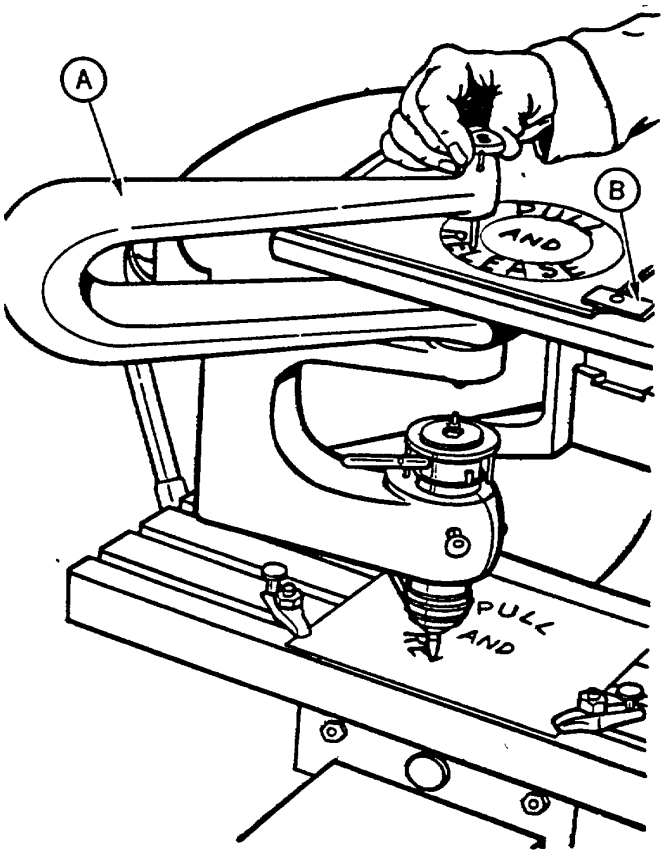
B. Solid Convex Forming Guide attached to Former Bar.

C. Former Point in contact with lower surface of Forming Guide.

D. Former Sleeve Lock Screw loosened to permit Spindle 1/2" free floating movement for work with Forming Guide.







REMOTE CONTROL SPINDLE FEED 1244-1

A. Electrical Switch Attached to Tracer Stylus which feeds and retracts Spindle.

B. Foot-operated electrical switch which can be used in place of hand-operated switch on tracing style.

C. Air-operated spindle down feed unit, connected by air line (D) to electrically-operated air valve. Maximum stroke, 1/4".

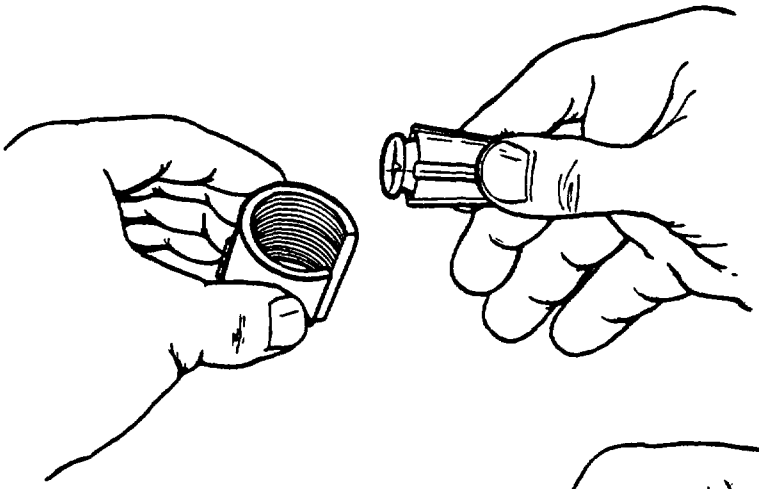
DIRECT COPYING ATTACHMENT

A. Direct copying attachment connected to upper member of cutter head. Replaces standard pantograph assembly.

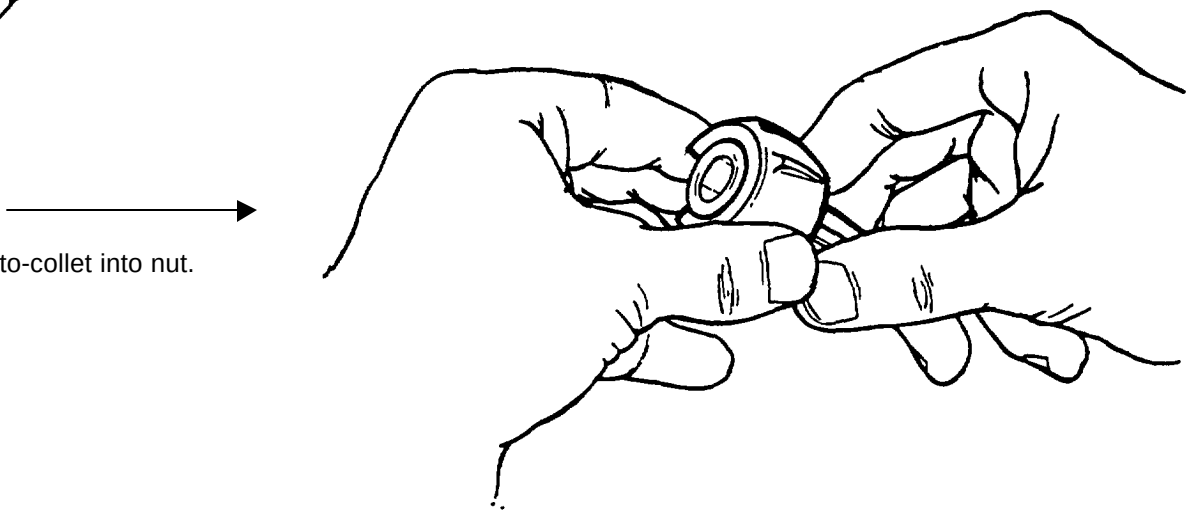
B. Copy Table of Direct Copying Attachment mounted on column top in place of slider head assembly.

ASSEMBLY OF

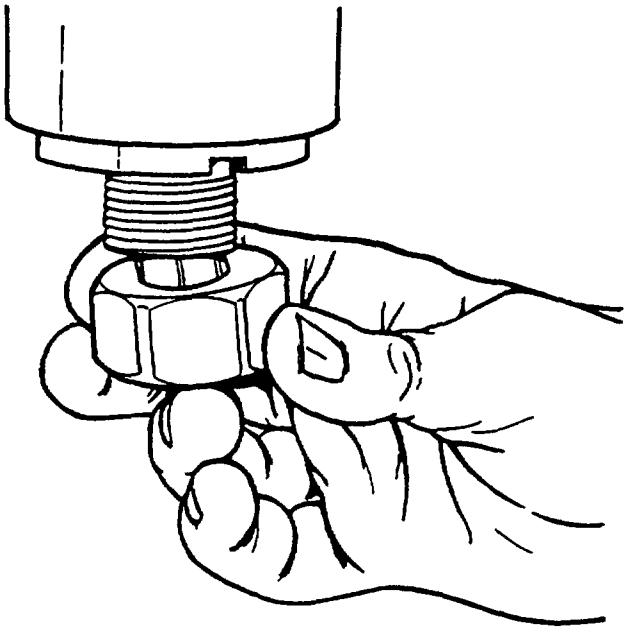
PANTO-COLLETS



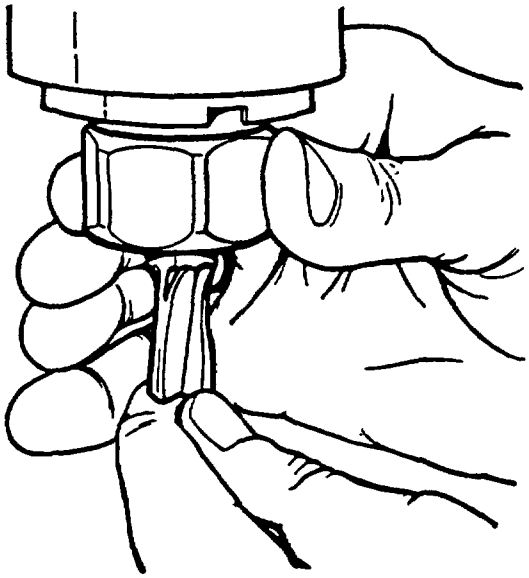
1. Select proper Pantocollet. Remove nut from spindle nose.



2. Snap Panto-collet into nut.



3. Insert Panto-collet in spindle with nut attached. Then engage nut.



4. Insert cutter and tighten nut.

PRELIMINARY OPERATIONS

UNPACKING

1. Carefully examine the machine to see that it is intact and that it has not been damaged in transit. The P1-2 is shipped boxed tight, not crated, to eliminate dust, dirt or cinders and to prevent anything being thrust through spaces in the crate to damage the machine. After removing box, check all parts with the packing list. Examine all packing paper, excelsior, etc., to make sure that no small parts have been overlooked.

LOCATING THE MACHINE

2. This machine is shipped complete in two units, the column-base and the pantograph. Before installing the pantograph, locate the column-base in a desirable position, centered in front of good window light, with operator's left side toward the window. Daylight is preferable when conditions permit, although good, indirect artificial lighting is usually satisfactory. Machine lamp is available to insure maximum visibility. User makes own installation.

CLEANING

3. Kerosene is preferable for use in cleaning the machine. Use rags free from lint, and fresh kerosene. Wipe entire machine thoroughly and immerse smaller parts. Do not at any time immerse the pantograph, as this will result in damage to components.

LEVELING

4. A flat, solid floor is of primary importance. Place a small machinists' level on the machine table. Shim up base as required. The base is drilled for lag screws used in shipping. These holes may be used for anchor bolts into the floor, although bolting down is not essential. If floor transmits too much vibration from surrounding machinery, good practice is to set machine on insulating pads.

SETTING SLIDER HEAD

5. First, remove eye nut on top of slider head see "A" on page 3. The front end of forming guide bar see "B" on page 3 can then be pushed down (or gently pried and tapped with wood block) releasing the hinged cutter head and link. The cutter head and link are also held in this "shipping position" when it is desired to operate the P1-2 as a light vertical miller and router with a fixed spindle. Now, with the eye nut removed, move the slider head - "C" on page 3 to the position which indicates on the numbered scale the ratio of reduction to be used. Scale is on top of slider head at left see "D" on page 3. Take acorn hex nut from parts box and tighten it on stud in place of eye nut.

INSTALLING PANTOGRAPH BARS

6. Now, holding pantograph bars in position shown on page 3, place slider bar "E" in slider block "P', with index line to the front. Then insert slider bar "G" in slider block "H" with index line on milled flat to the front also, making sure that clamping screws are loosened. Take care that edges of blocks and bars are not dented or nicked in this operation. These parts are carefully fitted and no force is necessary to slip the bars into the blocks, if started properly. After setting for the desired reduction and locking the bars in blocks by means of the clamping screw in each block, the machine is ready for use.

LUBRICATION

7. The problem of lubricating the P1-2 Pantomill is relatively simple and requires no lubrication drawing or chart.

a. SPINDLE. Two marked oil holes are provided on top of the cutter spindle. Apply two to four drops of spindle oil, NSN 9150-00-145-0112 to each oil hole twice daily.

b. ALL FEED SCREWS. Occasional application of an oil NSN 9150-30-145-0112 should be made. Knee elevate screw nut can be oiled by raising knee all the way up and sliding lower screw shield all the way up.

c. WAYS. A slight film of clean oil such as that described in paragraph 7b above, should be maintained on all bearing surfaces.

d. BEARINGS. All pantograph bearings, cutter head and link bearings, idler pulley bearings and motor bearings are grease-sealed and require no lubrication. (If motor has lubrication fittings, then grease or oil should be applied as required.)

POWER CONNECTION

CONNECTING POWER LEADS

8. When making power connection, be sure that the spindle rotates clockwise when looking down at it from above.

MACHINE OPERATION

BELT

9. Mount the belt tension rod into position (see page 5) and V-belt between motor and idler pulleys, and endless fabric belt between idler pulleys and spindle pulley. Belt tension rod should be adjusted so that there is no "whip" action by the belt at high speeds. Too much tension will stretch the belt unduly. The speed plate is mounted on the edge of the large tool shelf.

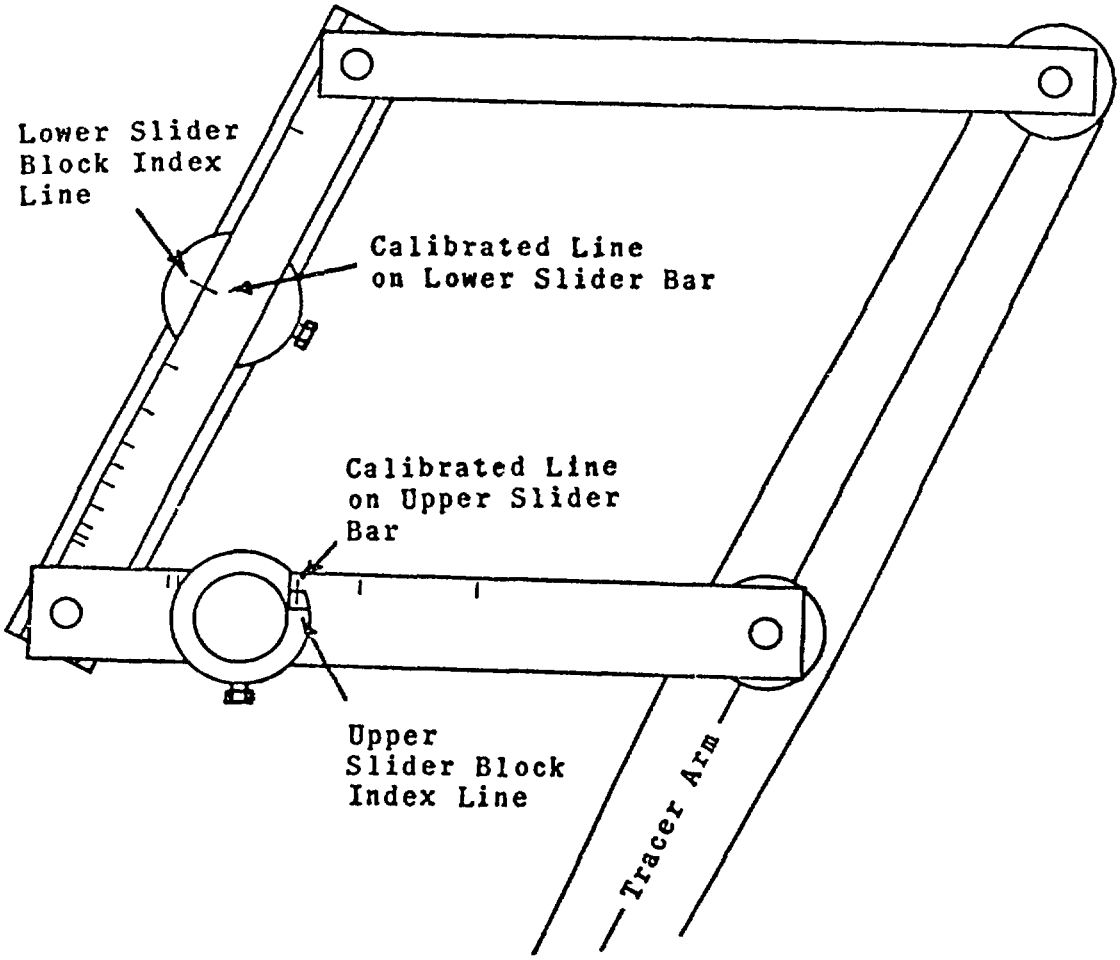
COPYHOLDER

10. Mount the copyholder bracket with stop screws facing front of machine. Mount copyholder on this bracket so that it fits snugly against one or the other stop screws, and then tighten copyholder hex head bolt.

SETTING THE PANTOGRAPIH

SLIDER HEAD ADJUSTMENT

11. The lower slider block has an index line on top which should be matched with the proper calibrated line on the lower slider bar. The upper slider block index line should be matched with the proper calibrated line on the upper slider bar.



12. Refer to page 3. You will find calibrations 2, 3, 4, 5, 6 and 8 at "D". When setting the pantograph bars for any reduction, also set the slider head to the closest calibrated figure, and slide this figure into the notch on the top of cutter head mounting bracket. This will give you the maximum cutting area at the required reduction.

13. Copy is laid out to keep within the range limits of the pantograph. See Chart 2717 at the back of this book. The setting of the pantograph is then determined from the size of the work to be engraved.

14. Example: If length of copy is 10" and length of finished work is to be 2", divide the finished work dimension into the length of copy dimension (10 ÷ 2 = 5). Therefore, set your pantograph bars at the reduction figure "5". If length of copy is 11" and length of finished work is to be 4", then the reduction is 11 ÷ 4 = 2.75. You will note that reduction 2.75 is not marked on the pantograph bars. To find it, refer to table beginning on page 29. If the exact setting does not appear in this table, use formula on page 27 or 28.

15. To obtain accurate reproduction through the pantograph bars, it is essential that the settings be made with a magnifying glass so that the index line on the blocks will be aligned with the calibrations on the bars.

Note:

After pantograph has been set accurately and there is an error in parallelism between copy table and machine table, it may be necessary to adjust screw "X" (see page 27). This will not affect the accuracy of the pantograph and the calibrations.

For odd reductions from 2 to 1 to infinity, table on page 29 is used. All pantomills are not identical and, therefore, it may be necessary to deviate slightly from the dimensions given in the table.

16. It is best after a special reduction has been set, to check the pantograph. First, place a point in the spindle, then raise the table until this point clears it by a fraction of an inch. Next, follow the inside edge of the copyholder with tracing style. If the point follows parallel to the T-slots, the reduction settings are correct. If the point forms

an arc or angle, the setting should be recalculated and reset. If point still runs off, it can be corrected by loosening either of the slider blocks and tapping one way or the other until path of point is true. (See page 27.)

a. For especially fine settings, put dial indicator rod in spindle nose. Draw up tight and, with indicator button below center of spindle, trace front or back of work table or one of the T-slots. Follow inside edge of copyholder with stylus as described above. This operation establishes accuracy, but does not necessarily result in correct ratio of reduction.

b. If reduction ratio has changed due to the above adjustments for accuracy, then the new reduction ratio must be determined by a trial cut, and the resulting deviation from the desired reduction ratio must be compensated for in the diameter of stylus and/or cutter. (Also see paragraph 18a below.)

17. For a 1 to 1 ratio, transfer style and collet from outer boss to inner boss on the tracer arm; set lower slider block on graduation "1-2" and upper slider block on graduation "1".

18. To set the pantograph, proceed as outlined in paragraph 6, page 11. Never force the pantograph bar slider blocks by striking with a hammer or any other hard object. These blocks are carefully inspected and tested before shipment from factory, and if at any time while setting the pantograph you find these blocks too tight, ascertain the cause. It may be that the clamping nuts are not sufficiently loose, or they may be gummed with oil.

a. DISTORTING MASTER. Another method often used to compensate for inherent inaccuracies in a specific machine is as follows: by trial cutting first

determine the direction and amount of the deviation or inaccuracy, then rework or distort the master to compensate. If this is done carefully, the pantomill will provide extreme repetitive accuracy.

CUTTER SPINDLE

19. The P1-2 cutter spindle has a 1/4" fast feed and a 1/16" slow feed to protect cutter, together with a full floating vertical movement of 1/2" for work with a forming guide on curved surfaces. It is a high precision unit of simple, sturdy construction, self-contained and quickly removable for grinding cutters in place in the spindle. Spindle bearings are not manually adjustable, but automatically compensate for normal wear. Proper lubrication will prevent excessive wear and increase operating efficiency.

a. SPINDLE REMOVAL. To remove spindle for any purpose, take out socket head cap screw in the center rear of spindle housing. Spindle housing is of hinged split construction and can easily be opened thereafter.

20. All spindle parts are made of the finest alloy steel, hardened and ground inside and out to precision tolerances. Super-precision preloaded ball bearings eliminate all end play. Spindle top is provided with an inside oil reservoir and an oil filter keeps out dirt. Milled grooves in spindle pulley allow indexing to grind flats on cutters.

a. A hinged cutter head as described above, permits spindle removal, making it unnecessary to disturb work. A thumbscrew locks spindle for flat surface engraving and releases it for work with a forming guide.

21. Spindle is either for taper shank cutters or 5/16" dia. panto-collet type for straight shank cutters, depending upon how the machine was ordered.

TABLE, SADDLE, KNEE

22. Each unit is provided with a gib and adjusting screws. To tighten gibs, turn adjusting screws, applying equal pressure at all points. When properly adjusted, all play will be eliminated. Table and saddle feed screws are each provided with thrust bearing adjustments to eliminate any play that may develop in the thrust bearings. (Nuts are non-adjustable.) Table, saddle and knee feed screws are each provided with micrometer dials graduated to thousandths of an inch. They are of an adjustable type for setting to zero for quick, accurate reading.

23. IMPORTANT. After machine has been set up for operation, but before taking a cut, make sure the table, saddle, knee and copyholder have been firmly clamped. The table clamp screw has a knurled head and is located on the front of saddle. The saddle clamp is also a knurled screw and is located on right side of saddle under table. The knee clamp is a lever, located on right side rear of knee.

USE OF COPY, MASTERS OR TEMPLATES

24. The originals from which reproductions are made are known by various terms. "Copy" is the term most used, although “Master" is gaining in general usage. Copy applies specifically to the standard brass letters or type which are set up on the copyholder of the machine, and which guide the pantograph through the tracing style in reproducing at cutter point. Shapes as distinguished from characters are also called masters, special copy or templates.

25. After setting up the copy type in the copyholder and before engraving, be sure that the copyholder is firmly against one of the stop screws in copyholder base. It is then square with the table. T-slots in the machine table and T-slots or dovetail grooves in copyholder are all parallel to front edge of table. This makes it easy to set up work and copy in accurate parallel relation to each other.

COPY TYPE

26. Copy is held on the machine by means of copyholders provided for that purpose. A number of different styles and sizes are available. Where special masters are used exclusively, we recommend Copyholder 8-2. All these copyholders are interchangeable, and can be quickly removed or installed whenever work requires different sizes of copy, etc.

TRACING STYLES

27. Two different kinds of tracing styles are used with the P1-2 Pantomill. For all cutting of sunk letters and designs from 90° V-groove copy, Style No. 3253 (conical point) is used. For cutting sunk letters and designs from square bottom groove copy, also for relief (raised) letters and designs from relief copy, the 25-1 or 795-1 Tracing Style (square nose) sets are used.

CARE AND USE OF STYLE 3253

28. This style should be kept ground to a conical point of 90° included angle on a Cutter Grinder by means of the 2/10" dia. collets which can be supplied for this purpose. All sunk V-groove copy is made to 90° angle and if the style is not ground to this angle and kept sharp, the copy type will soon be damaged sufficiently to produce imperfect lettering.

29. Keep copy type grooves clean by rubbing out several times a day with slightly greasy cloth. This takes but a few seconds and permits style to move over the copy with much less operator effort. The style, when placed in the grooves of the copy, should be clamped in its collet on the long arm of the pantograph in such a way that no excessive straining of the pantograph joints is caused. The slight springing when the style is moved from one letter to another will do no harm.

CARE AND USE OF STYLE SETS 795-1, 25-1

30. These are for engraving, raised letters and designs, or sunk lettering in which the thickness of line is not uniform as it is with plain block letters. Where the reduction ratio is great, the styles and rollers 25-1 are used. Where the ratio of reduction is not great, and for final finishing, the styles without rollers, 795-1, are used.

31. If the cutter is in the exact ratio of reduction to the styles according to the reduction ratio set on the pantograph, the forms engraved will be accurately proportioned to the forms of the copy. The exact size may be conveniently calculated in decimals of an inch by reducing the diameter marked on the roller in the ratio of reduction to which the pantograph is set. Thus, if the pantograph is set to reduce to one-tenth the size of copy, a cutter .06" dia. must be used with the .6" roller. It is generally

desirable to use the largest roller with a proportionately large cutter to do the rough work of outlining and removing the bulk of the stock, and to use the smaller rollers, or styles alone, with corresponding cutters, only when necessary to reach into fine spaces or corners of the work.

USE OF FORMING GUIDE

32. For curved work a hardened steel forming guide is necessary in addition to the flat copy or master template. The forming guide should be the exact opposite of the work, and preferably made of tool steel hardened. For instance, if the work is convex, the forming guide should be concave. Before using, its contour should be matched precisely with the part to be engraved. This is done through the use of lamp black, mechanics blue, etc.

33. The making of forming guides can be avoided in many cases through the use of adjustable forming guides. These save the expense of making hardened guides from solid steel blocks.

34. Forming guides may be made by turning on a lathe, shaping on a shaper, milled with a form cutter, or by hand with file or hand grinder.

35. The forming guide is secured to the forming guide holder or bar by means of four small screws.

36. Assuming that the work is clamped to the work table and copy on copyholder, the general procedure is as follows:

a. Check to see that cutter point and former point are approximately the same size and shape, especially if cutter point has a small radius. Former point is easily removed for changing sizes.

b. Lock spindle floating movement by tightening former sleeve lock screw (see page 7), and locate work in relation to copy.

c. Release spindle floating movement by loosening the former sleeve lock screw, and allow former point to come in contact with guide which should be directly above work.

d. The spindle housing has two set screws, one above and one below the socket cap screw which locks the spindle housing around the spindle barrel. These two set screws provide the adjustment of spindle housing to spindle diameter. Backing out of set screws reduces the bore diameter of the housing around the spindle. Tightening of set screws expands the spindle housing bore. This adjustment of set screws is especially important when using a forming guide because spindle must be free enough to move up and down to follow the shape of the forming guide. Care should be taken when making such adjustment to see that spindle is not so loose as to cause "cocking". Use a thin piece of paper as a shim and check upper and lower set screws to make sure that spindle bore is held parallel.

e. Extreme care should be taken when locating forming guide in relation to work. Place a cutter blank having a conical point in the cutter spindle and raise work close to cutter. Now move the cutter point over surface of work by moving tracing style. If the cutter point does not follow the curved surface of the work, move work table in the necessary directions.

f. When the work is in direct relation to the forming guide, the copy will probably be found out of alignment with work, due to moving the table.

g. Copy should now be re-located by shifting it back and forth and placing tracing style at extreme points, noting when cutter point locates laterally with work. After lining up, lock the table and do not move again.

h. Cover forming guide with grease so former point will slide without friction. When this has been done, the engraving can proceed without further thought to the forming guide. The spring-loaded studs in the cutter head will always keep the former point secure against the guide, thus causing the cutter to follow the same course as the guide surface.

MACHINE ADJUSTMENTS

PANTOGRAPH BARS

37. The pantograph bars and blocks have commercial double bearings at the pivot points. Looseness can be eliminated at these points by tightening the screws to preload the bearings. Extreme care must be used so the bearings will rotate freely--will not bind pantograph motion--and yet will not have lost motion. The bearings are permanently grease-sealed and need no lubrication.

CUTTER SPINDLE BORE

38. The spindle housing has two set screws, one above and one below the socket cap screw which locks the spindle housing around the spindle barrel. These two set screws provide the adjustment for the spindle vertical motion. Backing out of set screws reduces the bore diameter of the spindle housing around the spindle. Tightening of set screws expands the spindle housing bore. Care must be taken when making this adjustment so that the spindle moves vertically freely, and yet has no lost side motion which could result in poor finish or shortened cutter life. Placing a thin piece of paper between the ends of the adjusting set screws and the mating surface, will help to determine if both set screws are making contact. If they are not, and the locking screw is tightened, the bore could become tapered. A change in spindles will necessitate a bore readjustment.

CUTTER HEAD AND LINK

39. The cutter head and link pivot bearings are permanently grease-packed and need no lubrication. If looseness develops in these pivots, they can be adjusted by loosening locking set screw and tightening slotted cap. Caution should be used not to preload bearings so that cutter head or link bind.

GIBS

40. The table and saddle gibs are adjusted by loosening the two lock nuts (per slide) and tightening the socket head screws evenly, then retightening the lock nuts. The knee gib is adjusted with the three socket cap screws. When properly adjusted, the weight of the knee, saddle and table should be sufficient to keep knee from hanging when it is lowered with the handwheel.

P1-2 HEAVY-DUTY PANTOMILL WITH COMBINATION CUTTER HEAD

41. If your machine is the Heavy-Duty Model, it will have the combination cutter head which is of split construction. By removing four cap screws at lower end of cutter head, spindle, feed works and lower head segment are removed and can be replaced with 45,000 R.P.M. electric spindle in its own lower head segment. See page 5.

42. Combination cutter head, link and spindle are substantially the same as the standard P2-2, except that spindle has two belt pulleys to provide high spindle speeds. Pantograph bars and slider blocks are interchangeable with the standard P1-2.

43. Areas covered by the cutter at all reductions are slightly smaller than for the standard P1-2 because of the larger cutter head and link.

44. The same formulae for special reductions can be used for the P1-2 Heavy-Duty Model as for the standard P1-2. Likewise, the reduction table for the standard P1-2 also applies to the P1-2 Heavy-Duty Model.

CUTTER SPINDLE

45. Spindle bearings are preloaded. After several years the spindle may become inaccurate through ball bearing wear.

46. CAUTION. Avoid using cutters with shanks more than .001"- .002" undersize. Undersize cutters require excessive tightening of collet nut to prevent slippage, thus permanently distorting the collets, causing the cutters to run out of true.

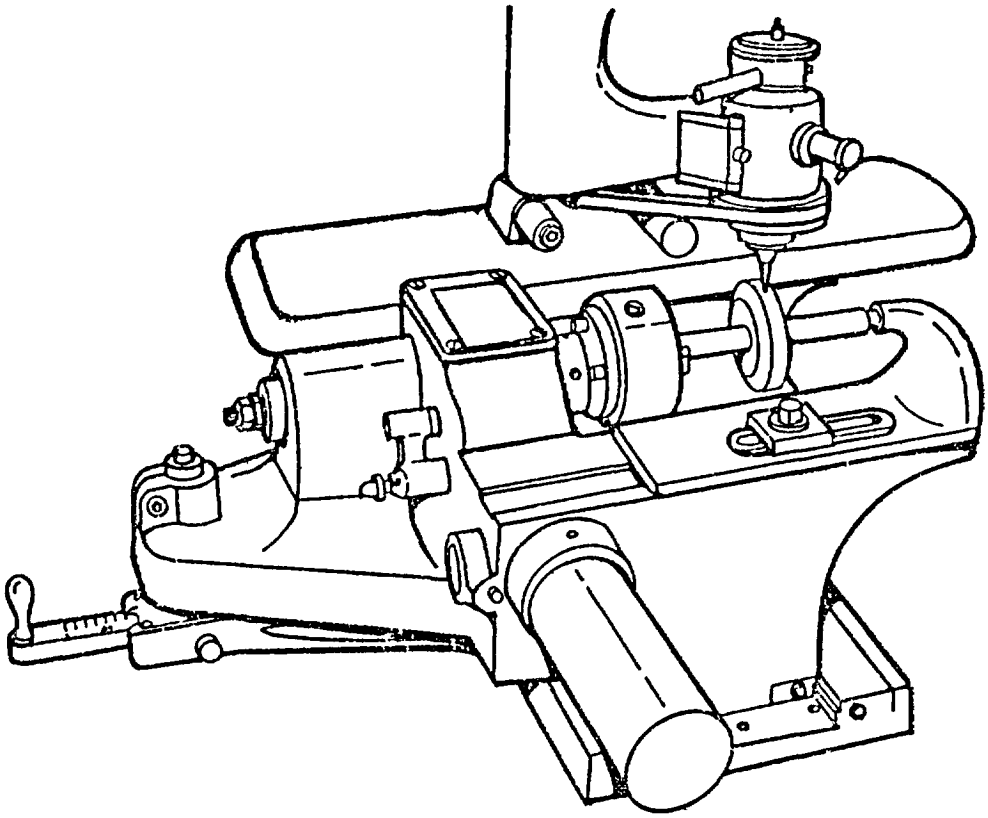
LUBRICATION

47. Two oil holes and two oil cups are located on top of spindle assembly. Oil according to instructions beginning in paragraph 7 on page 10. Occasional application should be made to oil hole in-hand wheel bearing with oil) NSN 9150-00-145-0112. All pantograph bearings, cutter head and link bearings, idler pulley bearings and motor bearings are grease-sealed and require no lubrication. (If motor has lubrication fittings, then grease or oil should be applied as required.)

OPERATING ADJUSTMENTS

48. The spindle, less feed works, is easily removed. Turn lower knurled ring to left until spindle is free. Do not allow spindle nose to drop on table top. When spindle is removed, prevent small chips and grinding dust from lodging around top seal. When replacing spindle, clean its outside surface thoroughly.

    On succeeding pages are REDUCTION TABLES and REFERENCE CHARTS, followed by PARTS LISTINGS which will help you identify, by photograph and brief description, all parts contained in the standard P1-2 Pantomill and P1-2 Heavy-Duty Pantomill.



727 Roll Attachment mounted on P1-2 Pantomill, with chip apron remove-d for clearer view. Features: A) correct speed of rotation; B) no forming guide required; C) cutter always at right angles, and D) width of characters variable. Capacity: range of diameters--3/4" to 3", length of work piece 7". With special attachments, longer rolls may be accommodated; also dia. to 3/8".

INSTALLATION

49. Lower machine table and wipe clean. Clean lower surface of roll attachment. Place attachment on machine table in near-center position. Match bolt holes in attachment with T-slots of machine table, and tighten bolts in place, making certain the attachment is square with front of table. (Scale of the attachment points toward front of machine.) Free lock on top slide and lower base to permit attachment to move freely. Remove machine belt and belt tension rod (fork fits against spindle) by loosening slip nut. Lock spindle in lowest position. Next, insert dowel pins of attachment adapter to cutter head with screws. Replace belt tension rod, place belt over pulleys and tighten slip nut to correct belt tension. Install connecting link between adapter and roll attachment. Note: connecting links of various lengths are provided so cutter spindle can be positioned along length of work piece. It may be necessary to alternate the use of connecting links to cover the entire length of the work piece.

OPERATION

50. Rotation of attachment spindle is accomplished by a steel band running over rollers, under sufficient tension to prevent slippage of the spindle. The band is adjusted before leaving the factory, and should not require any attention for a long time. If this band should require tightening, remove the tubular shields by loosening the small set screws. The tension adjusting screws can then be adjusted to exert more tension on the band. Back off hex nut to allow screw to turn. Then adjust tension by rotating screw with screwdriver. Retighten hex nut. **Note: do not move hex bolt (located above adjusting screw) except to change bands.**

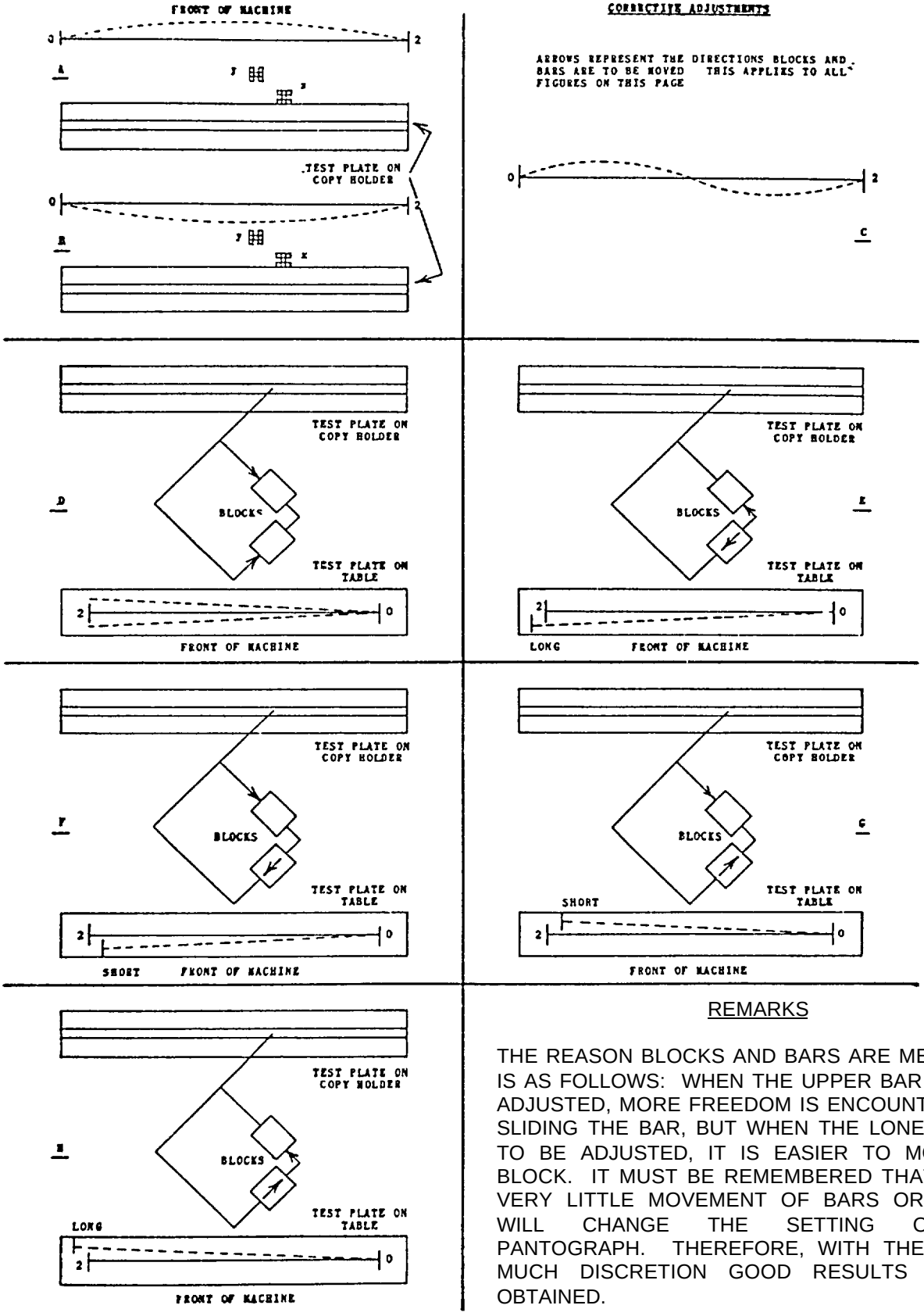
a. For mounting work on the attachment spindle, tension on the band should be released by means of the small lever with plunger locking pin, bringing it to an up-position. The spindle and work can then be rotated freely without any movement of the carriage slide, and the work can then be properly lined up and lever returned to its locked position, which will automatically tighten the band to its original tension. As the lever is moved to its locked position, the work may rotate slightly, and if it is necessary to line the job up accurately with the cutter, move the table slightly with the table screw. Work placed on the machine may be held with a chuck, arbor or special fixture, and should be accurate to .001". Check attachment to see that it runs true with the copyholder by placing a point in the spindle, and moving tracing style along edge of copyholder to see if the point follows edge of roll to be engraved. If the point does not follow properly, loosen fastening bolts and adjust attachment on table until roll is parallel with spindle movement.

b. Measure diameter of roll to be engraved, loosen brass thumb screws holding engraved scale, and set scale for proper diameter. Each graduation on scale is for 1/16" of diameter (graduations are approximate). Then center work with master. Replace point in machine spindle with cutter and proceed with engraving the same as on flat work, with the exception of taking lighter cuts. Cutter must be kept sharp, even more so than for highly accurate flat engraving to insure a clean, even cut. Important: Ball bearing slides must be kept clean and free from chips, and it is recommended that a brush be used to remove chips. While slides are protected by shields and aprons, do not use an air blast in cleaning the machine, as this may force some chips into the ball bearings, causing the slides to stick, possibly damaging them.

51. When roll attachment is not in use, lock top and lower base slides and release tension on steel bands.

CALCULATIONS--MASTER

52. The dimensions of the flat master utilized in roll attachment work are obtained as follows: the length of the master character or form will be the circumference (or portion of the circumference) of the work piece multiplied by the reduction (ratio) used. Example: 2" dia. part at 2 to 1 ratio - circumference 6.2832 x 2 = 12.5664 master dimension.



REMARKS

THE REASON BLOCKS AND BARS ARE MENTIONED IS AS FOLLOWS: WHEN THE UPPER BAR IS TO BE ADJUSTED, MORE FREEDOM IS ENCOUNTERED BY SLIDING THE BAR, BUT WHEN THE LONER BAR IS TO BE ADJUSTED, IT IS EASIER TO MOVE THE BLOCK. IT MUST BE REMEMBERED THAT ONLY A VERY LITTLE MOVEMENT OF BARS OR BLOCKS WILL CHANGE THE SETTING OF THE PANTOGRAPH. THEREFORE, WITH THE USE OF MUCH DISCRETION GOOD RESULTS CAN BE OBTAINED.

FORMULA FOR SPECIAL REDUCTIONS

(From 2-1 to 40-1)

CONSTANTS

(A = 20.0390

(B = 12.7450

(C = 10.0195

(D = 4.2483

FOR SETTING ON LOWER SLIDER BAR

Step 1. A ÷ Required Reduction = E

Step 2. C - E = Setting Distance from Graduation "2" on Lower Slider Bar in Inches.

FOR SETTING ON UPPER SLIDER BAR

Step 3. B ÷ Required Reduction + 1 = F

Step 4. D - F = Setting Distance from Graduation "2" on Upper Slider Bar in Inches.

EXAMPLE OF 9 to 1 REDUCTION

Step 1. 20.0390 ÷ 9 = 2.2266

Step 2. 10.0195 - 2.2266 = 7.793 inches from Graduation "2" on Lower Slider Bar.

Step 3. 12.7450 ÷ 9 + 1 or 10 = 1.2745

Step 4. 4.2483 - 1.2745 = 2.974 inches from Graduation "2" on Upper Slider Bar.

FORMULA FOR SPECIAL REDUCTIONS

(From 1-1 to 2-1)

CONSTANTS (A = 10,0195

(B = 12.745

(C = 6.3725

FOR SETTING ON LOWER SLIDER BAR

Step 1. A ÷ Required Reduction = D

Step 2. A - D = Setting Distance from Graduation "1" and "2" on Lower Slider Block in Inches

FOR SETTING ON UPPER SLIDER BAR

Step 3. B ÷ Required Reduction + 1 = E

Step 4. C - E = Setting Distance from Graduation "1" on Upper Slider Bar in Inches

EXAMPLE OF 1.8 TO 1 REDUCTION

Step 1. 10.0195 + 1.8 = 5.5559

Step 2. 10.0195 - 5.5559 = 4.4536 inches from Graduation "1" and "2" on Lower Slider Bar.

Step 3. 12.745 + 1.8 + 1 or 2.8 = 4.5518

Step 4. 6.3725 - 4.5518 = 1.821 inches from Graduation "1" on Upper Slider Bar.

REDUCTION TABLE FOR P1-2

REDUCTION	LOWER BAR INCHES	UPPER BAR INCHES	LOWER BAR MILLIMETERS	UPPER BAR MILLIMETERS
2-1	0.000	0.000	00.00	0.00
2.1-1	0.477	0.137	12.12	3.48
2.2-1	0.911	0.265	23.14	6.74
2.3-1	1.307	0.386	33.19	9.81
2.4-1	1.670	0.500	42.42	12.69
2.5-1	2.004	0.607	50.90	15.41
2.6-1	2.312	0.708	58.73	17.98
2.7-1	2.598	0.804	65.98	20.41
2.8-1	2.863	0.894	72.71	22.72
2.9-1	3.109	0.980	78.98	24.90
3-1	3.340	1.062	84.83	26.98
3.1-1	3.555	1.140	90.30	28.95
3.2-1	3.757	1.214	95.44	30.83
3.3-1	3.947	1.284	100.26	32.62
3.4-1	4.126	1.352	104.79	34.33
3.5-1	4.294	1.416	109.07	35.97
3.6-1	4.453	1.478	113.11	37.53
3.7-1	4.604	1.537	116.93	39.03
3.8-1	4.746	1.593	120.55	40.46
3.9-1	4.881	1.647	123.98	41.84
4-1	5.010	1.699	127.25	43.16
4.1-1	5.132	1.749	130.35	44.43
4.2-1	5.248	1.797	133.31	45.65

REDUCTION TABLE FOR P1-2

REDUCTION	LOWER BAR INCHES	UPPER BAR INCHES	LOWER BAR MILLIMETERS	UPPER BAR MILLIMETERS
4.3-1	5.359	1.844	136.13	46.83
4.4-1	5.465	1.888	138.82	47.96
4.5-1	5.566	1.931	141.39	49.05
4.6-1	5.663	1.972	143.84	50.10
4.7-1	5.756	2.012	146.20	51.11
4.8-1	5.845	2.051	148.46	52.09
4.9-1	5.930	2.088	150.62	53.04
5-1	6.012	2.124	152.70	53.95
5.1-1	6.090	2.159	154.69	54.84
5.2-1	6.166	2.193	156.61	55.69
5.3-1	6.239	2.225	158.46	56.52
5.4-1	6.309	2.257	160.24	57.53
5.5-1	6.376	2.288	161.95	58.10
5.6-1	6.441	2.317	163.60	58.86
5.7-1	6.504	2.346	165.20	59.59
5.8-1	6.564	2.374	166.74	60.30
5.9-1	6.623	2.401	168.23	60.99
6-1	6.680	2.428	169.66	61.66
6.1-1	6.734	2.453	171.05	62.31
6.2-1	6.787	2.478	172.40	62.95
6.3-1	6.839	2.502	173.70	63.56
6.4-1	6.888	2.526	174.97	64.16
6.5-1	6.937	2.549	176.19	64.74

REDUCTION TABLE FOR P1-2

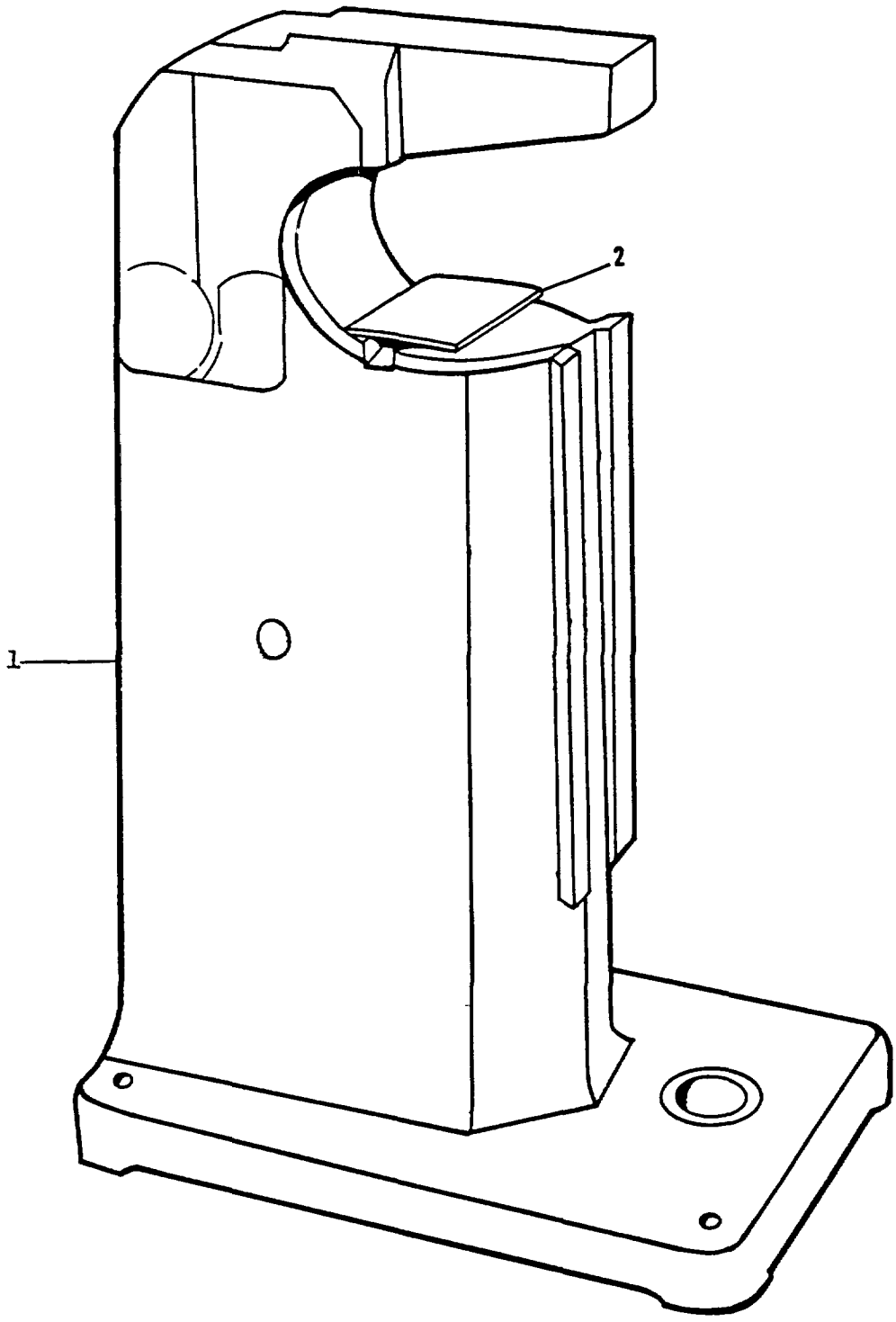
REDUCTION	LOWER BAR INCHES	UPPER BAR INCHES	LOWER BAR MILLIMETERS	UPPER BAR MILLIMETERS
6.6-1	6.983	2.571	177.38	65.31
6.7-1	7.029	2.593	178.53	65.87
6.8-1	7.073	2.614	179.64	66.40
6.9-1	7.115	2.635	180.73	66.93
7-1	7.157	2.655	181.78	67.44
7.1-1	7.197	2.675	182.81	67.94
7.2-1	7.236	2.694	183.80	68.43
7.3-1	7.274	2.713	184.77	68.90
7.4-1	7.312	2.731	185.71	69.37
7.5-1	7.348	2.749	186.63	69.82
7.6-1	7.383	2.766	187.52	70.26
7.7-1	7.417	2.783	188.39	70.70
7.8-1	7.450	2.800	189.24	71.12
7.9-1	7.483	2.816	190.07	71.53
8-1	7.515	2.832	190.87	71.94
9-1	7.793	2.974	197.94	75.53
10-1	8.016	3.090	203.60	78.48
11-1	8.198	3.186	208.22	80.93
12-1	8.350	3.268	212.08	83.01
13-1	8.478	3.338	215.34	84.78
14-1	8.588	3.399	218.13	86.32
15-1	8.683	3.452	220.56	87.67
16-1	8.767	3.499	222.68	88.86

SPEED CHART
(In Revolutions per Minute)

Surface Feet per Minute	Diameter					
	1/16	1/8	3/16	1/4	5/16	3/8
30	1833	917	611	458	367	306
40	2445	1222	815	611	489	408
50	3056	1528	1019	764	611	509
60	3667	1833	1222	917	733	611
70	4278	2139	1426	1070	856	713
80	4889	2445	1630	1222	978	815
100	6112	3056	2037	1528	1222	1019
125	7641	3820	2546	1910	1528	1274
150	9169	4584	3056	2292	1833	1527
175	10714	5348	3565	2674	2139	1784
200	12224	6112	4074	3056	2444	2036
250	15281	7640	5092	3820	3055	2548
300	18337	9168	6111	4584	3666	3057
400	24450	12224	8148	6112	4888	4076
500	30562	15280	10185	7640	6110	5095
700	42787	21392	14259	10696	8554	7133
900	55012	27504	18333	13752	10998	9170

CUTTING CHART

Material	Tensile Strength	Tungsten Carbide Tantalum Carbide Ft. per Min.			High Speed Steel Ft. per Min.		
		Dry	Wet	Type of Coolant	Dry	Wet	Type of Coolant
Cast Iron Average Brinell 150-170	18000 26000	250 275			90 110		
C.I. up to 1.5% Nickel Brinell 170-195	20000 28000	275 300			70 80		
C.I. up to 1% Cr. 3.5% Ni. Brinell 200-210	30000 36000	210 230			65 70		
Semi Steel. 20-30% Steel Scrap with 2% Si. or Better Brinell 170-195	30000 36000	175 200			62 72		
Steels Bessemer Screw Stock S.A.E. #1112	70000 90000		220 230	Cutting Oil		160 170	Cutting Oil
Free Cutting Bessemer Screw Stock High Sulphur Content	70000 90000		240 260	Cutting Oil		175 185	Cutting Oil
#2 Bessemer High Sulphur	70000 90000		270 300	Cutting Oil		165 175	Cutting Oil
Ultra Cut High Manganese, Same Machinability as #2 Bessemer	90000 110000		270 300	Cutting Oil		180 200	Cutting Oil
Open Hearth Screw Stock S.A.E. #1120	70000 85000		250 260	Cutting Oil		135 145	Soda Compound
Soft Forging Steel S.A.E. #1020 Low Sulphur For Carburizing	63000 80000		240 250	Soda Compound		110 120	Soda Compound
S.A.E. #1045	95000 125000		200 240	Soda Compound		80 90	Soda Compound
Alloy Steels 3.5% Ni. S.A.E. #2315 for Gear Blanks	80000 115000		165 175	Soda Compound		110 120	Soda Compound
Chrome Ni. up to .90 Cr. and 1.5 Ni. S.A.E. #3120 For Heat Treated Bolts and Gear Blanks	80000 110000		140 160	Soda Compound		90 100	Soda Compound
Aluminum Pure Cast Aluminum #43	19000		400 Up	Kerosene & Lard Oil		220 230	Kerosene & Lard Oil
Commercially Hard Temper Aluminum #2 SH.	24000		200 250	Kerosene & Lard Oil		130 140	Kerosene & Lard Oil
Dural High Tensile #17 ST.	58000		275 300	Soluble Oil		190 200	Soluble Oil
Copper Copper One-Half Hard Com- mercial	31000		180 200	Soluble Oil		100 120	Soluble Oil
Brass Brass, Cast Yellow	20000		400 600	Soluble Oil	200 220		
Brass One-Half Hard Com- mercial			250 300	Soluble Oil	135 165		
Bronze Bronze. Gun Metal	35000		200 220	Soluble Oil		130 150	Soluble Oil
Bronze, Phosphor	50000		160 180	Soluble Oil		95 115	Soluble Oil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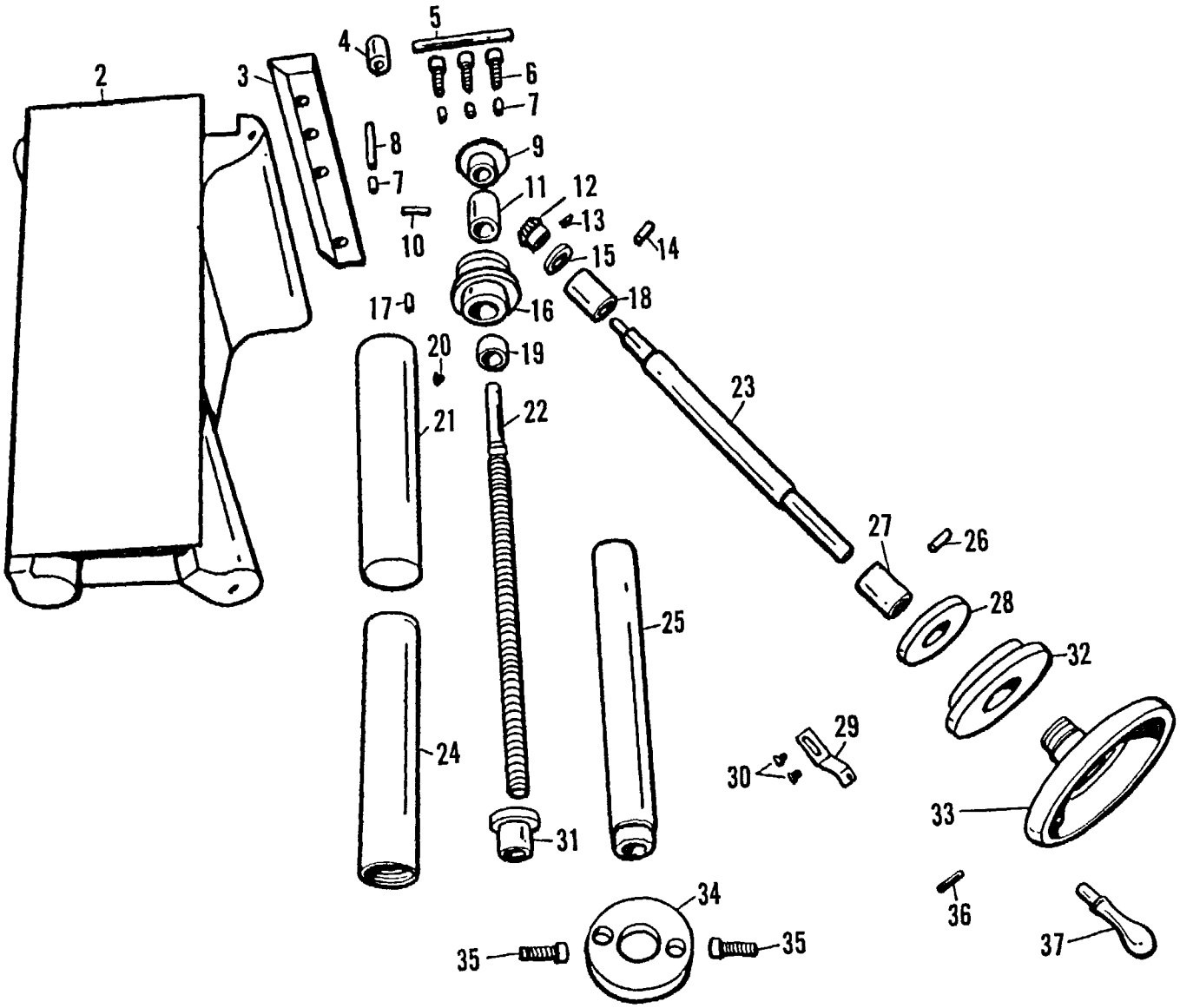
ORDER BY PART NUMBER AND NAME

COLUMN

Fig. No.	Part Name	Part No.	Fig. No.	Part Name	Part No.
1	Column	19236			
2	Tool Tray	19282			
				PARTS NOT SHOWN	
				Name Plate	19238
				Flat Head Screws for Above (3)	K-363
				Machine Name Plate	K-7554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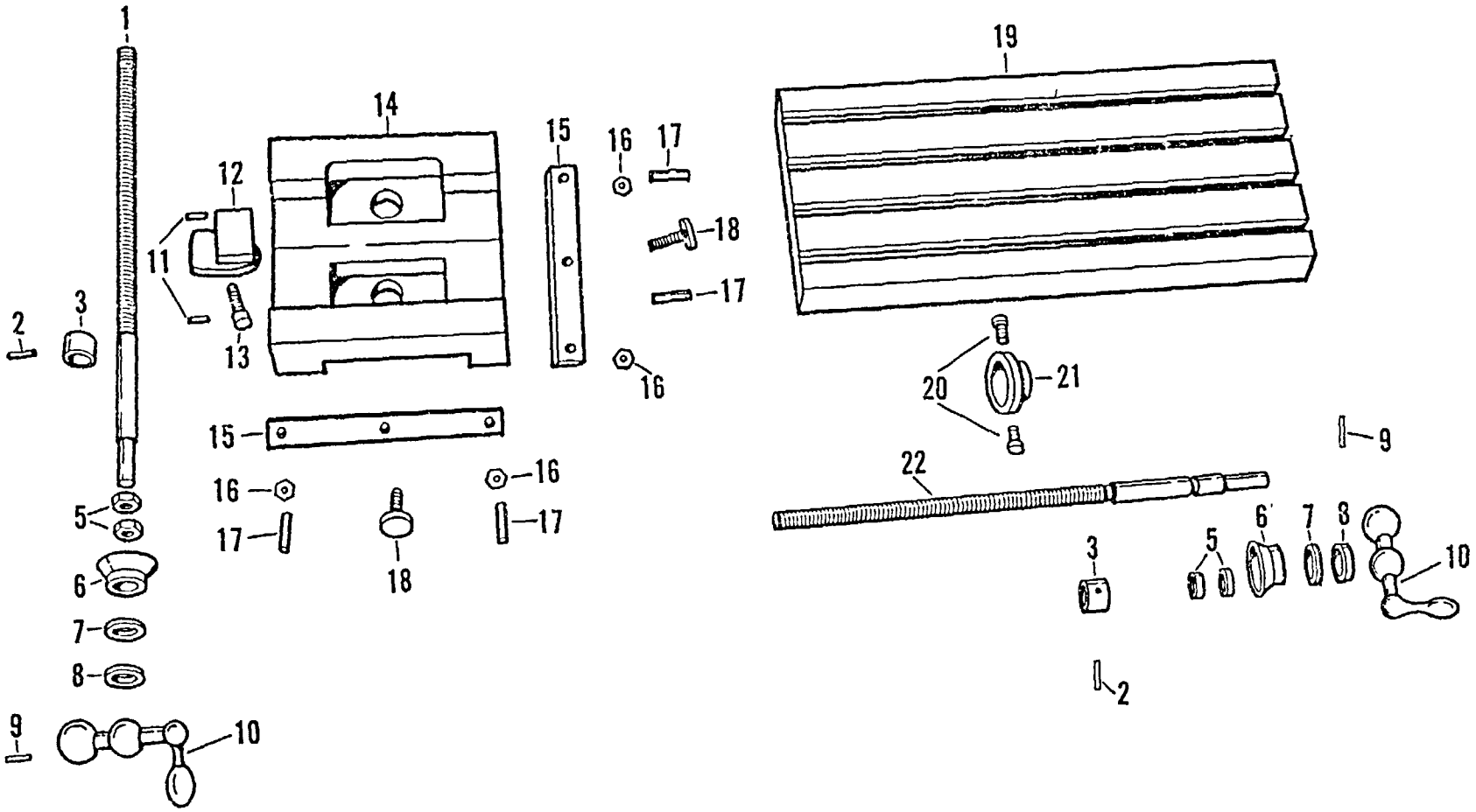
KNEE COMPONENTS

Fig. No.	Part Name	Part No.	Fig. No.	Part Name	Part No.
2	Knee	19190	31	Elevate Nut	19197
3	Knee Gib	19208	32	Knee Elevate-Dial	19202
4	Knee Clamp Nut	7534	33	Elevate Handwheel	19212
5	Pin Handle for Above .	12634	34	Elevate Screw Bracket Base	19192
6	Gib Cap Screws (3)	K-2030	35	Hex Head Cap Screws (2)	K-269
7	Lock Screws (4)	K-219	36	Roll Pin	K-5670
8	Stud	19207	37	Machine Handle	K-5693
9	Elevate Bevel Gear	19209			
10	Roll Pin	K-5670			
11	Oilite Bearing	K-5656			
12	Pinion	19224			
13	Roll Pin	K-5651			
14	Socket Set Screws (2)	K-198		PARTS NOT SHOWN	
15	Bearing Thrust Washer	19199	16a	Socket Set Screws (2)	K-198
16	Elevate Bearing Housing	19198	22a	Washer	19196
17	Dowel Pin	K-3358	35a	Washers (2)	3567
18	Oilite Bushing	K-5658			
19	Thrust Bearing	K-5659			
20	Button Head Screw	K-5601			
21	Elevate Screw Upper Sleeve	19194			
22	Elevate Screw	19195			
23	Elevate Handwheel Shaft	21577			
24	Elevate Screw Lower Sleeve	19193			
25	Elevate Screw Bracket	19191			
26	Socket Set Screw	K-198			
27	Elevate Shaft Bushing	21579			
28	Knee Dial Lock Nut	19203			
29	Index Bracket	19204			
30	Button Head Screws (2)	K-5387			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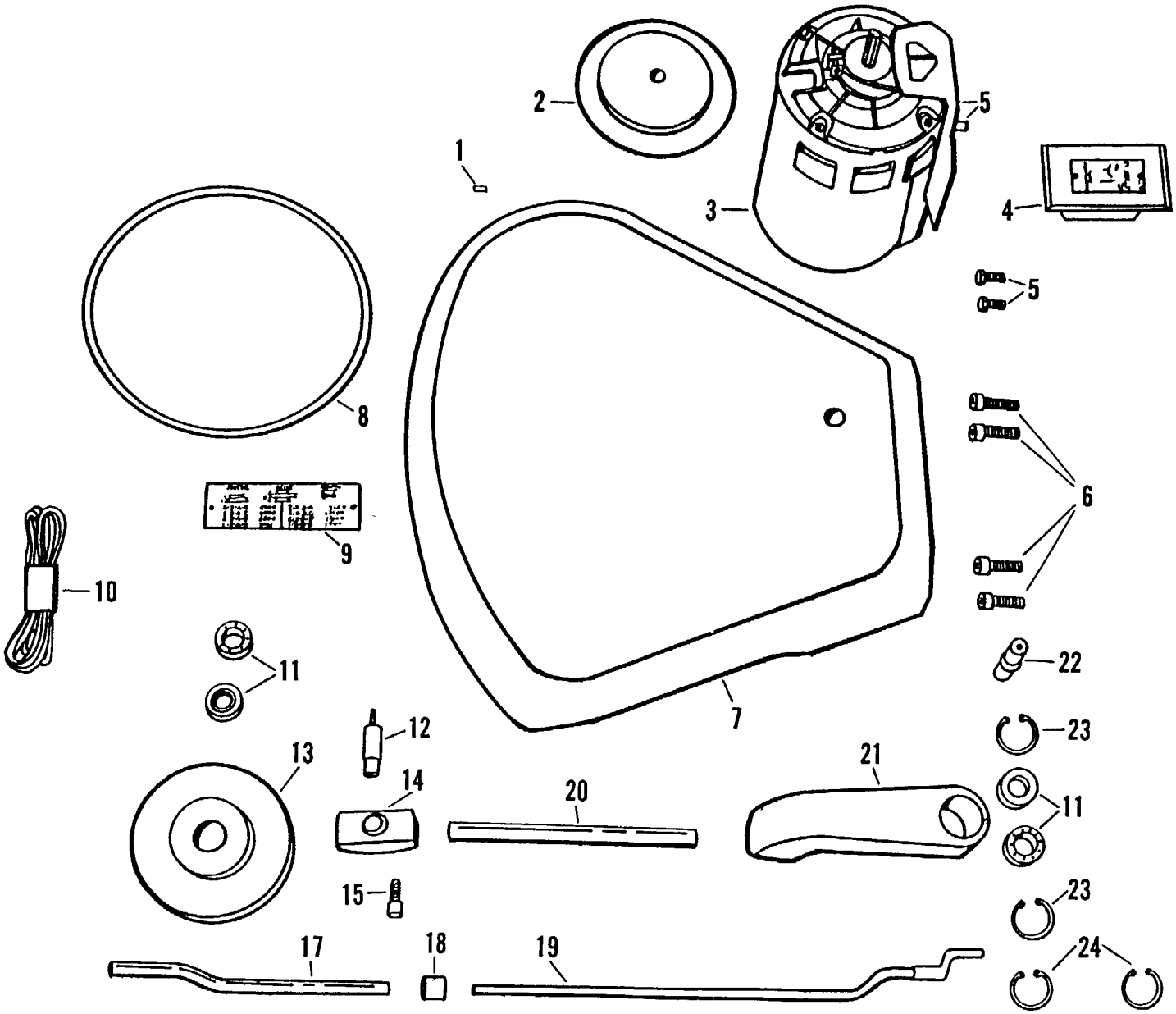
SADDLE AND TABLE

Fig. No.	Part Name	Part No.	Fig. No.	Part Name	Part No.
1	Saddle Feed Screw	22059			
2	Roll Pin (2)	K-5440			
3	Thrust Collar (2)	19217			
5	Adjusting Nuts (2)	22993			
6	Micrometer Dial (2)	19215			
7	Dial Washer (2)	19206			
8	Dial Lock Nut (2)	19216			
9	Roll Pin (2)	K-6477			
10	Feed Crank (2)	19210			
11	Roll Pins (2)	K-5440			
12	Saddle Feed Nut	22496			
13	Socket Cap Screw	K-154		PARTS NOT SHOWN	
14	Saddle	19211	1a	Mounting Bracket	22055
15	Saddle Gibs (2)	19218	5a	Brass Plug	11994
16	Hex Half-Nuts (4)	K-1354	5b	Socket Screw	K-3628
17	Socket Set Screws (4)	K-5661	22a	Mounting Bracket	22054
18	Lock Screw	19219			
19	Table	19220			
20	Socket Cap Screws (2)	K-2333			
21	Table Feed Nut	19222			
22	Table Feed Screw	22061			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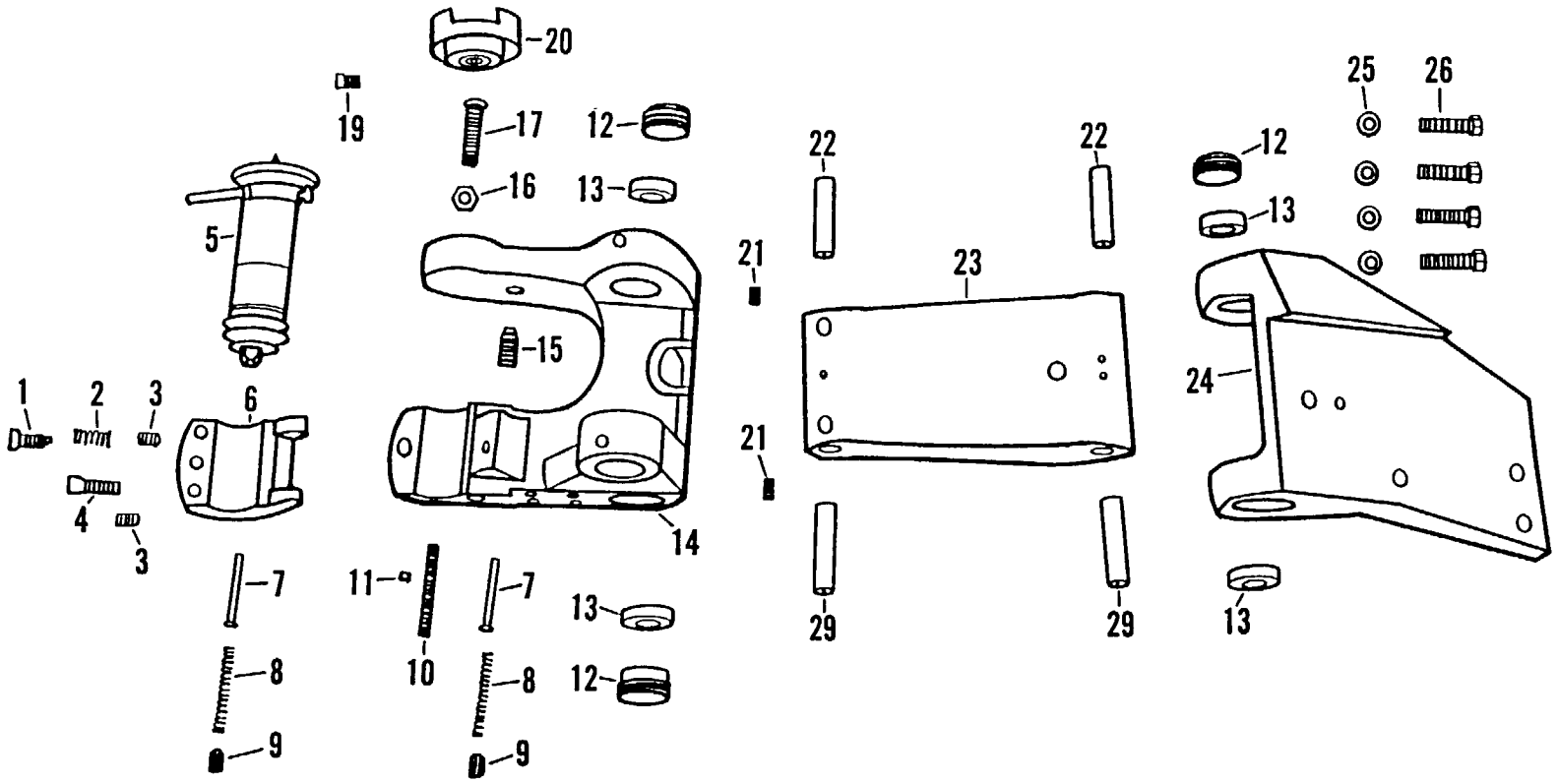
TOOL SHELF AND DRIVE COMPONENTS

Fig. No.	Part Name	Part No.	Fig. No.	Part Name	Part No.
1	Socket Set Screw	K-3927			
2	Motor Pulley	19241			
3	1/4 H.P. Motor	E-1153			
4	Starter Switch	E-2337			
5	Hex Head Cap Screws (4)	K-258			
6	Socket Cap Screws (4)	K-148			
7	Tool Shelf	19234			
8	Motor V-Belt	K-4298			
9	Spindle Speed Plate	K-7706			
10	Spindle Belt	K-5640			
11	Ball Bearings (2) Ball Bearings (2)	KB-64 KB-5681			
12	Drive Pulley Stud	19243			
13	Drive Pulley	19240			
14	Drive Pulley Bracket	19239			
15	Socket Set Screw	K-3898			
17	Belt Tension Rod Sleeve	19246		PARTS NOT SHOWN	
18	Tension Rod Collar	19247	9a	Drive Pins (4)	K-423
19	Tension Rod and Fork	CP-1862	15a	Hex Nut	K-3461
20	Drive Pulley Bar	19242	20a	Collar (2)	7027
21	Swinging Arm	19235	20b	Spring	13671
22	Swinging Arm Stud	19244	20c	Thumb Screw	19293
23	Retaining Rings (2)	K-5673	20d	Socket Set Screw	K-185
24	Retaining Rings (2)	K-4589	21a	Socket Set Screw	K-191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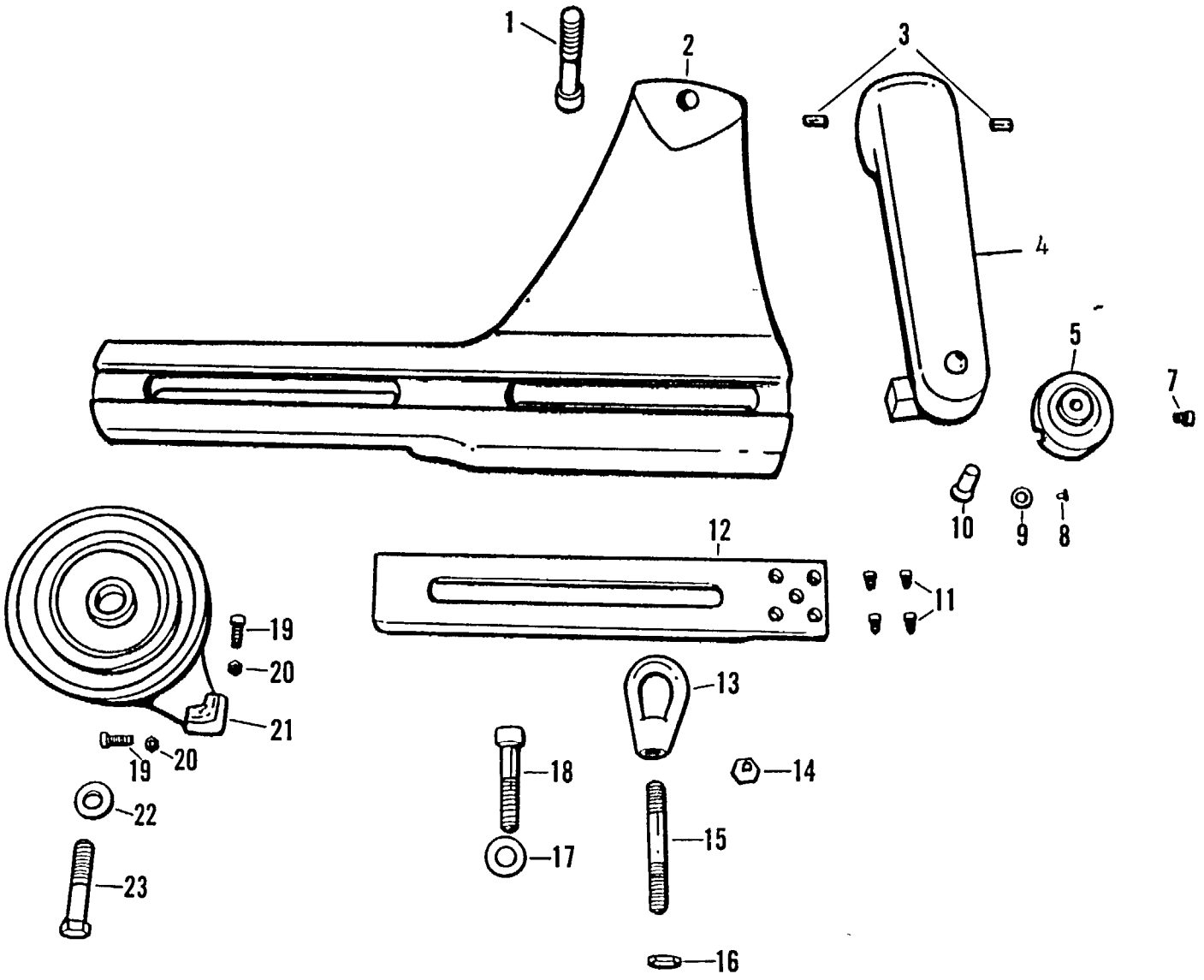
SPINDLE, CUTTER HEAD,
LINK AND MOUNTING BRACKET

Fig. No.	Part Name	Part No.	Fig. No.	Part Name	Part No.
1	Former Sleeve Lock Screw	21671			
2	Spring	9448			
3	Socket Set Screws (2)	20579			
4	Socket Cap Screw	K-144			
5	Cutter Spindle (Collet)	1189-7			
6	Cutter Head Cap	19231			
7	Former Sleeve Lift Pins (2)	8729			
8	Springs for Above (2)	9762			
9	Socket Set Screws (2)	K-2404			
10	Dowel Pin	K-5804			
11	Set Screw	K-187			
12	Bearing Retainer (3)	19228		PARTS NOT SHOWN	
13	Ball Bearings (4)	KB-5197	2a	Locking Plug	21670
14	Cutter Head	19226	20a	Bearings (2)	K-5592
15	Cutter Head Lock Screw	21549	20b	Button Head Cap Screw (3)	K-5601
16	Flex Lock Nut	22479	20c	Socket Cap Screw	6623
17	Bearing Stud	22470	22a	Spacers (2)	19230
19	Locking Screw	K-7091	24a	Socket Set Screw	K-198
20	Lover Slider Block	22481	29a	Spacers (2)	19230
21	Socket Set Screws (2)	K-198			
22	Upper Link Studs (2)	19229			
23	Cutter Head Link	19227			
24	Link Pivot Bracket	19237			
25	Washers (4)	K-453			
26	Hex Head Cap Screws (4)	K-270			
29	Lower Link Studs (2)	21525			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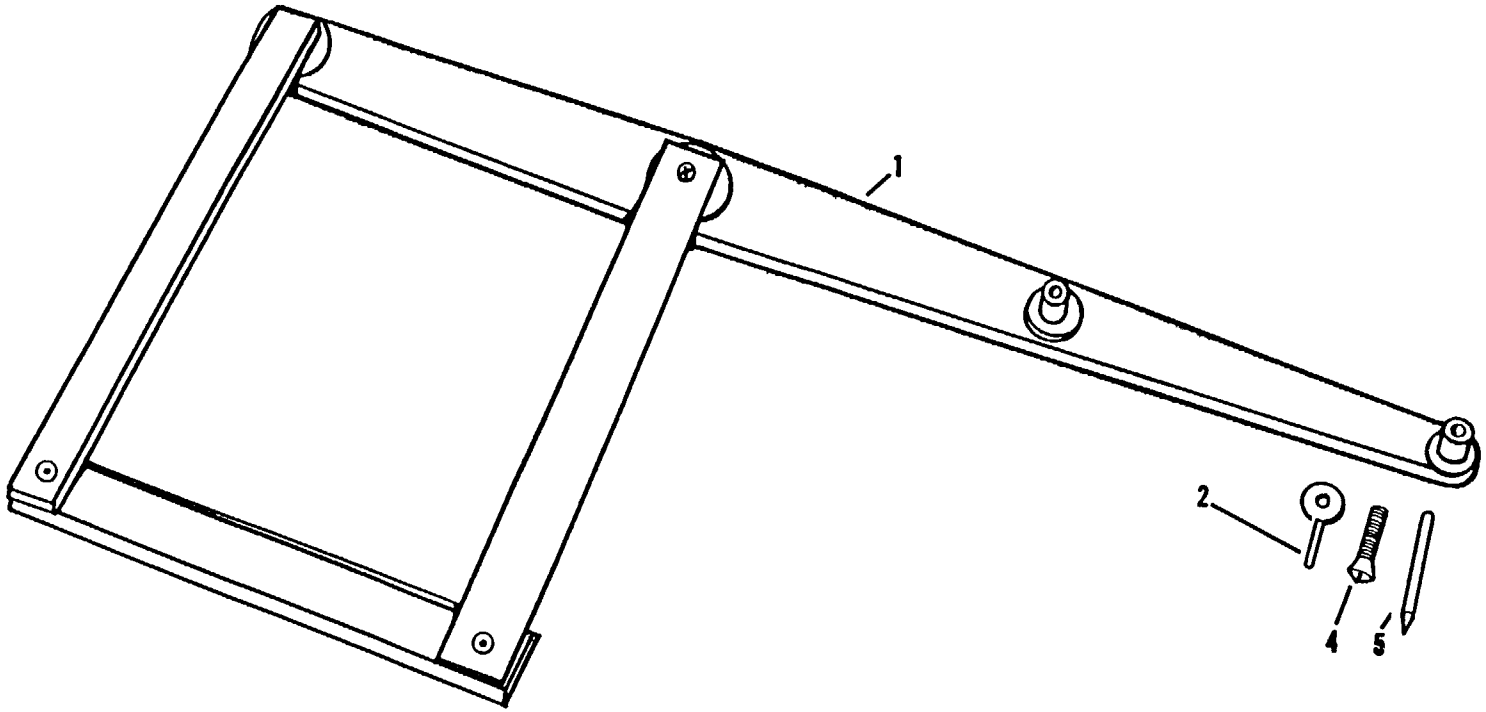
SLIDER HEAD

Fig. No.	Part Name	Part No.	Fig. No.	Part Name	Part No.
1	Socket Cap Screw	K-172			
2	Slider Head	19251			
3	Dowel Pins (2)	K-4545			
4	Upper Pantograph Support	19253			
5	Upper Slider Block	23202			
7	Locking Screw	K-7091			
8	Flat Head Screw	K-6609			
9	Washer	22478			
10	Bearing Stud	22474			
11	Philister Head Cap Screws (4)	K-374		PARTS NOT SHOWN	
12	Former Bar	19252	1a	Washer	K-6263
13	Eye Nut	K-5817	10a	Button Head Cap Screw (3)	K-5601
14	Acorn Nut	K-5672			
15	Stud	12619			
16	Hex Head Nut	K-305			
17	Washer	9649			
18	Socket Cap Screw	K-164			
19	Hex Head Set Screws (2)	14766			
20	Hex Head Nuts (2)	3335			
21	Copyholder Base	9048			
22	Washer	12973			
23	Hex Head Cap Screw	K-1585			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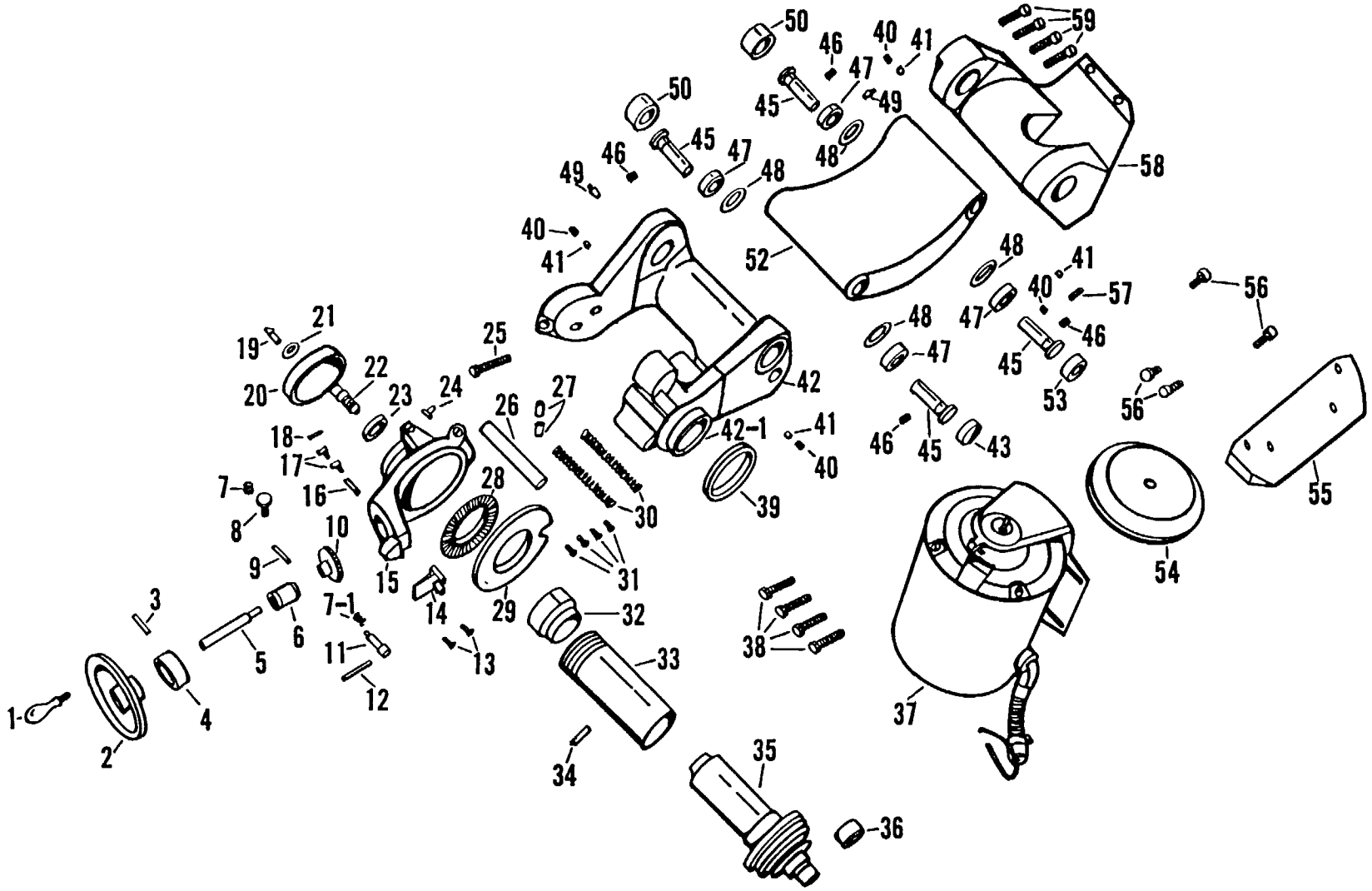
PANTOGRAPH BARS

Fig. No.	Part Name	Part No.	Fig. No.	Part Name	Part No.
1	Pantograph Bars and Link	CP-1951			
2	Collet Nut and Handle	CP-2263			
4	Pantograph Collet	3527			
5	Stylus	3253			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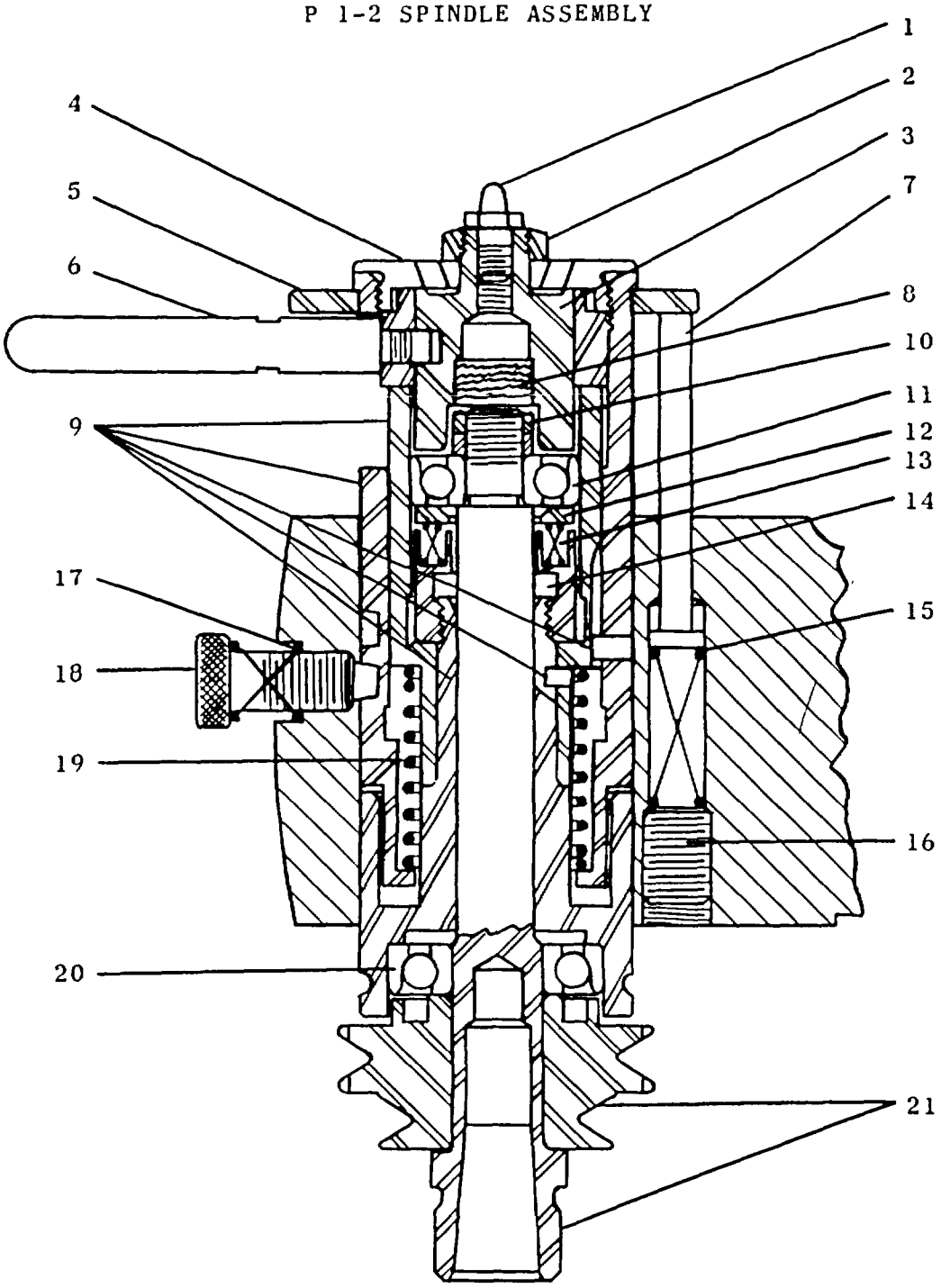
HEAVY-DUTY SPINDLE WITH COMBINATION CUTTER HEAD

Fig. No.	Part Name	Part No.	Fig. No.	Part Name	Part No.
1	Machine Handle	K-538			
2	Handwheel	10985	57	Socket Set Screw	K-2917
3	Taper Pin	K-462			
4	Collar	6381	58	Link Pivot Bracket	21486
5	Shaft	6355			
6	Bushing	6354	59	Socket Cap Screws (4)	K-271
7	Lock Screw Spring	6413			
7-1	Lock Screw Spring	6414			
8	Thumb Screw	6307			
9	Taper Pin	K-463			
10	Gear	6364			
11	Spindle Lock Screw	6161			
12	Lock Screw Pin	7516			
13	Flat Head Screws (2)	K-363			
14	Spindle Barrel Guide	5247			
15	Spindle Barrel Yoke	6352		PARTS NOT SHOWN	
16	Socket Set Screw	K-2262			
17	Oil Cups (2)	K-513	22a	Dowel Pin	12007
18	Dowel Pin	12610			
19	Former Point	6199	27a	Cap Screws (2)	K-144
20	Spindle Barrel Cap	6168			
21	Lock Nut	6220	39a	Belt Tension Clip	6171
22	Feed Stop Screw	6192			
23	Stop Screw Nut	62096	39b	Belt Tension Rod Coupling	21834
24	Feed Stop Key	6232			
25	Hex Head Cap Screw	K-1615	39c	Belt Tension Rod - Adjustable	21835
26	Cutter Head Guide Stud	6169			
27	Set Screws (2)	K-194	42a	Dowel Pin	K-2569
28	Spindle Feed Gear	17894			
29	Spindle Feed Yoke Plate	6382	42b	Socket Cap Screws (4)	K-2284
30	Former Yoke Springs (2)	6361			
31	Flat Head Screws (4)	K-363	42c	Ball Bearing Stud Bushing	21829
32	Spindle Barrel Plug	6194			
33	Spindle Barrel - Outer	17895	59a	Raising Block	21485
34	Spindle Barrel Guide Pin	6230			
35	Spindle Assembly	698-4	59b	Socket Cap Screw (6)	K-2870
36	Collet Nut	K-5425			
37	1/3 H.P. Drive Motor	E-1160	59c	Dowel Pin (2)	K-5528
38	Hex Head Cap Screws (4)	K-258			
39	Belt Tension Clip Adapter	10154			
40	Socket Set Screws (4)	K-218			
41	Brass Plugs (4)	11996			
42	Cutter Head	19100			
42-1	Cutter Head Bracket	19101			
43	End Thrust	6358			
44	Not Used				
45	Link Studs (4)	6357			
46	Socket Set Screws (4)	K-198			
47	Ball Bearings (4)	KB-27			
48	Felt Washers (4)	6231			
49	Grease Fittings 2)	K-2023			
50	Adjustable Nuts 2)	6359			
52	Cutter Head Link	6222			
53	Link Plug	6611			
54	Motor Pulley	21831			
55	Motor Bracket	21455			
56	Socket Cap Screws (4)	K-145			

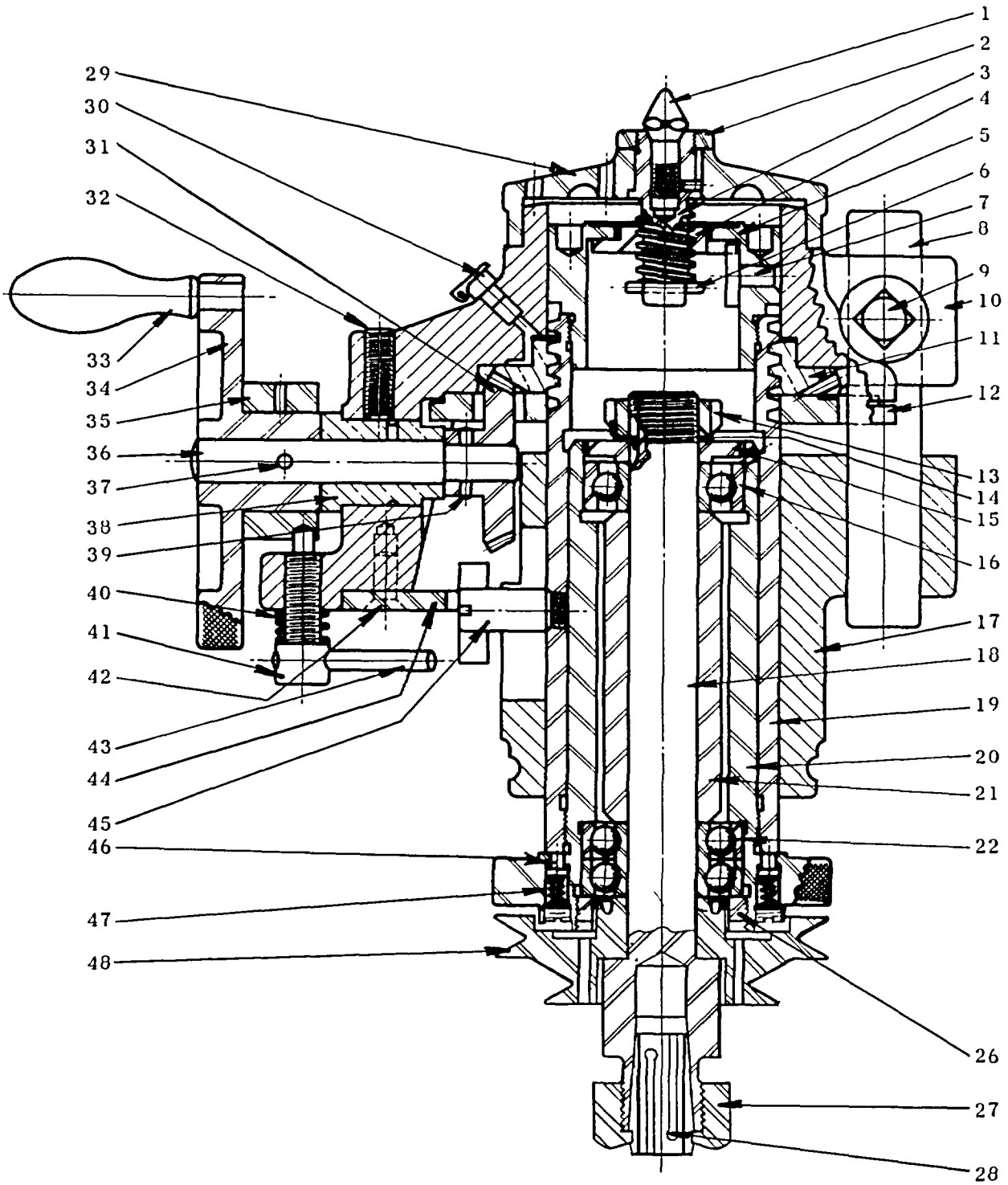
P 1-2 SPINDLE ASSEMBLY



SPINDLE ASSEMBLY

Fig. No.	Part Name	Part No.	Fig. No.	Part Name	Part No.
1	Former Point	CP-119			
2	Hex Head Nut	1492			
3	Spindle Feed Cam	20485			
4	Former Sleeve Cap	8701			
5	Former Sleeve Collar	8705			
6	Spindle Feed Lever	20487			
7	Former Sleeve Lift Pin (2)	8729			
8	Felt Plug	11459			
9	Former and Spindle Sleeves	CP-198			
10	Spindle Lock Nut (2)	8699			
11	Upper Ball Bearing	KB-3		PARTS NOT SHOWN	
12	Thrust Washer	8524	3a	Spindle Feed Stop Pin	20486
13	Spindle Thrust Spring (3)	8630	6a	Cam Bushing	20488
14	Spindle Sleeve Nut	8518	9a	Philister Head Cap Screws (2)	K-690
15	Former Sleeve Lift Spring (2)	9762	9b	Spindle Feed Stop Spring	8885
16	Socket Set Screws (2)	K-2404	9c	Thumb Screw	3288
17	Spring	9448	18a	Locking Plug	21671
18	Former Sleeve Lock Screw	21670	21a	Collet Type Cutter Spindle & Pulley	CP-1753
19	Spindle Feed Lift Spring	9072			
20	Lower Ball Bearing	KB-6			
21	Taper Shank Cutter Spindle Pulley	CP-424			

HEAVY-DUTY SPINDLE ASSEMBLY



HEAVY-DUTY SPINDLE ASSEMBLY

Fig. No.	Part Name	Part No.	Fig. No.	Part Name	Part No.
1	Former Point	6199	33	Machine Handle	K-538
2	Lock Nut	6220	34	Handwheel	10985
3	Feed Screw	6192	35	Collar	6381
4	Feed Screw Nut	6206	36	Spindle Feed Shaft	6355
5	Spindle Barrel Plug	6194	37	Taper Pin	K-462
6	Drill Rod Pin	12610	38	Feed Shaft Bushing	6354
7	Feed Stop Key	6232	39	Taper Pin	K-463
8	Cutter Head Stud	6169	40	Lock Screw Spring	6414
9	Socket Set Screw	K-3222	41	Spindle Lock Screw	6161
10	Spindle Barrel Yoke	6352	42	Flat Head Machine Screw (2)	K-363
11	Spindle Feed Gear	17894	43	Lock Screw Handle	7516
12	Spindle Feed Yoke Plate	6382	44	Spindle Barrel Guide	5247
13	Ball Bearing Lock Nut	K-84	45	Spindle, Barrel Guide Pin	6230
14	Ball Bearing Lock Washer	K-90	46	Lock Plunger (4)	9088
15	Dust Washer	9087	47	Spring (4)	8630
16	Ball Bearing	KB-20	48	Spindle Pulley	21833
17	Cutter Head Bracket	19101			
18	Cutter Spindle	18505			
19	Spindle Barrel--Outer	17895		PARTS NOT SHOWN	
20	Spindle Barrel--Inner	18508	3a	Drill Rod Pin	12007
21	Ball Bearing Spacer	18509	10a	Thumb Screw	6307
22	Ball Bearings (1 pair)	KB-25	10b	Former Yoke Spring (2)	6361
26	Ball Bearing Lock Nut	9086	10c	Lock Screw Spring	6415
27	Collet Nut	K-5425			
28	Panto-Collet	K-5423			
29	Spindle Barrel Cap	6168			
30	Oil Cup (2)	K-513			
31	Spindle Feed Gear	6364			
32	Socket Set Screw	K-2262			

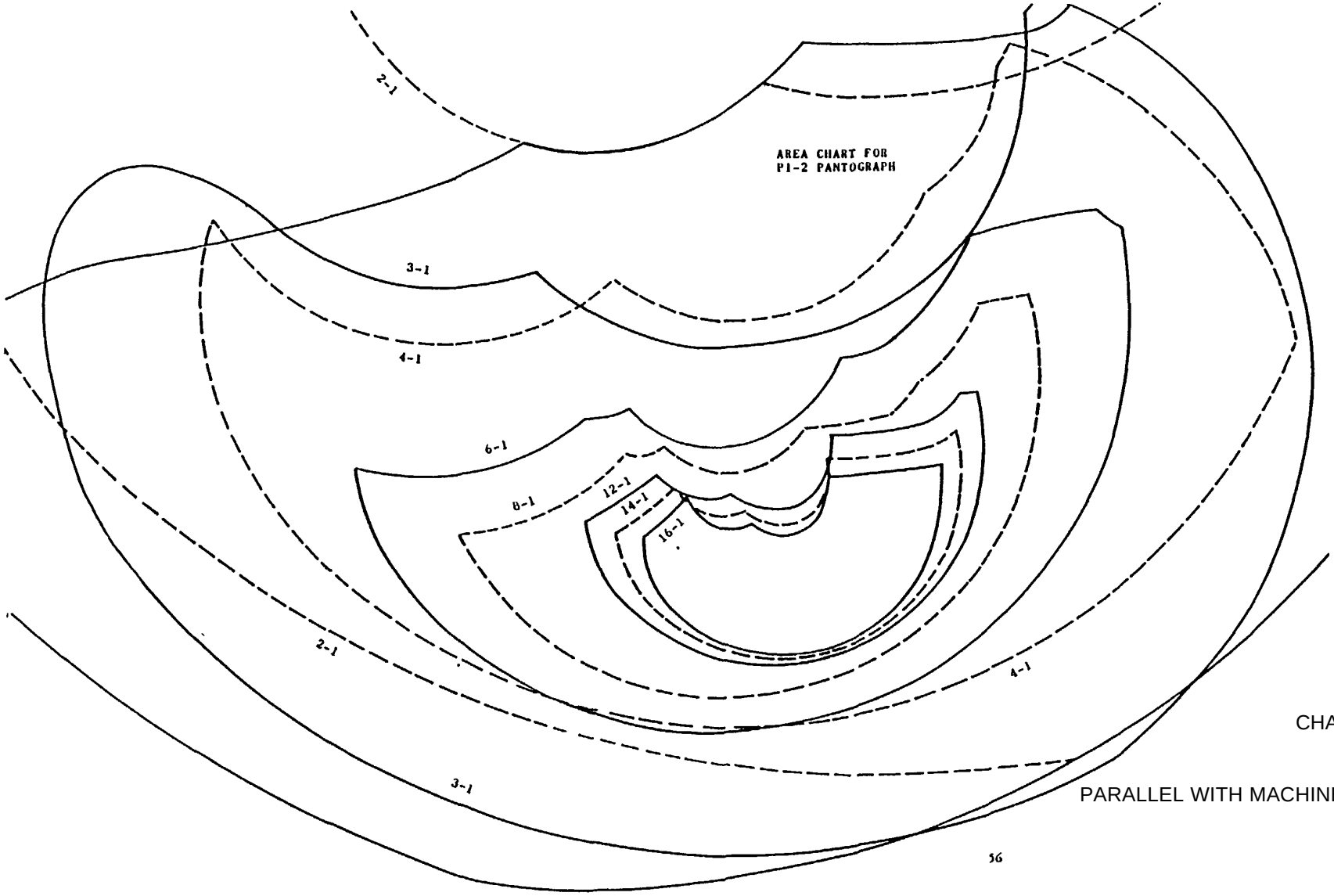


CHART 2717

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THE METRIC SYSTEM AND EQUIVALENTS

LINEAR MEASURE

1 Centimeter = 10 Millimeters = 0.01 Meters = 0.3937 Inches
1 Meter = 100 Centimeters = 1000 Millimeters = 39.37 Inches
1 Kilometer = 1000 Meters = 0.621 Miles

SQUARE MEASURE

1 Sq. Centimeter = 100 Sq. Millimeters = 0.155 Sq. Inches
1 Sq. Meter = 10,000 Sq. Centimeters = 10.76 Sq. Feet
1 Sq. Kilometer = 1,000,000 Sq. Meters = 0.386 Sq. Miles

WEIGHTS

1 Gram = 0 001 Kilograms = 1000 Milligrams = 0.035 Ounces
1 Kilogram = 1000 Grams = 2.2 Lb
1 Metric Ton = 1000 Kilograms = 1 Megagram = 1.1 Short Tons

CUBIC MEASURE

1 Cu Centimeter = 1000 Cu Millimeters = 0 06 Cu Inches
1 Cu Meter= 1,000,000 Cu Centimeters = 35 31 Cu. Feet

LIQUID MEASURE

1 Milliliter = 0.001 Liters = 0.0338 Fluid Ounces
1 Liter = 1000 Milliliters = 33.82 Fluid Ounces

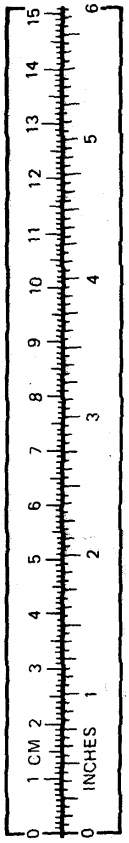
TEMPERATURE

5/9 (°F - 32) = °C
212° Fahrenheit is equivalent to 100° Celsius
90° Fahrenheit is equivalent to 32.2° Celsius
32° Fahrenheit is equivalent to 0° Celsius
9/5 C° + 32 = °F

APPROXIMATE CONVERSION FACTORS

TO CHANGE	TO	MULTIPLY BY
Inches	Centimeters	2.540
Feet	Meters	0.305
Yards	Meters	0.914
Miles	Kilometers	1.609
Square Inches	Square Centimeters	6.451
Square Feet	Square Meters	0.093
Square Yards	Square Meters	0.836
Square Miles	Square Kilometers	2.590
Acres	Square Hectometers	0.405
Cubic Feet	Cubic Meters	0.028
Cubic Yards	Cubic Meters	0.765
Fluid	Ounces Milliliters	29.573
Pints	Liters	0.473
Quarts	Liters	0.946
Quarts	Liters	0.946
Gallons	Liters	3.785
Ounces	Grams	28.349
Pounds	Kilograms	0.45
Short Tons	Metric Tons	0.0907
Pound-Feet	Newton-Meters	1.356
Pounds per Square Inch	Kilopascals	6.895
Miles per Gallon	Kilometers per Liter	0.425
Miles per Hour	Kilometers per Hour	1.609

TO CHANGE	TO	MULTIPLY BY
Centimeters	Inches	0.394
Meters	Feet	3.280
Meters	Yards	1.094
Meters	Yards	1.094
Kilometers	Miles	0.621
Square Centimeters	Square Inches	0 155
Square Meters	Square Feet .	10.764
Square Meters	Square Yards	1.195
Square Kilometers	Square Miles	0.386
Square Hectometers	Acres	2.471
Cubic Meters	Cubic Feet	35.315
Cubic Meters	Cubic Yards	1.308
Milliliters Fluid	Ounces	0.034
Liters	Pints	2.113
Liters	Quarts	1.057
Liters	Gallons	0.264
Grams	Ounces	0.035
Kilograms	Pounds	2 205
Metric Tons	Short Tons	1.102
Newton-Meters	Pound-Feet	0.738
Kilopascals	Pounds per Square Inch	0.145
Kilometers per Liter	Miles per Gallon	2.354
Kilometers per Hour	Miles per Hour	0.621



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