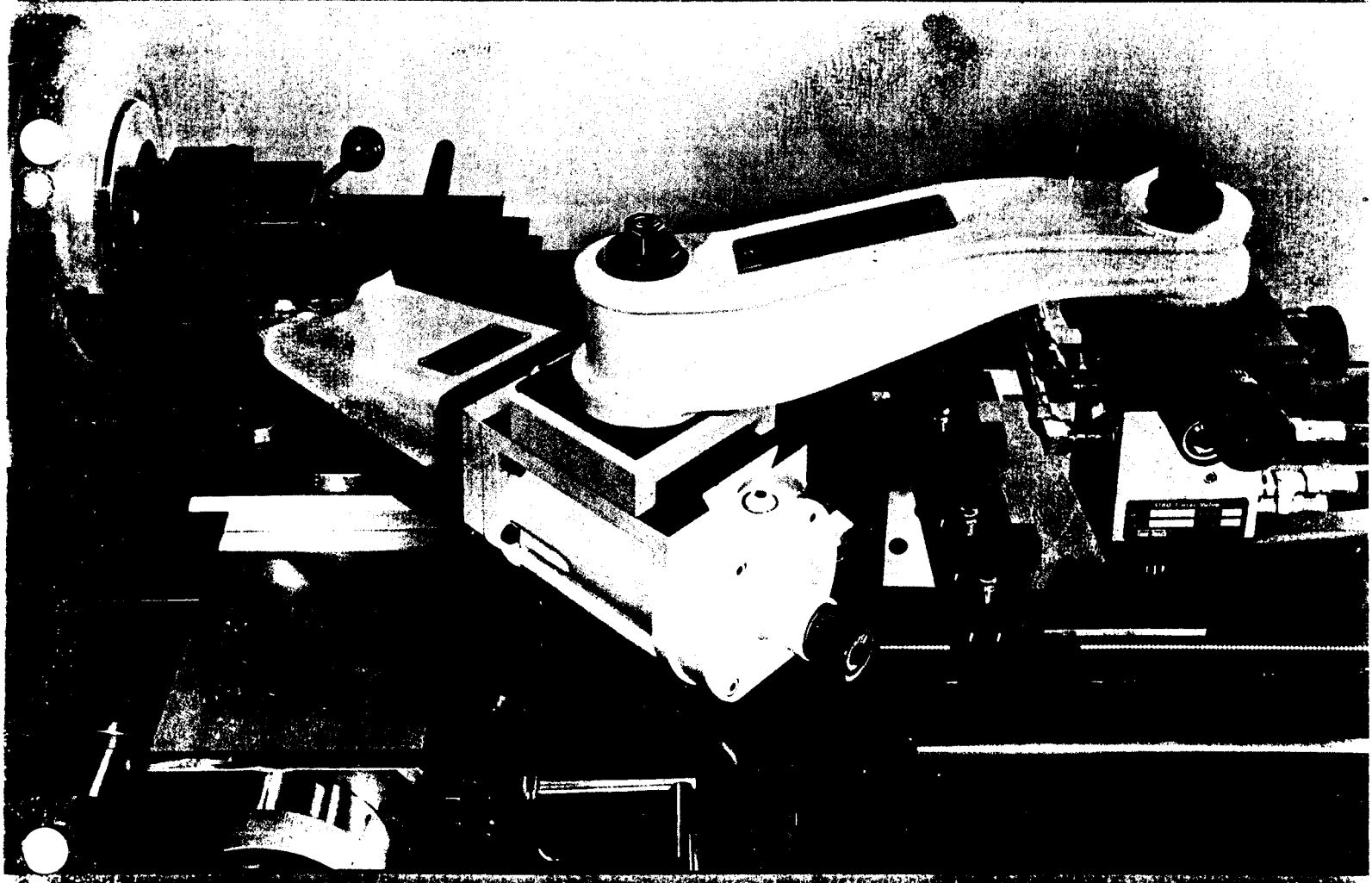
PIVOT TYPE
LATHE TRACER ATTACHMENTS

Description, Operation
and Service



TRUE-TRACE
CORPORATION

table of contents

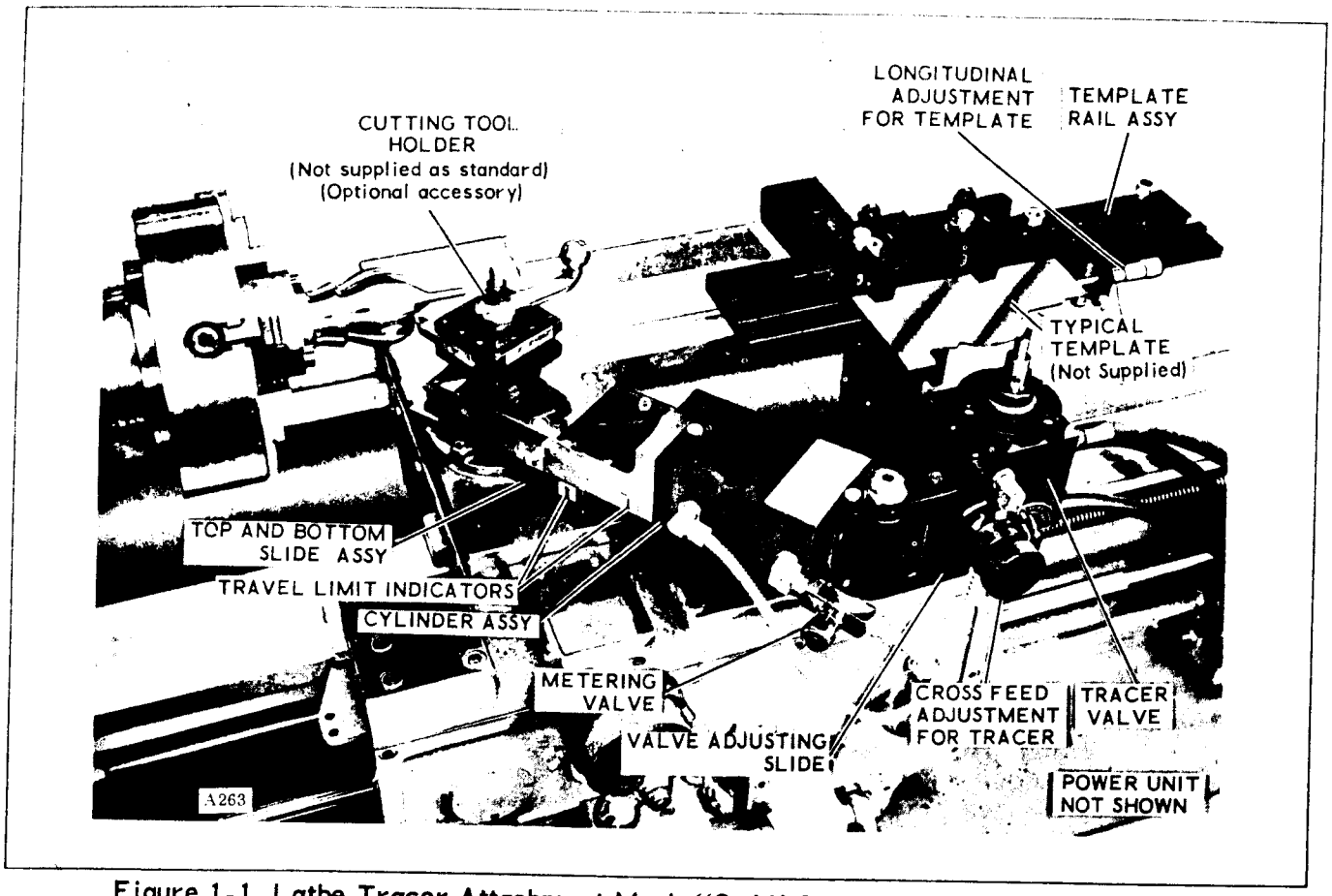


Figure 1-1. Lathe Tracer Attachment Mark "O-A" Series, Typical Installation

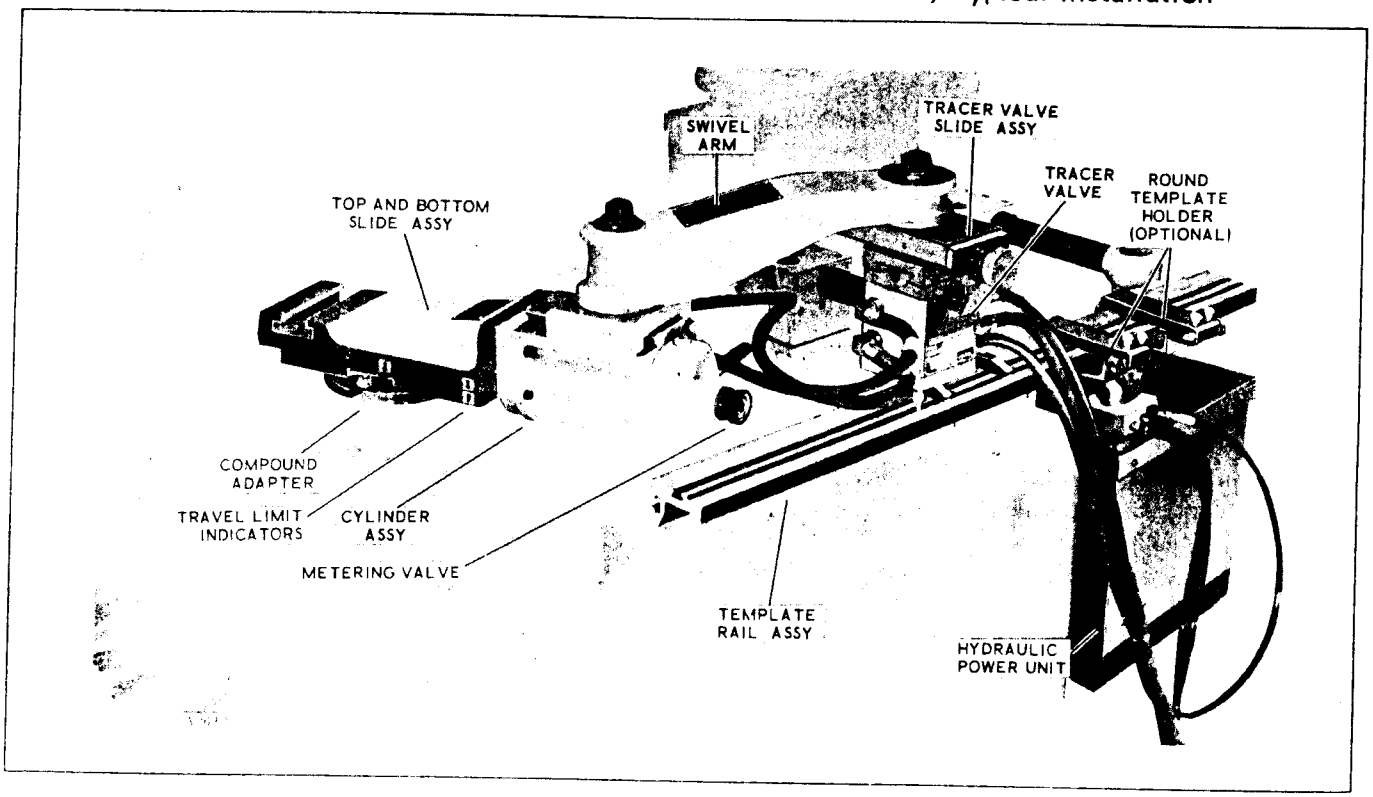


Figure 1-2. Lathe Tracer Attachment Mark IIA Series, Typical Installation

section I description

1-1. INTRODUCTION

1-2. Mark Series Lathe Tracer Attachments are hydraulic tracing systems designed for installation on conventional turning lathes. The attachments are designed for rapid and accurate duplication of machined parts in all shapes and contours using a profile template or master part. Each Lathe Tracer Attachment is supplied in kit form. The standard basic kit is designed for installation on most lathes with only simple alterations. When ordered for a specific lathe, the kit is pre-machined at the factory and is shipped ready for installation without further machining or fitting. When desired, the kit may also be installed by True-Trace factory engineers.

1-3. MARK "O" AND "O-A" SERIES

1-4. The Mark "O" and "O-A" Series Lathe Tracer Attachments are designed for use on tool room lathes of 9 to 13 inch capacity. They may be adapted to larger lathes where light contouring operations are required. The Mark "O" Series consists of the equipment listed in table 1-1. The Mark "O-A" Series consists of the equipment listed in table 1-2.

NOTE: The Mark "O" Series Lathe Tracer Attachments were manufactured to serial No. 50 only. This series is no longer in production.

a. The cylinder and slide assembly consists of a top slide, bottom slide, hydraulic cylinder, and a valve adjusting slide. The bottom slide is dovetailed into the top slide and is attached to the piston rod in the hydraulic cylinder. The hydraulic cylinder housing is attached to the top slide at one end and hinge connected to the valve adjusting slide on the opposite end. In operation, the top slide and cylinder housing are moved by hydraulic action and the bottom slide and piston rod remain fixed. Hydraulic pressure is regulated at the output of the hydraulic power unit. On the mark "O-A" Series, a metering valve is provided for the cylinder and is used to slowly "meter-in" to the work or to lock the cylinder in any desired position. (The metering valve may be used to lock the cylinder when the lathe is being used in a conventional manner to eliminate the need for removing the tracer attachment from the lathe. The cylinder is never locked when making a cut during a tracing operation.)

b. A compound adapter is cast as an integral part of the bottom slide. A compound pivot spud is attached to the bottom slide by a socket head screw. Two slots for securing the bottom slide to the lathe carriage cross slide are provided on each side of the bottom slide compound adapter. Travel limit indicators are provided on the top and bottom slides.

c. The tracer valve (fig. 1-3) dovetails onto the valve adjusting slide and is secured to the slide by a valve adjusting screw. The valve adjusting screw is manually controlled by a knob which is graduated in thousandths of an inch. The tracer valve is operated with the stylus pointing up. The tracer valve is a precision hydraulic valve carefully flow balanced to control the tracing operation. In operation, the tracer valve is guided by a contour template or

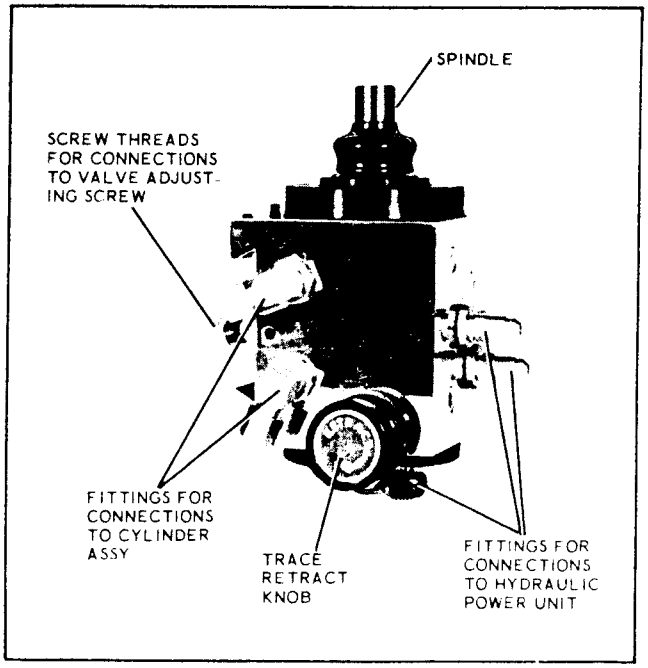


Figure 1-3. Tracer Valve, Model Group 1068. (Used with Mark "O" and "O-A")

master part and provides for the "in" and "out" motion of the slide in turning operations, or for the "left" and "right" motion when performing facing operations.

d. The hydraulic power unit (fig. 1-4) is a single pressure self-contained unit including an electric motor and hydraulic pump. The electric motor is a totally enclosed type. The hydraulic pump is a Tuthill gear type. The hydraulic reservoir has a 15 gallon capacity. The interior and exterior surfaces of the reservoir are coated with hard-baked enamel for durability and ease of cleaning. The outuput pressure is adjusted at the factory for 160 psi. The unit should seldom be adjusted higher than 160 psi for operation of the Mark "O" and "O-A" Series Lathe Tracer Attachments. The pump capacity is 1.5 gallons per minute.

NOTE: Early models of the hydraulic power unit had a 10 gallon capacity.

e. The template rail assembly provided as standard equipment with the Mark "O" Series is shown in figure 1-5. The template rail assembly provided as standard equipment with the Mark "O-A" Series is shown in figure 1-6. Each template rail assembly

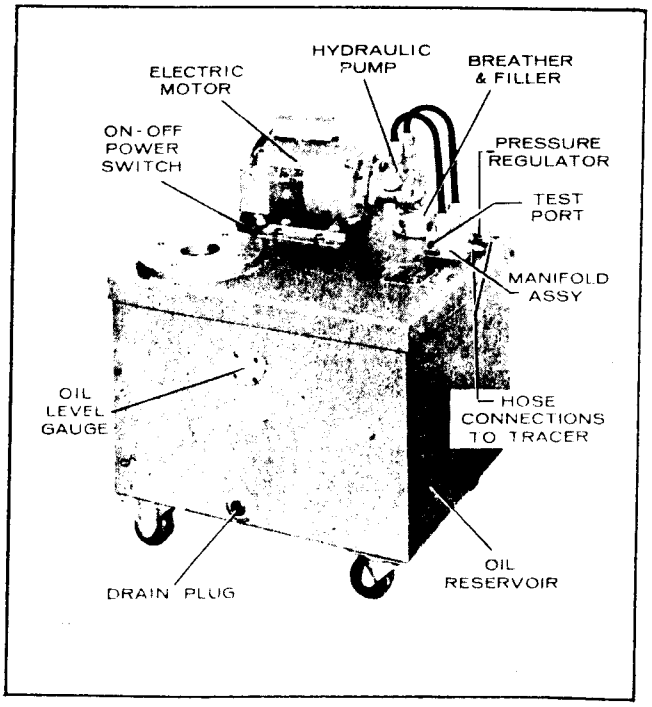


Figure 1-4. Typical Hydraulic Power Unit Used With Mark Series Lathe Tracer Attachments

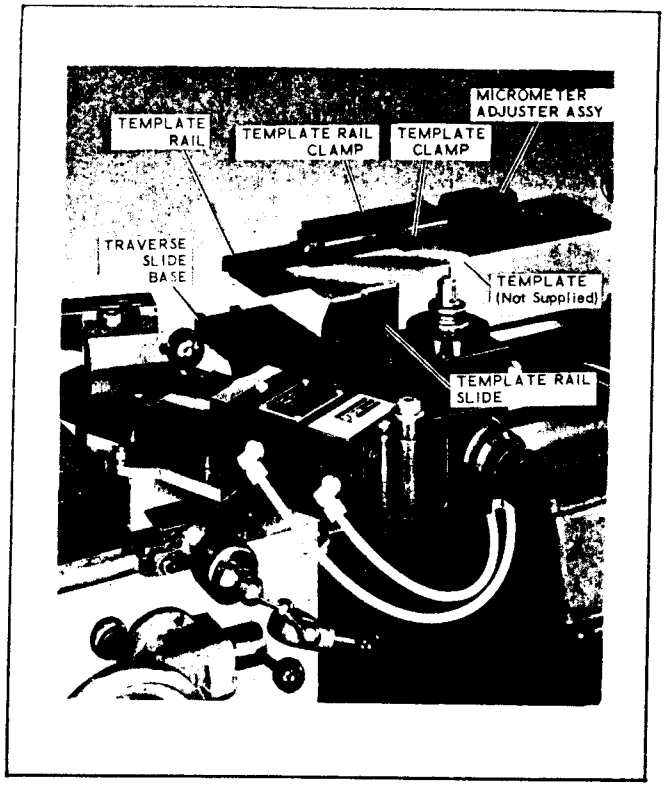


Figure 1-5. #40640 Template Rail Assembly. (Used with Mark "O" Series)
(Mark "O" Series manufactured to serial No. 50 only.)

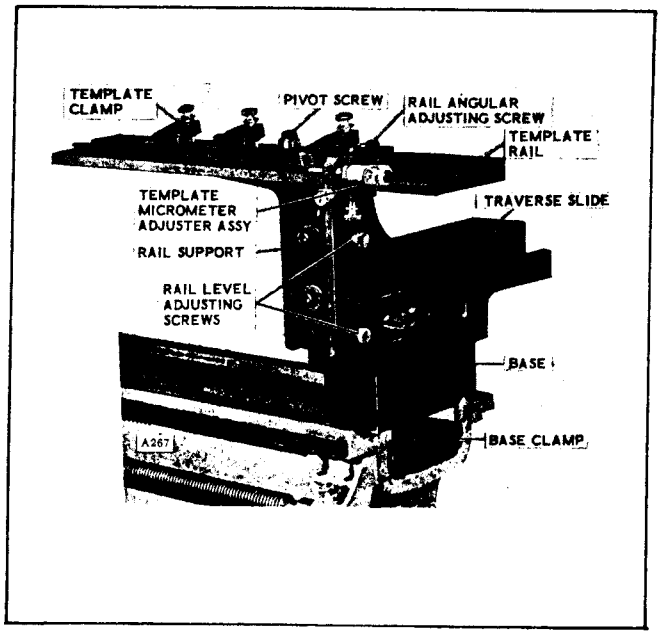


Figure 1-6. #40685 Template Rail Assembly. (Used with Mark "O-A" Series)

includes all necessary clamps and brackets for adapting the template rail assembly to the lathe. Both template rail assemblies are adjustable in horizontal and vertical axis and include a micrometer adjuster assembly for making fine horizontal template adjustments. The template rail assemblies are similar in construction, except that the template rail assembly provided with the Mark "O-A" Series has additional adjustment features.

f. A Round Template Holder (fig. 1-7) is available as OPTIONAL equipment for use with the Mark "O-A" Template Rail Assembly. The holder consists of two clamp assemblies as shown in figure 1-7. Each clamp assembly consists of a front clamp and a rear clamp. The front clamp fits over the front of the template rail and is locked in position by a thumbscrew in the bottom of the clamp. The rear clamp slides into the T-slot of the template rail and is attached to the front clamp by two socket head screws.

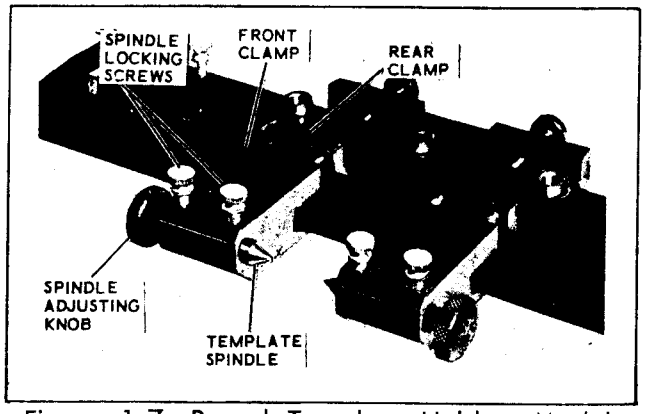


Figure 1-7. Round Template Holder, Model 3057-02. (Used with Mark "O-A" Series)

Table 1-1. Equipment Supplied With the Early Mark "O" Series Lathe Tracer Attachment (manufactured to Serial No. 50 only)

Qty	Description	Model Part No.
1	Cylinder and Slide Assy	N D
1	Tracer Valve	1068-05
1	Template Rail Assy	40640
1	Hydraulic Power Unit	5013-07
2	Tracer Hyd. Hose Assys	20377
3	Hyd. Pressure, Drain & Exhaust Hose Assy	55126

Table 1-2. Equipment Supplied With a Standard Mark "O-A" Series (Model 2055-01) Lathe Tracer Attachment

Qty	Description	Model Part No.
1	Cylinder and Slide Assy	40600
1	Tracer Valve	1068-05
1	Template Rail Assy	40685
1	Hydraulic Power Unit	5013-07
1	Tracer Hyd. Hose Assy	20377
1	Tracer Hyd. Hose Assy	20378
3	Hyd. Pressure, Drain & Exhaust Hose Assy	55126

1-5. MARK IIA SERIES

1-6. The Mark IIA Series Lathe Tracer Attachment is designed for use on a standard lathe of 13 to 20 inch capacity. It may also be adapted to smaller or larger lathes as required. The Mark IIA Series consists of the equipment listed in table 1-3.

a. The bottom slide dovetails into the top slide and is attached to the piston rod in the cylinder assembly. A removable compound adapter plate is attached to the bottom slide. Slots for securing the bottom slide to the lathe cross slide are provided in the compound adapter plate. Travel limit indicators are provided on the top and bottom slides.

b. In operation, the top slide and cylinder housing are moved by hydraulic action and the bottom slide and piston rod remain fixed. The cylinder assembly includes a metering valve which may be used to slowly "meter-in" to the work or to lock the cylinder and slide in any desired position. A safety by-pass valve in the cylinder assembly prevents damage to the equipment in the event the equipment is improperly operated when the cylinder is locked.

c. The swivel arm assembly dovetails onto the cylinder assembly at one end and is attached to the valve slide assembly (fig. 1-8) on the opposite end. The valve slide assembly is a precision two-way micrometer adjustable slideway. The tracer valve dovetails into the lower slide of the valve slide

assembly. The micrometer adjustments allow the tracer valve to be positioned independently of the tool slide angle. The slides are set at 90 degrees to each other and are fitted with gibs to insure proper adjustment. The micrometer dials are graduated in increments of 0.001 inch. The tracer valve is a precision hydraulic valve carefully flow balanced to control the tracing operation. In operation, the tracer valve is guided by a contour template or master part and provides for the "in" and "out" motion of the cross slide in turning operations, or for the "left" and "right" motion when performing facing operations. The tracer valve is operated with the stylus pointing down.

d. The hydraulic power unit (fig. 1-4) is a self-contained unit similar to the unit described in paragraph 1-4d.

e. The template rail assembly provided as standard equipment with the Mark IIA is the Universal Template Rail Assembly described in paragraph 1-15. Early model Mark IIA and III Series Lathe Tracer Attachments were supplied with the 40754 Template Rail Assembly. (This template rail is shown in figures 2-11 and 2-12.)

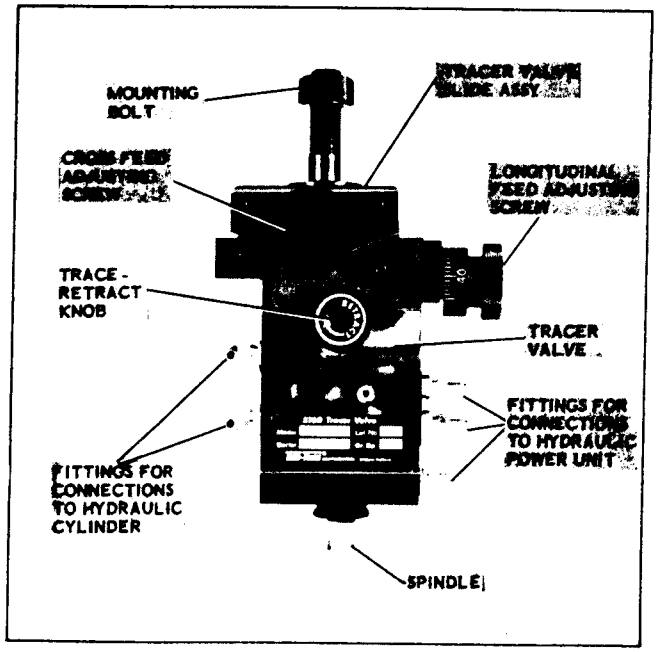


Figure 1-8. Typical 1066 Tracer Valve with 4049 Valve Slide Assembly. (Used with Mark IIA thru VI Series)

f. A Round Template Holder (fig. 1-9) is available as OPTIONAL equipment for use with the 43570 and 43585 Template Rail Assemblies. The holder consists of two clamp assemblies as shown in figure 1-9. Each clamp assembly is secured to the bottom of the template rail by a bottom clamp and thumbscrew, and to the rear of the template rail by two top clamp locking screws.

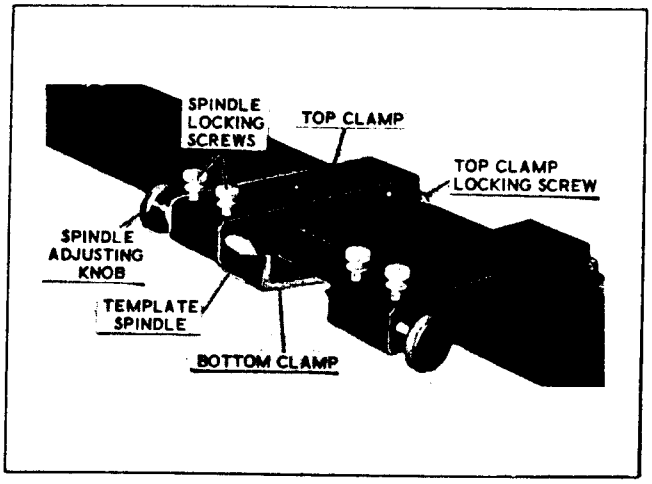


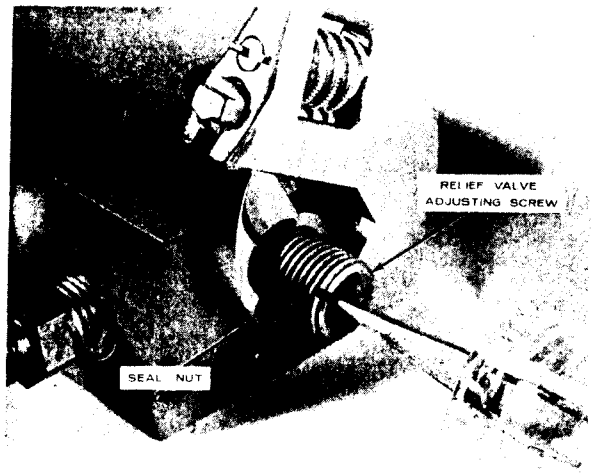
Figure 1-9. Round Template Holder, Model 3057-03. (Used with Mark IIA thru VI Series)

Table 1-3. Equipment Supplied With a Standard IIA Series (Model 2056-01) Lathe Tracer Attachment

Qty	Description	Model/Part No.
1	Top and Bottom Slide	40734
1	Cylinder Assy	40729
1	Swivel Arm Assy	40731
1	Valve Slide Assy	4049-02
1	Tracer Valve	1066-05
1	Hydraulic Power Unit	5013-07
1	Hyd. Pressure Hose Assy	55127
2	Drain & Exhaust Hose Assys	55128
1	Tracer Valve & Cylinder Hose Assy	55129
1	Tracer Valve & Cylinder Hose Assy	55130
1	Template Rail Assy (Universal)	43570

PARTS LISTS AND ADJUSTMENTS FOR MODEL SERIES 5013 HYDRAULIC POWER SUPPLY CONTAINING A VACUUM UNIT.

THIS SHEET TO BE INSERTED INTO THE M-306B MANUAL (1/15/68)



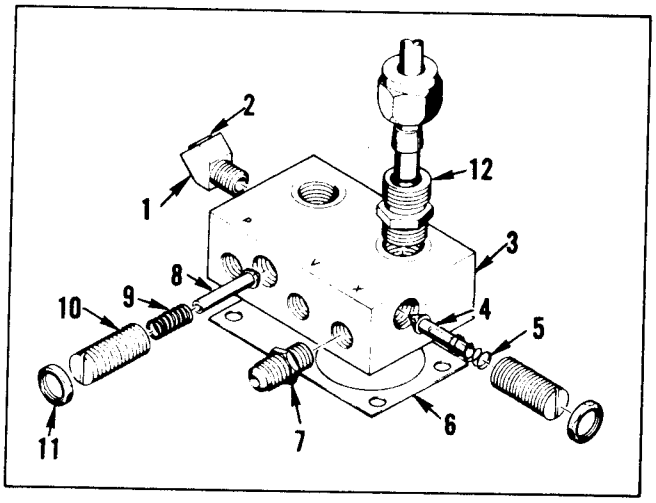
Pressure Relief Valve for the Adjustment of Vacuum, is adjusted in the same manner as the main pressure relief valve shown in Sec. IV, Page 4-2.

The vacuum line should pull approximately 5 inches of mercury for the average installation of a Mark Series attachment.

To increase vacuum, turn the *Valve Adjusting Screw* clockwise. To decrease vacuum, turn valve adjusting screw counterclockwise and lock the seal nut, which also serves as a lock nut.

CAUTION: In making this adjustment, do not have too much vacuum because this will aerate the oil and cause the cylinder to be spongy and trace an irregular pattern. Better to have not enough vacuum than too much. "Ref. D-310 for Bleeding of Cylinders."

ADJUSTMENT OF VACUUM



VACUUM MANIFOLD ASSEMBLY

Index	Part No.	Description	Mfr.	Qty.
12	192-07	Connector, (1/2 Tube to 3/4 In Str Thrd)	Lz	2
11	199-55	Nut, Tru-Seal (9/16-18)	Fr	2
10	50198	Screw, Adjusting Relief Valve	Tru	2
9	55060	Spring, Relief Valve	Tru	1
8	50200	Plunger	Tru	1
7	103-04(50) (-48) 110-04(16) 110-07	Connector (1/4 Male Pipe to 1/4 Tube) Connector (1/4 Male Pipe to 1/4 Tube) Connector (1/4 Male Pipe to 1/4 Tube) Connector (1/4 Male Pipe to 5/8 Tube)	Wh Wh Wh Wh	5 5 1 2
6	50176	Gasket, Manifold		
5	55412	Spring, Relief Valve	Tru	1
4	50197	Plunger	Tru	1
3	50188	Manifold	Tru	1
2	104-03	Plug, Pipe (1/4 N.P.T.)	Con	1
1	127-02	Elbow 45° Street (1/4 N.P.T.)	Wh	1

1-7. MARK III SERIES

1-8. The Mark III Series Lathe Tracer Attachment is similar in construction to the Mark IIA Series (par. 1-5). It is designed for use on a standard lathe of 19 to 24 inch capacity. It may also be adapted to smaller or larger lathes as required. The Mark III Series consists of the equipment listed in table 1-4.

Table 1-4. Equipment Supplied With a Standard Mark III Series (Model 2057-01) Lathe Tracer Attachment

Qty	Description	Model Part No.
1	Top and Bottom Slide	40800
1	Cylinder Assy	40820
1	Swivel Arm Assy	40731
1	Valve Slide Assy	4049-02
1	Tracer Valve	1066-05
1	Hydraulic Power Unit	5013-19
1	Hyd. Pressure Hose Assy	55127
2	Drain & Exhaust Hose Assy	55128
1	Tracer Valve & Cylinder Hose Assy	55129
1	Tracer Valve & Cylinder Hose Assy	55130
1	Template Rail Assy	43570

NOTE: Mark IIA and III Series were formerly provided with the 40754 Template Rail Assembly. They are currently provided with the 43570 Universal Template Rail Assembly (par. 1-15).

1-9. MARK IV SERIES

1-10. The Mark IV Series Lathe Tracer Attachment is similar in construction to the Mark IIA Series (par. 1-5). It is designed for use on a standard lathe of 20 to 28 inch capacity. It may also be adapted to smaller or larger lathes as required. The Mark IV Series consists of the equipment listed in table 1-5.

Table 1-5. Equipment Supplied With a Standard Mark IV Series (Model 2058-01) Lathe Tracer Attachment

Qty	Description	Model Part No.
1	Top and Bottom Slide	40900
1	Cylinder Assy	40910
1	Swivel Arm Assy	40917
1	Valve Slide Assy	4049-03
1	Tracer Valve	1066-07
1	Hydraulic Power Unit	5013-22
2	Hyd. Pressure & Exhaust Hose Assy	55197
1	Drain Hose Assy	55198
1	Tracer Valve & Cylinder Hose Assy	55199
1	Tracer Valve & Cylinder Hose Assy	55200
1	Template Rail Assy	43585

1-11. MARK V SERIES

1-12. The Mark V Series Lathe Tracer Attachment is similar in construction to the Mark IIA Series (par. 1-5). It is designed for use on a standard lathe of 25 to 32 inch capacity. It may also be adapted to smaller or larger lathes if required. The Mark V consists of the equipment listed in table 1-6.

NOTE: Mark IV, V and VI Series were formerly provided with the 43554 Template Rail Assembly. They are currently provided with the 43585 Universal Template Rail Assembly (par. 1-15).

1-13. MARK VI SERIES

1-14. The Mark VI Series Lathe Tracer Attachment is similar in construction to the Mark IIA Series (par. 1-5). It is designed for use on a standard lathe of 25 to 32 inch capacity. It may also be adapted to smaller or larger lathes as required. The Mark VI Series consists of the equipment listed in table 1-7.

Table 1-6. Equipment Supplied With a Standard Mark V Series (Model 2059-01) Lathe Tracer Attachment

Qty	Description	Model/Part No.
1	Top and Bottom Slide	43000
1	Cylinder Assy	43010
1	Swivel Arm Assy	43013
1	Valve Slide Assy	4049-03
1	Tracer Valve	1066-07
1	Hydraulic Power Unit	5013-22
2	Hyd. Pressure & Exhaust Hose Assys	55197
1	Drain Hose Assy	55198
1	Tracer Valve & Cylinder Hose Assy	55199
1	Tracer Valve & Cylinder Hose Assy	55200
1	Template Rail Assy	43585

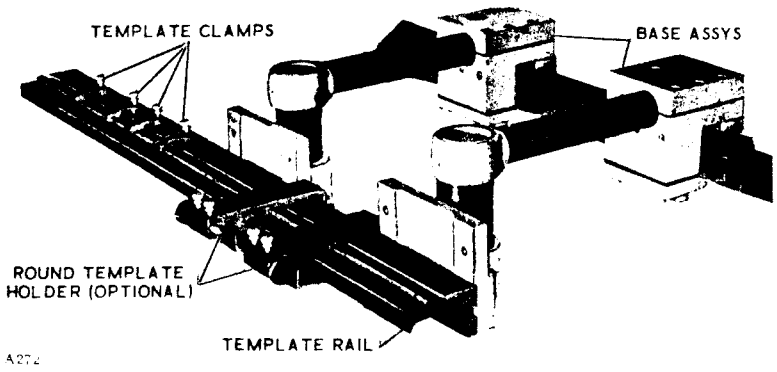
Table 1-7. Equipment Supplied With a Standard Mark VI Series (Model 2060-01) Lathe Tracer Attachment

Qty	Description	Model/Part No.
1	Top and Bottom Slide	43500
1	Cylinder Assy	43510
1	Swivel Arm Assy	43013
1	Valve Slide Assy	4049-03
1	Tracer Valve	1066-07
1	Hydraulic Power Unit	5013-22
2	Hyd. Pressure & Exhaust Hose Assys	55197
1	Drain Hose Assy	55198
1	Tracer Valve & Cylinder Hose Assy	55199
1	Tracer Valve & Cylinder Hose Assy	55200
1	Template Rail Assy	43585

1-15. UNIVERSAL TEMPLATE RAIL ASSEMBLY

1-16. The "Universal" Type Template Rail Assembly (fig. 1-10) is currently supplied as standard equipment with the Mark IIA, III, IV, V, and VI Series Lathe Tracer Attachments. The template rail assembly is attached to the bed of the lathe by two rugged base assemblies. Each base assembly is secured by a wedge clamp at the rear and a flat clamp at the front. An elbow type extension assembly slides into each base and provides in-and-out adjustment of the template rail. The extension assemblies may be installed pointing up or down depending upon overall height requirements. A template rail mount is installed on each extension assembly. Up and down adjustment of the template rail is provided by sliding the mounts up or down on the extension assemblies. The template rail is attached to the face of each mount with two socket head screws and square nuts. The square nuts slide in a T-slot in the rear of the template rail. Each mount has two sets of mounting holes so that the template rail may be mounted along the lower portion of the mounts (as shown in detail A, fig. 1-10), or along the upper portion of the mounts (as shown in detail B, fig. 1-10). The template rail may be secured in any position along the length of the rail. Four template clamps are provided in a T-slot on the top of the template rail. The 4-foot rail is standard for the Mark IIA and III Series, and a 6-foot rail is standard for the Mark IV, V and VI Series. Longer template rails are available upon special order.

1-17. FACING TEMPLATE RAIL. Facing Template Rail, Model Group 3058, (fig. 1-11) is available as OPTIONAL equipment for use with the Universal Template Rail Assembly. The facing template rail consists of a template rail mount and a 12-inch long template rail. The template rail is attached to the mount by four screws. Additional mounting holes are provided in the template rail for changing the position of the template rail with respect to the mount. The template rail mount may be installed in a mounting hole provided in the top of either of the Universal Template Rail Assembly base assemblies as shown in figure 2-23. The template rail mount is secured by a socket head setscrew in the side of the base assembly. A T-slot in the top of the facing template rail will accommodate the template clamps provided with the Universal Template Rail Assembly.



DETAIL A

Front view showing extension assemblies pointing down and template rail attached to the lower mounting holes in the mounts.

DETAIL B

Rear view showing extension assemblies pointing up and the template rail attached to the upper mounting holes in the mounts.

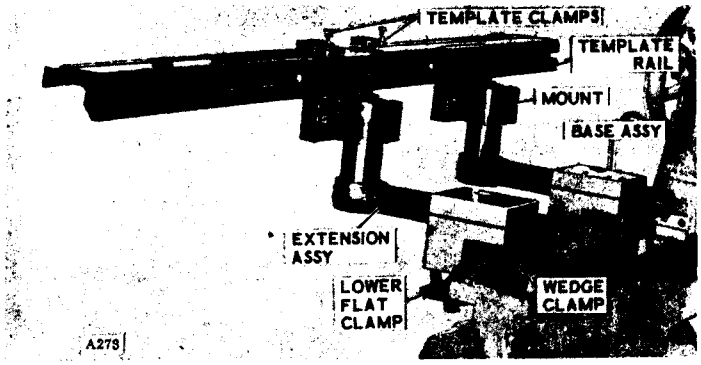


Figure 1-10. Typical Universal Template Rail Assembly. Used with Mark IIA thru VI Series)

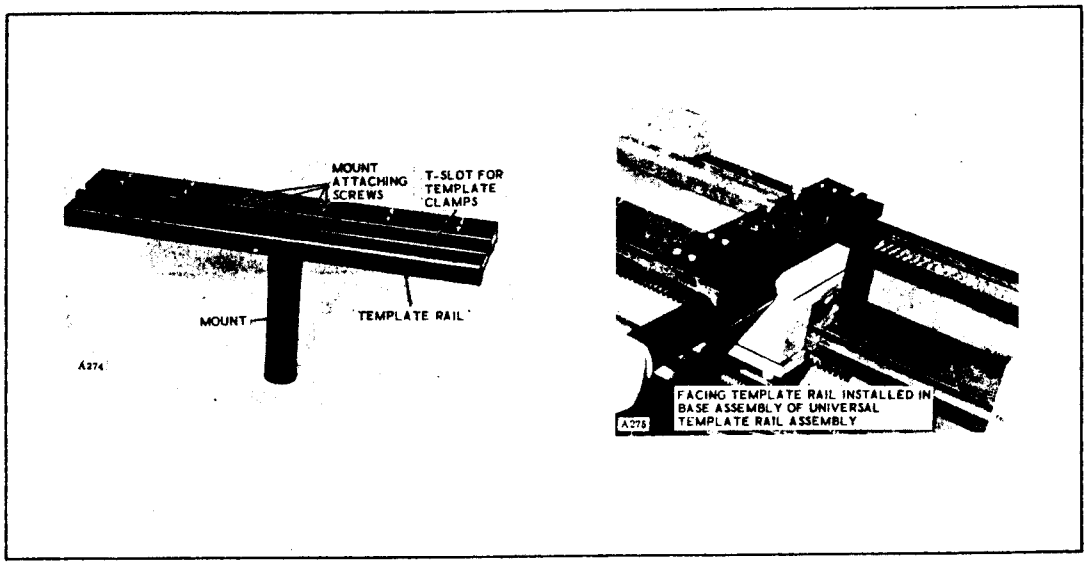


Figure 1-11. Facing Template Rail Assembly Model Group 3058.

1-21. TECHNICAL CHARACTERISTICS

	*Mark "O"	Mark "O-A"	Mark IIA	Mark III	Mark IV	Mark V	Mark VI
Cylinder Bore	1.75 in.	1.75 in.	3.0 in.	3.0 in.	4.0 in.	4.5 in.	4.5 in.
Cylinder Stroke	3.0 in.	3.0 in.	4.0 in.	5.0 in.	6.0 in.	8.0 in.	10.0 in.
Tracer Stylus Pressure	6-9 oz	6-9 oz	6-9 oz	6-9 oz	6-9 oz	6-9 oz	6-9 oz
Tracer Stylus Bore	0.375 in.	0.375 in.	0.375 in.	0.375 in.	0.375 in.	0.375 in.	0.375 in.
Lathe Swing ** (Recommended)	9-13 in.	9-13 in.	13-20 in.	19-24 in.	20-28 in.	25-32 in.	25-32 in.
Valve Slide Adjustment:							
Parallel to Cross Slide (In-and-out)	3-3/8 in.	3-3/8 in.	3 in.	3 in.	3 in.	3 in.	3 in.
Parallel to Bed (Longitudinal)	1/2 in.	1/2 in.	1 in.	1 in.	1 in.	1 in.	1 in.
Length of Template Rail	14 in.	14 in.	48 in.	48 in.	72 in.	72 in.	72 in.
Length of Facing Template Rail (Optional)	-	-	12 in.	12 in.	12 in.	12 in.	12 in.
Hydraulic Power Unit							
Horsepower	1/2	1/2	1/2	1	1	1	1
Operating Power	115/230V ac, single ph, 60 cps	115/230V ac, single ph, 60 cps	115/230V ac, single ph, 60 cps	220/440V ac, 3-ph, ph, 60 cps	220/440V ac, 3-ph, 60 cps	220/440V ac, 3-ph, 60 cps	220/440V ac, 3-ph, 60 cps
Pump Capacity	1.5 gpm	1.5 gpm	1.5 gpm	3 gpm	3 gpm	3 gpm	3 gpm
Normal Operating Pressure	160 psi	160 psi	160 psi	200 psi	200 psi	200 psi	200 psi
Maximum Output Pressure	275 psi	275 psi	275 psi	300 psi	300 psi	300 psi	300 psi
Reservoir Capacity (Max.)	15 gal	15 gal	15 gal	15 gal	15 gal	15 gal	15 gal
Reservoir Operating Capacity	15 gal	15 gal	15 gal	15 gal	15 gal	15 gal	15 gal

* Mark "O" Series not manufactured after Serial No. 50.

** RECOMMENDED - Lathe swing depends upon height of the original lathe compound. Check this height against the stack height of the attachment (see dimensional data in Section II). Choose an attachment which has a stack height closest to the original lathe height or less than the lathe height and use riser spacers to increase the attachment stack height.
(Attachments which are smaller than recommended may be used for light work.)

section II installation

2-1. UNPACKING

2-2. The Lathe Tracer Attachments (except for Mark "O-A" Series) are shipped from the manufacturer with the tracer slide assembly mounted on top of the hydraulic power unit as shown in figure 2-1. This is also a convenient way to store the tracer slide assembly when not in use. The template rail assembly and optional equipment are shipped in separate containers. All hydraulic fittings are protected from dirt and moisture by plastic caps. Save these caps for use in storing the equipment and for protecting the equipment whenever the hydraulic hose assemblies are disconnected.

CAUTION: Be very careful not to allow dirt, or moisture to enter the system through the hydraulic fittings. Foreign matter is one of the greatest contributors to trouble in all precision hydraulic systems.

2-3. PRELIMINARY FITTING PROCEDURES

NOTE: If the Lathe Tracer Attachment has been ordered for the specific lathe on which it is to be installed, the preliminary set-up procedures will not be applicable. These instructions are general instructions for adapting the Lathe Tracer Attachment to the lathe.

2-4. The tracer slide assembly of the Lathe Tracer Attachment replaces the lathe compound assembly when the lathe is converted to tracer operation. The tracer slide assembly must, therefore, be installed at very nearly the same height as the lathe compound assembly so that the relationship of the cutting tool to the spindle centerline will not be changed. Before making any adaptations to the Lathe Tracer Attachment, first check to see if the cutting tool holder can be adjusted for variations in height. If an adjustable cutting tool holder is used, more tolerance can be accepted between the height of the lathe compound assembly and the height of the tracer slide assembly.

2-5. The template rail assembly used will have to be adapted to the lathe on which it is to be installed (if it has not been ordered for the specific lathe). This adaptation consists primarily of machining the bottom of the base assembly and, in some cases, machining the base clamp. The Universal Template Rail Assembly will fit most lathes without machining.

NOTE: Before installing the Lathe Tracer Attachment, it is recommended that the operator refer to Section III and determine the type of tracing operation to be performed. Refer to figures 3-11, 3-12, 3-14, 3-15, and 3-16 for examples of typical installations.

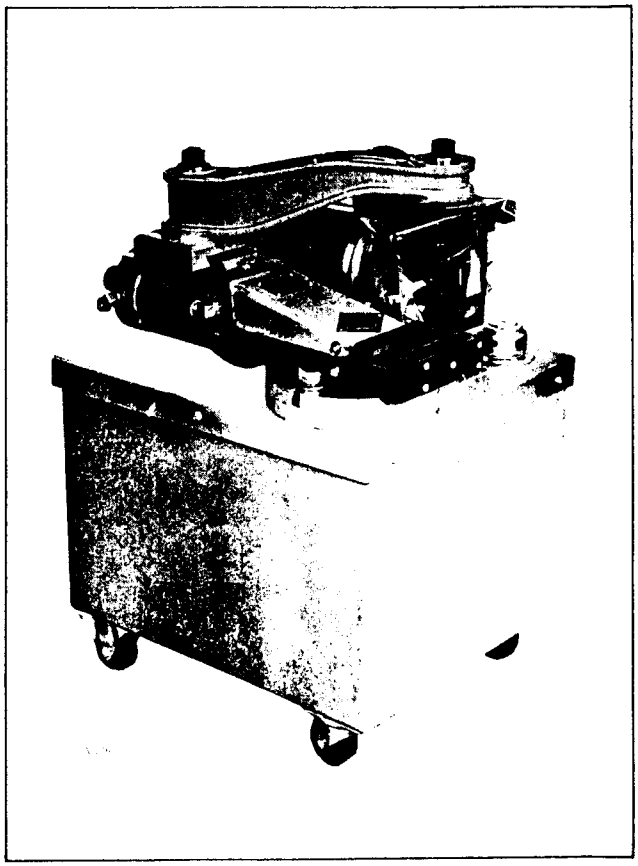


Figure 2-1. Tracer Slide Assembly Installed on Top of Hydraulic Power Unit for Shipping or Storage

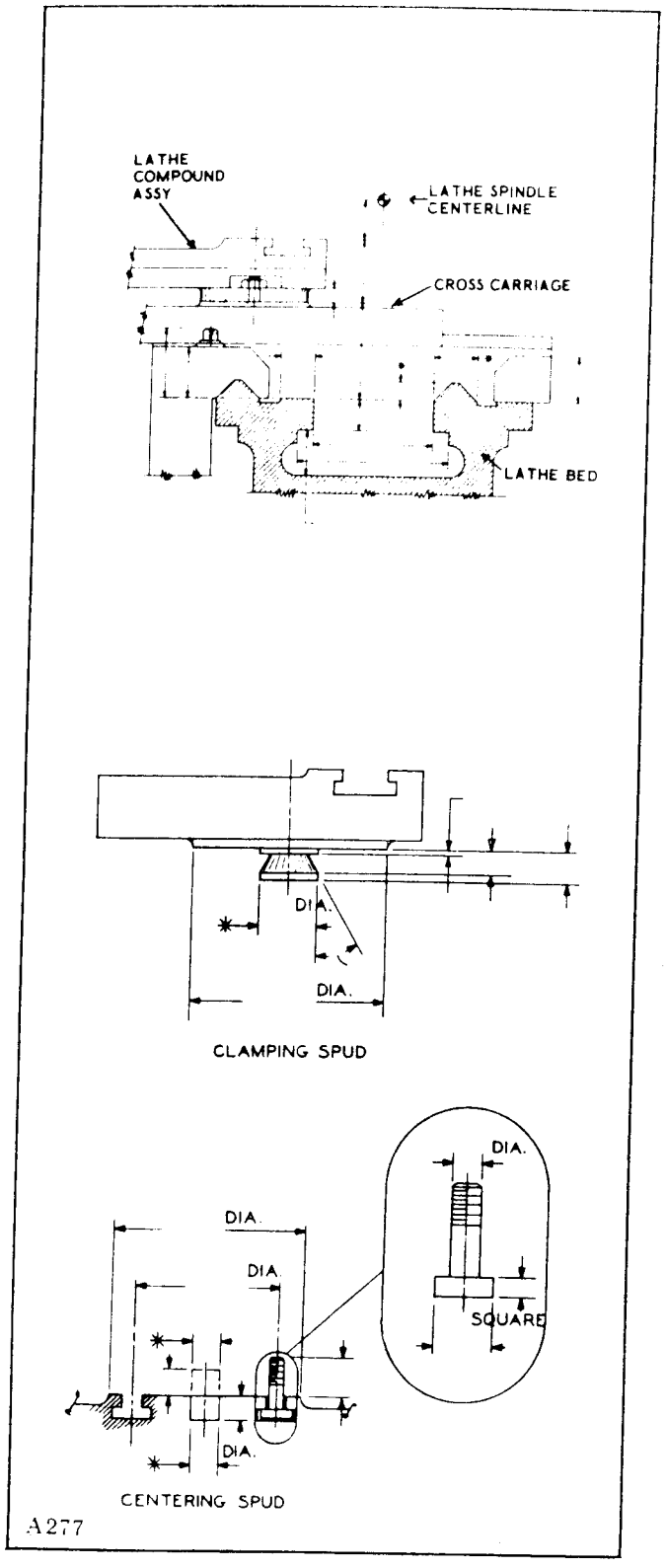


Figure 2-2. Dimensions to be Measured on a Lathe for Ordering a Factory Fitted Lathe Tracer Attachment, or for Installing a Standard Lathe Tracer Attachment

2-6. PRELIMINARY FITTING PROCEDURES, MARK "O" AND "O-A" SERIES

2-7. GENERAL. Figure 2-2 shows the measurements that should be made on the lathe when ordering a Lathe Tracer Attachment for a specific lathe. These dimensions will also be required when installing a Lathe Tracer Attachment that has not been ordered for the specific lathe on which it is to be installed.

2-8. PRELIMINARY FITTING PROCEDURES FOR THE TRACER SLIDE ASSEMBLY. Figure 2-3 shows the important dimensions for a Mark "O" or "O-A" Series. Install the tracer slide assembly as described in figure 2-4.

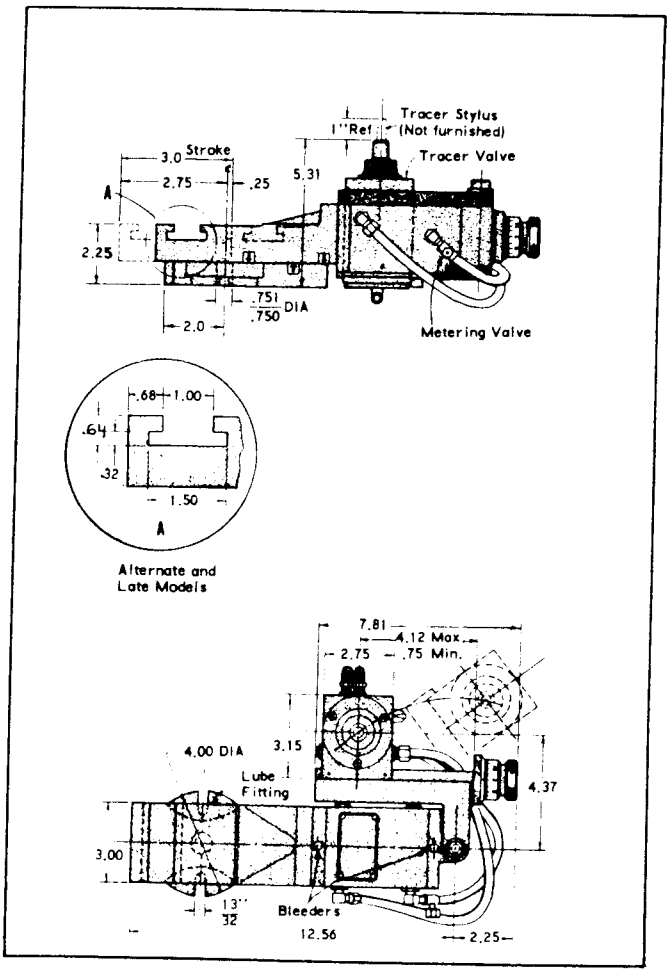
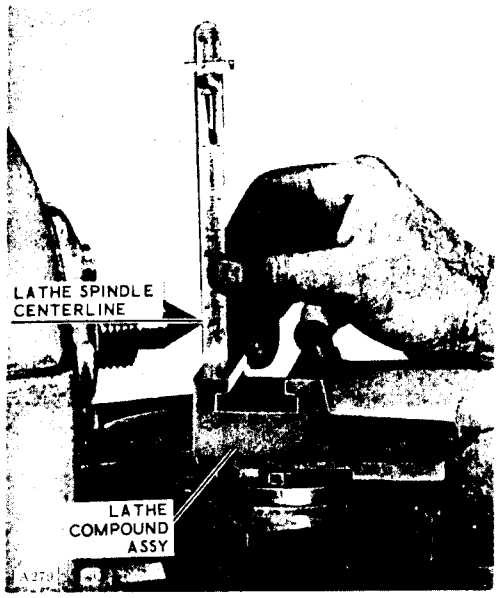
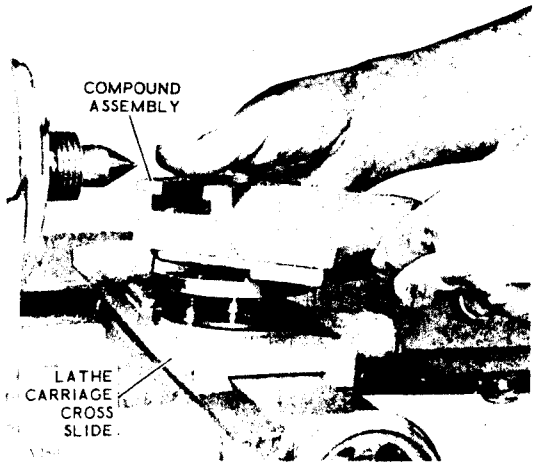


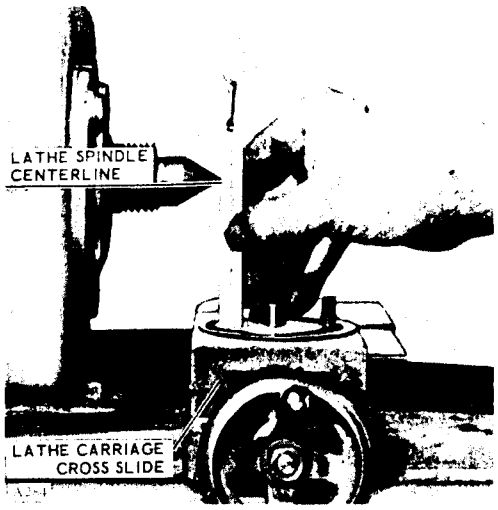
Figure 2-3. Principal Dimensions of Tracer Slide Assembly for Mark [redacted] and "O-A" Series Lathe Tracer Attachments



STEP 1 Remove the cutting tool holder from the lathe compound assembly. Measure the distance from the top of the lathe compound to the lathe spindle centerline.



STEP 2 Remove the compound assembly from the lathe carriage cross slide.



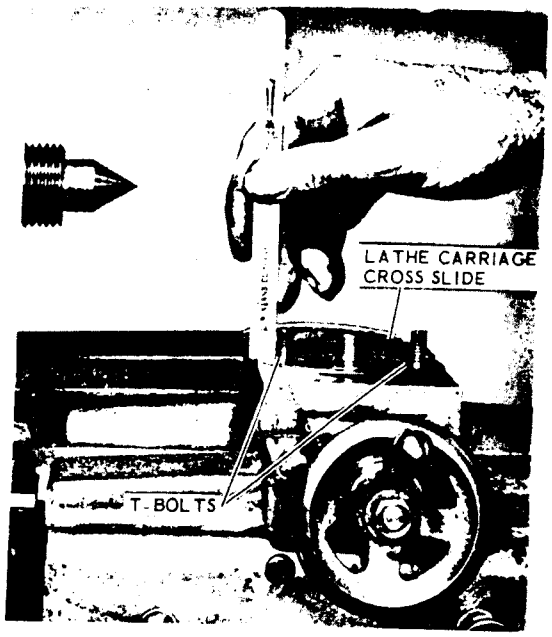
STEP 3 Measure the distance from the top of the lathe carriage cross slide to the lathe spindle centerline. Determine the height of the lathe compound assembly by subtracting the measurement taken in Step 1 from the measurement taken in this step. Compare the height of the compound assembly with the standard stack height of the Lathe Tracer Attachment slide assembly. The standard stack height of the Mark "O" and "O-A" Series is 2.25 inches.

(a) If additional height is required, a riser plate may be installed on the bottom of the tracer slide assembly as described in paragraph 2-16. A riser plate of proper height may be machined to match the compound adapter on the bottom slide or a pre-machined riser plate may be obtained from True-Trace. The following riser plates are available for the Mark "O" and "O-A" Series:

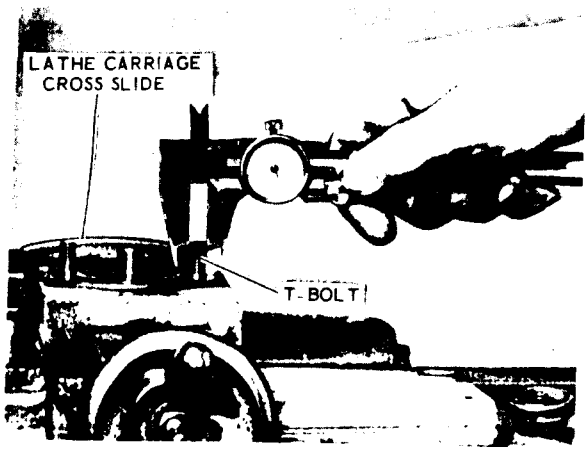
Riser Model No.	Thickness	O.D.	Pivot Pin Hole Size
3076-02	1 IN.	4 IN.	0.750/0.751 IN.
3076-01	1/2 IN.	4 IN.	0.750/0.751 IN.

(b) If the tracer slide assembly is too high, the compound adapter on the bottom slide assembly may be machined down approximately 1/8 inch. If greater reduction in height is required, a special slide assembly may be required. Special slide assemblies may be purchased from True-Trace upon special order.

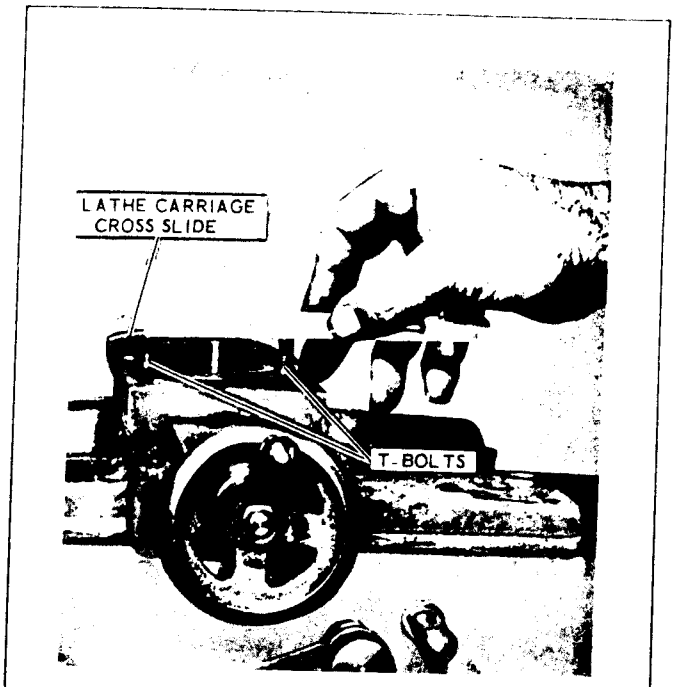
Figure 2-4. Preliminary Fitting Procedures for Mark "O" and "O-A" Series (Sheet 1 of 2)



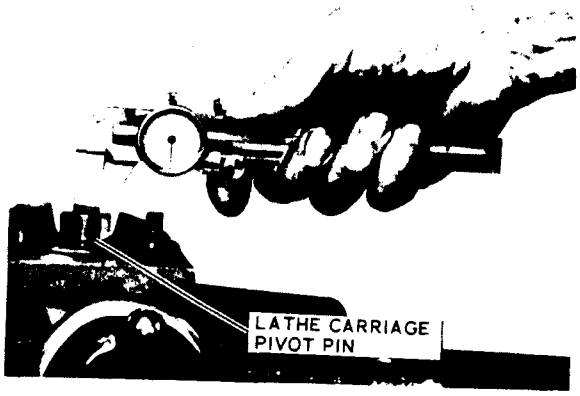
STEP 4 Measure the height of the T-bolts in the lathe carriage cross slide. The bolts must be 5/8 ± 1/16 inch high for attaching the standard tracer slide assembly. If a riser plate is to be used, add the thickness of the riser plate to the standard T-bolt length.



STEP 5 Measure the diameter of the T-bolts in the lathe carriage cross slide. Two 3/8-inch diameter (or smaller) T-bolts are required for attaching the tracer slide assembly.



STEP 6 Measure the center-to-center dimensions of the T-bolts in the lathe carriage cross slide. The minimum dimensions for installation of the tracer slide assembly is 2-3/4 inches - the maximum dimension is 3-5/8 inches.



STEP 7 Measure the diameter of the pivot pin in the lathe carriage cross slide. The pivot hole in the tracer slide assembly is 3/4 inch ID. The Mark "O" and "O-A" Series are also supplied with a compound pivot spud which is inserted in the pivot hole in the slide assembly and attached with a socket head cap screw. The compound pivot spud may be used in place of the pivot pin in the lathe carriage cross slide. It is 1-1/2 inch OD and may be machined to a smaller diameter if necessary.

Figure 2-4. Preliminary Fitting Procedures for Mark "O" and "O-A" Series (Sheet 2 of 2)

2-9. PRELIMINARY FITTING PROCEDURES FOR THE MARK "O-A" TEMPLATE RAIL ASSEMBLY. Figure 2-5 shows a typical installation of the Mark "O-A" template rail assembly and its maximum adjustment dimensions. (The Mark "O" template rail assembly is installed in a similar manner.) Before determining the height of the template rail assembly, install the tracer slide assembly on the lathe. The height of the edge of the template being traced must be 1/2 inch lower than the tracer valve stylus spindle. Keeping this in mind, determine the height at which the template rail assembly should be installed and still allow for maximum use of the vertical adjustment features of the template rail assembly. Note that an alignment notch should be machined in the bottom of the base to match the angle of the rear of the lathe bed.

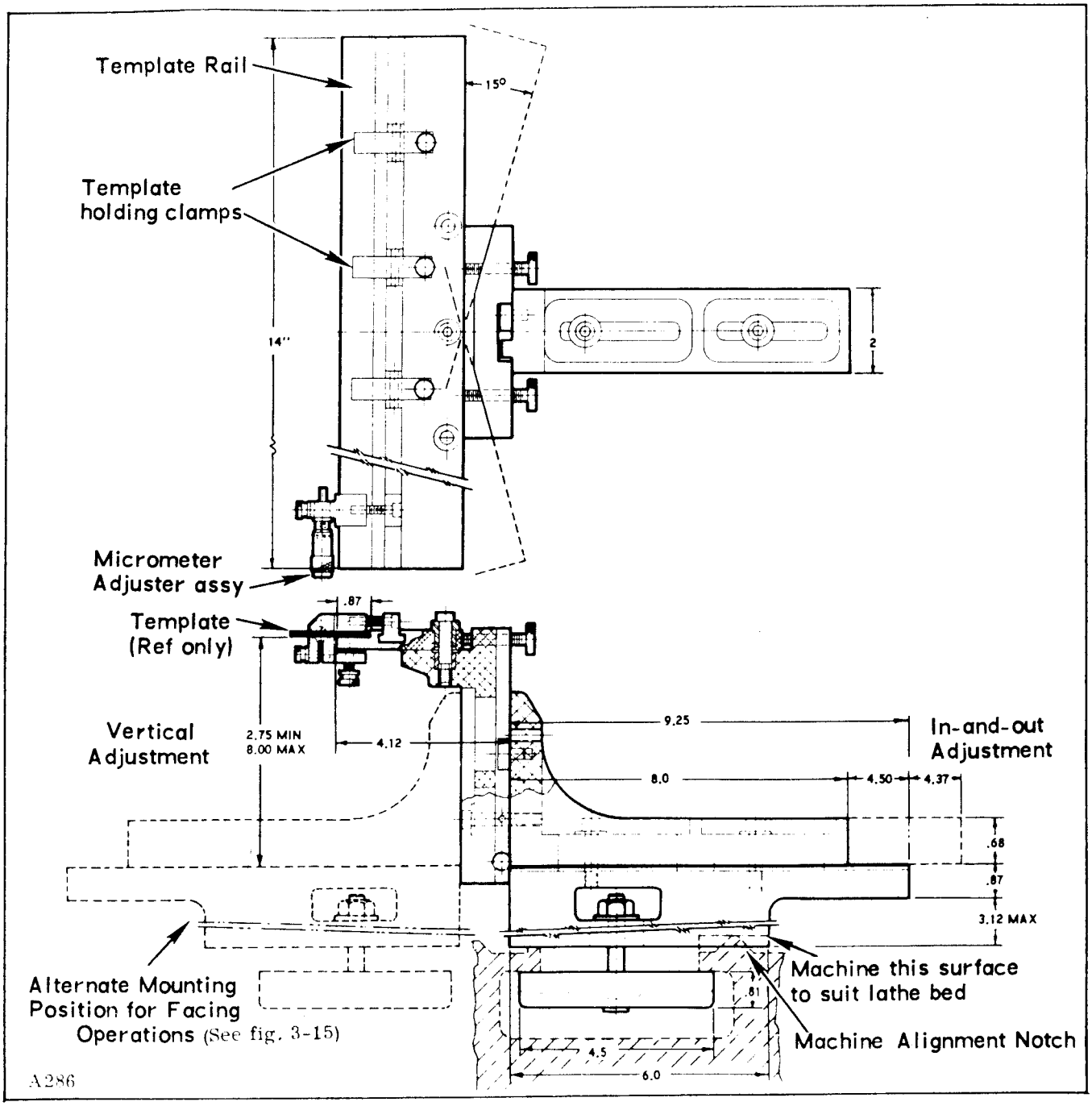


Figure 2-5. Typical Installation of the 40685 Template Rail Assembly. (Used with Mark "O-A" Series)

2-10. PRELIMINARY FITTING PROCEDURES, MARK IIA, III, IV, V, AND VI SERIES

2-11. GENERAL. Figure 2-2 shows the measurements that should be made on the lathe when ordering a Lathe Tracer Attachment for a specific lathe. These dimensions will also be required when installing a Lathe Tracer Attachment that has not been ordered for the specific lathe on which it is to be installed.

2-12. PRELIMINARY FITTING PROCEDURES FOR THE TRACER SLIDE ASSEMBLY. Figure 2-6 shows the important dimensions for the Mark IIA Series. Figure 2-7 shows the important dimensions for the Mark III Series. Figure 2-8 shows the important dimensions for the Mark IV Series, and figure 2-9 shows the important dimensions for the Mark V and Mark VI Series. Procedures for installing a Mark IIA, III, IV, V or VI are identical. Install the tracer slide assembly as described in figure 2-10.

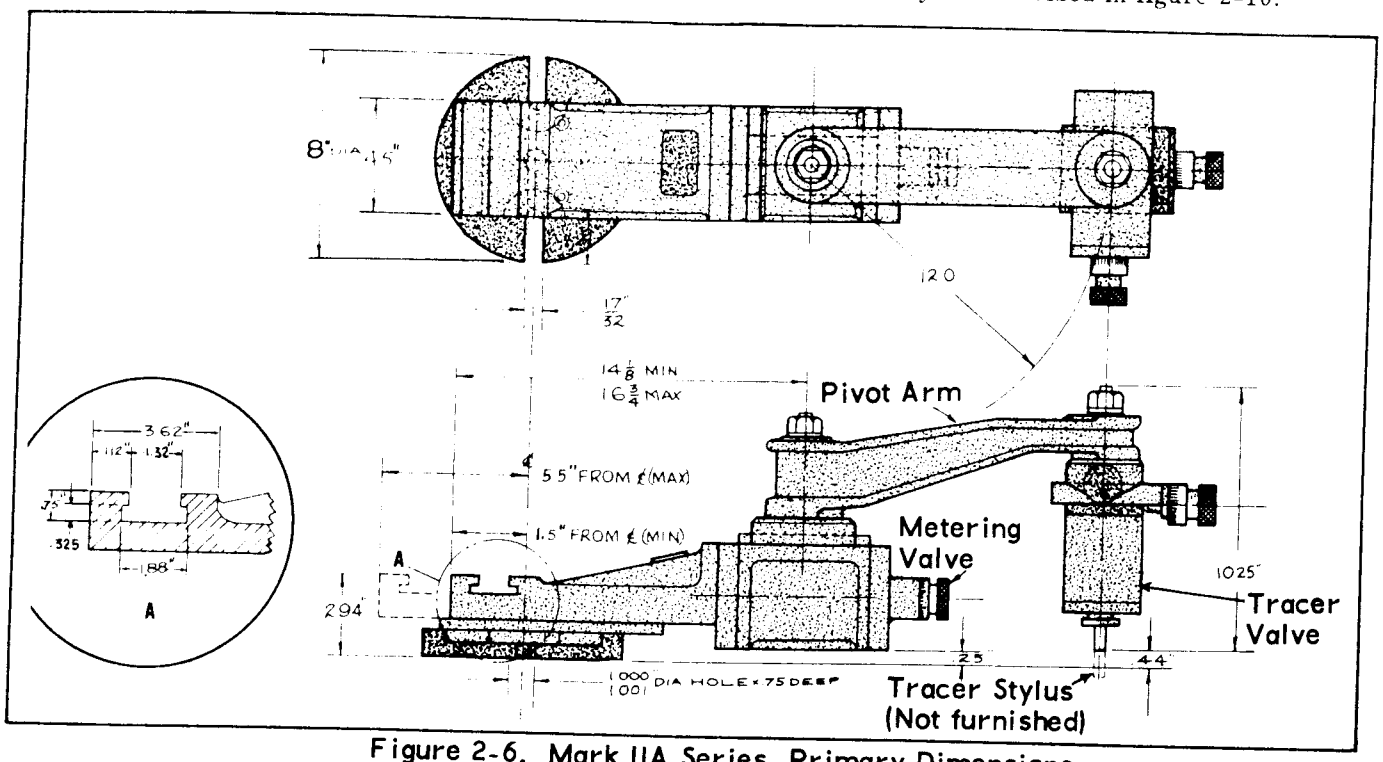


Figure 2-6. Mark IIA Series, Primary Dimensions

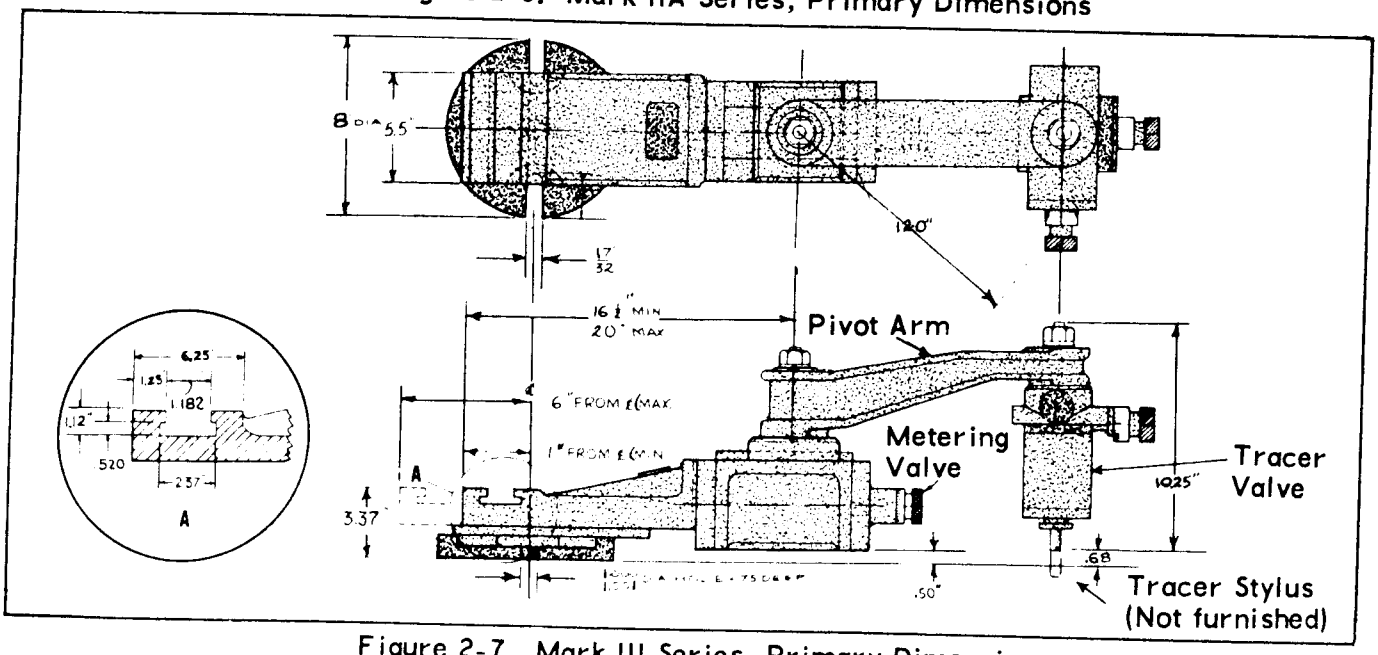


Figure 2-7. Mark III Series, Primary Dimensions

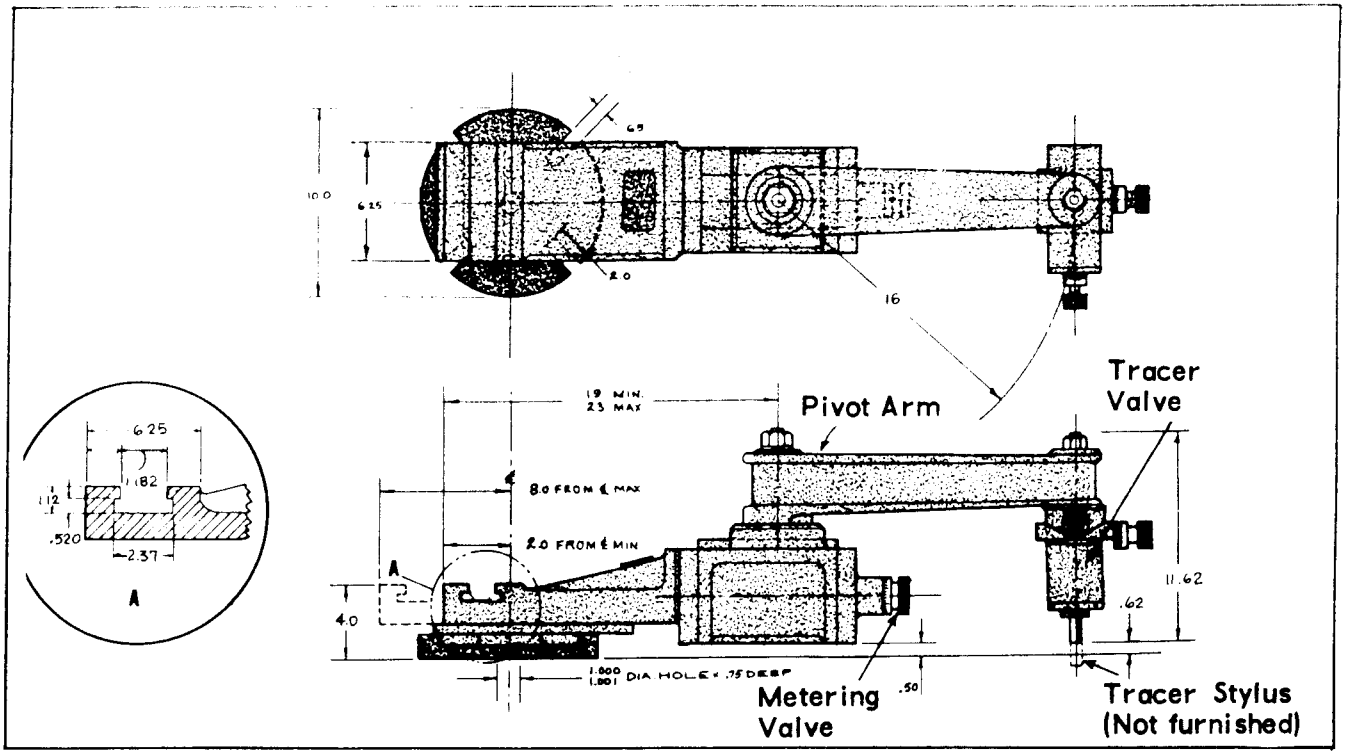


Figure 2-8. Mark IV Series, Primary Dimensions

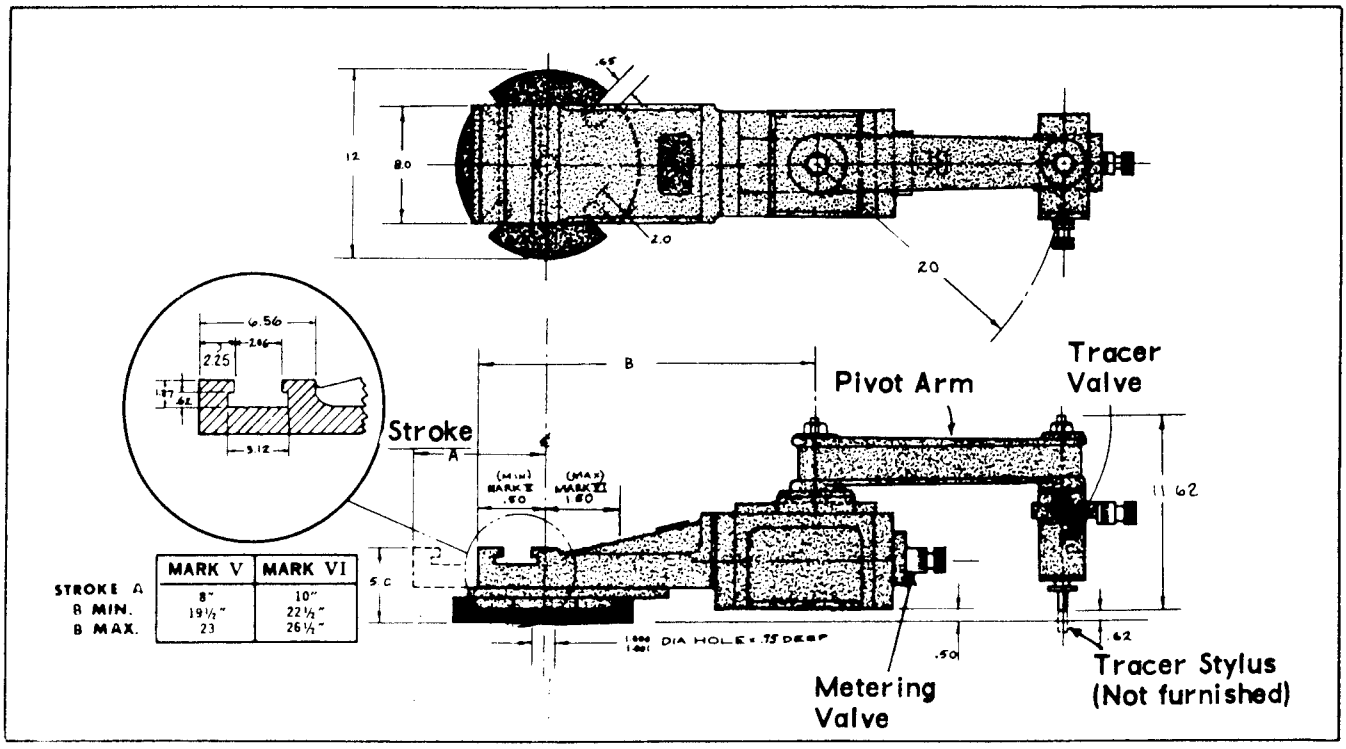
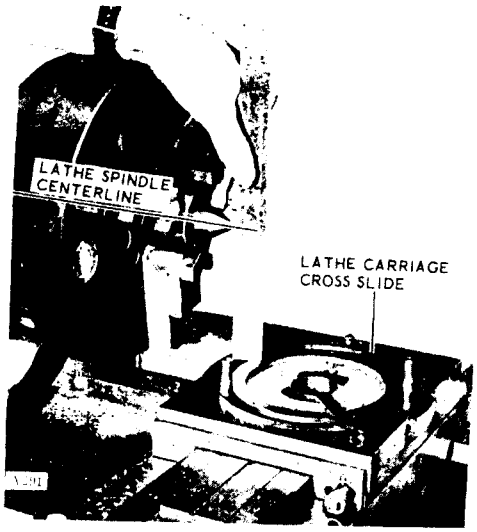


Figure 2-9. Mark V and VI Series, Primary Dimensions

STEP 1 Remove the cutting tool holder from the lathe compound assembly. Measure the distance from the top of the lathe compound to the lathe spindle centerline.

STEP 2 Remove the compound assembly from the lathe carriage cross slide.



STEP 3 Measure the distance from the top of the lathe carriage cross slide to the lathe spindle centerline. Determine the height of the lathe compound assembly by substracting the measurement taken in Step 1 from the measurement taken in this step. Compare the height of the compound assembly with the standard stack height of the Lathe Tracer Attachment top and bottom slide assembly. The standard stack heights are as follows:

Mark IIA	2.94 inches	Mark IV	4.00 inches
Mark III	3.37 inches	Mark V	5.00 inches
		Mark VI	5.00 inches

(a) If additional height is required, a riser plate may be installed on the compound adapter as described in paragraph 2-16. A riser may be machined using the tracer compound adapter as a pattern or a riser plate may be obtained from True-Trace. The following riser plates are available:

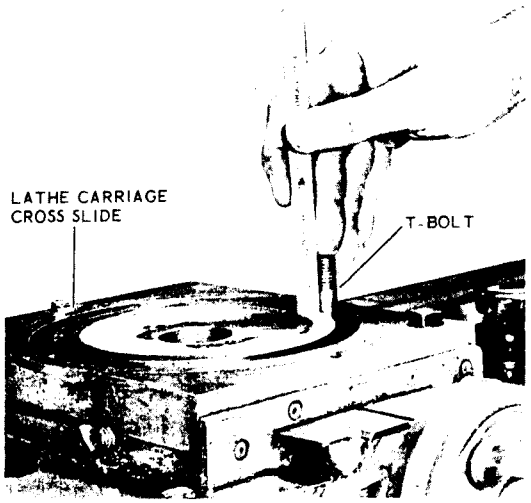
Mark Series	Riser Model No.	Thickness	O.D.	Pivot Pin Hole Size
IIA	3076-03	½ in.	8 in.	1.000 1.001 in.
IIA	3076-04	1 in.	8 in.	1.000 1.001 in.
III	3076-03	½ in.	8 in.	1.000 1.001 in.
III	3076-04	1 in.	8 in.	1.000 1.001 in.
IV	3076-05	1 in.	10 in.	1.000 1.001 in.
V	3076-06	1 in.	12 in.	1.000 1.001 in.
VI	3076-06	1 in.	12 in.	1.000 1.001 in.

-continued on next page-

Figure 2-10. Preliminary Fitting Procedures for Mark IIA, III, IV, V, and VI Series (Sheet 1 of 3)

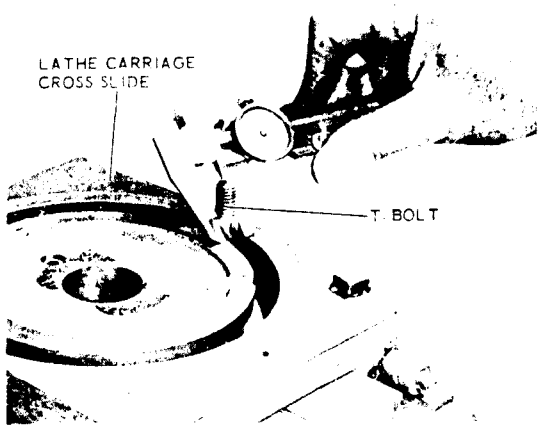
Step 3 - Continued

(b) If the tracer top and bottom slide assembly is too high, the compound adapter can be machined down approximately 1/4 inch. If greater reduction in height is required, a special compound adapter (or complete slide assembly) may be required. Special compound adapters and tracer slide assemblies may be purchased from True-Trace upon special order.



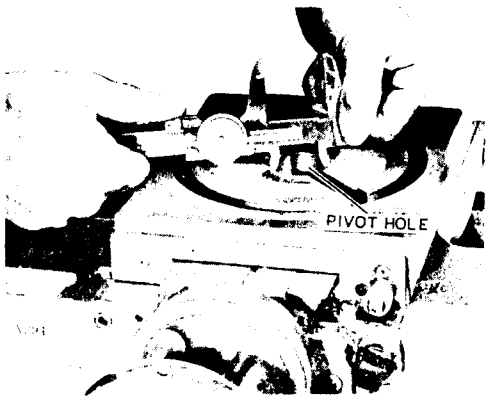
STEP 4 Measure the height of the T-bolts in the lathe carriage cross slide. Compare the height of the T-bolts with the height required for the Lathe Tracer Attachment being installed as follows:

Mark IIA	1-1/8 ± 1/16 inch (2 bolts)
Mark III	1 ± 1/16 inch (2 bolts)
Mark IV	1-1/4 ± 1/16 inch (4 bolts)
Mark V	1-1/4 ± 1/16 inch (4 bolts)
Mark VI	1-1/4 ± 1/16 inch (4 bolts)



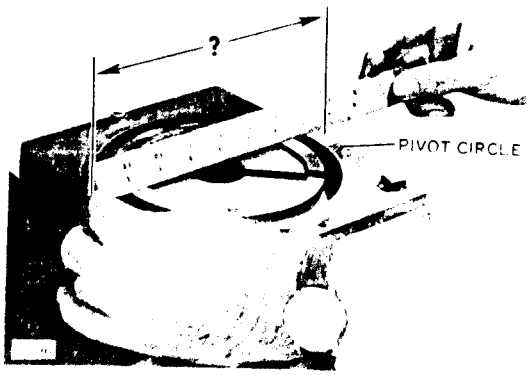
STEP 5 Measure the diameter of the T-bolts in the lathe carriage cross slide. Compare the diameter of the T-bolts with the maximum diameter that can be used with the Lathe Tracer Attachment being installed as follows:

Mark IIA	1/2 inch	Mark V	5/8 inch
Mark III	1/2 inch	Mark VI	5/8 inch
Mark IV	5/8 inch		



STEP 6 Measure the inside diameter of the pivot hole in the lathe carriage cross slide. Compare the diameter of the pivot hole with the maximum diameter of the pivot hole in the Lathe Tracer Attachment being installed. Mark IIA, III, IV, V, and VI Series all have 1-inch diameter pivot holes.

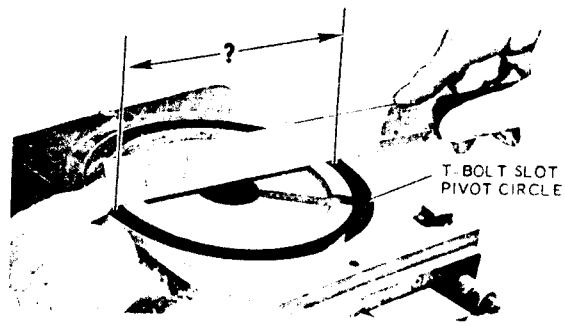
Figure 2-10. Preliminary Fitting Procedures for Mark IIA, III, IV, V, and VI Series (Sheet 2 of 3)



STEP 7 Measure the outside diameter of the pivot circle on the lathe carriage cross slide. Compare the diameter of the pivot circle with the diameter of the compound adapter on the Lathe Tracer Attachment being installed as follows:

Mark IIA	8 inches	Mark V	12 inches
Mark III	8 inches	Mark VI	12 inches
Mark IV	10 inches		

If the outside diameter of the pivot circle is smaller than the compound adapter, turn the compound adapter to the correct diameter.



STEP 8 Measure the center-to-center diameter of the pivot circle T-bolt slot in the lathe carriage cross slide. Compare the diameter of the pivot circle T-bolt slot with the minimum and maximum requirements for the Lathe Tracer Attachment being installed as follows:

MARK IIA	4-3/4 in. min.
	7-1/4 in. max.
Mark III	4-3/4 in. min.
	7-1/4 in. max.
Mark IV	7-1/8 in. min.
	9-1/4 in. max.
Mark V	6-1/4 in. min.
	11-1/4 in. max.
Mark VI	6-1/4 in. min.
	11-1/4 in. max.

Figure 2-10. Preliminary Fitting Procedures for Mark IIA, III, IV, V, and VI Series (Sheet 3 of 3)

2-13. PRELIMINARY FITTING PROCEDURES FOR THE 40754 TEMPLATE RAIL ASSEMBLY. Figure 2-11 shows a typical installation and the principle dimensions of Template Rail Assembly (used with early models of the Mark IIA and III Series). The standard template rail assembly is not premachined. The base and base clamp must be machined to fit the particular lathe on which the template rail assembly is to be installed.

a. Figure 2-12 shows a typical installation of a "factory adapted" template rail assembly. Standard template rail assemblies may be easily adapted in the same way. In the illustration shown, a leveling screw has been installed in each base as an aid in leveling the template rail with respect to the lathe. In addition, a 1/2-13 socket head screw has been installed to provide for tightening each clamp from the top of the rail.

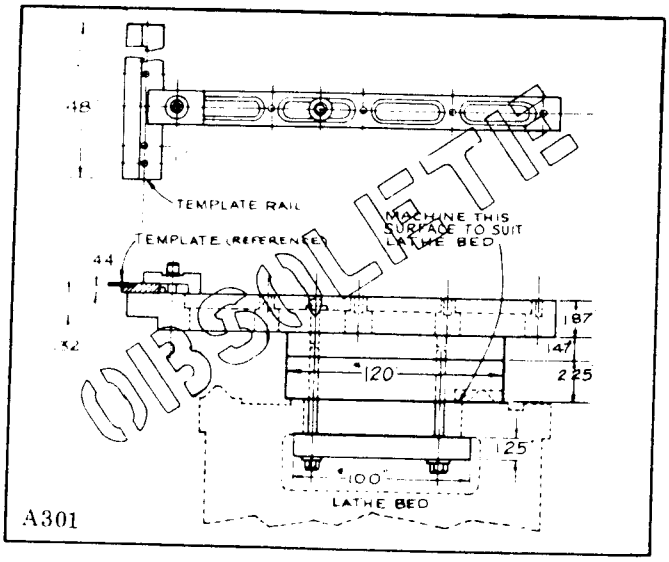


Figure 2-11. =40754 Template Rail Assembly. (Used with Early Mark II and III Series)

b. Figure 2-13 shows an alternate method of attaching the template rail assembly of a standard kit. This method does not utilize leveling screws or the extra 1/2-13 socket head screws. This method, however, is quite satisfactory where the clamping bolts will be readily accessible and where particular care is taken in the machining of the base to provide an exact fit on the lathe, and eliminating the necessity of the adjustment provided by the leveling screw.

c. To adapt the template rail assembly to the lathe, proceed as follows:

(1) Install the tracer slide assembly and determine dimension X, figure 2-12.

(2) Subtract dimension Y from dimension X to obtain dimension Z. This will be the total stack height of the template rail assembly.

NOTE: If leveling screws are to be used, subtract 3/16 inch from dimension Z to allow for the screw head.

(3) Machine the base riser block to fit the lathe bed ways and to obtain the required stack height. Be sure to allow clearance for the carriage wings.

(4) Cut the base clamps to fit the underside of the lathe ways. Bevel the ends, if necessary, to clear the bed reinforcing ribs and other obstructions.

2-14. PRELIMINARY FITTING PROCEDURES FOR THE 43554 TEMPLATE RAIL ASSEMBLY. Figure 2-14 shows a typical installation and the principle dimensions of Template Rail Assembly (used with early models of the Mark IV, V and VI Series). The set-up procedures for this template rail assembly are identical to those described in paragraph 2-13.

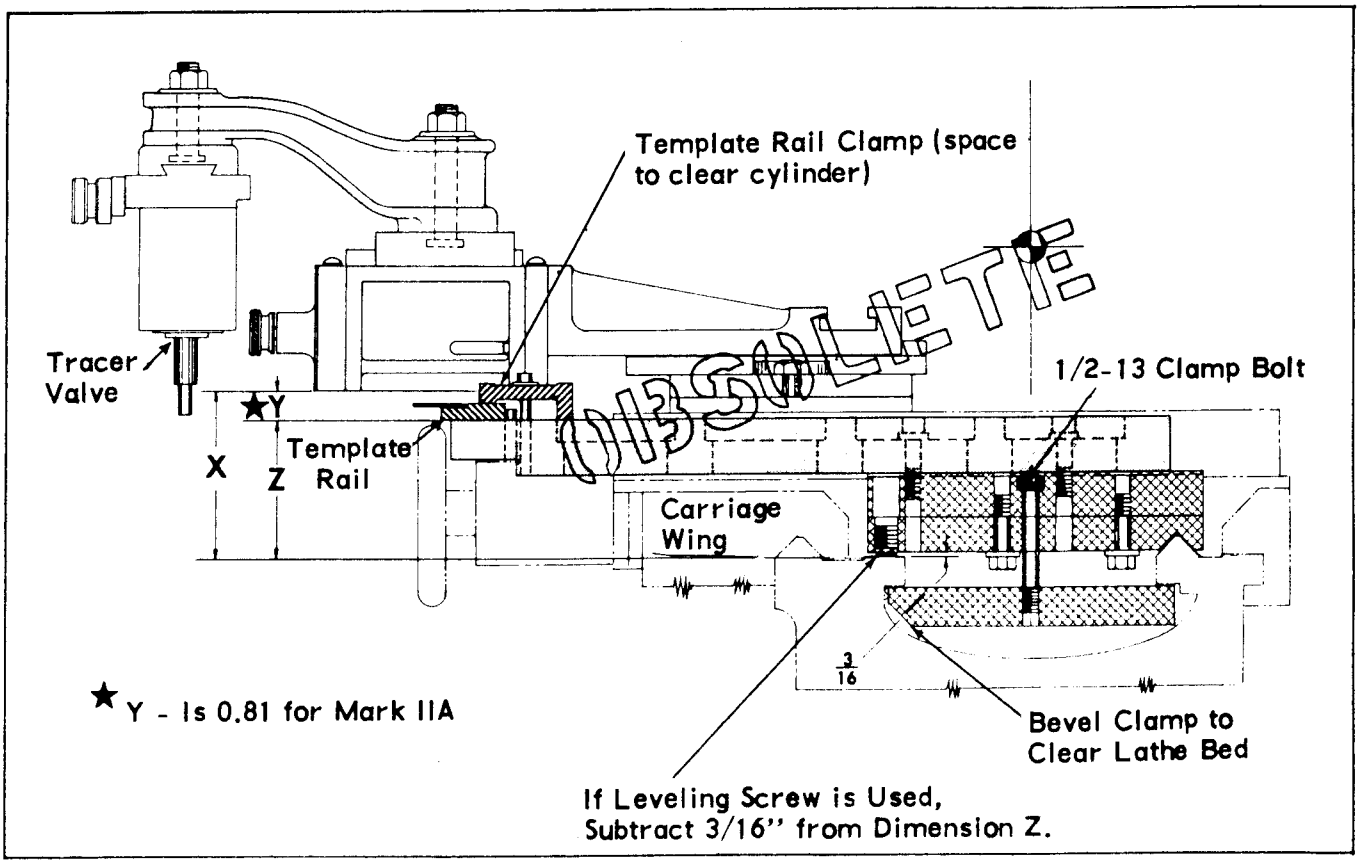


Figure 2-12. Typical Installation of Earlier "Factory Adapted" Template Rail Assemblies. (Ref. =40754 and =43554)

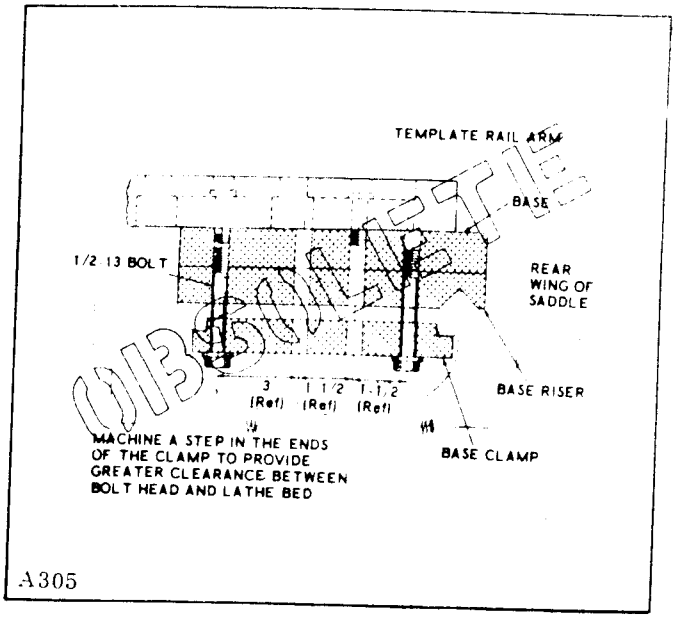


Figure 2-13. Alternate Installation of Early Template Rail Assembly #40754 and #43554.

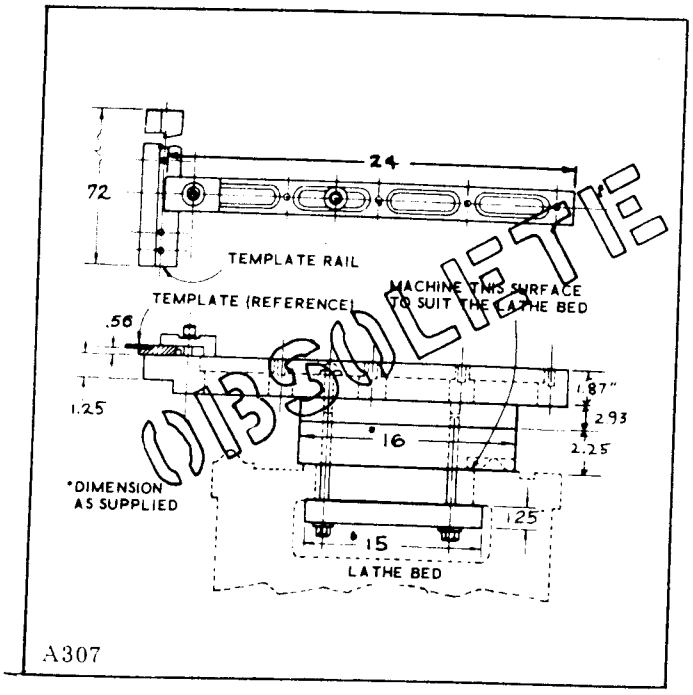


Figure 2-14. Typical Installation of Earlier #43554 Template Rail Assembly. (Also see Figures 2-12 and 2-13)

2-15. PRELIMINARY FITTING PROCEDURES FOR THE UNIVERSAL TEMPLATE RAIL ASSEMBLY. The preliminary fitting procedures for the Universal Template Rail Assembly, consist of measuring the lathe for dimensions A and B, figure 2-15 and determining the angle of the front lathe way.

a. For some lathes, it may be necessary to install longer clamp screws to satisfy the requirements of dimensions A and B. (Refer to figures 5-10 and 5-11 for correct size of the screws.)

b. For some lathes, it may be necessary to machine the wedge clamps to fit the angle of the lathe way.

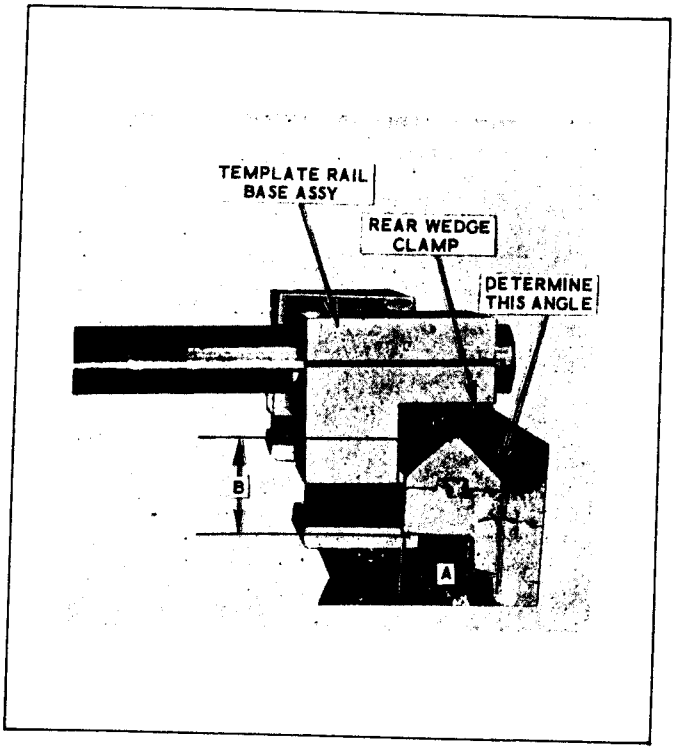


Figure 2-15. Critical Dimensions for Installing Universal Template Rail Assembly #43570 and #43585. (Used with Later Mark IIA thru VI Series)

2-16. RISER PLATES

2-17. Figure 2-16 shows dimensions for the standared riser plates available from True-Trace as optional equipment for the Mark Series. The riser plates must be attached to the compound adapter using two 1-inch long groove pins as shown in detail "A", figure 2-16.

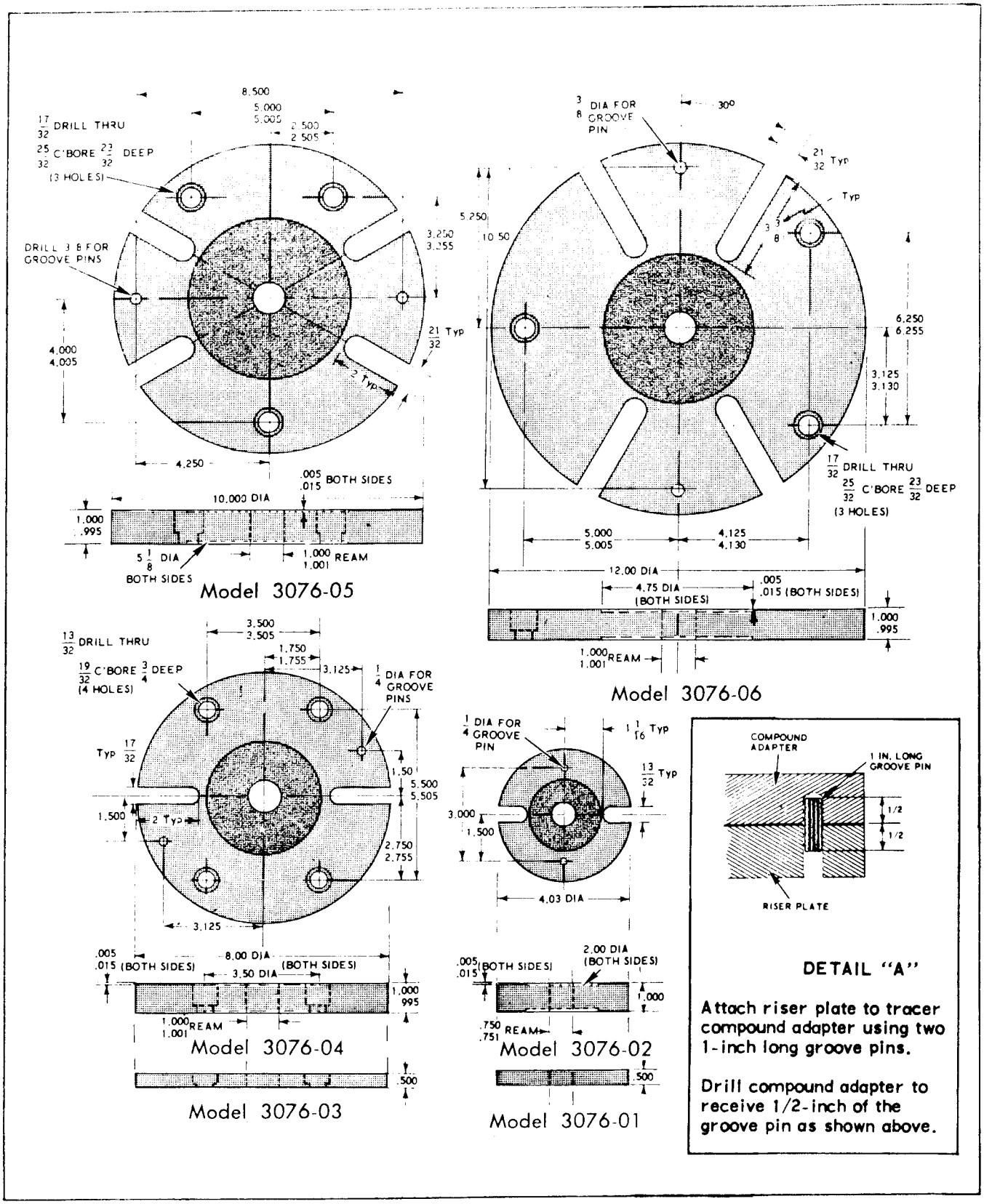


Figure 2-16. Riser Plates Available as Optional Equipment With Mark Series Lathe Tracer Attachments

2-18. INSTALLATION PROCEDURES

2-19. When installing a Lathe Tracer Attachment on a lathe, install the tracer slide assembly first. Position the hydraulic power unit in its operating location and connect the hydraulic hose assemblies, but do not make electrical connections. Install the template rail assembly next. Then fill the hydraulic power unit reservoir with hydraulic oil and make the electrical connections. It is very important that no electrical power is applied to the hydraulic power unit until the procedures described in paragraph 2-31 have been completed.

2-20. INSTALLING MARK "O" AND "O-A" SERIES

2-21. INSTALLING TRACER SLIDE ASSEMBLY. Install a Mark "O" or "O-A" tracer slide assembly as described in figure 2-17.

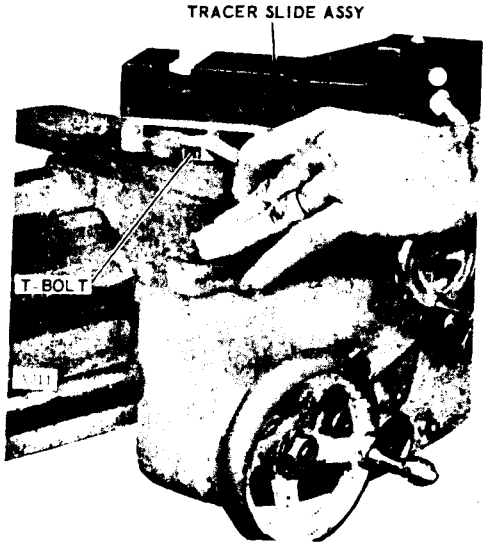
2-22. INSTALLING TEMPLATE RAIL ASSEMBLY. Install the template rail assembly as described in figures 2-18 and 2-19. Figures 2-18 and 2-19 describe the installation procedures for the 40685 Template Rail Assembly (supplied with the Mark "O-A" Series). The 40640 Template Rail Assembly, furnished with earlier Mark "O" Series, is installed in a similar manner.

2-23. INSTALLING MARK IIA, III, IV, V AND VI SERIES

2-24. INSTALLING TRACER SLIDE ASSEMBLY. Install a Mark IIA, III, IV, V, or VI Series tracer slide assembly as described in figure 2-20.

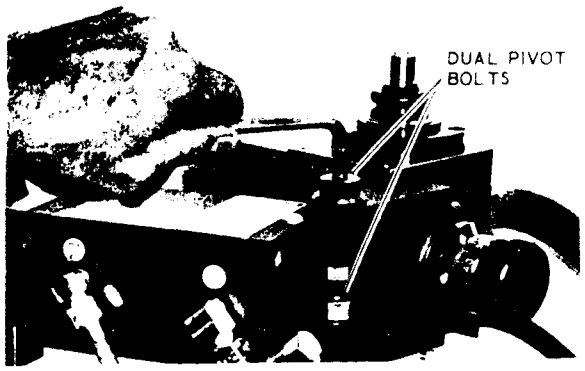
2-25. INSTALLING TEMPLATE RAIL ASSEMBLY (with early Mark IIA thru VI Series). To install the 40754 Template Rail Assembly (supplied with early models of the Mark IIA and III Series) or the 43554 Template Rail Assembly (supplied with early models of the Mark IV, V and VI Series), refer to figures 2-12 through 2-14 in the preliminary set-up procedures. Be careful to install the template rail parallel to the lathe bed.

2-26. INSTALLING "UNIVERSAL" TEMPLATE RAIL ASSEMBLY (with current Mark IIA thru VI Series). To install the Universal Template Rail Assembly, refer to figure 2-21 for the various installation configurations. When determining the configuration to use, keep in mind that the top of the template rail must be 1 inch below the bottom of the spindle on the tracer valve. To install the template rail assembly, follow the procedures described in figure 2-22.



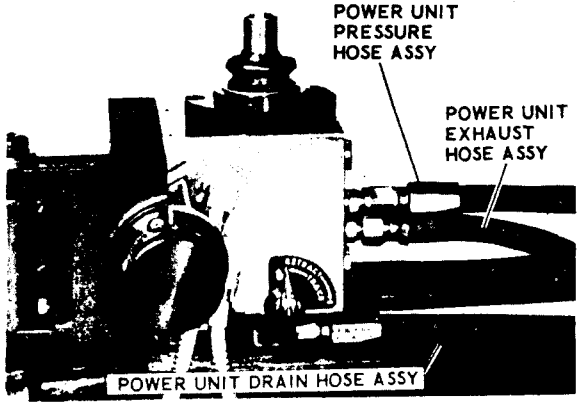
STEP I If the Lathe Tracer Attachment has not been ordered for the specific lathe on which it is to be installed, perform the preliminary set-up instructions described in figure 2-4. Remove the lathe compound assembly and install the tracer slide assembly on the lathe carriage cross slide. Position the tracer slide assembly approximately at the desired operating angle and tighten the nuts on the T-bolts securely.

Figure 2-17. Installation Procedures for Mark "O" or "O-A" Series Tracer Slide Assembly (Sheet 1 of 2)

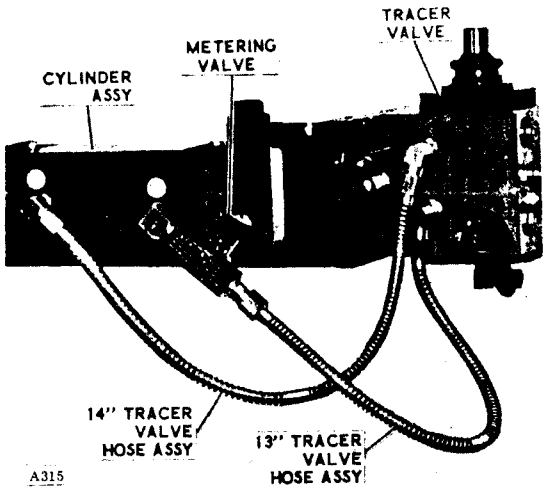


STEP 2 Loosen the valve adjusting slide pivot bolt (or bolts).

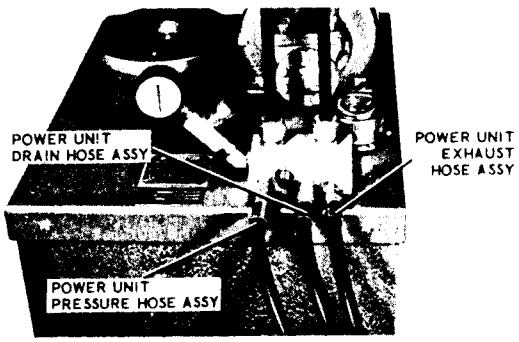
NOTE: The Mark "O" and early models of the Mark "O-A" Series are equipped with a single pivot bolt as shown in step 3. Current models of the Mark "O-A" Series are equipped with two pivot bolts as shown in this illustration.



STEP 3 Remove the plastic caps from the hydraulic fittings on the tracer valve. Connect the power unit hydraulic pressure hose assembly to the P fitting. Connect the hydraulic exhaust hose assembly to the X fitting and connect the hydraulic drain hose assembly to the drain fitting on the bottom of the tracer valve.

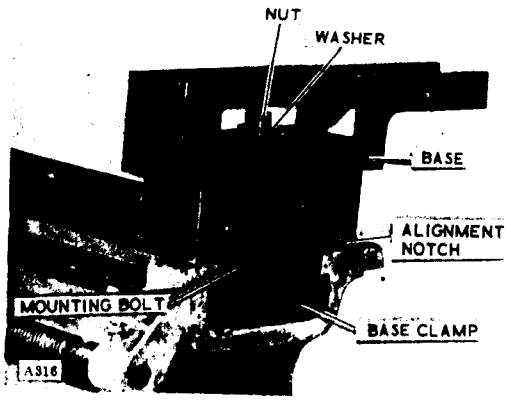


STEP 4 Connect the 14-inch hydraulic hose assembly between fitting C1 on the tracer valve and fitting C1 on the cylinder assembly. For the Mark "O" Series, connect the second 14-inch hose assembly between fitting C2 on the tracer valve and fitting C2 on the cylinder assembly. For the Mark "O-A" Series, connect the 13-inch hydraulic hose assembly between fitting C2 on the tracer valve and the metering valve at fitting C2 on the cylinder assembly.



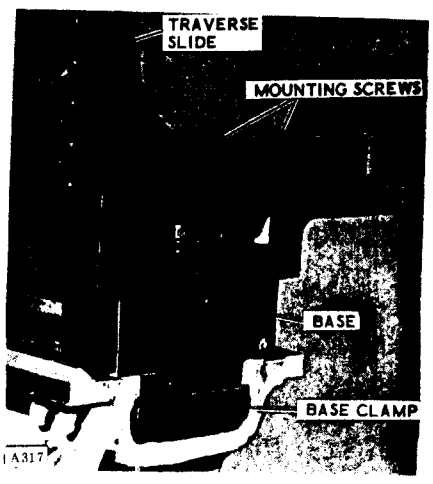
STEP 5 Prepare the hydraulic power unit for operation as described in paragraph 2-31 Position the hydraulic power unit at the right-hand end of the lathe, or behind the lathe. The unit must be located within approximately 5 feet of the tracer valve. Remove the plastic caps from the hose fittings. Connect the hydraulic pressure hose assembly to the P fitting on the hydraulic power unit. Connect the hydraulic exhaust hose assembly to the X fitting and the hydraulic drain hose assembly to the D fitting on the hydraulic power unit.

Figure 2-17. Installation Procedures for Mark "O" of "O-A" Series Tracer Slide Assembly (Sheet 2 of 2)

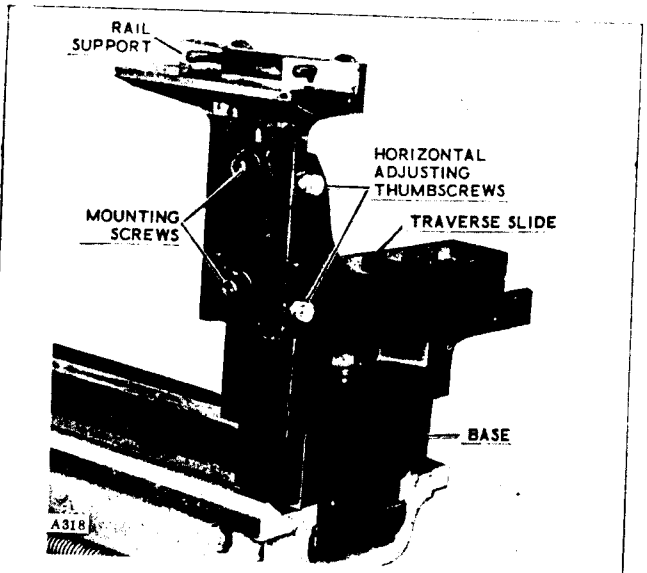


STEP 1 If the template rail assembly was not purchased for the specific lathe on which it is to be installed, perform the preliminary set-up procedures described in paragraph 2-9. Install the tracer slide assembly as described in figure 2-17. Insert the mounting bolt through the template rail base clamp and position the base clamp between the lathe ways as shown above. Place the template rail base over the mounting bolt and seat the alignment notch over the rear way. Move the base to the point on the lathe way that is approximately in line with the tracer valve spindle and install the washer and nut on the mounting bolt.

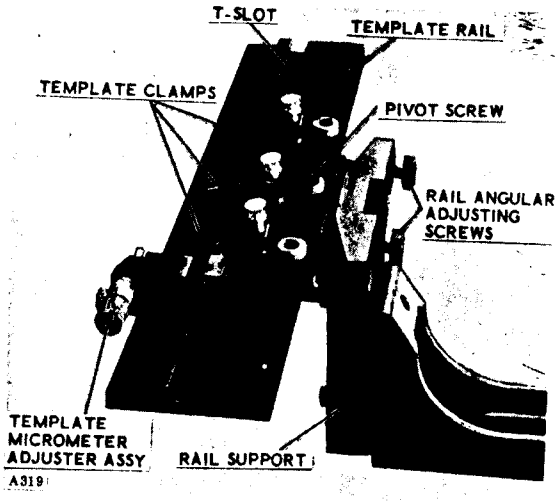
NOTE: Throughout this figure, the template rail is shown installed on the end of the lathe only to show the relationship of the parts.



STEP 2 Slide the traverse slide into the channel on the top of the base and secure it with the two mounting screws and washers.

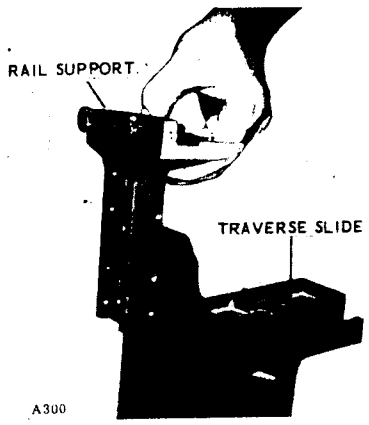


STEP 3 Slide the rail support down onto the face of the traverse slide. Secure the rail support with the two mounting screws and washers.



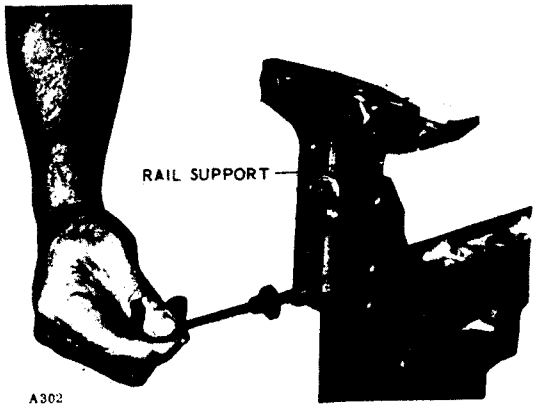
STEP 4 Install the template rail on the top of the rail support and secure it with the pivot screw. Align the template rail parallel to the lathe way using the rail angular adjusting screws. Align the template rail horizontal to the lathe way using the two thumbscrews on the side of the rail support. Make final adjustments as described in paragraph 2-28. Slide the template micrometer adjuster assembly into the T-slot on the template rail and secure it with the clamp screw. Slide the three template clamps into the T-slot on the template rail.

Figure 2-18. Installing =40685 Template Rail Assembly. (Mark "O-A" Series — Turning Operations)

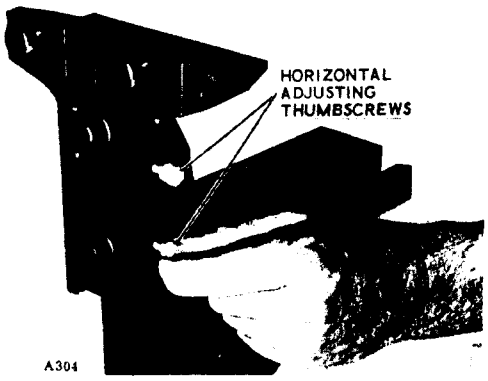


NOTE: For most facing operations, the tracer attachment is operated at a much sharper angle than for turning operations (see par. 3-24). To compensate for the change in operating angle, the Mark "O-A" template rail is installed with the template rail facing towards the lathe.

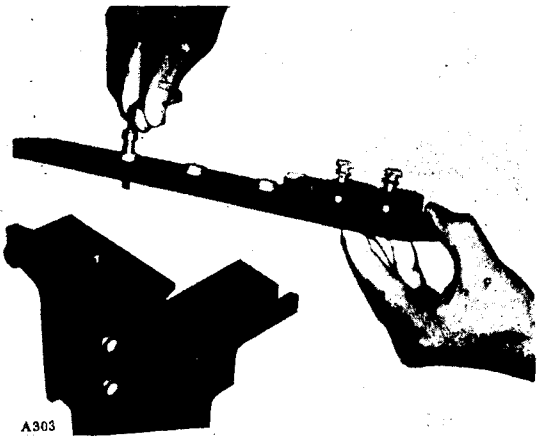
STEP 1 Install the base and traverse slide as described in steps 1 and 2, figure 2-18. Slide the rail support down onto the face of the traverse slide with the rail angular adjusting screws facing away from the lathe.



STEP 2 Secure the rail support with the two mounting screws and washers.

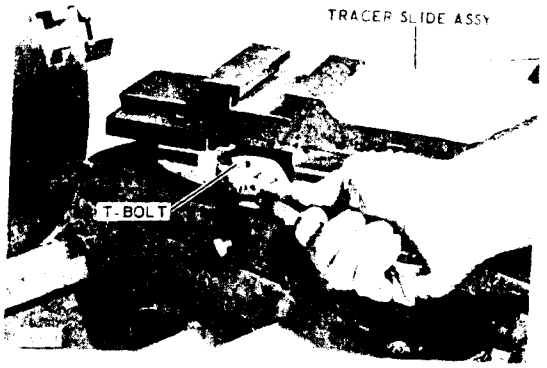


STEP 3 Remove the two horizontal adjusting thumbscrews from the left-hand side of the rail support and screw them into the holes on the right-hand side of the rail support.

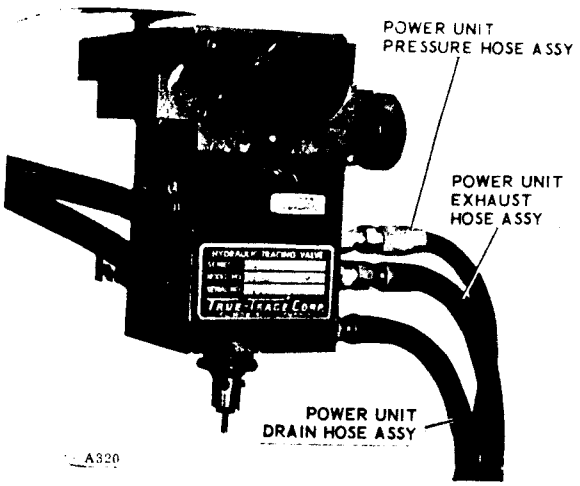


STEP 4 Attach the template rail to the top of the rail support using the pivot screw. If the tracer attachment is being used for both contour and facing operations, the template rail assembly is usually installed in a position on the lathe suitable for contour operation. When the template rail assembly is rearranged for facing operations, the template rail may be repositioned by moving the centering screw to one of the other mounting holes in the template rail as shown in this photograph. Make final adjustments to the template rail position as described in paragraph 2-28.

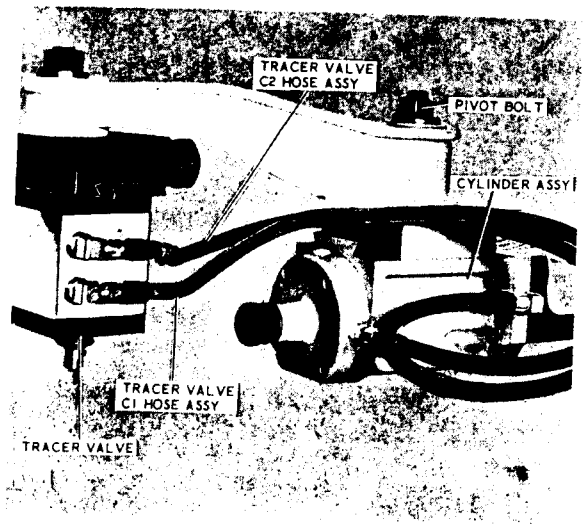
Figure 2-19. Installing =40685 Template Rail Assembly. (Mark "O-A" Series — Facing Operations)



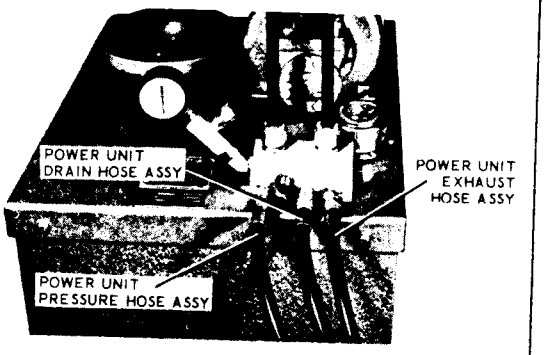
STEP 1 If the Lathe Tracer Attachment was not purchased for the specific lathe on which it is to be installed, perform the preliminary set-up procedures described in figure 2-10. Remove the lathe compound assembly and install the tracer slide assembly on the lathe carriage cross slide. Position the tracer slide assembly approximately at the desired operating angle and tighten the nuts on the T-bolts securely.



STEP 3 Remove the plastic caps from the hydraulic fittings on the tracer valve. Connect the power unit hydraulic pressure hose assembly to the P fitting on the tracer valve. Connect the hydraulic exhaust hose assembly to the X fitting, and the drain hose assembly to the D fitting on the tracer valve.



STEP 2 Loosen the nut on the pivot bolt. Connect the shortest tracer valve hydraulic hose assembly between fitting C2 on the tracer valve and fitting C2 on the cylinder assembly. Connect the second tracer valve hydraulic hose assembly between fitting C1 on the tracer valve and fitting C1 on the cylinder assembly.



STEP 4 Prepare the hydraulic power unit for operation as described in paragraph 2-31. Position the hydraulic power unit at the right-hand end of the lathe, or behind the lathe. The unit must be within 5 feet of the tracer valve for the Mark IIA and III Series, and within 9 feet of the tracer valve for the Mark IV, V, and VI Series. Remove the plastic caps from the hose fittings. Connect the power unit hydraulic pressure hose assembly to the P fitting on the hydraulic power unit. Connect the hydraulic exhaust hose assembly to the X fitting, and the hydraulic vacuum hose assembly to the D (or V) fitting on the hydraulic power unit.

Figure 2-20. Installation Procedures for Mark IIA, III, IV, V, or VI Series Tracer Slide Assembly

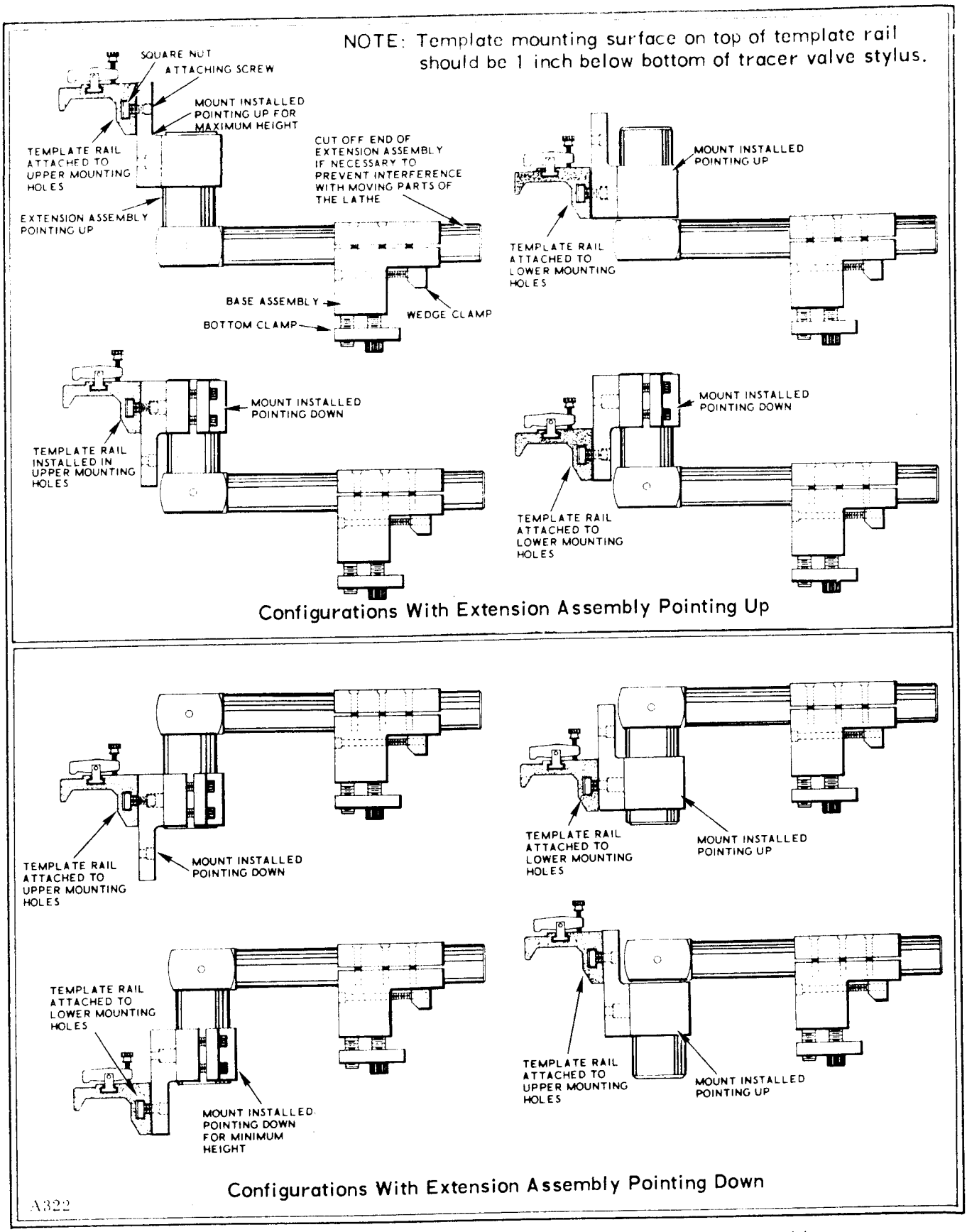
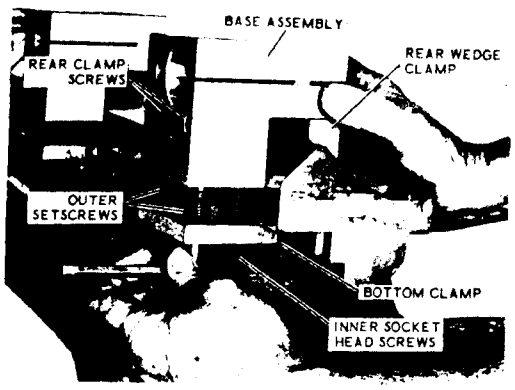
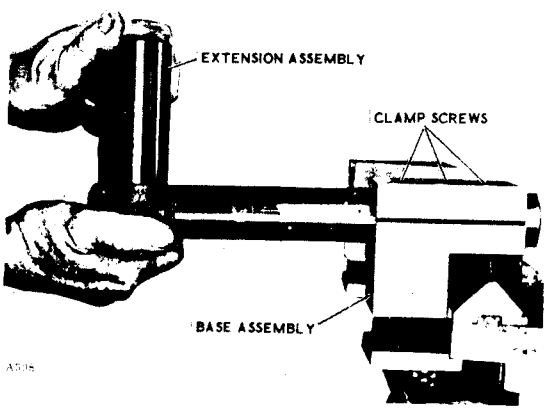


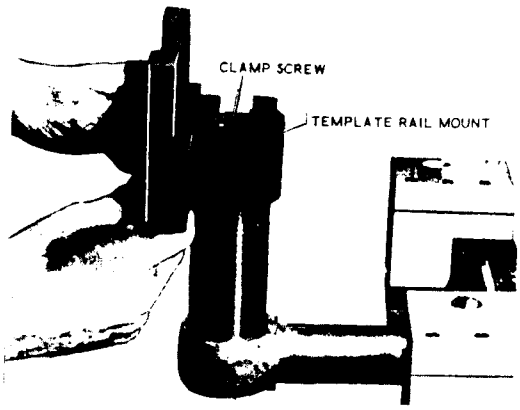
Figure 2-21. Installation Configurations for Universal Template Rail Assembly. (Used with current Mark IIA thru VI Series)



STEP 1 Install the tracer slide assembly as described in figure 2-20. Position the two base assemblies on the lathe way approximately 18 inches apart. The base assemblies may be positioned so that they support the template rail from one end as shown in detail A, figure 1-10, or to support the template rail near the center as shown in detail B, figure 1-10. Secure each base assembly to the lathe way using the combination of the rear wedge clamp and the bottom clamp. The rear wedge clamp is adjusted by tightening the three socket head screws in the front of the base assembly. The bottom clamp is tightened first using the two socket head screws, then secured by tightening the two outer setscrews.

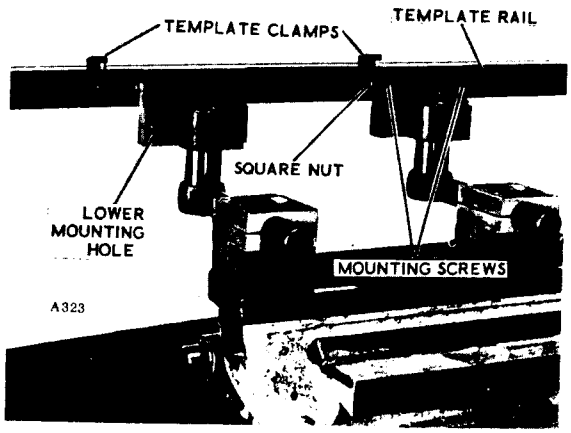


STEP 2 Slide an extension assembly into each base assembly. Position the extension assemblies equal distances from the base assemblies. Secure each extension assembly by tightening the three socket head screws in the top of the base assembly.



NOTE: To determine the height at which the template rail mounts should be installed, keep in mind that the template mounting surface on the top of the template rail must be 1 inch below the bottom of the tracer valve spindle.

STEP 3 Slide a template rail mount onto each extension assembly. Position the two template rail mounts at the same height and secure each mount by tightening the two socket head clamp screws.



STEP 4 Insert two socket head screws through the upper or lower pair of template rail mounting holes in each template rail mount. Screw a square nut onto the threads of each screw. Slide the rear of the template rail over the square nuts so that the square nuts slide in the rear T-slot of the template rail. Slide the template rail to the desired position and tighten the four mounting screws. Slide the template clamps into the T-slot in the top of the template rail. Check that the template rail is perfectly parallel to the lathe bed. Make final adjustments to the template rail position as described in paragraph 2-29.

Figure 2-22. Installation Procedures for Universal Template Rail Assembly. (Used with current Mark IIA thru VI Series)

2-27. INSTALLING FACING TEMPLATE RAIL. To install the facing template rail on the Universal Template Rail Assembly, refer to figure 2-23 and proceed as follows:

NOTE: The following instructions assume that the turning template rail has been adjusted to the proper operating height of **1 inch below** the tracer valve spindle. (Refer to paragraph 3-24.)

a. Loosen the socket head setscrew in the base assembly.

b. Insert the facing template rail mount into the hole in the top of the base assembly. Push down on the rail until the mount bottoms in the base assembly. Check the height of the facing template rail with respect to the turning template rail. The facing template rail must be exactly the same height as the turning template rail.

c. If the facing template rail is higher than the turning template rail, determine the difference and cut that amount PLUS 1/8 inch off the end of the mount. The additional 1/8 inch is necessary to allow for slight adjustments in height.

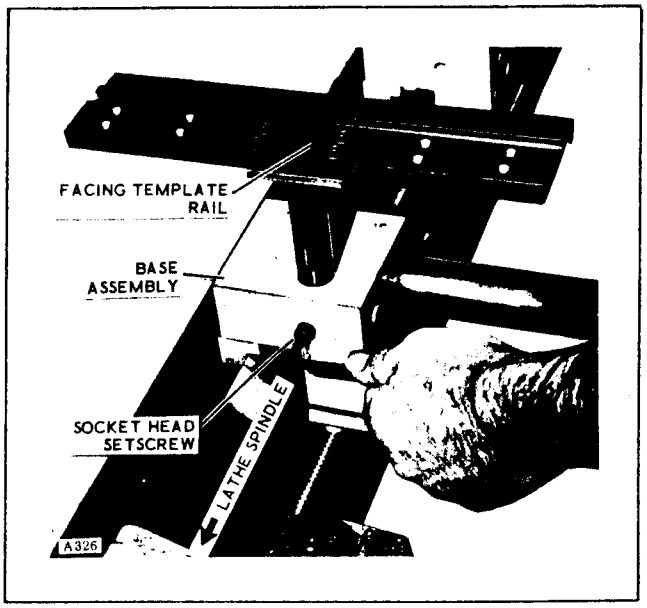


Figure 2-23. Installing Model 3058 Facing Template Rail on Universal Template Rail Assembly. (Mark IIA thru VI Series)

d. Install the facing template in the base assembly at a 90 degree angle to the lathe bed. The rail should be facing AWAY from the lathe spindle. Secure the facing template rail in the base assembly by tightening the socket head setscrew securely as shown in figure 2-23.

e. The facing template rail may be repositioned on its mount as required. Figure 2-24 shows the template rail installed for a typical facing operation.

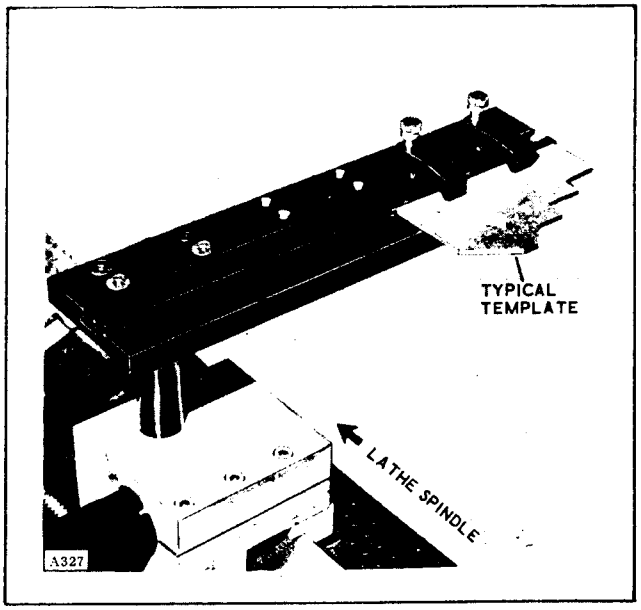
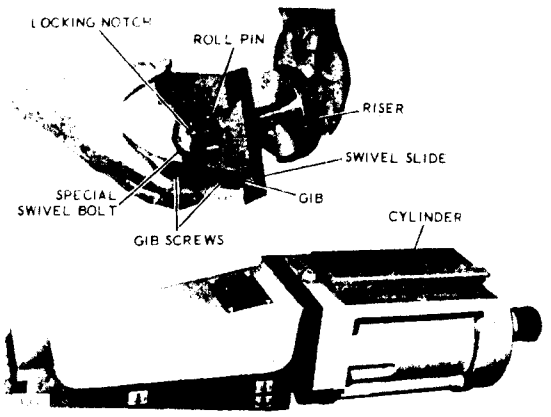


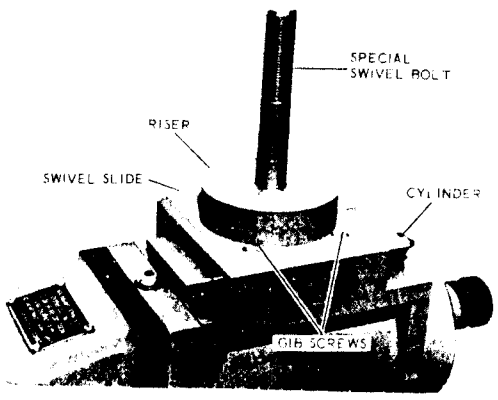
Figure 2-24. Facing Template Rail Positioned for a Typical Facing Operation (Typical Template Installed)

NOTE: On some lathes the facing template rail for the Mark IIA Series cannot be installed at the same level as the turning template rail. When the Mark IIA or III Series is installed on these lathes, it is necessary to insert a riser between the top slide and swivel arm when the facing template rail is used. For these installations, the facing template rail mount should be cut short enough to allow the base of the mount to rest on the top of the base assembly. Install the riser as described in figure 2-25. (The riser and special long bolt are supplied as part of Model 3058-01 Facing Template Rail Assembly for the Mark IIA and III Series.)

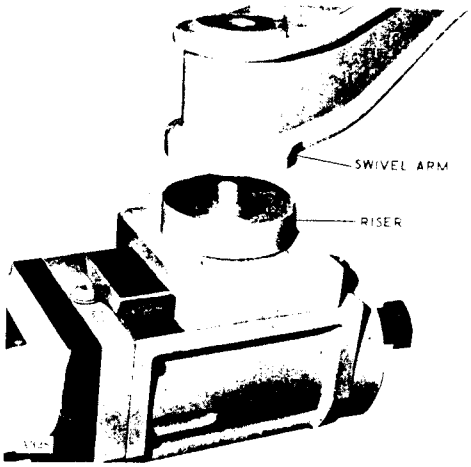


NOTE: When a Mark IIA, or III Series is to be used for facing operations, the swivel arm must be raised approximately 1 inch by installing a riser between the swivel arm and the swivel slide. To compensate for the additional height, a 1 inch longer swivel bolt must also be installed. This bolt and riser are supplied as part of the Facing Template Rail kit for Mark IIA and III Series.

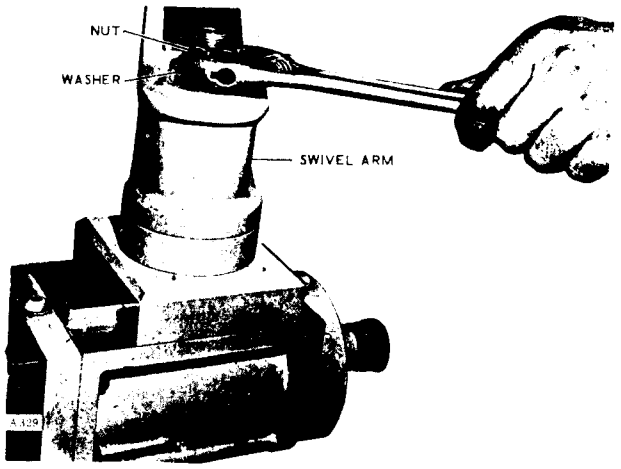
STEP 1 Remove the swivel arm from the swivel slide by removing the attaching nut and washer. Loosen the two gib screws in the swivel slide and remove the swivel slide from the top of the cylinder. Remove the swivel bolt. Insert the special swivel bolt through the swivel slide. Be very careful to lock the bolt head by seating the roll pin the mounting hole into the notch in the bolt head.



STEP 2 Reinstall the swivel slide on the top of the cylinder. Position the swivel at the desired position and tighten the two gib screws securely.



STEP 3 Place the swivel arm over the end of the swivel bolt.



STEP 4 Attach the swivel arm to the swivel bolt using the nut and washer removed in step 1 above.

Figure 2-25. Installing Riser on Mark IIA and III when using Model 3058 Facing Template Rail.

2-28. ALIGNMENT OF TEMPLATE RAILS

NOTE: Before aligning the template rail, install the hydraulic power unit as described in paragraph 2-31. Final positioning of the template rail is dependent upon the type of cutting operations to be performed (see Section III).

2-29. TURNING TEMPLATE RAIL. After the Lathe Tracer Attachment has been installed, the template rail assembly must be aligned with respect to the lathe bed and the tracer slide assembly to insure accurate tracing operations.

a. LEVEL ADJUSTMENT. Level the template rail with respect to the lathe ways. This can be done by making measurements from each end of the template rail to a given level point on the lathe bed or by indicating the template rail. To indicate the template rail, proceed as follows:

(1) Attach a dial indicator to the tracer valve as shown in figure 2-26.

(2) Turn on the hydraulic power unit and center the travel limit indicators on the top and bottom slide assembly.

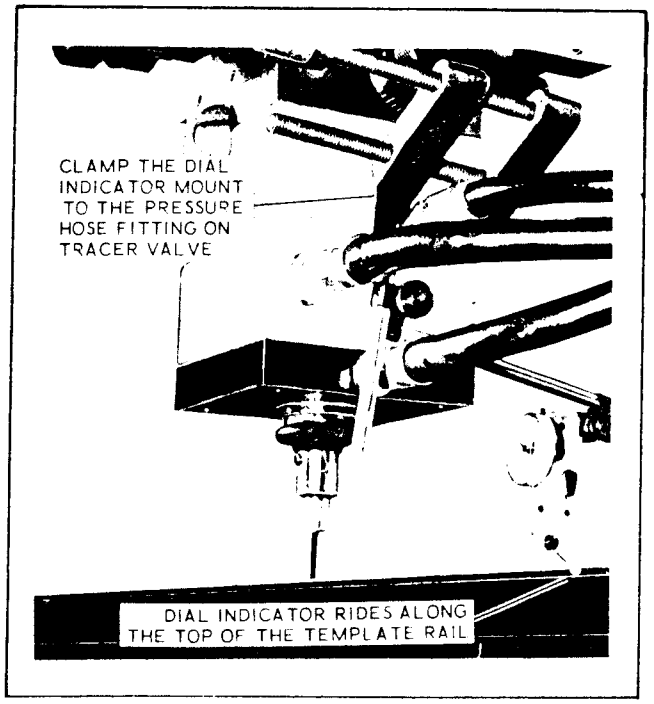


Figure 2-26. Dial Indicator Attached to Tracer Valve for Indicating Template Rail

(3) Position the indicator on the top surface of the template rail near the tailstock end. Place the TRACE-RETRACT knob on the tracer valve in the TRACE position and traverse the lathe carriage at least 12 inches along the template rail while observing the dial indicator. If the dial indicator deflects in either direction, make the proper adjustment to the template rail position and repeat the test until the template rail is level.

b. PARALLEL ADJUSTMENT. The parallel adjustment of the template rail is very critical. The template rail may be aligned on the axial parallel plane using a dial indicator attached to the tracer valve as described in subparagraph a above with the tip of the stylus riding slightly against the shoulder on the top of the template rail. Another method of aligning the template rail on the axial parallel plane is as follows:

(1) Turn on the hydraulic power unit and center the travel limit indicators on the top and bottom slide assembly.

(2) Place a dial indicator on the lathe carriage with the tip of the dial riding on the edge of the cutting tool holder as shown in figure 2-27.

(3) Insert a test stylus (3/8 inch dowell) in the tracer valve spindle.

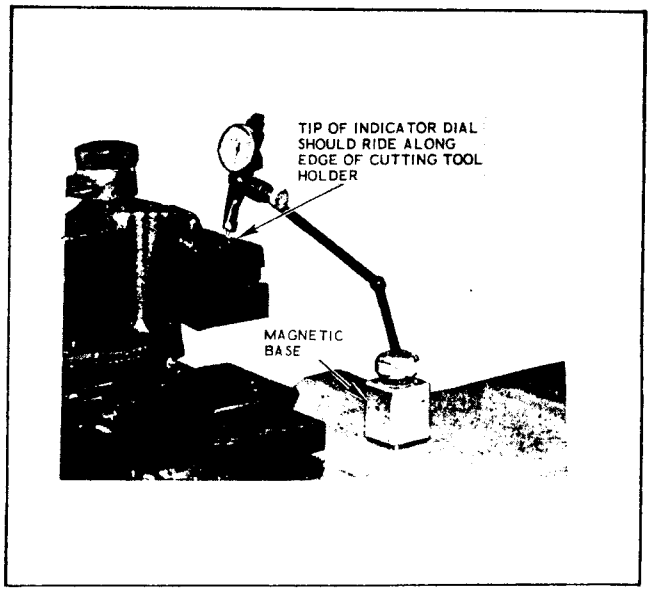


Figure 2-27. Indicator Dial Installed on Lathe for Checking Template Rail Alignment

(4) Move the tracer valve to a point near the tailstock end of the template rail, with the stylus riding slightly against the shoulder on the top of the template rail as shown in figure 2-28.

(5) Place the TRACE-RETRACT knob on the tracer valve in the TRACE position and traverse the lathe carriage at least 12 inches along the template rail while observing the dial indicator. If the dial indicator deflects in either direction, make the proper adjustment to the template rail position and repeat the test until the template rail is parallel to the lathe bed.

NOTE: The facing template rail may be aligned in a manner similar to the procedure described in paragraph 2-29 except traverse with the lathe carriage cross slide.

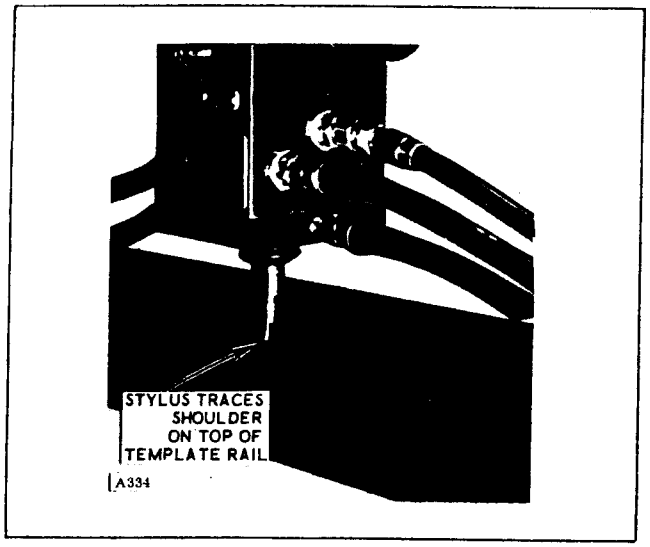


Figure 2-28. Tracing Shoulder on Top of Template Rail to Check Alignment

2-30. ALIGNMENT OF THE ROUND TEMPLATE HOLDER (Optional Equipment). Make a 1/2 to 1-inch diameter test rod 12 to 15 inches long. Center drill holes in each end of the rod. Be sure the rod is perfectly round and has a smooth, polished surface. Install the rod between the two template spindles of the round template holder. Tighten the spindles firmly against the ends of the rod and secure each spindle by tightening the two knurled screws. Follow the procedure described in paragraph 2-29b with the tracer stylus tracing along the rod. (See figure 2-29.) The round template holders are not adjustable. Adjustments must be made by adjusting the template rail on which the round template holder is installed.

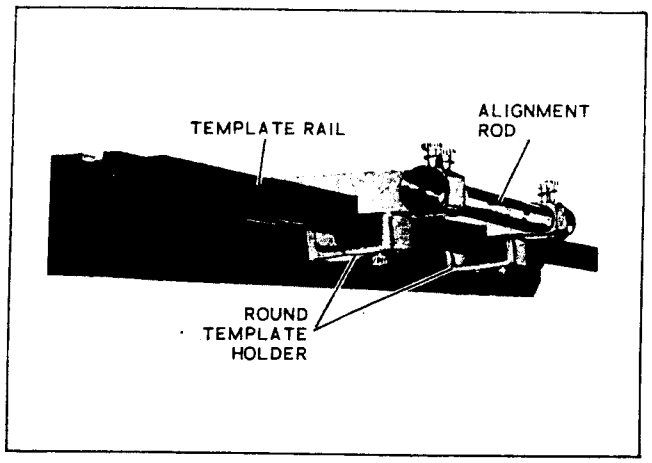


Figure 2-29. Alignment Rod Installed in Round Template Holder (Bottom View)

2-31. INSTALLING HYDRAULIC POWER UNIT

CAUTION: Use extreme care when making hydraulic connections and when filling the reservoir to prevent dirt, grease, shavings, and other foreign matter from entering any of the lines, hoses or fittings. Most failures in hydraulic systems can be traced to dirt in the system.

2-32. HYDRAULIC OIL RESERVOIR. Before filling the hydraulic oil reservoir, inspect the interior of the reservoir for evidence of dust or dirt. If dust or dirt is present, clean the reservoir thoroughly before filling with hydraulic oil. To gain access to the inside of the reservoir, remove the six screws that attach the motor mounting plate to the top cover and lift the hydraulic power supply straight up out of the reservoir. (Refer to the exploded views, figures 5-12 and 5-13.)

a. Removing the breather cap will provide access to the fill hole. Be sure to thoroughly clean the breather cap before remove and before replacement.

b. Use 15 gallons of hydraulic oil.

IMPORTANT

True-Trace recommends MOBIL OIL CO. Velocite "S" hydraulic oil for operation of the Lathe Tracer Attachments. NEVER operate the hydraulic power unit with less than 15 gallons of oil in the reservoir.

2-33. ELECTRICAL CONNECTIONS. The hydraulic power units with 115/230V ac, single phase, pump motors are shipped from the factory wired for 115V ac operation. If it is desired to operate the power unit from 230V ac, single phase power, change the motor wiring connections as shown on the instruction plate on the motor housing.

a. Hydraulic power units with 220/440V ac, 3-phase, pump motors (Serial Numbers 0 through 544) are shipped from the factory wired for 220V ac operation. If it is desired to operate these power units from a 440V ac, 3-phase, power source, change the motor wiring connections as shown on the instruction plate on the motor housing.

b. Hydraulic power units with 220/440V ac, 3-phase, pump motors (Serial Numbers 545 and subsequent) are not wired at the factory and are supplied without on-off switches or power cords. Make wiring connections as shown on the instruction plate on the motor housing.

2-34. INITIAL STARTING PROCEDURE. The hydraulic power unit has been factory adjusted for the pressure shown in the table in paragraph 1-21. The power unit should never be adjusted above the maximum pressures shown in paragraph 1-21.

a. Install the tracer slide assembly and make the hydraulic hose connections specified in figure 2-17 or 2-20.

b. Perform the installation procedures described in paragraphs 2-32 and 2-33.

CAUTION: When first applying electrical power to the hydraulic power unit, apply the power only momentarily and check the electric motor for proper rotation. As shown in figure 2-30, the fan should rotate in a counterclockwise direction as viewed from the fan end of the electric motor.

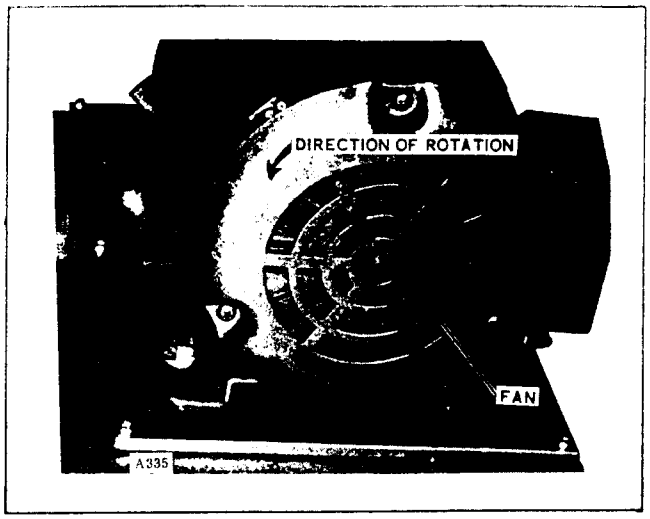


Figure 2-30. Direction of Rotation of the Hydraulic Power Unit Motor

c. Apply electrical power to the hydraulic power unit and run the tracer slide assembly through one cycle. This will completely purge and fill the hydraulic system. Recheck the hydraulic oil level in the sight gauge. Add hydraulic oil, if necessary, to bring the reservoir level up to its specified level of 15 gallons.

NOTE: In some cases, it may be necessary to prime the hydraulic pump. To prime the pump, disconnect the pressure hose from the tracer valve. Insert the end of the pressure hose through the breather hole down into the hydraulic oil in the reservoir. BE SURE TO KEEP A FIRM GRIP ON THE HOSE and operate the hydraulic power unit until the oil starts to flow.

d. Bleed the system of any air as follows:

(1) Open both bleeders on the cylinder approximately ONE turn (see figure 3-11 or 3-12).

(2) Operate the tracer slide in both directions until there are no air bubbles at either of the bleeders (approximately 6 strokes). Be sure the cylinder bottoms on each stroke.

(3) Tighten the bleeders securely after bleeding the system.

section III
operation

3-1. PRINCIPLES OF OPERATION

3-2. During operation of the Lathe Tracer Attachment, the hydraulic power unit supplies hydraulic pressure continuously to the tracer valve. The tracer valve is a precision hydraulic flow control valve which is operated by the combination of the template being traced and the movement of the lathe carriage.

a. A stylus inserted in the tracer valve spindle contacts the outer surface of the template. As the lathe carriage moves, it pulls the stylus along the surface of the template. The stylus controls the movement of a spool in the tracer valve (see figure 3-1). This spool functions as a valve gate. When the spool is in its raised position, hydraulic pressure is applied to port C2 of the cylinder. When the spool is in its lowered position, hydraulic pressure is applied to port C1 of the cylinder. When the spool is in its null position, hydraulic pressure is locked in a static condition between the valve and cylinder.

b. The piston rod in the cylinder is held in a fixed position since it is attached to the bottom slide and the bottom slide, in turn, is attached to the lathe carriage cross slide. The top slide and the cylinder body move as a unit. Therefore, when hydraulic pressure is applied to port C2 of the cylinder, the top slide moves in a direction away from the work (retracts). When hydraulic pressure is applied to port C1, the top slide moves in towards the work.

c. The tracer valve RETRACT knob is attached to a cam which raises the spool when the knob is set to RETRACT and thus causes the top slide to retract to its full travel. When the knob is set to TRACE, pressure against the stylus controls the action of the spool.

3-3. The volume of output from the hydraulic power unit is controlled by a combination of the volume output of the hydraulic pump and the action of a pressure relief valve. As long as the pressure at the pressure outlet remains lower than the setting of the pressure relief valve, the total output of the pump will pass through the pressure outlet to the tracer valve. As the pressure increases, the pressure relief valve will bypass any volume of oil required to prevent the pressure from building up beyond the adjusted limits. When no oil is flowing to the associated equipment (null condition), the full output from the pump will pass through the pressure relief valve and return to the hydraulic reservoir.

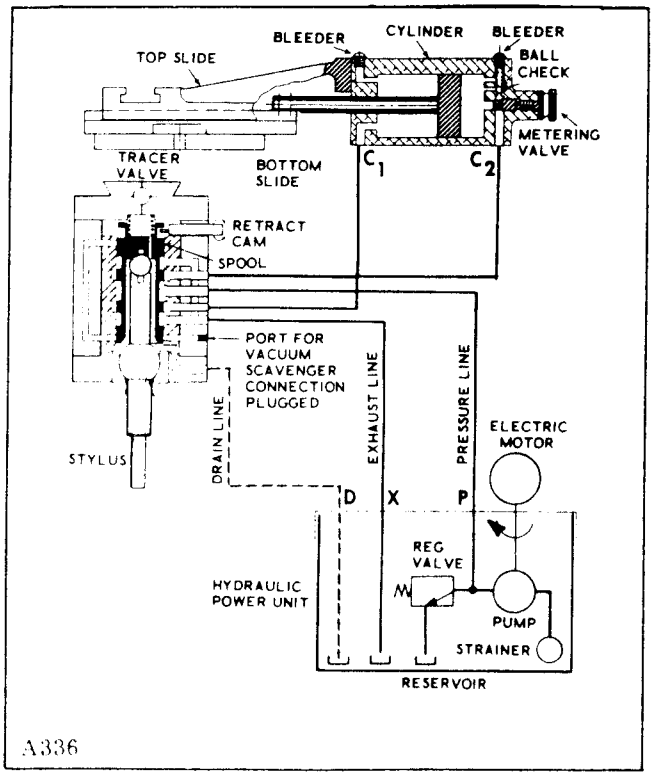


Figure 3-1. Hydraulic Schematic Diagram

3-4. TRACER TERMINOLOGY (GLOSSARY)

3-5. **DEFLECTION.** The common description in most dictionaries for the word deflection is: to cause to swerve, or bend from a course. In tracing work the term "deflection" has reference to the movement of the tracer spindle. The movement of the spindle is brought about by the contact of the stylus against a template, causing the spindle to deflect.

a. This movement is transferred by use of pivots, ball cams, levers, slides or other mechanical means to effect an axial movement of a spool inside the hydraulic tracer valve. The axial movement of a spool opens and closes the ports of the tracer valve leading to the hydraulic actuators (i.e. cylinders or hydraulic motors). Since the ratio of the spindle deflection to the spool movement is normally 1 to 1, it can be seen that if the spindle is moved .001 inch the spool will move in an axial direction an equal amount, or .001 inch. The fact that the movement of the spindle is directly transposed into axial movement of the spool, has led to the use of the term "deflection" in reference to spool travel. Therefore, when a spool is said to have a deflection of 0.004 below null, reference is being made to the drop below the null position.

b. There are tracers where this ratio is not 1 to 1 and therefore, this figure should not be used as being common to all tracers. The tracer valves used with the Mark Series described in this manual have a ratio of deflection of the stylus of 5 to an axial movement of the spool of 2. For example, if the stylus moves .0005 inch, the spool will move only approximately .0002 inch.

3-6. **NULL POSITION.** There is one position where the spool is located that will close all passageways to all hydraulic actuators, and all hydraulic flow will be balanced. This position of the tracer spool is referred to as the "null" position.

a. For the tracer valves used with the Mark Series, the rate control adjusting screw is set at the factory at a point where the spool will be approximately .004 inch below null. Therefore, when the stylus contacts the template, the spindle is deflected by an amount which will correspond to a spool movement of .004 inch and thereby stop the travel of the tracer in the direction of the template.

b. From this point, if the spool is moved still further (in the same direction away from the nose) the valve will start to open the other port leading to the opposite end of a two-way cylinder or to the reversing side of a hydraulic motor.

3-7. **SPOOL MOVEMENT.** Spool movement can be as little as .0001 inch on the spool (.00025 stylus deflection), to open the hydraulic flow to a hydraulic actuator and start the movement of a slide. It can be seen that from the null position, the spool movement required to effect a cross over of the hydraulic circuit can be as little as .0001 movement either side of null, or a total movement of .0002. The total amount of movement used in a particular tracing operation will depend upon the feed rate at which the tracing will be done. The faster the feed rate the greater the movement required of the tracer valve spool, so as to permit a greater opening of the passageways in the tracer valve to the hydraulic actuators.

3-8. **COMPENSATING FOR DEFLECTION.** In all tracing applications there should be some compensation for the deflection required of the tracing valve for it to operate. In the Mark Series Tracer Valves, where a reversal of movement is obtained with as little as .0002 inch of travel, this compensation can in many cases be ignored. That is to say, the stylus tip can be made the same size as the cutting tool tip, when the tracing application is at a nominal feed rate and tolerances for the part are not too critical. There should always be a radius on the stylus as described in paragraph 3-11 g.

a. It should be noted, however, that when feed rate is increased, requiring greater deflection of the stylus, the relationship of the stylus tip to the cutting tool tip will be affected by the amount of deflection of the spindle required to achieve the greater feed rate desired.

3-9. OPERATING CONSIDERATIONS

3-10. The lathe tracer attachment has been designed to perform tracing operations efficiently and accurately. It is simple to operate providing the operator adheres to certain basic principles. Before attempting to operate the equipment, the operator should consider the following:

a. PROPER INSTALLATION. The lathe tracer attachment should be installed as described in Section II. Before installing the template rail assembly, refer to the applicable paragraph in this section for the type of cutting operation to be performed (turning, facing, boring, etc.).

b. BLEEDING AIR FROM SYSTEM. Always bleed air from the system as described in paragraph 2-34d any time a hydraulic hose has been disconnected and reconnected to either the hydraulic power unit, cylinder, or tracer valve. As a good GENERAL RULE, bleed the air from the system any time the lathe tracer attachment has not been operated for a period longer than two or three days.

c. CORRECT STYLUS DESIGN. The design of the stylus used in the tracer valve is very important for accurate cutting operations. Design of the stylus is dependent upon the design of the cutting tool used with the lathe tracer attachment. Refer to paragraph 3-11 for a description of stylus design.

d. CORRECT TEMPLATE DESIGN. Templates may be constructed of any hard material within the limitations described in paragraph 3-14. The smallest included angle on the template cannot be less than 30 degrees as described in paragraph 3-16.

e. CORRECT OPERATING ANGLE. Operating angle of the tracer slide must be determined with respect to the smallest included angle of the template and the angle of the cutting tool tip as described in paragraph 3-16.

f. MAXIMUM AVAILABLE STROKE WITH RESPECT TO THE SLIDE OPERATING ANGLE. The maximum available stroke of the tracer slide is affected by the angle at which the tracer slide is operated as described in paragraph 3-18.

g. CORRECT FEED RATE. The lathe carriage feed rate should be at least one-fifth of the forward speed (seeking speed) of the tracer slide (5 to 1 ratio) as described in paragraph 3-31.

3-11. STYLUS DESIGN

NOTE: The information contained in paragraphs 3-12 through 3-14 is based on the assumption that the items specified in paragraph 3-9 have been taken into consideration.

3-12. DETERMINING TRACER VALVE DEFLECTION FACTOR. To determine the tracer valve deflection factor, proceed as follows:

a. Insert a 3/8 inch dowell pin, 1-3/4 inches long, in the tracer valve spindle.

b. Attach a dial indicator to the tracer valve as shown in figure 3-2 with the tip of the dial indicator resting against the dowel pin.

c. Turn on the hydraulic power unit. Place the RETRACT-TRACE knob on the tracer valve in the RETRACT position. Allow the tracer slide to retract then close the metering valve on the cylinder.

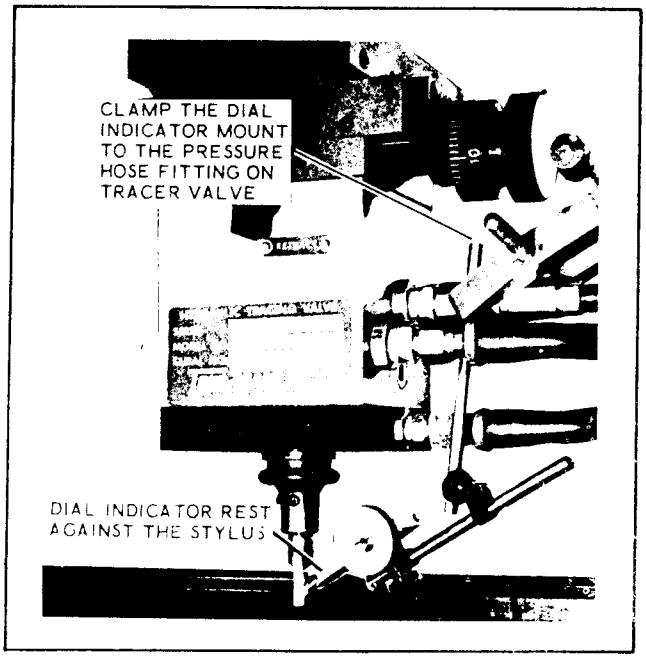


Figure 3-2. Method of Attaching Dial Indicator to Tracing Valve for Checking Spindle Deflection

d. Install a template or piece of flat stock on the template rail. Swing the swivel arm to the point where the stylus (dowell pin) is approximately 1/2 inch from the edge of the template.

e. Position the tracer valve at 90 degrees to the lathe ways. Zero the dial indicator. Place the RETRACT-TRACE knob on the tracer valve in the TRACE position.

f. Open the metering valve on the cylinder and let the stylus (dowell pin) contact the template. When the stylus comes to a stop, the dial indicator will show the amount of movement necessary to stop the cylinder. This is the DEFLECTION FACTOR. The faster the slide movement forward, the more opening there is between the spool and the sleeve in the tracer valve. Therefore, the deflection factor will vary depending upon the below null adjustment of the tracer valve (see paragraph 3-31.)

g. For example: Assume that the dial indicator reading was .005. This deflection factor of .005 inch is the amount that must be compensated for by making the radius of the stylus .005 inch larger than the radius of the cutting tool as described in paragraph 3-13.

3-13. STYLUS CONFIGURATION. The stylus may be a chisel point type or round type as shown in figure 3-3 depending upon the radius of the cutting tool.

a. Determine the deflection factor as described in paragraph 3-12. If the tip of the cutting tool has no radius at all, the stylus must still have a radius equal to the deflection factor to maintain true translation between the template and the work piece.

b. When a chisel point type stylus is used the chisel point must be ground at the same angle as the tip of the cutting tool. Figure 3-4 shows a typical condition for determining the radius of the stylus with respect to the radius of the cutting tool. The radius for a round type stylus would be determined in a similar manner.

c. Figure 3-5 describes a simple procedure for making a chisel point type stylus.

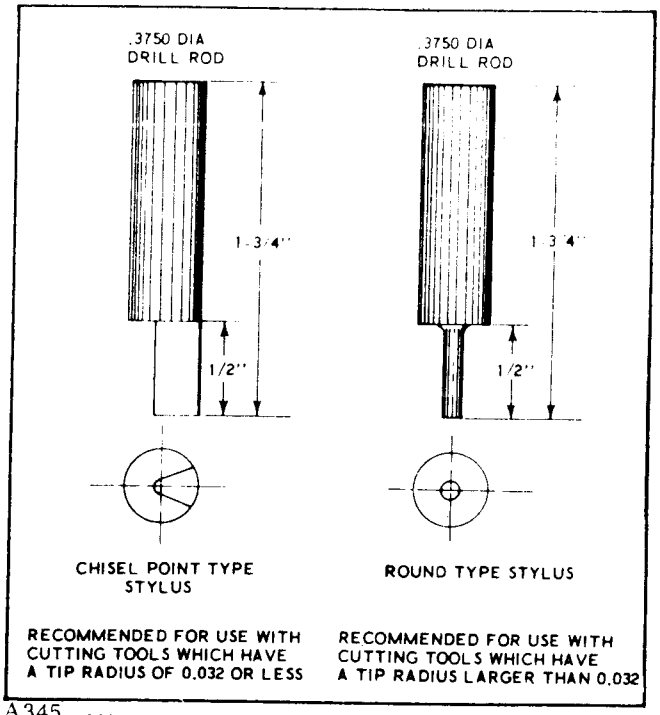


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Figure 3-3. Stylus Configurations

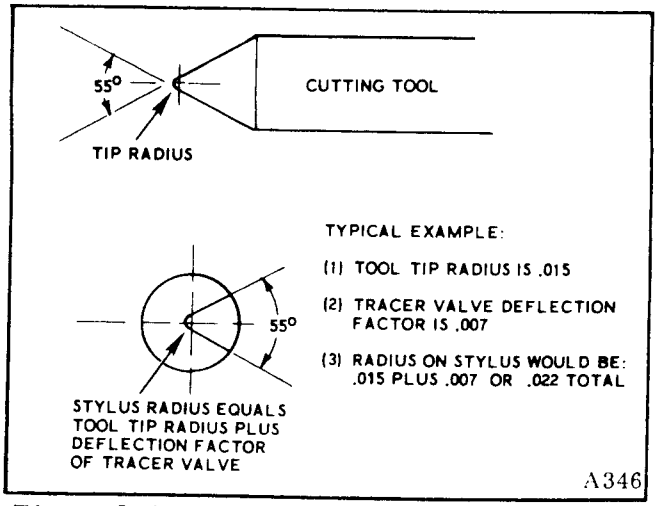

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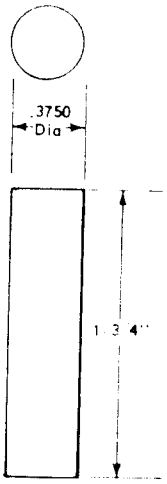
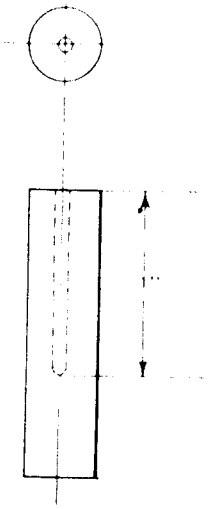
Figure 3-4. Determining Radius of Stylus with Respect to Radius of Cutting Tool Tip

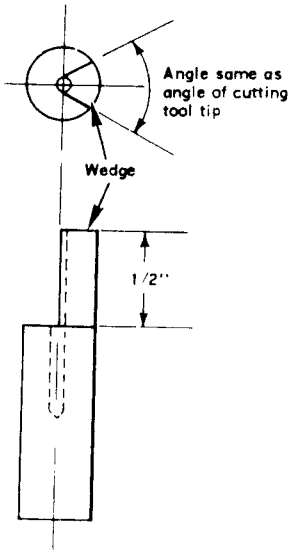
NOTE: It is good shop practice to cut a trial work piece to check the stylus to cutting tool relation. There may be conditions where the work piece may be either under or oversize compared to the template. This is not uncommon and can be readily corrected in most cases. Here are some of the common reasons for these conditions:



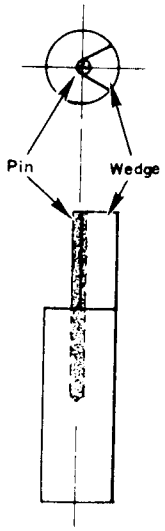
STEP 1 Cut a length of 0.3750 in. diameter drill rod 1-3/4 inches long.



STEP 2 Determine the proper radius of the stylus as described in figure 3-4. Center drill a hole of the same radius as the stylus, 1 inch deep, in one end of the drill rod.



STEP 3 Grind a 1/2-inch long wedge on the drilled end of the rod. The wedge should have the same angle as the cutting tool tip (usually 55 degrees).



STEP 4 Insert a pin of the proper radius into the hole in the rod. Bottom the pin in the hole and trim the end flush with the end of the wedge.

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Figure 3-5. Simplified Procedure for Making a Chisel Point Type Stylus

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c. The radius of the stylus may be slightly too small or too large as compared with the cutting tool.

b. The configuration of the stylus in the tracing area may not be the same as that of the cutting tool. In the cutting area, this is an important factor.

c. The cutting tool may not be following the stylus due to loose linkage. This loose linkage may be anywhere; in the tracer attachment (such as loose gib screws or improperly adjusted gibs), in the lathe carriage, cutting tool holder, etc. There cannot be any uncompensated for lost motion, even in the lathe cross slide lead screw since when direction is changed by bringing the lathe cross slide in and out manually in loading and unloading work, the OD dimension may change without the operator being aware of it.

3-14. TEMPLATE DESIGN

3-15. Templates are generally made from flat steel. Templates may also be made from other materials, such as aluminum or plastic. Figure 3-6 shows a typical template installed on the template rail. Note the following requirements:

a. The rear edge of the template must be perfectly square with the front (tracing) surface and parallel to the centerline of the part. During installation, the rear edge of the template must be seated firmly against the shoulder on the template rail.

b. The minimum width of the template cannot be less than 7/8 inch so that all areas of the tracing edge will extend beyond the edge of the template rail.

c. The tracing edge of the template must be perfectly square and free of all nicks and burrs. (Any nicks or uneven surfaces on the tracing edge of the template will be duplicated on the work piece.)

d. It is recommended that the template have a 1-inch lead in area and a 1-inch lead out area.

e. The configuration of the template must be such that the smallest included angle or angles is not less than 30 degrees as described in paragraph 3-16.

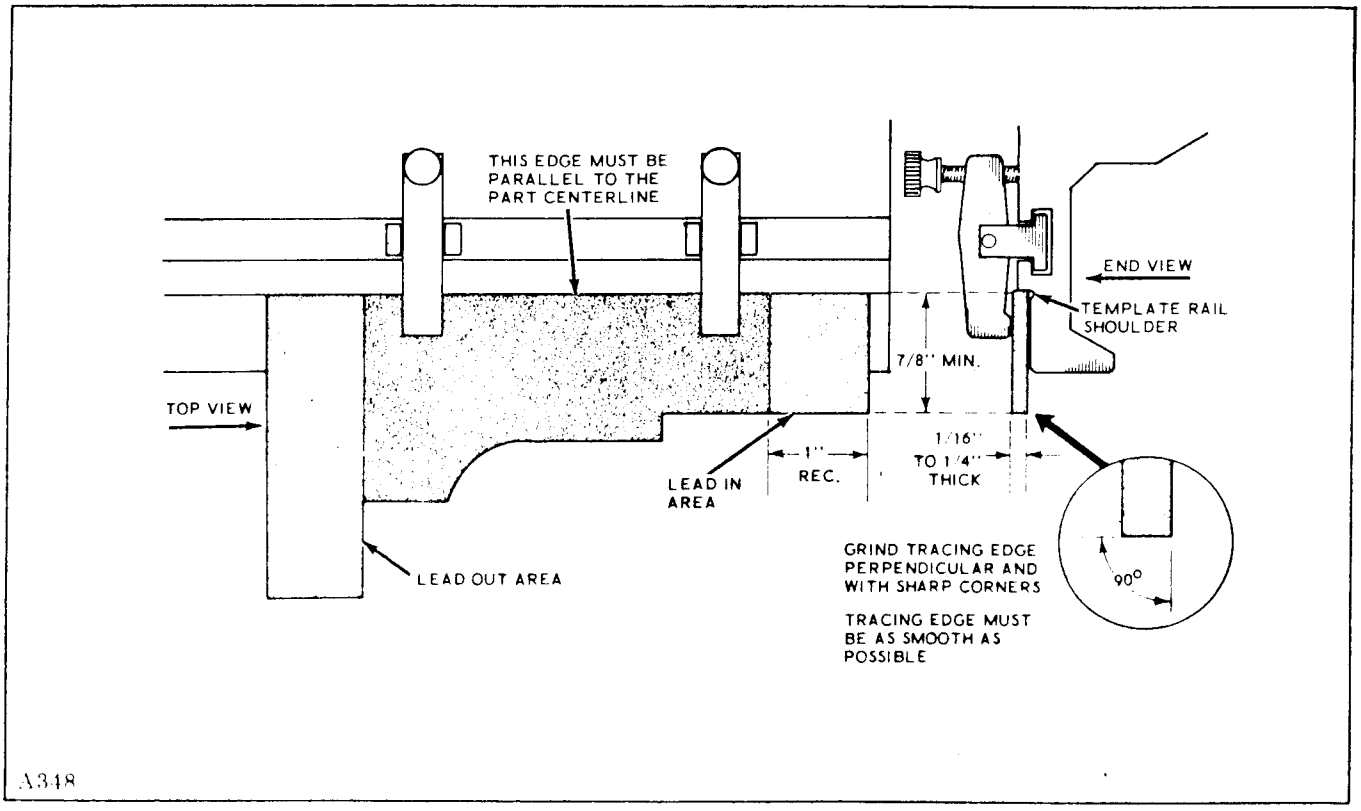


Figure 3-6. Typical Template Design

3-16. DETERMINING CORRECT OPERATING ANGLE

3-17. GENERAL. In tracer attachment operation, the cutting tool and tracer stylus are directly related in that the stylus must seek the template at the same angle that the cutting tool seeks the work piece. Since the cutting tool is attached to the tracer slide, the angle of the cutting tool is established by positioning the tracer slide on the lathe carriage cross slide. If a chisel point type stylus is used, the stylus is turned in the tracer valve spindle at the same angle as the tracer slide.

a. The correct operating angle is dependent upon the smallest included angle on the template. The configuration of the template must be such that the smallest included angle is not less than 30 degrees as shown in figure 3-7. The tracer slide must be positioned at an angle which bisects the smallest angle in the template as shown in figure 3-7.

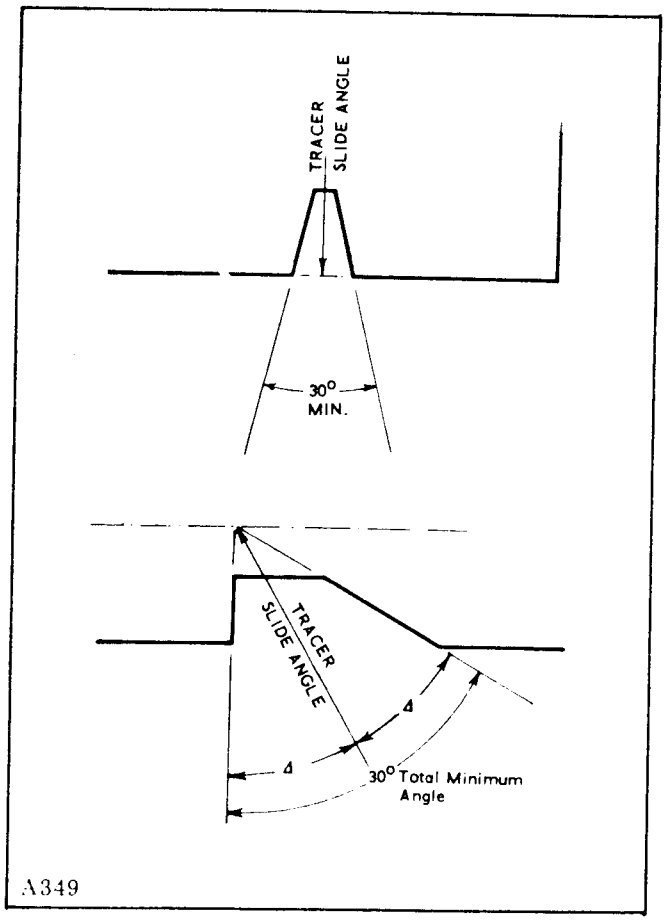


Figure 3-7. Determining Smallest Included Angle on the Template

b. Figure 3-8 shows the established angles for a typical work piece.

c. Figure 3-9 shows a variety of contour configurations and the cutting tool angle at critical positions along each contour.

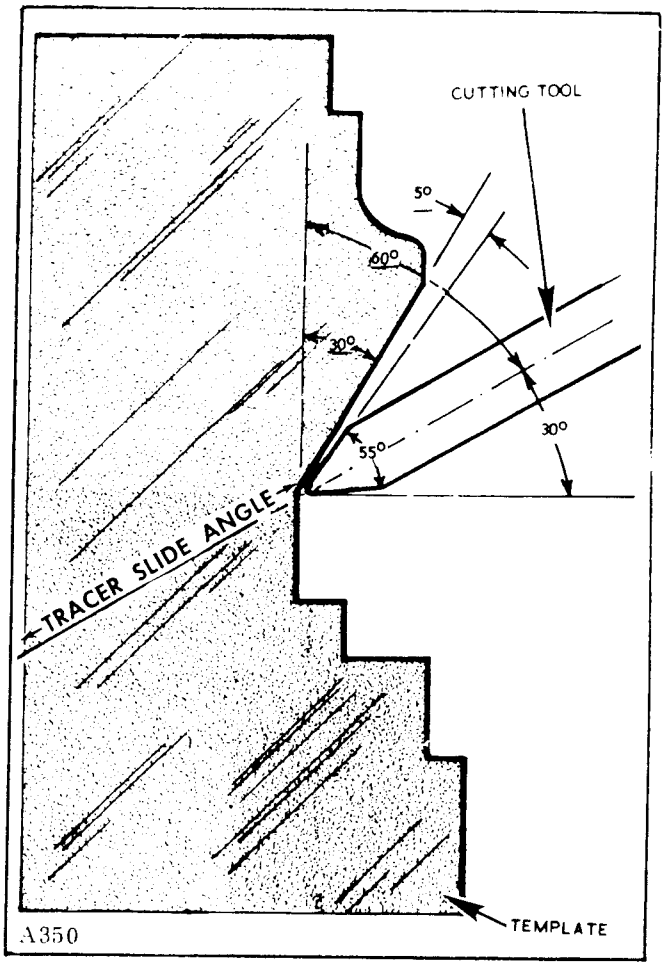


Figure 3-8. Positioning Cutting Tool and Tracer Slide Angle with Respect to the Smallest Included Angle of Template

3-18. OPERATING ANGLE VERSUS MAXIMUM STROKE OF TRACER SLIDE

3-19. For turning operations, the lathe tracer attachment can operate at its maximum stroke when the tracer slide is positioned at 90 degrees to the lathe ways. This position is referred to as the ZERO degrees position. As the tracer slide is angled towards the lathe tail stock, the maximum stroke available for turning operations becomes less as shown in figure 3-10. For facing and boring opera-

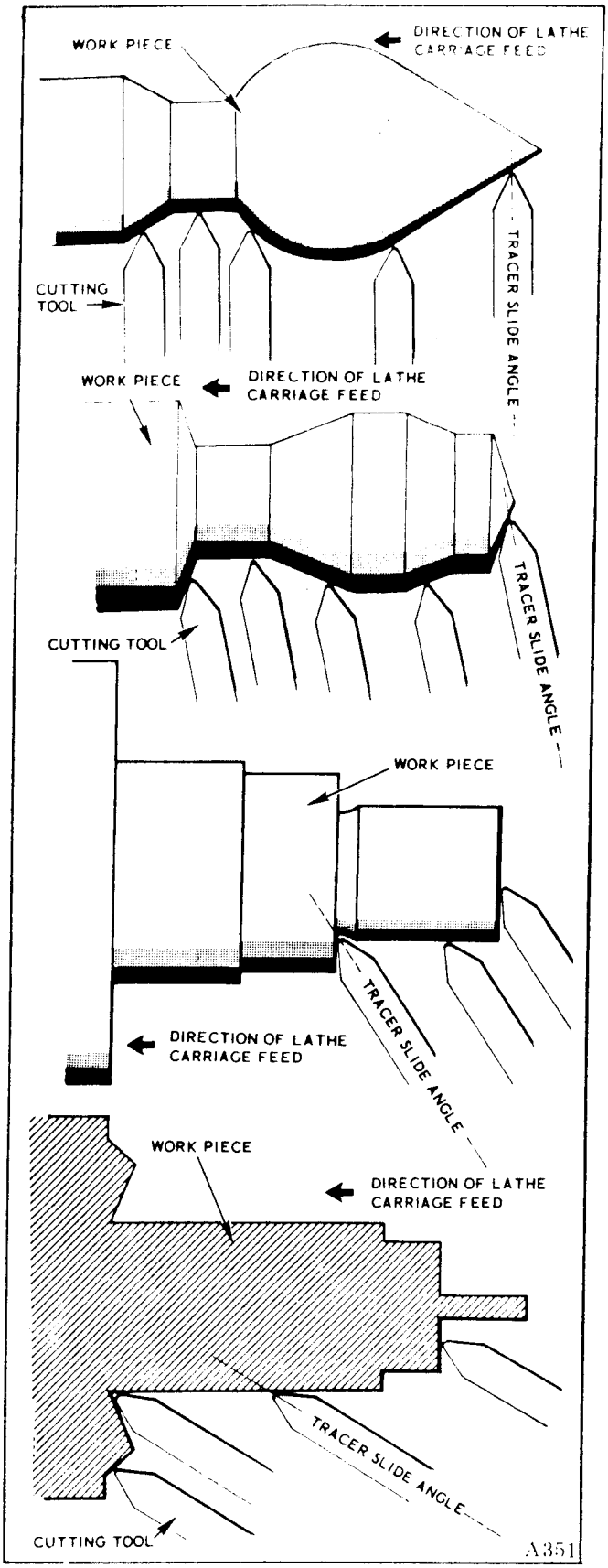
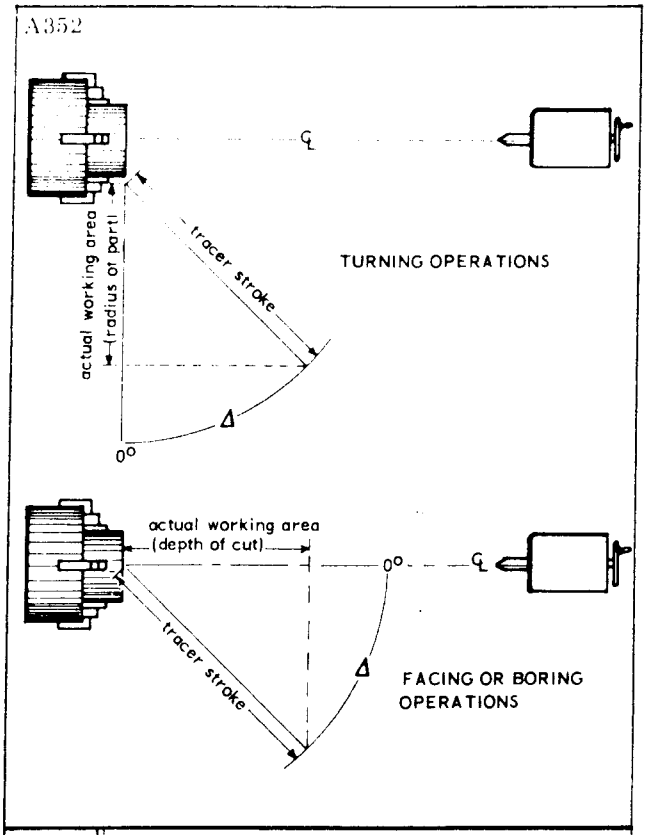


Figure 3-9. Relation of Tracer Slide Angle to Various Types of Contours (Cutting tool is shown at critical points along each contour)

tions, the lathe tracer attachment can operate at its maximum stroke when the tracer slide is positioned parallel to the lathe ways. Referring to the parallel position for facing or boring operations as the ZERO position, the table contained in figure 3-10 can also be used to determine the maximum stroke available at various slide angles.



Oper. Angle Deg.	Actual Working Area - depth of cut (inches)					
	"O" "O-A"	IIA	III	IV	V	VI
0	3.00	4.00	5.00	6.00	8.00	10.00
5	2.98	3.98	4.98	5.97	7.96	9.96
10	2.95	3.93	4.92	5.90	7.87	9.84
15	2.87	3.86	4.82	5.79	7.72	9.65
20	2.81	3.75	4.69	5.63	7.51	9.39
25	2.72	3.62	4.53	5.43	7.25	9.06
30	2.60	3.46	4.33	5.19	6.92	8.66
35	2.46	3.27	4.09	4.91	6.55	8.19
40	2.30	3.06	3.83	4.59	6.12	7.66
45	2.12	2.83	3.54	4.24	5.66	7.07
50	1.93	2.57	3.21	3.85	5.14	6.42
55	1.72	2.29	2.87	3.44	4.58	5.73
60	1.50	2.00	2.50	3.00	4.00	5.00
65	1.27	1.69	2.11	2.53	3.38	4.22
70	1.03	1.37	1.71	2.05	2.74	3.42
75	.78	1.03	1.29	1.55	2.06	2.58

Figure 3-10. Operating Angle Versus Maximum Available Stroke of Tracer Slide

3-20. TURNING OPERATION

3-21. To perform a standard turning operation with the lathe tracer attachment, proceed as follows:

a. Install the lathe tracer attachment as described in Section II. Refer to figure 3-11 for a typical installation and the function of operating controls for the Mark IIA, III, IV, V and VI Series. Refer to figure 3-12 for a typical installation and the function of operating controls for the Mark "O" and "O-A" Series.

b. Select the correct slide angle for the configuration of the template (par. 3-16). Pay close attention to the required side clearance of the cutting tool throughout the entire cutting range.

NOTE: For most tracing operations, the cutting tool should be positioned at the same angle as the tracer slide. In some cases, however, it may be necessary to set the cutting tool at an angle to maintain adequate side clearance for the cutting tool. In extreme cases, it may be necessary to grind additional side clearance on the cutting tool.

c. Prepare a stylus as described in paragraph 3-11. Install the stylus in the tracer valve spindle.

d. Set the tracer slide at the correct angle and temporarily tighten the compound nuts. Turn on the hydraulic power unit. Position the cutting tool at the starting point of the work piece. As a SAFETY PRECAUTION, do not tighten the cutting tool in the holder at this time.

CAUTION: Be sure that the tracer slide assembly is positioned within the range of the cylinder travel with relation to the work piece with a minimum of 1/4 inch to spare.

e. If a chisel point type stylus is used, position the stylus at the same angle as the cutting tool. Tighten the setscrews in the spindle securely.

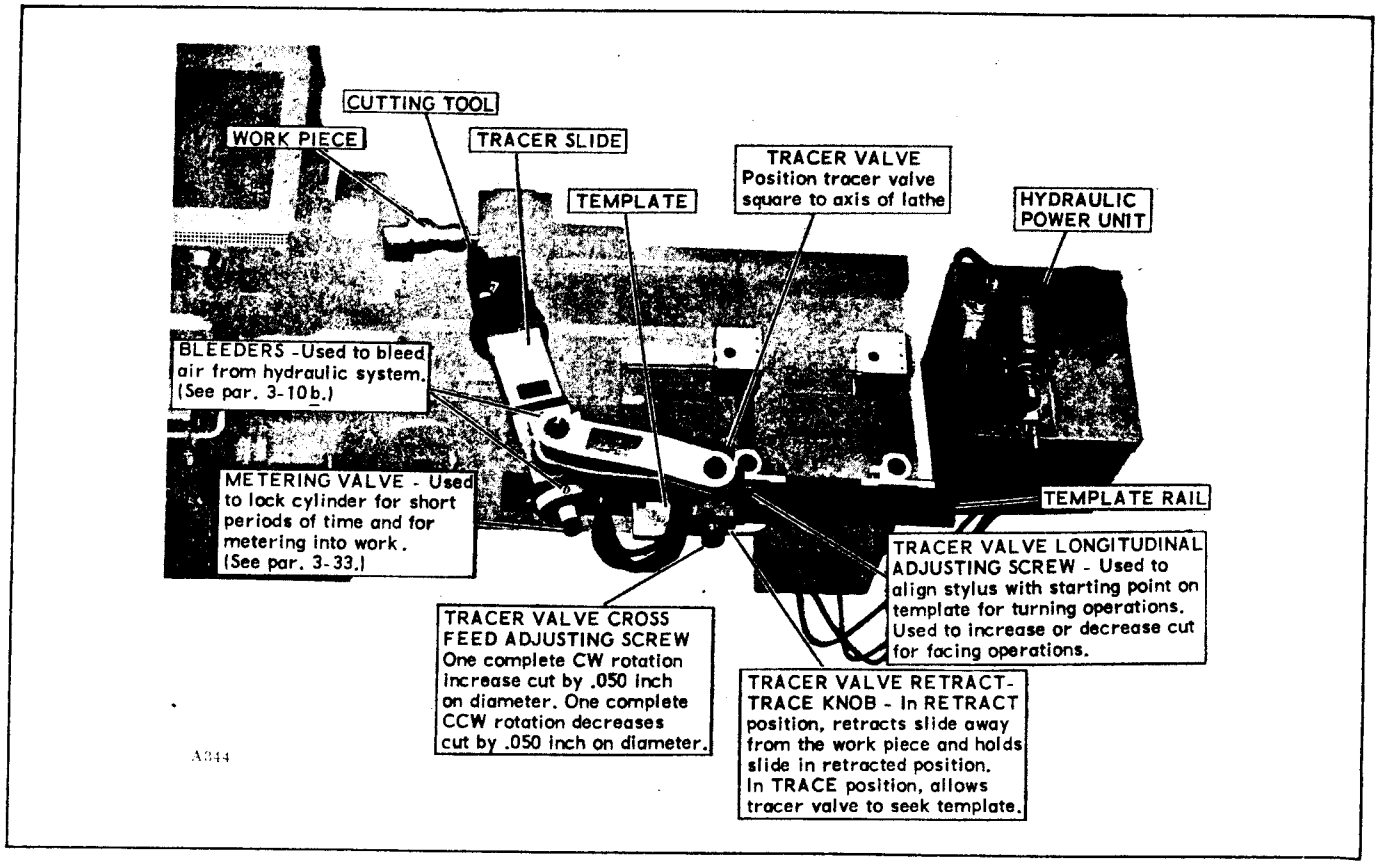


Figure 3-11. Typical Installation and Function of Operating Controls for Mark IIA, III, IV, V and VI Series

f. Swing the tracer valve near the edge of the template rail and check that there is 1 inch clearance between the bottom of the tracer valve spindle and the template mounting surface on the template rail. Align the template rail as described in paragraph 2-28.

g. Install the template on the template rail. Make sure the tracer valve slide assembly is positioned square to the axis of the lathe as shown in figures 3-11 and 3-12. Move the cutting tool to the starting point on the work piece, but NOT IN CONTACT with the work piece. Lock the tracer slide by closing the metering valve. Move the stylus near the edge of the template. Align the starting point on the template with the stylus and tighten the template clamps securely.

h. Align the stylus at the relative starting point on the template using the cross feed and longitudinal feed adjusting screws on the tracer valve slide (see figures 3-11 and 3-12). For the Mark "O" and "O-A" Series, adjust the stylus to the starting point on the template using the cross feed adjustment screw on the valve adjusting slide and the longitudinal adjuster on the template rail assembly.

i. Secure the compound nuts, swivel arm nut, and tool holder. Readjust the tracer stylus with respect to the starting point on the template if necessary.

NOTE: If the work piece has not been rough cut, refer to paragraph 3-22 before proceeding with step j below.

j. At this point, it is recommended that the operator make a "dry run" to make sure that all adjustments have been properly made. Turn the tracer valve cross feed and longitudinal adjusting screws allowing the attachment slide and tool to back off from the work piece approximately .050 inch. Open the metering valve approximately two full turns. Move the lathe carriage manually the entire length of the template paying close attention to the travel limit indicators on the tracer slide assembly to be sure that cylinder travel has not been exceeded. By watching the stylus at the template, this "dry run" also determines that adequate side clearance has been allowed for the stylus and cutting tool. Upon completion of the "dry run" tighten the cutting tool in its holder.

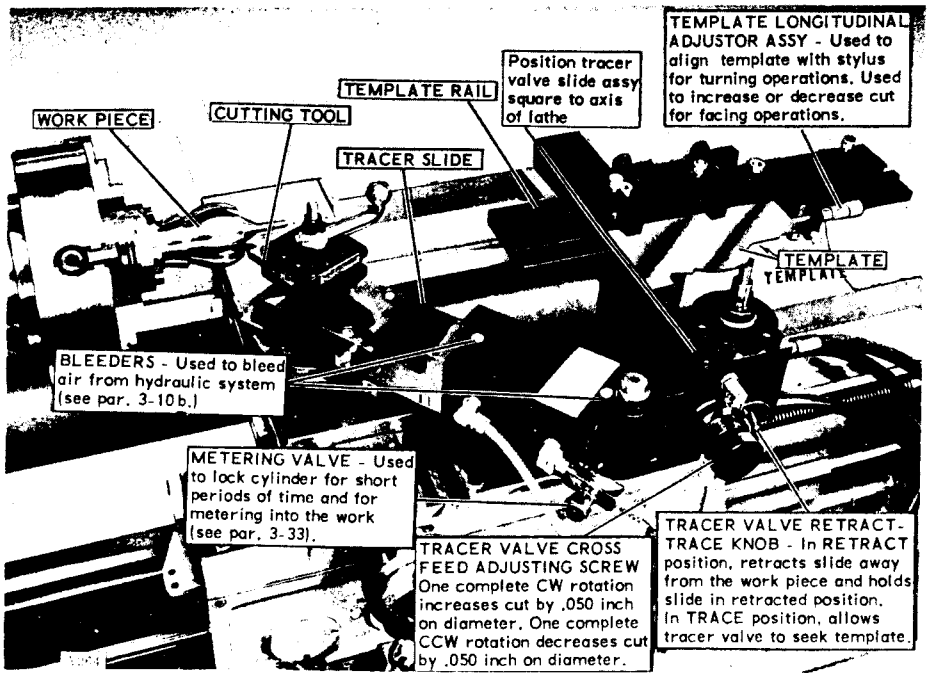


Figure 3-12. Typical Installation and Function of Controls for Mark "O" and "O-A" Series

k. It is recommended that the operator cut a trial work piece before making final cuts. If the work piece is under or oversize, refer to paragraphs 3-13 and 3-32.

l. Select the appropriate feed rate and speed for the part. (See paragraph 3-31.)

CAUTION: NEVER lean on any portion of the lathe tracer attachment during a cutting operation. Leaning on the attachment or bumping it during operation will cause an inaccuracy in the work piece. Be CAREFUL not to let the hydraulic hoses interfere with the operation of the tracer valve or slide. Make sure the hydraulic hoses from the hydraulic power unit are slack to prevent creating a drag or bind on the tracer valve.

3-22. CUTTING FROM BAR STOCK

3-23. When the work piece is to be cut from bar stock, it is generally faster to make a series of rough cuts before making the finish cut. Figure 3-13 shows a typical example of cutting from bar stock. The cutting operations would be as follows:

a. Perform steps a through i, paragraph 3-21.

b. Set the stylus at point A (fig. 3-13) near the template. Set the cutting tool at point A on the bar stock. (At this point the tracer slide should be in its extreme forward position with the cross slide compound of the lathe backed out enough to allow the tracer slide to be in its extreme forward position.)

c. Return the carriage to point B. Dial in the desired depth of cut using the lathe cross feed adjustment.

d. Energize the lathe carriage feed and make the first cut. (For the first cut, the tracer stylus will not be in contact with the template.

e. At the end of the first cut, return the carriage to starting point B on the template. Dial in the lathe cross feed adjustment again for the desired depth of cut. Engage the lathe carriage feed and make the second cut. When the stylus reaches point C on the template, it will contact the template and trace over the largest diameter area.

f. At the end of the second cut, close the metering valve and return the carriage to starting point B on the template. Dial in the lathe cross feed adjustment again for the desired depth of cut. Open the metering valve and engage the lathe carriage feed.

g. Proceed in this manner until all rough cuts have been completed.

h. Dial the tracer valve slide adjustment the desired amount for the finish cut and trace over the entire contour of the part.

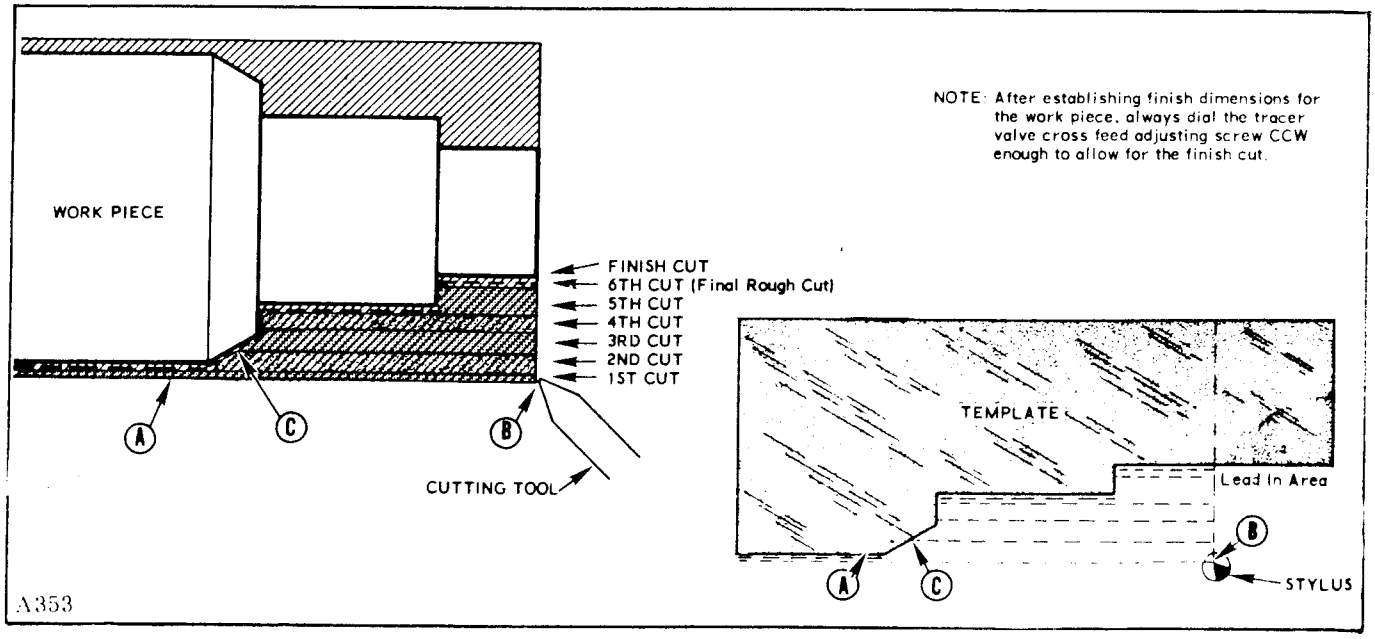


Figure 3-13. Typical Example of Cutting From Bar Stock

3-24. FACING OPERATION

3-25. GENERAL. To perform a standard facing operation with the lathe tracer attachment, proceed as follows:

a. Install the lathe tracer attachment as described in Section II. Figure 3-14 shows a typical installation for a facing operation using the facing template rail supplied as optional equipment with the Universal Template Rail Assembly.

b. Select the correct slide angle for the configuration of the template (par. 3-16). Pay close attention to the required side clearance of the cutting tool throughout the entire cutting range.

c. The Mark "O" and "O-A" template rail assemblies may be installed to accomodate any required tracer slide angle. Figure 3-15 shows a typical installation for a facing operation. In this installation, note that the the template rail assembly has been installed back of the lathe centerline with the template rail facing into the lathe. For other facing operations, the template rail assembly could be installed forward of the lathe centerline with the template rail facing into the lathe. The determining factor is always the required tracer slide angle.

NOTE: For some facing operations, it may be necessary to set the cutting tool at an angle to maintain adequate side clearance for the cutting tool. In extreme cases, it may be necessary to grind additional side clearance on the cutting tool.

d. The Mark IIA, III, IV, V and VI Series may be installed to accommodate any required tracer slide angle. Figure 3-16 shows alternate methods of installation for facing operations. Use of the facing template rail whenever possible is the preferred method.

e. After installing the template rail assembly, perform the facing operation as described in steps c through l, paragraph 3-21. In step j, make the "dry run" using the lathe carriage cross feed.

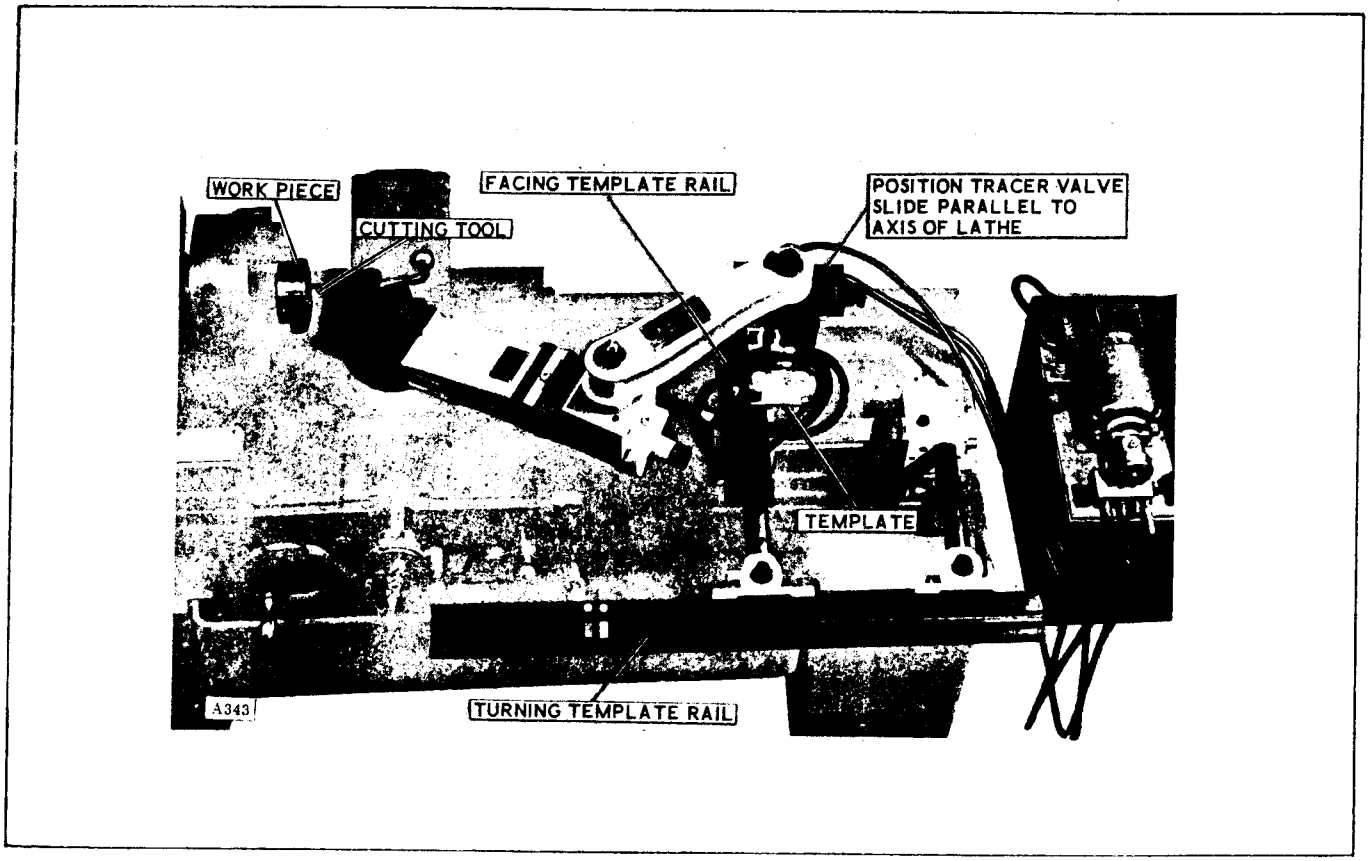


Figure 3-14. Typical Installation for a Facing Operation Using Facing Template Rail Supplied as Optional Equipment with Universal Template Rail Assembly

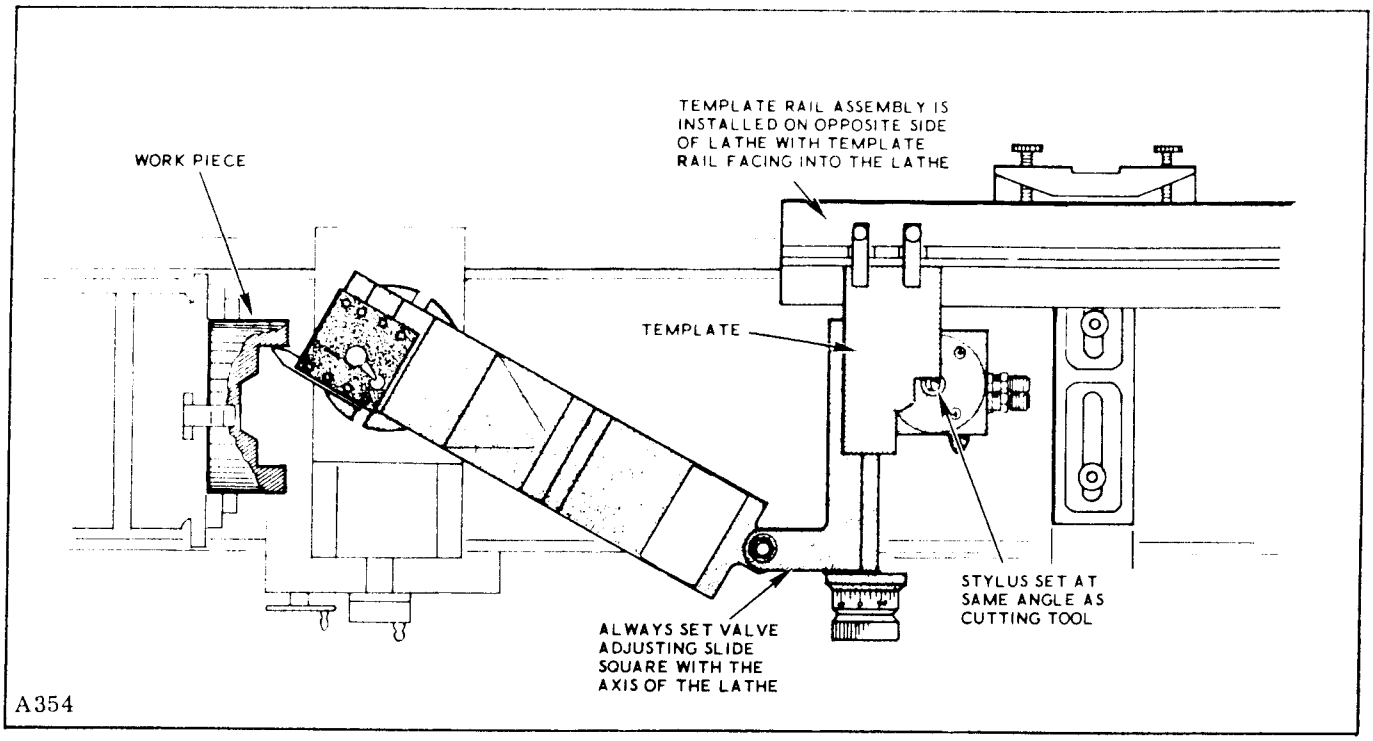


Figure 3-15. Typical Installation of Mark "O" and "O-A" Series for Facing Operation

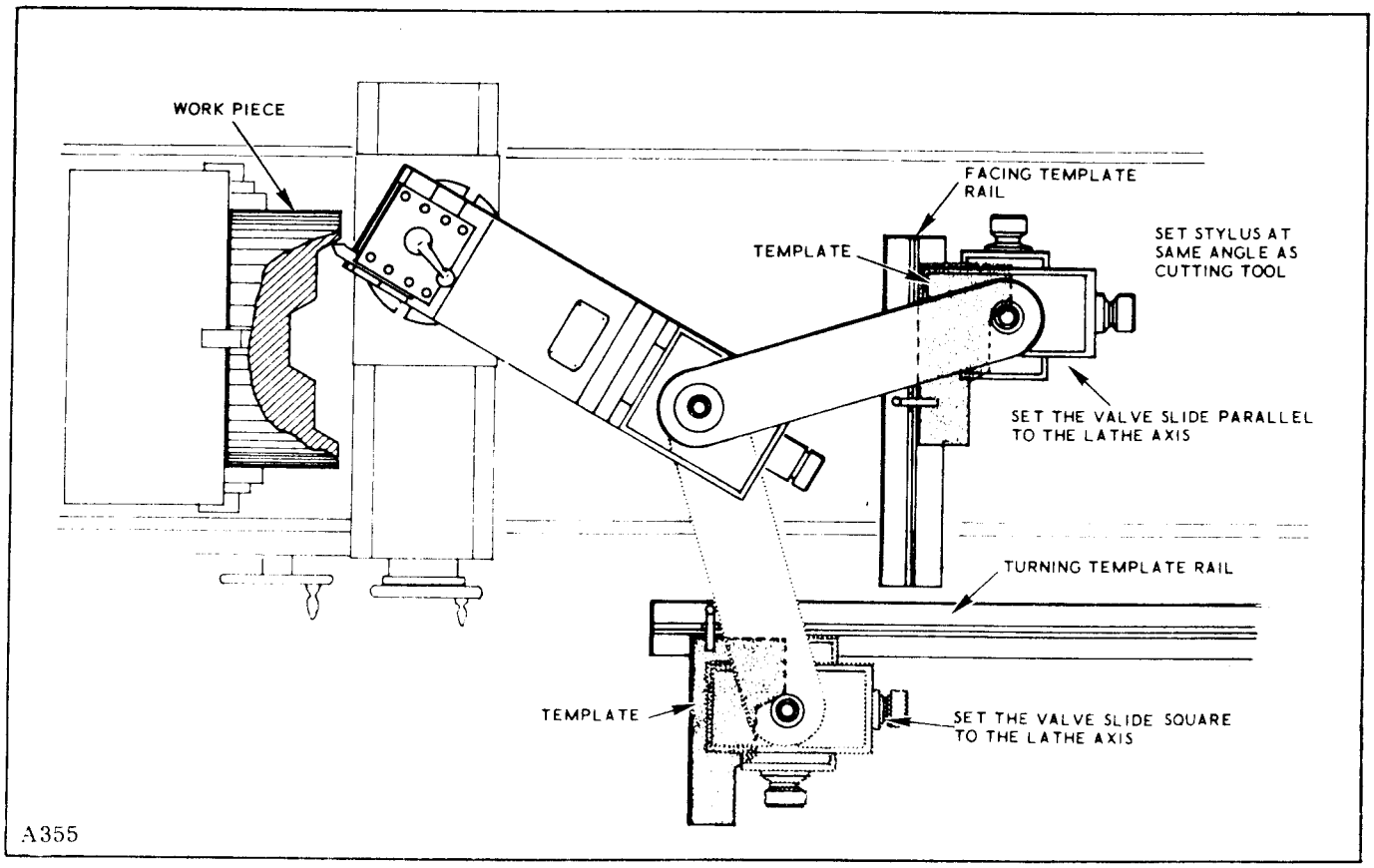


Figure 3-16. Alternate Methods of Installing Mark IIA, III, IV, V and VI Series for Facing Operation

3-26. FACING BOTH SIDES OF CENTER. Some facing operations require angles which oppose each other as shown in figure 3-17. These facing operations can be performed without changing the tracer slide angle by designing the template to permit cutting the first angles with the lathe spindle rotating clockwise and cutting the opposing angles with the lathe spindle rotating counterclockwise. As shown in figure 3-17, the template is designed to bring the cutting tool out of the work piece when the first angles have been cut. The template will then allow the tool to cut along the extreme outer surface of the work piece to the centerline. At this point, the spindle direction is reversed and the template leads the cutting tool back into the work piece for cutting the opposing angle.

a. This technique may also be used to cut angles on the inside diameter and the outside diameter of a given work piece without the necessity of changing the tracer slide angle. A typical example is shown in figure 3-18.

b. In figure 3-18 note that the template is designed to allow the stylus to trace just beyond the centerline of the work piece. At this point, the template has been angled out sharply to guide the cutting tool out of the work piece. The outside diameter of the piece part is then cut by reversing the direction of rotation of the lathe spindle.

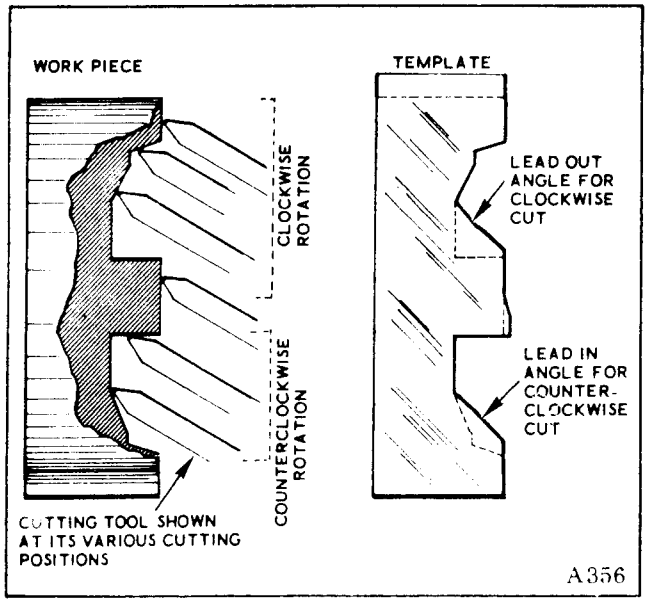


Figure 3-17. Example of Facing Both Sides of Center by Reversing Spindle Rotation

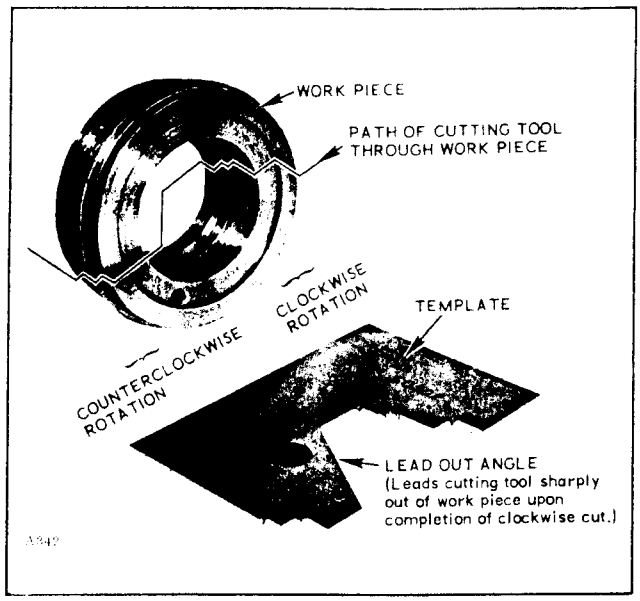


Figure 3-18. Typical Work Piece and Facing Template Used to Produce the Part

3-27. BORING OPERATION

3-28. To perform a boring operation, proceed as described in paragraph 3-20 except as follows:

a. Whenever possible, position the tracer slide so that when the slide is in its retract position with the boring bar in place, the boring bar does not retract into the work piece (see figure 3-19).

b. Upon completion of the first rough cut, with the boring bar still inserted into the work piece, CLOSE THE METERING VALVE before retracting the lathe carriage to prevent any forward motion of the tracer slide and boring bar. Be sure to position the stylus in the lead in area of the template before opening the metering valve. Open the metering valve and make the final cut.

3-29. REVERSE SEEK TRACING

3-30. Reverse seek tracing is normally used in areas where conventional turning or boring practices cannot be used as shown in the typical example, figure 3-20. To arrange the lathe tracer attachment for reverse seek operation, a reversing valve is installed on the cylinder as shown in figure 3-21. The reversing valve reverses the flow of hydraulic

oil through the cylinder lines and causes the tracer valve and slide to seek towards the operator.

a. Set up and operation for reverse seek tracing is identical to that described for boring or turning.

b. **Extreme care** should be taken when using reverse seek tracing to position the tracer slide so that when the slide is retracted, the slide or cutting tool does not strike the lathe or work piece.

c. It is **important** to note that in reverse seek operation, pressure applied to the stylus moves the tracer slide in the opposite direction from conventional tracing. Pulling the stylus towards the operator to retract the tool and slide (as is often done in conventional tracing) will actually move the tool and tracer slide in the opposite direction.

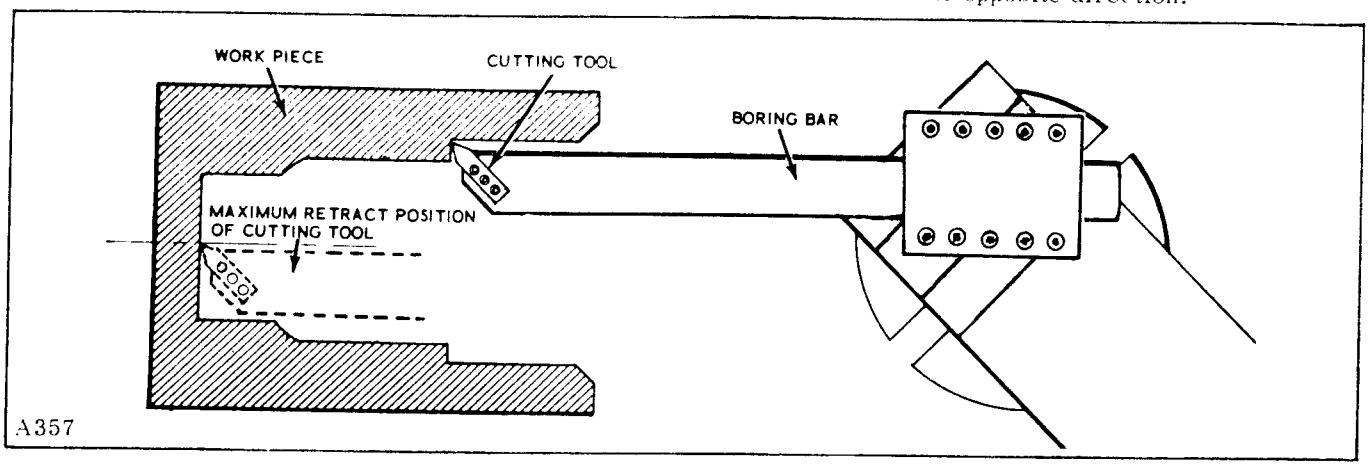


Figure 3-19. Typical Set up for a Boring Operation

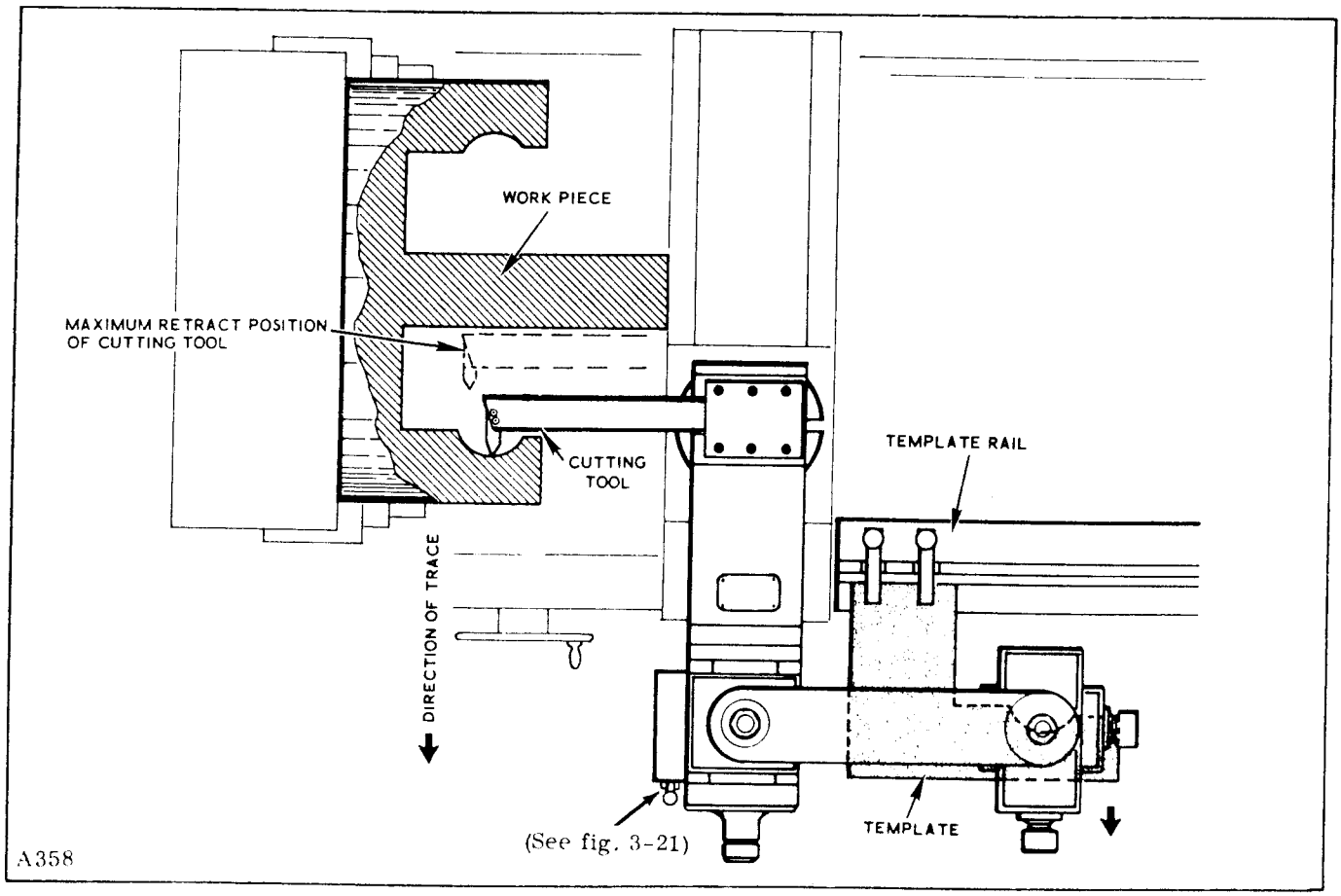


Figure 3-20. Typical Set up for Reverse Seek Tracing

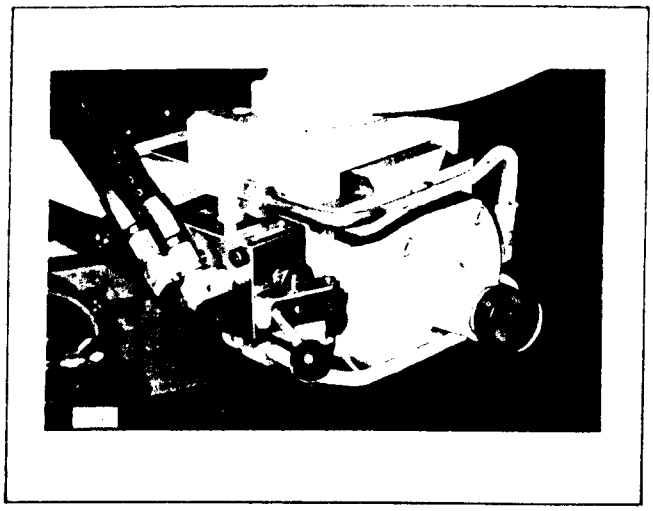


Figure 3-21. Reverse Seeking Valve (Optional Equipment) Installed on Tracer Cylinder

3-31. CONTROLLING TRACING FEED RATE

3-32. LATHE CARRIAGE FEED. Do not traverse faster than the tracer-controlled stylus can follow the template. The tracer feed rate can be regulated as described in paragraph 3-34. Tracing at less than maximum feed does not impair the accuracy of the trace in any manner. When the maximum tracing feed rate is exceeded, however, the work piece may be over-cut or under-cut. If the excessive carriage feed occurs when the tracer is climbing up a contour (stylus moving out away from the template) the tracer cannot climb as fast as the template contour changes. This over-deflects the tracer spindle and causes under-cutting of the work piece. It may also break the stylus or damage the tracer valve. If the excessive carriage feed occurs when the tracer is moving into a contour (moving into the template), the tracer valve cannot maintain contact with the template. This causes an oversize on the work piece. Time the tracer feed on the lathe. NEVER try to force the tracer to accommodate a more rapid movement.

3-33. USING METERING VALVE. The metering valve is generally used to lock the cylinder and slide in a fixed position for **a short period of time.** Turning the valve towards its closed position will cause the slide to seek the template slower. This control is useful when making deep cuts since the operator will want to feed into the work slowly and bring the stylus out of the template rapidly.

3-34. ADJUSTING TRACER VALVE. For most lathe tracer applications, the "IN" feed rate (approaching the template) should be approximately one half the "OUT" feed rate (stylus moving away from the template). Therefore, the tracer valves are set at the factory at this feed rate ratio. For some applications, the factory set feed rates may be too fast or too slow for the machining operation to be performed. To adjust the tracer valve for a faster or slower feed rate proceed as follows:

a. Check that the hydraulic power unit is operating at its proper output pressure. (Readjust if necessary as described in Section IV.)

b. Turn the metering valve on the cylinder to its full open position. (For the Mark "O" Series, ignore this step.)

c. Remove the dust boot from the nose of the tracer valve (see figure 3-22.)

d. Loosen the setscrew (3) approximately two full turns using a 3/32 Allen wrench. (Do not remove the setscrew.)

e. Rotate the nose adjusting screw (5) counterclockwise (looking at the nose end of the tracer valve) to increase the feed rate in toward the template. Turn the adjusting screw clockwise to decrease the feed rate.

NOTE: This adjustment is very sensitive. As little as 1/16 of a turn will greatly change the feed rate.

f. After turning the nose adjusting screw, manually deflect the tracer spindle (1) through its maximum travel and hold it in this position until the cylinder is fully extended to its limit of travel.

g. Using a stop watch, determine the number of seconds required for the cylinder to reach its opposite extreme of travel. Start timing from the moment the tracer spindle is released. Continue adjusting the tracer and timing the cylinder travel until the desired feed rate has been obtained.

h. After the desired feed rate has been obtained, tighten the setscrew (3) with a 3/32 Allen wrench. **Do Not Tighten Excessively.** There is a small nylon plug (4) between the tip of the setscrew and the nose adjusting screw. This plug does the locking and only requires a small amount of pressure to securely lock the nose adjusting screw.

i. Replace the dust boot on the tracer valve.

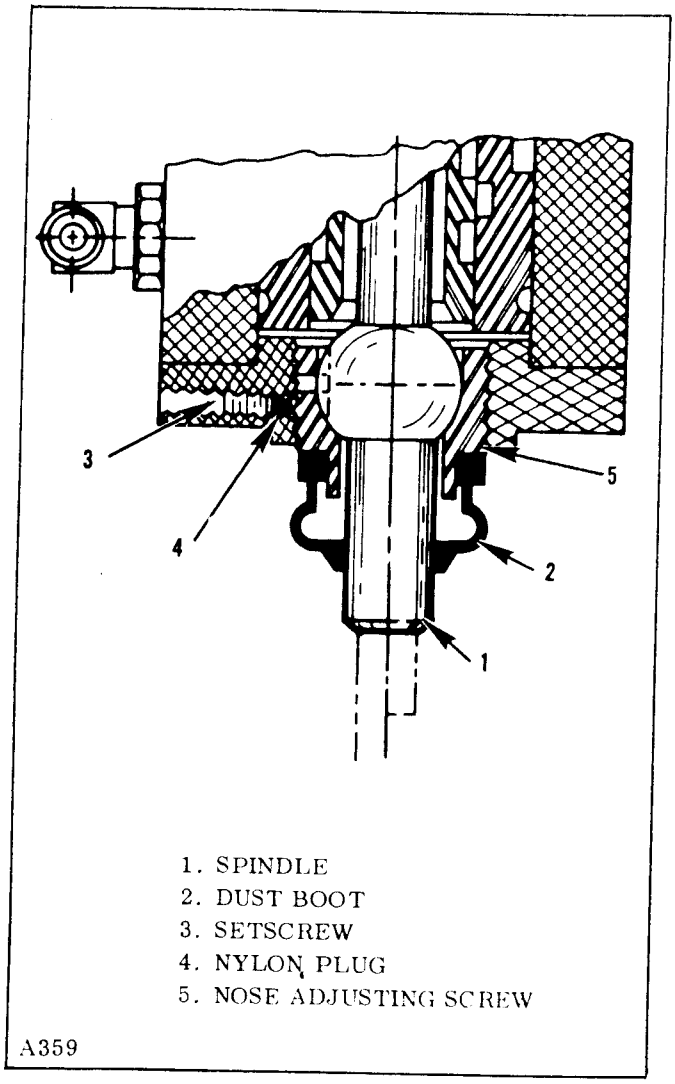


Figure 3-22. Location of Adjusting Screw in Tracer Valve

CAUTION: Many factors can affect the performance of the lathe tracer attachment. If the gibs in the tracer valve or tracer slide are too tight, the feed rate will be greatly affected. If the hydraulic power unit is not adjusted for the proper pressure or if the hydraulic oil is too cold, the feed rate will be affected. (Refer to Section IV.)

3-35. STORING THE LATHE TRACER ATTACHMENT

3-36. When not in use the tracer slide assembly may be installed on top of the hydraulic power unit as shown in figure 2-1. Two special brackets, screws and washers are provided with the Mark "O" and "O-A" Series for use in attaching the slide assembly to the hydraulic power unit as shown in figure 3-23.

CAUTION: Be careful to cap all hydraulic fittings when storing the lathe tracer attachment. **Keep the oil clean at all times.**

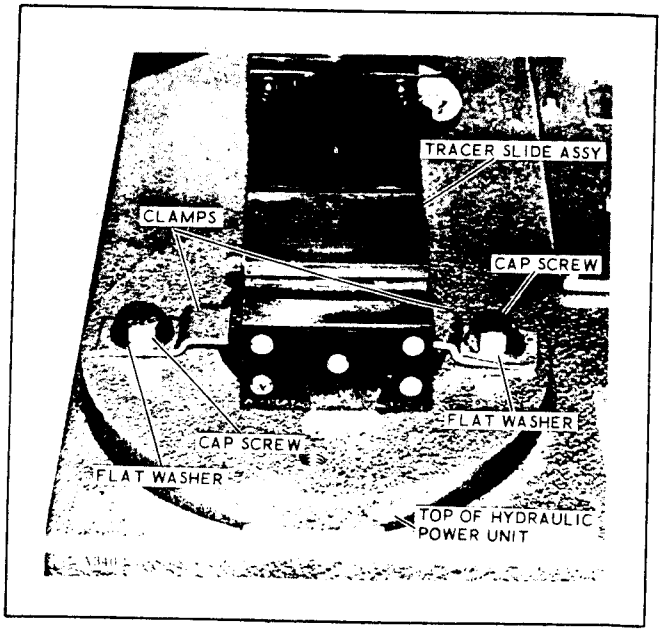


Figure 3-23. Mark "O-A" Series Tracer Slide Assembly Installed on Hydraulic Power Unit for Storage

section IV
maintenance

4-1. ROUTINE MANTENANCE

IMPORTANT: Foreign matter in hydraulic oil is one of the greatest contributors to trouble in hydraulic systems. Impurities in the hydraulic oil can cause excessive friction at various points in the hydraulic system. It can also clog the strainer in the hydraulic power unit and severely reduce the amount of oil available to the pump. This condition can cause, in addition to slow operation of the tracer valve, a noisy pump, and in time permanent damage to the pump. KEEP OIL CLEAN AT ALL TIMES.

4-2. LUBRICATION. Lubricate the tracer slide assembly after every **4 HOURS** of operation using a grease gun. There is only one lubrication fitting. This fitting is located on the side of the top slide. (See figure 4-1.)

SLIDE LUBRICATION NOTICE

Use Vactra No. 2, Mobile Oil Co., for the slide assembly. This lubricant has been found to effectively reduce friction in the ways, and helps to attain a smooth, free-tracing operation with a minimum of power.

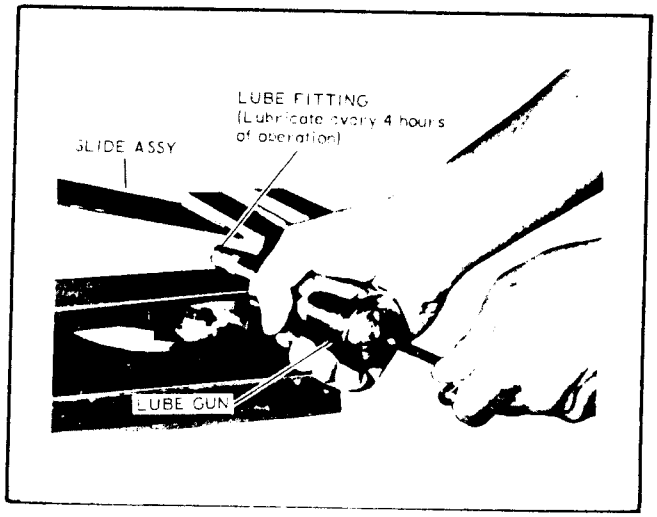


Figure 4-1. Lubricating Slide Assembly

4-3. CHANGING OIL IN HYDRAULIC POWER UNIT. Under most operating conditions, the oil need only be changed once a year. Under extreme operating conditions (dirty shop conditions or high temperature operation), change the oil every six months. Check the condition of the oil as follows:

a. Take a sampling of oil from the drain plug on the hydraulic reservoir. Use a glass test tube.

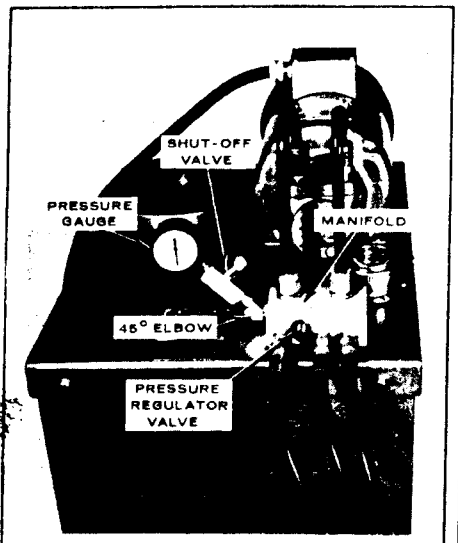
b. Compare the sampling of oil with a test tube filled with new oil. Check for foreign matter and color. Before re-filling the hydraulic reservoir, clean the system as described in step c below.

c. Make sure there is 15 gallons of hydraulic oil in the reservoir. Add three pints of Mobisol A, Mobil Oil Co., to the hydraulic oil. Operate the hydraulic power unit through complete cycles for 24 hours. The unit may be used for regular operation during the cleaning period. Do NOT leave the solution in the unit longer than the specified 24 hour period. This solution will damage hoses, seals, and piston cups if used longer than 24 hours. Do not use the solution stronger than specified (this is approximately 5% of volume of hydraulic oil). Drain the hydraulic reservoir at the end of the cleaning period. Remove the top assembly from the power unit and clean the inside of the reservoir thoroughly with solvent. Dry with compressed air. Wash the strainer in solvent and dry with compressed air.

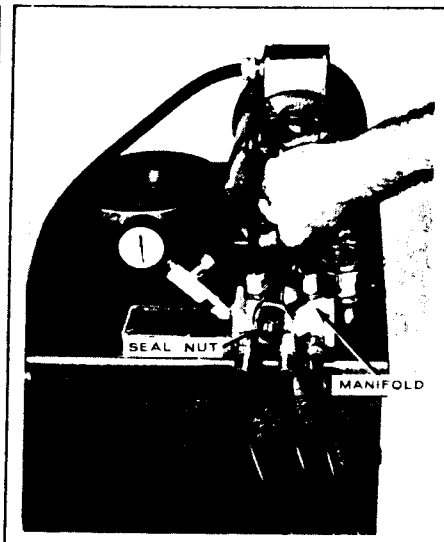
4-4. BREATHER CAP. Clean the breather cap element in solvent at least once every 6 months.

4-5. ROUTINE ADJUSTMENTS

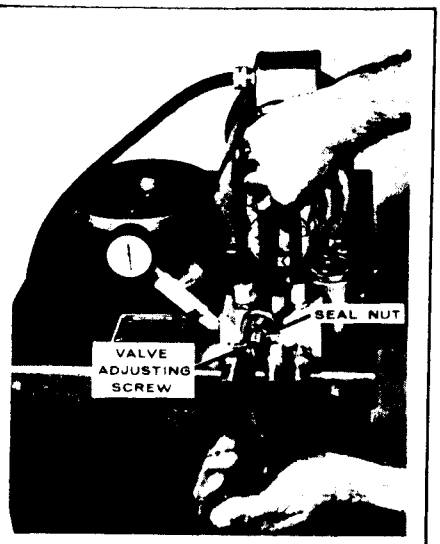
4-6. HYDRAULIC POWER UNIT. To adjust the hydraulic power unit, proceed as described in figure 4-2.



STEP 1 Remove the plug from the 45° elbow on the manifold. Install a 0 to 300 psi pressure gauge in the elbow. As protection for the gauge, it is recommended that a shut-off valve be installed between the manifold and the pressure gauge.



STEP 2 Leave the hydraulic hose assemblies connected to the tracer valve or cap the ends of the hoses. When the hose assemblies are connected to the tracer valve, the valve should be held at null (no pressure on the spindle).



STEP 3 Loosen the seal nut with a wrench and turn the valve adjusting screw until the pressure gauge indicates the correct operating pressure as specified in the chart below. Turning the adjusting screw clockwise increases the pressure; counterclockwise decreases the pressure. Hold the adjusting screw firmly and tighten the seal nut. It is not necessary to remove the pressure gauge to operate the power unit.

Model Attachment	Mark "O"	Mark "O-A"	Mark IIA	Mark III	Mark IV	Mark V	Mark VI
Normal Operating Pressure	160 psi	160 psi	160 psi	200 psi	200 psi	200 psi	200 psi

Figure 4-2. Procedure for Adjusting Output Pressure of Hydraulic Power Unit

4-7. GIB ADJUSTMENTS. Refer to figures 5-1 through 5-7 and adjust the gibs as follows:

a. Loosen the front and rear gib screws slightly.

b. Tighten the front gib screw until a bind occurs; then back off slightly.

c. Tighten the rear gib screw until a bind occurs; then back off slightly.

d. Check that the gibs are snug but not binding.

CAUTION: If the gibs in the slide assembly are too loose or too tight, accuracy of the machined part will be affected.

Table 4 1. Trouble-shooting Chart (Sheet 1 of 3)

Trouble	Probable Cause	Remedy
Chatter (hydraulic pulsation) or rough finish on work piece (Be sure to use good cutting practice.)	Improper gib adjustment (too tight or too loose)	Adjust gibs as described in paragraph 4-7.
	Loose linkage between tracer and cutting tool. Cutting tool holder loose. T-bolts on cross slide loose	Check linkage at each point between tracer valve and cutting tool. Tighten all loose bolts and nuts. Check for wear and other factors that could contribute to lost motion. ELIMINATE ALL LOST MOTION between tracer valve and cutting tool.
	Hydraulic pressure too high	Readjust hydraulic power unit if necessary as described in figure 4-2.
	Inadequate lubrication and maintenance	Refer to paragraph 4-2. Remember the slide assembly MUST be lubricated after every 4 hours of operation.
	Air in hydraulic system	Bleed the hydraulic system of all trapped air as described in paragraph 2-34 d. Make sure there is sufficient oil in the system.
	Loose stylus in spindle of tracer valve	Be sure the stem of the tracing stylus is seated firmly and tight inside the tracer valve spindle. Make sure the setscrews are tight.
Tracing too slowly	Tracer out of adjustment	Readjust the tracer valve as described in paragraph 3-31.
	Hydraulic power unit not adjusted properly	Readjust the hydraulic power unit as described in figure 4-2. Check for dirty strainer in hydraulic power unit.
	Air in hydraulic system	Bleed the hydraulic system of all trapped air as described in paragraph 2-34 d. Make sure there is sufficient oil in the system.
	Foreign matter in hydraulic system	Clean the system as described in paragraph 4-3. KEEP OIL CLEAN AT ALL TIMES.
	Pump in hydraulic power unit defective	Check the pump for evidence of binding, wear, or dirt clogging.
	Hydraulic oil too cold	Oil temperature should be between 90° and 120° F for optimum operation. Allow the hydraulic power unit to operate for approximately one hour prior to performing tracing operations.
	Inadequate lubrication and maintenance	Refer to paragraph 4-2. Remember the slide assembly MUST be lubricated after every 4 hours of operation.
	Improper hydraulic oil	Use Mobil Velocite "S" (Mobil Oil Co.) hydraulic oil in the hydraulic power unit.
	Gibs too tight	Adjust gibs as described in paragraph 4-7.

Table 4-1. Trouble-shooting Chart (Sheet 2 of 3)

Trouble	Probable Cause	Remedy
Variation between template and machined part	Improper radius of stylus	Refer to paragraph 3-4.
	Lathe carriage speed too fast	Refer to paragraph 3-32.
	Loose linkage between tracer and cutting tool	Refer to "loose linkage" on page 4-3.
	Template not held securely on template rail	Tighten the template clamps securely.
	Improper gib adjustment	Refer to paragraph 4-7.
	Inaccuracies in machine tool	Check the machine tool carefully. Precision duplicating can only be accomplished if your machine tool is accurate.
Excessive leakage of tracer valve or cylinder	Loose hose connections	Tighten all hose connections. Tighten all pipe plugs and fittings.
	Defective seal	Refer to the exploded views in Section V and replace any defective seals.
Tracer valve fails to trace	Clogged hydraulic line	Check that hydraulic oil is flowing through the system. Clean the system if necessary as described in paragraph 4-3c.
	Pressure and exhaust lines reversed	Make sure the hose assemblies between the tracer valve and hydraulic power unit are properly connected. Reversing the pressure and exhaust lines may cause hydraulic bind in the system.
	Improper gib adjustment	Refer to paragraph 4-7.
	Contaminated hydraulic oil	Filter or replace the hydraulic oil. Refer to paragraph 4-3c.
	Air in hydraulic circuit	Tighten all fittings and hose connections. Bleed the system using the two bleeders on the top of the cylinder.
	Metering valve in full closed position	Open the metering valve to its normal operating position.
Sluggish operation of tracer valve	Improper hydraulic oil	Use Mobil Velocite "S" (Mobile Oil Co.) oil in the hydraulic power unit.
	Hydraulic oil too cold	Oil temperature should be between 90° and 120°F for optimum operation. Allow the hydraulic power unit to operate for approximately one hour prior to performing tracing operations.
	Contaminated hydraulic oil	Refer to paragraph 4-3c.

Table 4-1. Trouble-shooting Chart (Sheet 3 of 3)

Trouble	Probable Cause	Remedy
Excessive noise in hydraulic power unit	Foreign matter or impurities in hydraulic oil	Refer to paragraph 4-3.
	Cavitation - inadequate supply of oil in pump	Be sure there is the correct amount of hydraulic oil in reservoir. Be sure the strainer is clean.
	Worn, faulty or dirty relief valve	Be sure that the pressure relief valve is clean and functioning properly.
	Defective pump	Check the operation of the pump. Replace if defective.
	Loose pipe on intake side of pump	Tighten pipes on intake side of pump.
Electric pump motor stalls	Defective motor	Replace motor if defective.
	Hydraulic pressure settings too high	Refer to figure 4-2.
	Hydraulic pump frozen	Replace pump if necessary.
No oil pressure out of hydraulic power unit	Pressure hose assembly pinched or collapsed	Check the pressure hose assembly and repair if necessary.
	Worn, faulty or dirty relief valve	Be sure the pressure relief valve is clean and functioning properly.
	Defective pump	Check the pump and replace if necessary.

section V
repair parts list

5-1. INTRODUCTION

5-2. This section contains exploded view illustrations and repair parts lists for the Series Mark Lathe Tracer Attachment. Items listed as "Com'l" in the Part Number columns may be procured from standard commercial sources or directly from True-Trace. For items not manufactured by True-Trace, the manufacturer's part number has been included and the code letters for the manufacturer's are listed in the Mfr column. Code letters assigned to manufacturers are as follows:

AL	Alemite Co.
BOST	Boston Gear Works
CL	Carr Lane Mfg. Co.
COL	Manitrol, Div. of Perry-Fay Co.
COM	Commercial Items
ES	Elastic Stop Nut Corp of America
FR	Flick-Reedy Corp.
GITS	Gits Bros. Mfg. Co.
LZ	Lenz Mfg. Co.
MIN	Minnesota Rubber Co.
PK	Parker Seal Comp, Div. of Parker Hannifin Corp.
PMH	Paul-Munroe Hydraulics, Inc.
PUR	Purolator Products, Inc.
RUB	Rubbercraft Corp. of Calif.
SHK	Shakeproof Lockwasher Co.
SRT	L. S. Starrett Co.
TB	Thomas & Betts
TIN	Tinnerman Products Corp.
TRU	True-Trace Corp.
TUT	Tuthill Pump Co.
WH	The Weatherhead Co.

5-3. ORDERING PARTS

5-4. Read these instructions before ordering parts. Fill in the following information on the photograph of the nameplate so that it will be available to you when ordering parts:

Model No. . . . . Lot No. . . . . .

Serial No. . . . . (Stamped on Slide Assy.)

TO INSURE PROMPT AND ACCURATE SERVICE, THE FOLLOWING INFORMATION MUST ALSO BE GIVEN:

(1) State exactly, quantity of each part and part number.

(2) State definitely whether the parts are to be shipped EXPRESS, FREIGHT, or PARCEL POST.

NOTE: All new and repaired parts are shipped F.O.B. El Monte, California.

5-5. PARTS RETURNED FOR CREDIT

5-6. Before returning any parts, write a letter to the company giving an exact list and description of the materials, why you wish to return them, whether for repair, credit, or replacement, and also the Model No. and Lot No.. of the equipment from which the parts were taken. If authority is granted for their return, transportation charges must be prepaid and the Sender's name marked on the outside of the box or package.

5-7. PARTS RETURNED FOR REPAIR

5-8. When parts are returned to the company for repair, transportation charges must be prepaid and the Sender's name marked on the outside of the box or package.

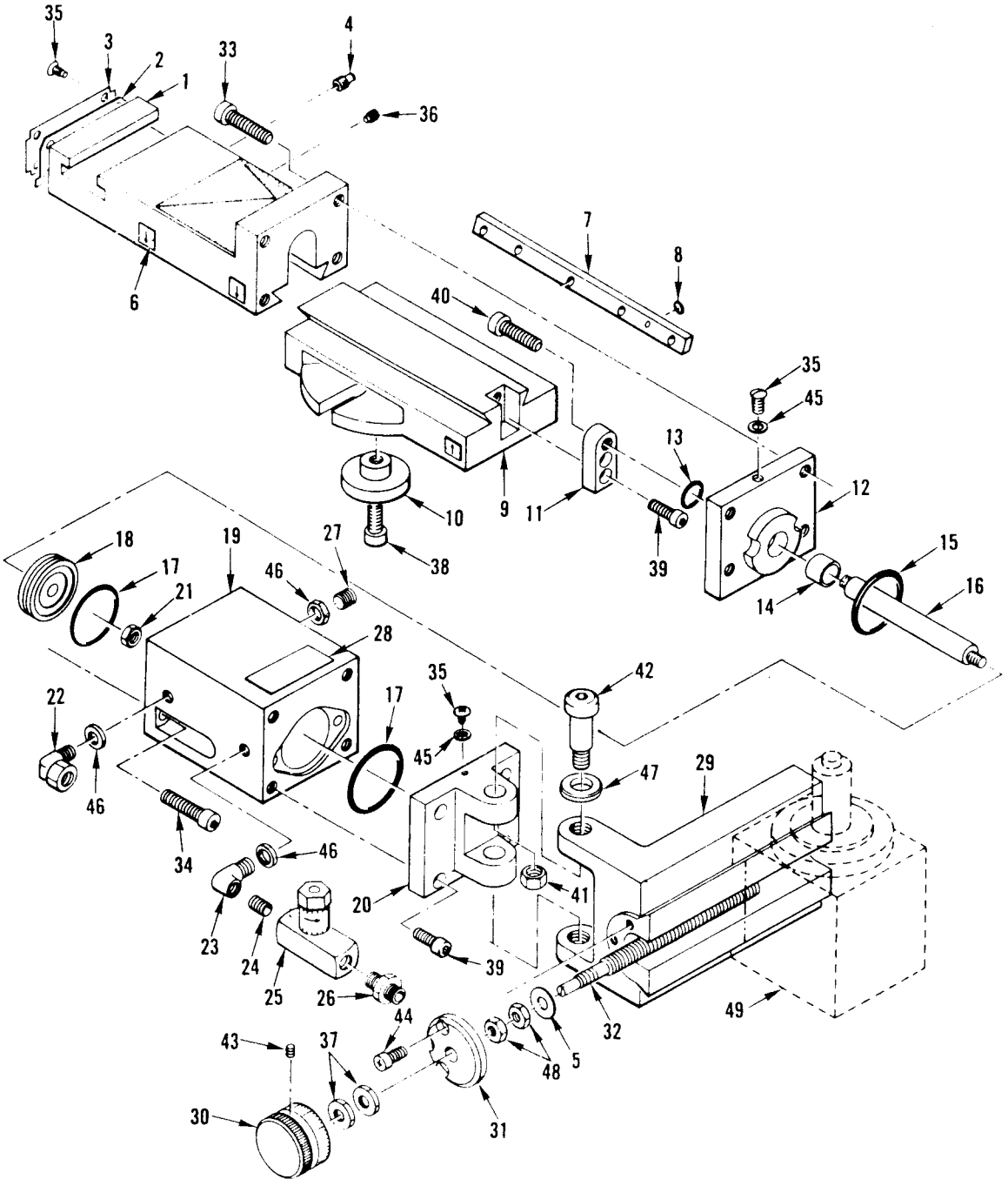


Figure 5-1. Exploded View of Mark "O-A" Series Lathe Tracer Attachment and . . .

F3943

Index	Part No.	Description	Mfr	Qty
49	1005-05	Valve, Lever (Ref Only - see fig 5-6)	Tru	1
48	611-02	Bearing, Thrust (5/16x3/4x1/16)	Bost	2
47	308-02	Washer, Tee Slot (1/2x1x3/16)	Com	2
46	193-01	Nut, Seal (1/8 NPT)	Fr	4
45	116-02	Washer, Seal (Stat-O-Seal #6061-001-8)	Pk	2
44	204-21	Screw, Mach, Pan Hd (#10-32 NFx3/8)	Com	3
43	248-13	Set Screw, HexSoc-Nylok (#8-32 NCx3/8)	Com	1
42	178-17	Screw, Shoulder (1/2-10x1)	Com	2
41	197-03	Nut, Hex (3/8-16 NC)	Com	2
40	150-17	Screw, Cap-Hex Soc (5/16-18 NC x 5/8)	Com	1
39	150-03	Screw, Cap-Hex Soc (1/4-20 NC x 5/8)	Com	6
38	150-20	Screw, Cap-Hex Soc (5/16-18 NC x 1)	Com	1
37	197-24	Nut, Hex-Jam (3/8-16 NC)	Com	2
36	32795	Set Screw, Oval Point (Nylok)	Tru	5
35	198-11	Screw, Truss Hd (#8-32 NC x 1/4)	Com	7
34	150-06	Screw, Cap-Hex Soc (1/4-20 NC x 1)	Com	2
33	150-21	Screw, Cap-Hex Soc (5/16-18 NC x 1-1/4)	Com	2
32	40624	Screw, Valve Adjusting	Tru	1
31	40612	Plate, Mounting	Tru	1
30	40625	Knob, Micro-Adjusting	Tru	1
29	40609	Slide, Adjusting	Tru	1
28	31221	Label, Model No.	Tru	1
27	169-02	Plug, Pipe - Hex Soc (1/8 NPT)	Com	2
26	230-04	Connector, Pipe (1/4 Tube Flareless to 1/8 NPT)	WH	1
25	55454	Valve, Metering (Colorflow 1/8F-200-B)	Col	1
24	125-01	Nipple, Close-Brass (1/8 NPT)	WH	1
23	128-01	Elbow, 90°, Street-Brass (1/8 to 1/8 NPT)	WH	1
22	231-04	Elbow, 90° (1/4 Tube Flareless to 1/8 NPT)	WH	1
21	197-02	Nut, Hex (5/16-18 NC)	Com	1
20	40606	Head, Cylinder	Tru	1
19	40604	Housing, Cylinder	Tru	1
18	15225	Piston	Tru	1
17	246-27	Quadring, Rubber (1/8 x 1-1/2 x 1-3/4)	Min	1
16	40607	Rod, Piston	Tru	1
15	175-17	O-Ring, Buna-N-Rubber (Parker #2-226)	Pk	2
14	55206	Bearing, Brass, Oil Retaining	Tru	1
13	246-10	Quadring, Rubber (3/32x1/2x11/16)	Min	1
12	40605	Head, Rod End	Tru	1
11	40623	Bracket, Rod Pick-up	Tru	1
10	40634	Spud, Compound	Tru	1
9	40601	Slide, Bottom	Tru	1
8	175-06	O-Ring, Buna-N-Rubber (Parker #2-6)	Pk	1
7	40603	Gib, Top Slide	Tru	1
6	31702	Plate, Pointer	Tru	3
5	307-07	Washer, Thrust (5/16x5/8x1/16)	Bost	1
4	323-03	Fitting, Lub (1/4-28 NPT)	Al	1
3	40638	Cover, Wiper, Dovetail	Tru	1
2	40637	Wiper, Dovetail Way	Tru	1
1	40602	Slide, Top	Tru	1
	40600	Cylinder and Slide Assembly	Tru	

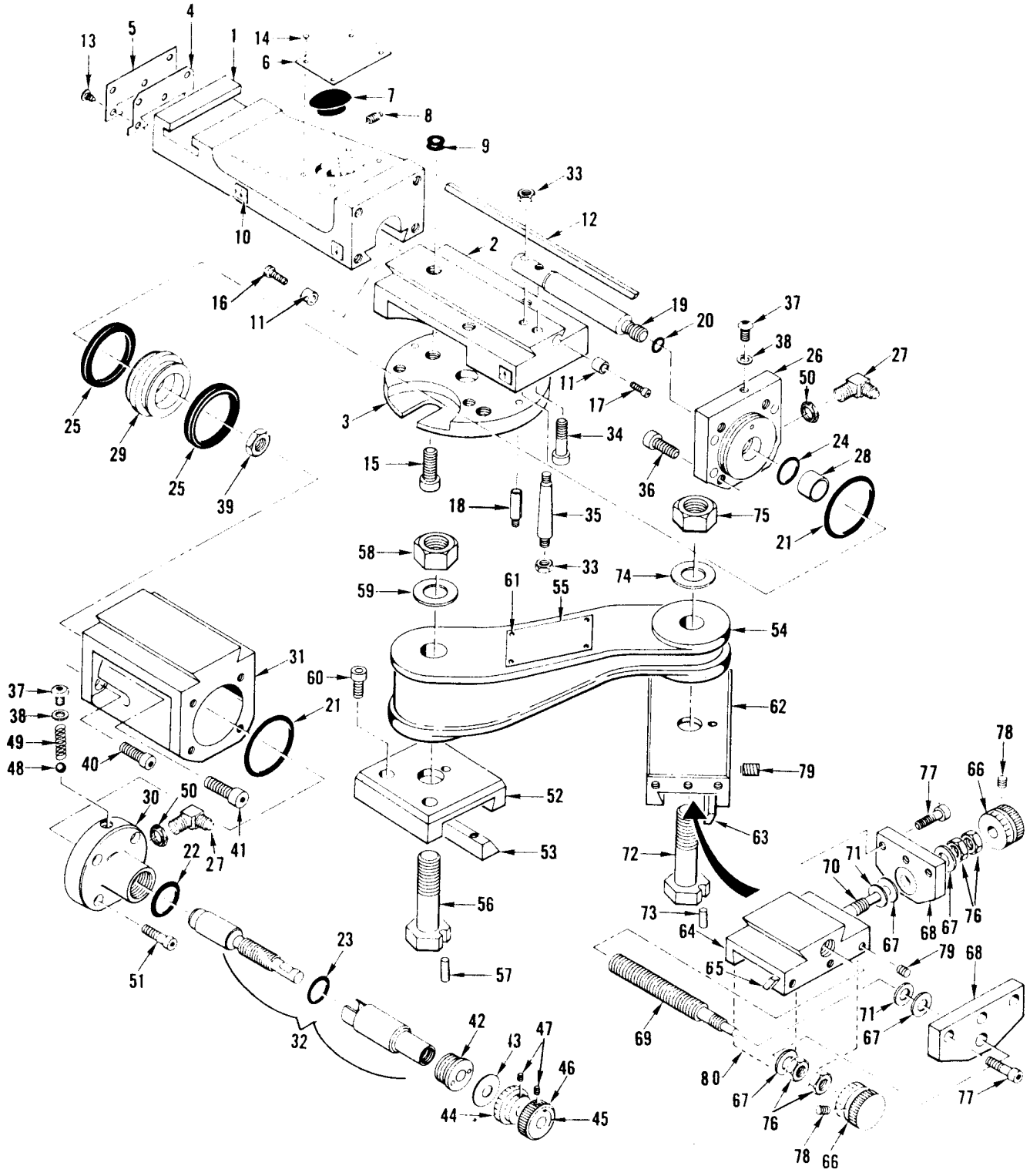


Figure 5-2. Exploded View of Mark IIA Series Lathe Tracer Attachment and

F3945

Index	Part No.	Description	Mfr.	Qty.
80	1066-05	Valve, Tracer (Ref. Only - See fig 5-7)	Tru	1
79	255-37	Set Screw, Nylok (1/4-20 NC x 5/8)	Com	8
78	241-29	Set Screw, Nylok (#8-32 NC x 3/8)	Com	2
77	148-18	Screw, Cap-Hex Soc (#10-32 NF x 1/2)	Com	6
76	172-72	Nut, Hex-Jam (5/16-24 NF)	Com	4
75	172-57	Nut, Hex (Same as Item 58)	Com	1
4	307-32	Washer, Thrust (Same as Item 59)	Bost	1
73	185-70	Pin, Roll (Same as Item 70)	Com	1
72	40712-4	Bolt, Swivel Arm	Tru	1
71	307-07	Washer, Thrust (5/16 x 5/8 x 1/16)	Bost	2
70	15193	Screw, Long. Feed	Tru	1
69	15194	Screw, Cross Feed	Tru	1
68	15215	Plate, Mounting	Tru	2
67	303-02	Bearing, Thrust (3/16 x 3/4 x 1/16)	Bost	4
66	15192	Knob	Tru	2
65	15212	Gib	Tru	1
64	15209	Slide, Long. Feed	Tru	1
63	15210	Gib	Tru	1
62	15211	Slide, Cross Feed	Tru	1
	40761	Valve Slide Assy, Model 4049-02, Lot 2 (Items 62 thru 79)	Tru	
61	201-35	Screw, Mach. (#6-32 NC x 1/4)	Com	2
60	150-03	Screw, Cap-Hex Soc (1/4-20 NC x 5/8)	Com	2
59	307-32	Washer, Thrust (3/4 x 1-5/8 x 3/16)	Bost	1
58	172-57	Nut, Hex (3/4 - 16 NF)	Com	1
57	185-70	Pin, Roll (3/16 Dia x 1/2)	Com	1
56	40712-0	Bolt, Swivel Arm	Tru	1
55	41242	Name Plate	Tru	1
54	40710	Arm, Swivel	Tru	1
53	40713	Gib	Tru	1
52	40709	Slide, Swivel	Tru	1
	40731	Swivel Arm Assy (Items 52 thru 61)	Tru	

Index	Part No.	Description	Mfr.	Qty.
51	150-07	Screw, Cap-Hex Soc (1/4-20 NC x 1-1/4)	Com	4
50	199-02	Nut - Seal (1/4 - 18 NPT)	Fr	2
49	20465	Spring	Tru	1
48	212-09	Ball-Chrome (5/16 Dia.)	Com	1
47	157-02	Set Screw, Hex. Soc. (#8-32 NC x 1/4)	Com	2
46	40762	Knob	Tru	1
45	30080	Emblem, Directional	Tru	1
44	40763	Collar	Tru	1
43	56293-04	Washer, Spring (5/16 x 15/16 x 1/8)	Shk	1
42	30040	Gage, Retainer	Tru	1
41	150-23	Screw, Cap. Hex. Soc. (5/16-18NC x 1-3/4)	Com	2
40	150-09	Screw, Cap. Hex. Soc. (1/4-20NC x 1-3/4)	Com	2
39	140-14	Nut, Lock - Hex. (1/2-20NF-3)	Es	1
38	116-08	Washer, Seal (Stat-o-Seal #600-001-3/8)	Pk	2
37	168-40	Screw, Cap. -Hex. Soc. (3/8-16NC x 1/2)	Com	2
36	150-05	Screw, Cap. -Hex. Soc. (1/4-20NC x 7/8)	Com	4
35	40787	Pin, Taper-Rod Mount	Tru	1
34	148-53	Screw, Cap. Hex. Soc. (3/8-24NF x 1-1/4)	Com	1
33	172-71	Nut, Hex. Jam (1/4 - 28NF)	Com	2
32	30112	Valve, Stem & Poppet Assy. (Includes Item 23)	Tru	1
31	40726	Housing, Cylinder	Tru	1
30	40724	Head, Cylinder	Tru	1
29	40725	Piston	Tru	1
28	25728	Bearing	Tru	1
27	120-03	Elbow, 90° (1/4 SAE, Flare to 1/4 pipe)	Wh	2
26	40707	Head, Rod End	Tru	
25	365-34	Packing, U-Cups, Buna-N-Rubber (5/16 x 2-3/8 x 3)	Com	2
24	246-15	Quadring, Rubber (1/8 x 3/4 x 1)	Min	1
23	173-51	O-Ring, Buna-N-Rubber (Parker #2-110)	Pk	1
22	175-01	O-Ring, Buna-N-Rubber (Parker #2-210)	Pk	1
21	175-23	O-Ring, Buna-N-Rubber (Parker #2-232)	Pk	1
20	173-12	O-Ring, Buna-N-Rubber (Parker #2-12)	Pk	1
19	40727	Rod, Piston	Tru	1
	40729	Cylinder & SVA Valve (Items 19 thru 51)	Tru	
18	40015	Pin, Dowel - Expanding	Tru	2
17	150-07	Screw, Cap. Hex. Soc. (1/4-20NC x 1-1/4)	Com	1
16	150-06	Screw, Cap. Hex. Soc. (1/4-20NC x 1)	Com	1
15	148-50	Screw, Cap. Hex. Soc. (3/8-24NF x 3/4)	Com	3
14	164-06	Screw, Self-Tapping (#4-40 x 1/4)	Com	4
13	198-11	Screw, Mach. Truss HD. (#8-32NC x 1/4)	Com	5
12	40737	Gib	Tru	1
11	40002	Bushing	Tru	2
10	31702	Plate, Pointer	Tru	3
9	55869	Plug, Welch (1/2 Dia. Hole)	Com	1
8	323-03	Fitting, Lube (1/4-28 Taper Thread)	Al	1
7	55343	Grommet - Rubber (Rubbercraft #67)	Rub	1
6	40748	Name Plate	Tru	1
5	40771	Cover, Wiper Dovetail	Tru	1
4	40770	Wiper, Dovetail Way	Tru	1
3	40723	Adapter, Compound	Tru	1
2	40736	Slide, Bottom	Tru	1
1	40735	Slide, Top	Tru	1
	40734	Slide Assy (Items 1 thru 18)	Tru	

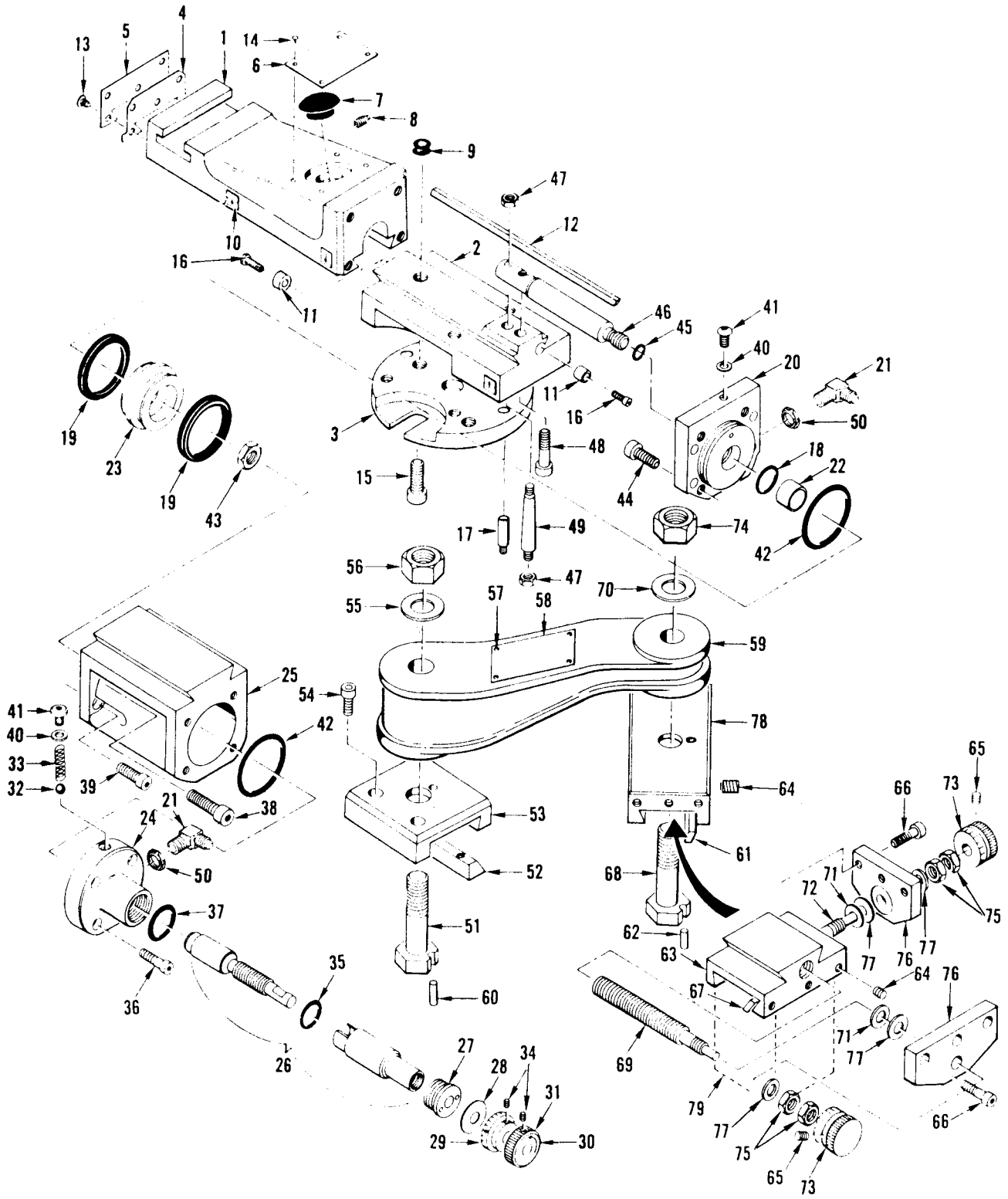


Figure 5-3. Exploded View of Mark III Series Lathe Tracer Attachment and . . . .

F3947

Index	Part No.	Description	Mfr.	Qty.
79	186-34	Screw, Cap-Hex Soc (3/8-16 NC x 3/8)	Com	2
78	15211	Slide, Cross Feed	Tru	1
77	305-02	Bearing, Thrust (1 Pcs x 4x1 Pc)	Bost	4
76	15215	Mounting Plate	Tru	2
75	172-72	Nut, Hex (5/16-24 NF)	Com	4
74	172-57	Nut, Hex (Same as Item 56)	Com	2
73	15142	Knob	Tru	2
72	15195	Screw, Long, Feed	Tru	1
71	307-07	Washer, Thrust (5/16 x 5/8 x 1/16)	Bost	2
70	307-42	Washer, Thrust (Same as Item 55)	Bost	1
69	15194	Screw, Cross Feed	Tru	1
68	40712-4	Bolt, Swivel Arm	Tru	1
67	15212	Gib	Tru	1
66	148-18	Screw, Cap-Hex Soc (#10-32 NF x 1/2)	Com	6
65	241-29	Set Screw, Nylok (#8-32 NC x 3/8)	Com	2
64	255-37	Set Screw, Nylok (1/4-20 NC x 5/8)	Com	6
63	15209	Slide, Long, Feed	Tru	1
62	185-70	Pin, Roll (Same as item 60)	Com	1
61	15210	Gib	Tru	1
	40761	Valve Slide Assy, Model 4049-02, Lot 2 (Items 61 thru 78)	Tru	
60	185-70	Pin, Roll (3/16 Dia x 1/2)	Com	1
59	40710	Arm, Swivel	Tru	1
58	41242	Nameplate	Tru	1
57	201-35	Screw, Mach. (#6-32 NC x 1/4)	Com	1
56	172-57	Nut, Hex (3/4 - 16 NF)	Com	1
55	307-32	Washer, Thrust (3/4 x 1-5/8 x 3/16)	Bost	2
54	150-03	Screw, Cap-Hex Soc (1/4-20 NC x 5/8)	Com	2
53	40709	Slide, Swivel	Tru	1
52	40713	Gib	Tru	1
51	40712-0	Bolt, Swivel Arm	Tru	1
	40731	Swivel Arm Assy (Items 51 thru 60)	Tru	
50	199-02	Nut, Seal (1/4-18 NPT)	Fr	2
49	40787	Pin, Taper - Rod Mount	Tru	1
48	148-53	Screw, Cap-Hex Soc (3/8-24 NF x 1-1/4	Com	1
47	172-71	Nut, Hex-Jam (1/4-28 NF)	Com	2
46	40806	Rod, Piston	Tru	1
45	173-12	O-Ring, Buna-N-Rubber (Parker #2-12)	Pk	1
44	150-05	Screw, Cap-Hex Soc (1/4-20 NC x 7/8)	Com	4
43	140-14	Nut, Lock-Hex (1/2-20 NF - 3)	Es	1
42	175-23	O-Ring, Buna-N-Rubber (Parker # 2-232)	Pk	2
41	168-34	Screw, Cap-Hex Soc (3/8-16 NC x 3/8)	Com	2

Index	Part No.	Description	Mfr	Qty.
40	186-34	Screw, Soc (Same as Item 41)	Com	2
39	157-34	Screw, Cap-Hex Soc (1/4-20 NC x 1-3/4)	Com	2
38	168-2	Screw, Cap-Hex Soc (5/16-18 NC x 1-3/4)	Com	2
37	173-91	O-Ring, Buna-N-Rubber (Parker #2-210)	Pk	1
36	150-07	Screw, Cap-Hex Soc (Same as Item 1c)	Com	4
35	173-51	O-Ring, Buna-N-Rubber (Parker #2-110)	Pk	1
34	157-02	Set Screw, Hex Soc (#8-32 NC x 1/4)	Com	2
33	20465	Spring	Tru	1
32	212-09	Ball, Chrome (5/16 Dia)	Com	1
31	40762	Knob	Tru	1
30	30080	Emblem, Directional	Tru	1
29	40763	Collar	Tru	1
28	50258-04	Washer, Spring (1/2 x 1" Dia x 1.5)	Sur	1
27	30040	Cage, Retainer	Tru	1
26	30112	Valve Stem & Poppet Assy (Includes item 35)	Tru	1
25	40803	Housing, Cylinder	Tru	1
24	40724	Head, Cylinder	Tru	1
23	40725	Piston	Tru	1
22	25728	Bearing	Tru	1
21	120-04	Elbow, 90° (1/4 Sae, Flare to 1/8 Pipe	WH	2
20	40707	Head, Rod End	Tru	1
19	365-34	Packing, U-Cup Buna-N-Rubber (5/16 x 2-3/8 x 3)	Com	2
18	246-15	Quadring, Rubber (1/8 x 3/4 x 1)	Min	1
	40820	Cylinder & SVA Valve (Items 18 thru 49)	Tru	
17	40015	Pin, Dowel, Expanding	Tru	2
16	150-07	Screw, Cap-Hex Soc (1/4-20 NC x 1-1/4)	Com	2
15	148-49	Screw, Cap-Hex Soc (3/8-24 NF x 5/8)	Com	3
14	164-06	Screw, Cap-Hex Soc (#4-40 x 1/4)	Com	4
13	198-11	Screw, Mach - Truss Hd (#8-32 NC x 1/4)	Com	5
12	40804	Gib	Tru	1
11	40002	Bushing	Tru	2
10	31702	Plate, Pointer	Tru	3
9	55869	Plug, Welch (1/2 Dia Hole)	Com	1
8	323-03	Fitting, Lube (1/4-28 Taper Thrd)	Al	1
7	55343	Grommet - Rubber (Rubbercraft #67)	Rub	1
6	40748	Name Plate	Tru	1
5	40808	Cover, Wiper Dovetail	Tru	1
4	40809	Wiper, Dovetail Way	Tru	1
3	40807	Adapter, Compound	Tru	1
2	40802	Slide, Bottom	Tru	1
1	40801	Slide, Top	Tru	1
	40800	Slide Assy (Items 1 thru 17)	Tru	

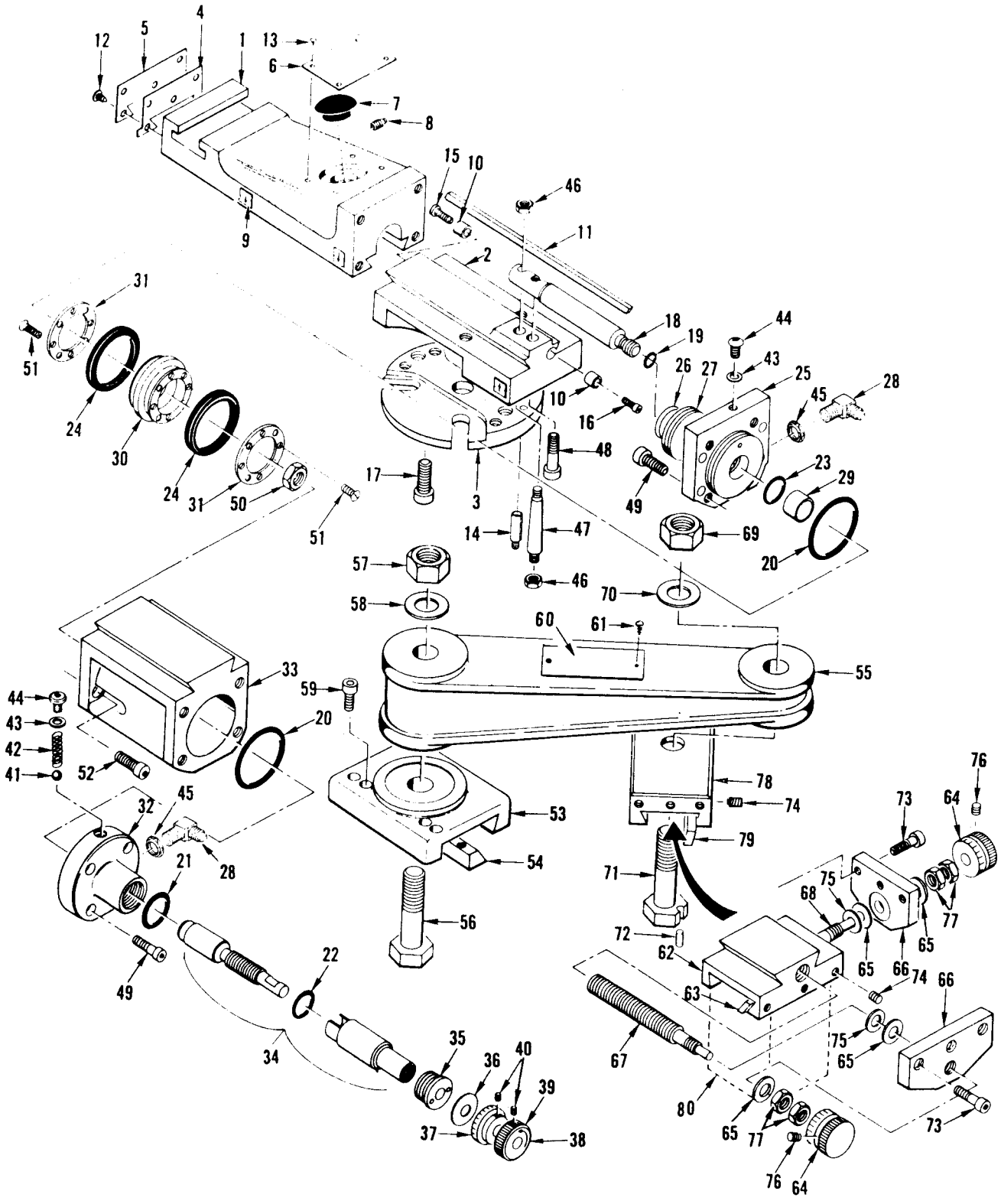


Figure 5-4. Exploded View of Mark IV Series Lathe Tracer Attachment and. . .

F3949

Index	Part No.	Description	Mfr.	Qty.
80	1060-07	Valve, Travel (See Item 53)	Tru	1
79	15210	Gib	Tru	1
78	15211	Slide, Cross Feed	Tru	1
77	172-72	Nut, Hex-Jam (5/16-24 NF)	Com	4
76	241-29	Set Screw, Nylok (#8-32 NC x 3/8)	Com	2
75	307-07	Washer, Thrust (5/16 x 5/8 x 1/16)	Bost	2
74	255-37	Set Screw, Nylok (1/4-20 NC x 5/8)	Com	8
73	148-18	Screw, Cap-Hex Soc (#10-32 NF x 1/2)	Com	6
72	185-70	Pin, Roll (3/16 Dia)	Com	1
71	40712-4	Bolt, Swivel Arm	Tru	1
70	307-32	Washer, Thrust (1/4 x 1-5/8 x 1/16)	Com	1
69	172-57	Nut, Hex (5/4 - 18 NF)	Com	1
68	15193	Screw, Long. Feed	Tru	1
67	15194	Screw, Cross Feed	Tru	1
66	15215	Plate, Mounting	Tru	2
65	303-02	Bearing, Thrust (5/16 x 3/4 x 1/16)	Bost	4
64	15192	Knob	Tru	2
63	15212	Gib	Tru	1
62	15209	Slide, Long. Feed	Tru	1
	92112	Valve Slide Assy. Model 4049-03, Lot 2 (Items 62 thru 79)	Tru	
61	201-35	Screw, Mach (#6-32 NC x 1/4)	Com	2
60	41242	Name Plate	Tru	1
59	150-20	Screw, Cap-Hex Soc (5/16-18 NC x 1)	Com	4
58	307-45	Washer, Thrust (1 x 2-1/2 x 1/4)	Bost	1
57	172-59	Nut, Hex (1 - 14 NF)	Com	1
56	42023	Bolt	Tru	1
55	40918	Arm, Swivel	Tru	1
54	42022	Gib	Tru	1
53	42021	Slide, Swivel	Tru	1
	40917	Swivel Arm Assy (Items 53 thru 61)	Tru	
2	150-58	Screw, Cap-Hex Soc (7/16-14 NC x 2-1/4)	Com	4
51	200-10	Screw, Mach.(#8-32 NC x 1/4)	Com	8
50	142-12	Nut, Flexloc - Thin (3/4 - 16 NF)	Com	1
49	150-54	Screw, Cap-Hex Soc (7/16 - 14 NC x 1-1/4)	Com	8

Index	Part No.	Description	Mfr	Qty
48	148-53	Screw, Cap-Hex Soc (1/2-20 NF x 1-3/4)	Com	1
47	40914	Pin, Taper	Tru	1
46	197-52	Nut, Hex (3/8-24 NF)	Com	2
45	199-02	Nut, Seal (1/4-18 NPT)	Fr	2
44	168-34	Screw, Cap-Hex Soc (3/8-16 NC x 3/8)	Com	2
43	116-08	Washer, Seal (Stat-O-Seal #600-001-3/8)	Pk	2
42	20171	Spring	Tru	1
41	212-09	Ball, Chrome (5/16 Dia)	Com	1
40	157-02	Set Screw, Hex Soc (#8-32 NC x 1/4)	Com	2
39	40762	Knob	Tru	1
38	50089	Emblem, Directional	Tru	1
37	40763	Collar	Tru	1
36	56293-04	Washer, Spring (5/16x15/16x1/8)	Stk	1
35	30040	Cage Retainer	Tru	1
34	30112	Valve Stem & Poppet (Includes item 22)	Tru	1
33	40905	Housing, Cylinder	Tru	1
32	40908	Head, Cylinder	Tru	1
31	60598	Retainer, Packing	Tru	2
30	40909	Piston	Tru	1
29	40912	Bearing	Tru	1
28	106-04	Elbow, 90° (3/8 SAE to 1/4 NPT)	WH	2
27	40913	Gland, Packing	Tru	1
26	223-07	Wiper, Buna - N	Com	1
25	40907	Head, Rod End	Tru	1
24	60592	Packing, Piston	Tru	2
23	246-23	Quadring, Rubber (1/8x1-1/4x1-1/2)	Min	1
22	173-51	O-Ring, Buna-N-Rubber(Parker #2-110)	Pk	1
21	175-01	O-Ring, Buna-N-Rubber(Parker #2-210)	Pk	1
20	175-31	O-Ring, Buna-N-Rubber (Parker #2-240)	Pk	2
19	173-56	O-Ring, Buna-N-Rubber (Parker #2-115)	Pk	1
18	40911	Rod, Piston	Tru	1
	40910	Cylinder & SVA Valve (Items 18 thru 52)	Tru	
17	150-09	Screw, Cap-Hex Soc (1/2-13 NC x 1)	Com	3
16	150-07	Screw, Cap-Hex Soc (1/4-20 NC x 1-1/4)	Com	1
15	150-06	Screw, Cap-Hex Soc (1/4-20 NC x 1)	Com	1
14	40015	Pin, Dowel-Expanding	Tru	2
13	164-06	Screw, Self Tapping (#4-40 x 1/4)	Com	4
12	198-11	Screw, Mach. (#8-32 NC x 1/4)	Com	5
11	40904	Gib	Tru	1
10	40002	Bushing	Tru	2
9	31702	Plate, Pointer	Tru	3
8	323-15	Fitting, Lube (1/8 Pipe Thrd)	Al	1
7	55343	Grommet, Rubber (Rubbercraft #67)	Rub	1
6	40748	Name Plate	Tru	1
5	40915	Cover, Wiper Dovetail	Tru	1
4	40916	Wiper, Dovetail Way	Tru	1
3	40903	Adapter, Compound	Tru	1
2	40902	Slide, Bottom	Tru	1
1	40901	Slide, Top	Tru	1
	40900	Slide Assembly (Items 1 thru 17)	Tru	

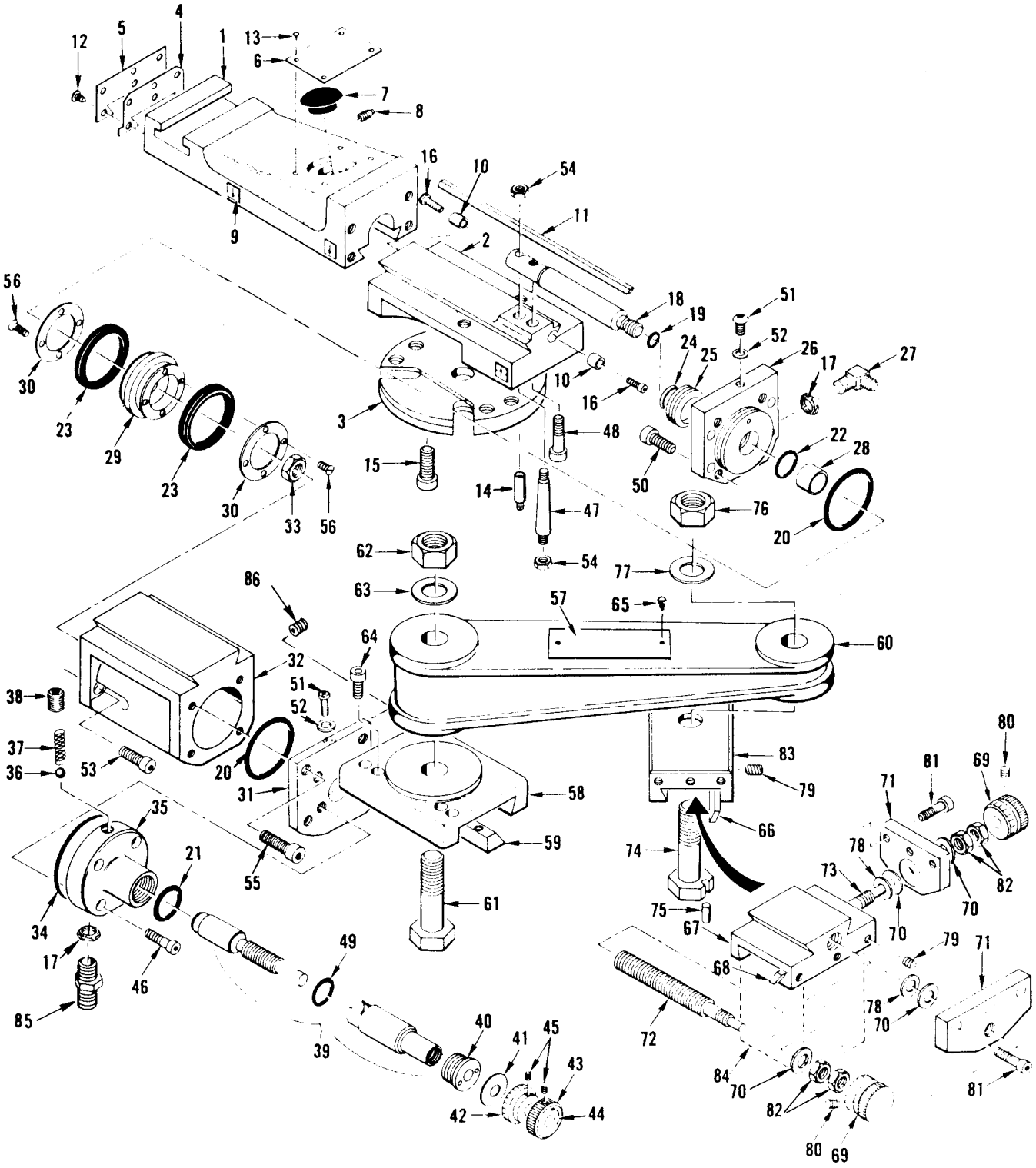
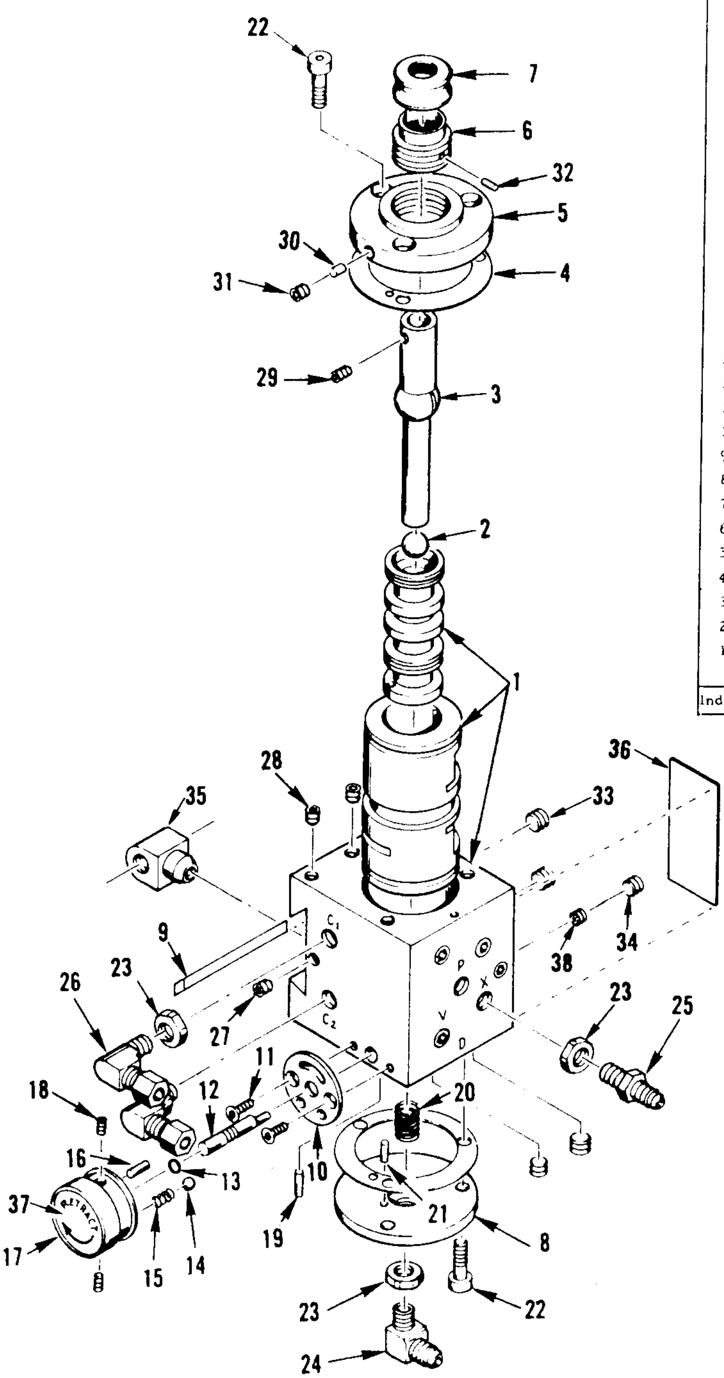


Figure 5-5. Exploded View of Mark V and VI Series Lathe Tracer Attachment

F3951

Index	Part No.	Description	Mfr.	Qty.
86	1[illegible]	Plug, Pipe [illegible]	Com	1
85	11[illegible]	Connector [illegible] Flare)	Wh	1
84	10[illegible]	Valve, Tracer (Se[illegible])	Tru	1
83	15211	Slide, Cross Feed	Tru	1
82	172-22	Nut, Hex-Jam (5/16 - 24NF)	Com	4
81	145-18	Screw, Cap-Hex Soc (#10-32 NF x 1/2)	Com	6
80	241-2[illegible]	Set Screw, Nylok (#8-32 NC x 3/8)	Com	2
79	255-[illegible]7	Set Screw, Nylok (1/4-20 NC x 5/8)	Com	8
78	30[illegible]	Washer, Thrust ([illegible])	Bost	2
77	307-[illegible]2	Washer, Thrust (3/4 x 1-[illegible] x [illegible]16)	Bost	1
76	172-[illegible]	Nut, Hex (3/4-16 NF)	Com	1
75	188-70	Pin, Roll (3/16 D[illegible])	Com	1
74	40712-4	Bolt	Tru	1
73	1519[illegible]	Screw, Long. Feed	Tru	1
72	15194	Screw, Cross Feed	Tru	1
71	15215	Plate, Mounting	Tru	2
70	303-02	Bearing, Thrust (5/16 x 3/4 x 1/16)	Bost	4
69	15192	Knob	Tru	2
68	15212	Gib	Tru	1
67	15209	Slide, Long.	Tru	1
66	15210	Gib	Tru	1
	92112	Valve Slide Assy, Model 4049-03, Lot 2 (Items 66 thru 83)	Tru	
65	201-35	Screw, Mach. (#6-32 NC x 1/4)	Com	2
64	150-20	Screw, Cap-Hex Soc (5/16-18 NC x 1)	Com	4
63	307-45	Washer, Thrust (1 x 2-1/2 x 1/4)	Com	1
62	197-59	Nut, Hex (1 - 14 NF)	Com	1
61	42023	Bolt	Tru	1
60	43518	Arm, Swivel	Tru	1
59	42022	Gib	Tru	1
58	43014	Slide, Swivel	Tru	1
57	41242	Name Plate	Tru	1
	43013	Swivel Arm Assy (Items 57 thru 65)	Tru	
56	201-53	Screw, Mach. (#8-32 NC x 3/8)	Com	8
55	150-70	Screw, Cap (Same as Item 15)	Com	4
54	172-73	Nut, Hex-Jam (3/8 - 24 NF)	Com	2
53	150-74	Screw, Cap-Hex Soc (1/2-13 NCx2-1/4)	Com	4
52	116-08	Washer, Seal (Stat-O-Seal #600-001-3/8)	Pk	2
51	168-40	Screw, Cap-Hex Soc (3/8-16 NC x 1/2)	Com	2
50	150-70	Screw, Cap-Hex Soc (Same as Item 15)	Com	4
49	173-51	O-Ring, Buna-N-Rubber (Parker #2-110)	Pk	1
48	148-66	Screw, Cap-Hex Soc (1/2-20NF x 1-1/2)	Com	1

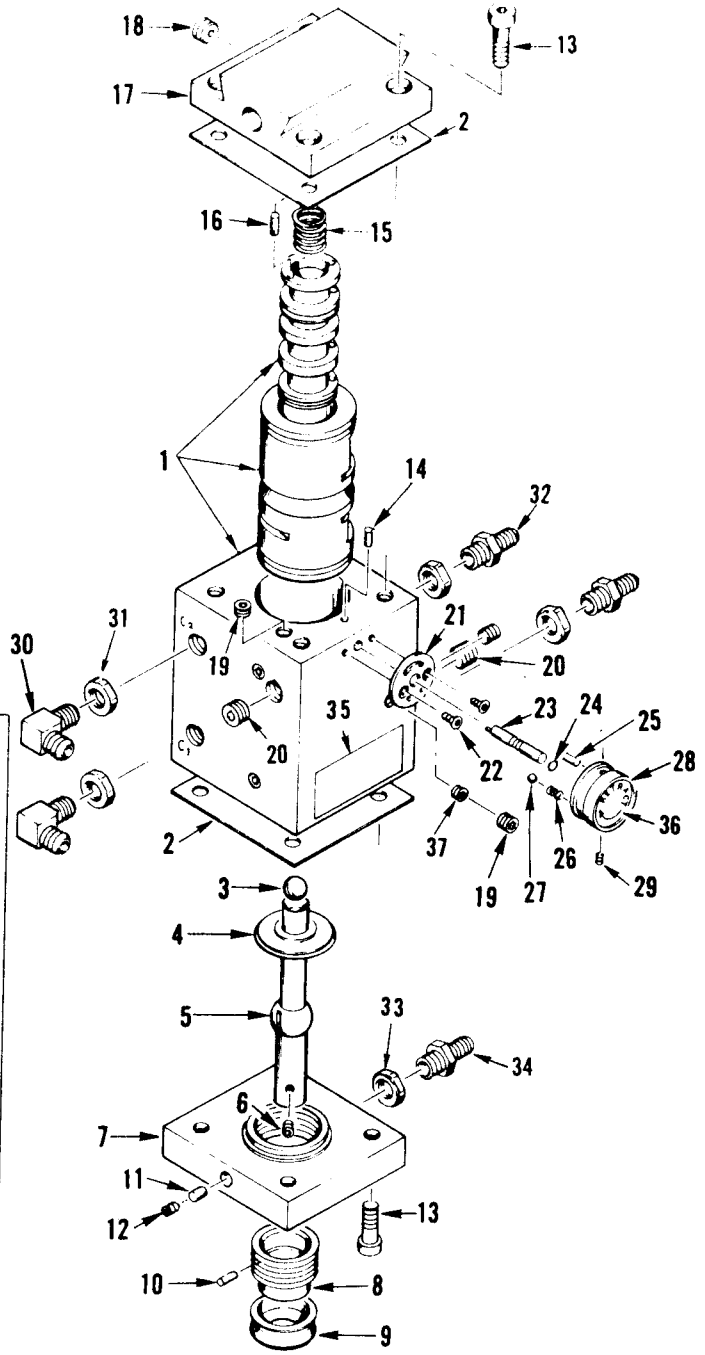
Index	Part No.	Description	Mfr	Qty
47	4[illegible]11	Pin, Taper	Tru	1
46	150-07	Screw, Cap-Hex Soc (Same as Item 16)	Com	5
45	157-02	Set Screw (#8-32 NC x 1/4)	Com	2
44	[illegible]	Emblem, Directional	Tru	1
43	40762	Knob	Tru	1
42	407[illegible]	Collar	Tru	1
41	[illegible]-4	Washer, Spring ([illegible])	[illegible]	1
40	[illegible]04[illegible]	Cage Retainer	Tru	1
39	[illegible]112	Valve Stem & Poppet Assy (Items [illegible] thru 4[illegible])	Tru	1
38	201-[illegible]	Screw, Mach. (#6-32 NC x 1/4)	Com	2
37	[illegible]	Spring	Tru	1
36	212-05	Ball, Chrome (7/32 Dia)	Com	1
35	15065	Body, Valve	Tru	1
34	175-15	O-Ring, Buna-N Rubber (Parker #2-224)	Pk	1
33	142-12	Nut, Flex-Loc (3/4-16 NF)	Com	1
32	43007 (V) 43507 (VI)	Housing, Cylinder	Tru	1
31	43012	Head, Head End	Tru	1
30	60511	Retainer, Packing	Tru	2
29	60610 (V) 60540 (VI)	Piston	Tru	1
28	40912	Bearing	Tru	1
27	120-07	Elbow, 90° (3/8 SAE to 1/4 NPT)	WH	1
26	43009	Head, Rod End	Tru	1
25	40913	Gland, Packing	Tru	1
24	223-07	Wiper, Buna-N	Com	1
23	60510	Packing, Piston	Tru	1
22	246-23	Quadring, Rubber (1-1/4 x 1-1/2 x 1/8)	Min	1
21	175-01	O-Ring, Buna-N-Rubber (Parker #2-210)	Pk	1
20	175-35	O-Ring, Buna-N-Rubber (Parker #2-244)	Pk	2
19	173-18	O-Ring, Buna-N-Rubber (Parker #2-18)	Pk	1
18	43011	Rod, Piston	Tru	1
17	199-02	Nut, Seal (1/4 - 18 NPT)	Fr	2
	43010 (V) 43510 (VI)	Cylinder & SVA Valve (Items 17 thru 56)	Tru	
16	150-07	Screw, Cap-Hex Soc (1/4-20 NC x 1-1/4)	Com	2
15	150-70	Screw, Cap-Hex Soc (1/2-13 NC x 1-1/4)	Com	3
14	40015	Pin, Dowel - Expanding	Tru	2
13	164-06	Screw, Self-Tapping (#4-40 x 1/4)	Com	4
12	198-11	Screw, Mach. (#8-32 NC x 1/4)	Com	6
11	43004 (V) 43504 (VI)	Gib	Tru	1
10	40002	Bushing	Tru	2
9	31702	Plate, Pointer	Tru	3
8	323-15	Fitting, Lube (1/8 Pipe Thrd)	Al	1
7	55343	Grommet, Rubber (Rubbercraft #C 7)	Rub	1
6	40748	Name Plate	Tru	1
5	43005	Cover	Tru	1
4	43006	Wiper, Dovetail Way	Tru	1
3	43003	Adapter, Compound	Tru	1
2	43012 (V) 43502 (VI)	Slide, Bottom	Tru	1
1	43001	Slide, Top	Tru	1
	43000 (V) 43500 (VI)	Slide Assembly (Items 1 thru 16)	Tru	



Index	Part No.	Description	Mfr.	Qty.
38	[illegible]	Orifice, Bleed	Tru	1
37	15167	Decal	Tru	1
36	20368	Name Plate	Tru	1
35	30028	Nut, Riding	Tru	1
34	191-01	Plug, Pipe (1/16-27NPTF)	Com	3
33	191-02	Plug, Pipe (1/8-27NPTF	Com	6
32	15207	Pin, Anti-Rotation	Tru	1
31	224-22	Set Screw (#10-32NF x 3/8)	Com	1
30	20028	Plug, Locking	Tru	1
29	224-19	Set Screw (#10-32NF x 3/16)	Com	2
28	281-16	Set Screw, Nylok (#10-32NF x 5/8)	Com	3
27	152-33	Set Screw (#10-32NF x 1/4)	Com	1
26	231-04	Elbow, 90° (1/4 Tube, Flareless to Male Pipe)	Wh	2
25	110-03	Connector (1/4 Tube, Flare to Male Pipe)	Wh	2
24	120-03	Elbow, 90°(1/4 tube, Flare to Male Pipe)	Wh	1
23	199-02	Nut, Seal (1/4-18NPT)	Fr	5
22	148-17	Screw, Cap-Hex, Soc, (#10-32NF x 3/8)	Com	6
21	209-26	Pin, Groove (Type "B" 3/32 x 3/8)	Com	1
20	15132	Spring	Tru	1
19	193-06	Pin, Dowel (3/32 x 3/4)	Com	1
18	153-42	Set Screw - Hex, Soc, (#8-32NC x 1/4)	Com	2
17	15169	Knob	Tru	1
16	207-48	Pin, Groove-(Type "D" 1/8 x 3/8)	Com	1
15	20526	Spring	Tru	1
14	212-05	Ball, Chrome (.1875 Dia.)	Com	1
13	173-06	O-Ring (Parker #2-6)	Pk	1
12	20016	Shaft, Retract	Tru	1
11	159-19	Screw, Cap - Hex. Soc, (#6-32 x 1/4)	Com	2
10	15168	Ring, Detent	Tru	1
9	15154	Gib	Tru	1
8	15153	Cap	Tru	1
7	15156	Boot, Dust	Tru	1
6	15205	Screw - Adjusting	Tru	1
5	15152	Nose	Tru	1
4	15164	Gasket	Tru	2
3	15203	Spindle	Tru	1
2	212-15	Ball, Chrome (.500 Dia.)	Com	1
1	93407	Body, Sleeve & Spool Assy (Matched Set)	Tru	1
	93406	Valve, Tracer (Model 1068-05 - Lot 6)	Tru	

Figure 5-6. Exploded View and Replaceable Parts List for Model 1068-05 Tracer Valve. (Used with Mark "O-A" Series)

F3953



Index	Part No.	Description	Mfr.	Req'd.
37	32836	Orifice, Bleed	Tru	1
36	15167	Decal	Tru	1
35	31295	Label, Model	Tru	1
34	110-03	Connector (1/8 Male Pipe to 1/4 Tube, Flare)	Wh	1
33	199-01	Nut, Seal (1/8-27 NPT)	Fr	1
32	110-04	Connector (1/4 Male Pipe to 1/4 Tube, Flare)	Wh	2
31	199-02	Nut, Seal (1/4-18 NPT)	Fr	4
30	120-04	Elbow, 90° (1/4 Male Pipe to 1/4 Tube, Flare)	Wh	2
29	153-42	Set Screw (#8-32NC x 1/4)	Com	2
28	15169	Knob	Tru	1
27	212-05	Ball, Chrome (.1875 Dia.)	Com	1
26	20526	Spring	Tru	1
25	207-48	Pin, Groove (Type "D" 1/8 x 3/8)	Com	1
24	173-06	O-Ring (Parker #2-6)	Pk	1
23	20016	Shaft, Retract	Tru	1
22	159-09	Screw, Cap (#4-40NC x 1/4)	Com	2
21	15168	Ring, Detent	Tru	1
20	191-03	Plug, Pipe (1/4-18 NPTF)	Com	3
19	191-01	Plug, Pipe (1/16-27NPTF)	Com	6
18	33156	Plug, Orifice (1/8-27NPTF)	Tru	1
17	15208	Plate, Mounting	Tru	1
16	207-26	Pin, Groove (Type "D" 3/32 x 3/8)	Com	1
15	15131	Spring	Tru	1
14	145-06	Pin, Dowel (5/32 x 3/4)	Com	1
13	150-05	Screw, Cap-Hex.Soc. (1/4-20NC x 5/8)	Com	4
12	152-35	Set Screw (#10-32NF x 3/8)	Com	1
11	20028	Plug, Locking	Tru	1
10	15207	Pin, Anti-Rotation	Tru	1
9	15156	Boot, Dust	Tru	1
8	15205	Screw, Adjusting	Tru	1
7	15238	Nose	Tru	1
6	224-19	Set Screw (#10-32NF x 3/16)	Com	2
5	15203	Spindle	Tru	1
4	15239	Trough, Oil	Tru	1
3	212-16	Ball, Chrome (.3750 Dia.)	Com	1
2	15273	Gasket	Tru	1
1	42882	Body, Sleeve & Spool Assy. (Mat'l to Build)	Tru	1
	42816	Valve, Tracer Model 1066-05	Tru	

Figure 5-7. Exploded View and Replaceable Parts List for Model 1066-05 Tracer Valve. (Used with Mark IIA and III Series)

Index	Part No.	Description	Mfr.	Qty.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible] M[illegible]	[illegible]	[illegible]
34	[illegible]	Connector for [illegible] Male [illegible] Flare (Wt.	[illegible]	[illegible]
[illegible]	[illegible]	Nut, Seal [illegible] 27 [illegible]	Tru	1
2[illegible]	[illegible]	Connector for (1/4 Male Pipe [illegible] Flare) Wt.		2
[illegible]	[illegible]	Nut, Seal (1/4-18 [illegible])	Tru	4
[illegible]	120-L2	Elbow, 90° [illegible] 4 Male Pipe [illegible] Flare, Wt.		2
[illegible]	[illegible]	[illegible]	Com	[illegible]
[illegible]	[illegible]	[illegible]	Tru	[illegible]
[illegible]	[illegible]	Ball, [illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	Tru	[illegible]
[illegible]	[illegible]	[illegible]	Com	[illegible]
[illegible]	[illegible]	[illegible]	Tru	[illegible]
[illegible]	[illegible]	[illegible] Detent	Tru	1
[illegible]	[illegible]	[illegible] (#4-40NC x 1/4)	[illegible]	2
21	[illegible]	[illegible] Detent	Tru	1
20	[illegible]	Plug, Pipe (1/4-18 NPTF)	Com	3
19	[illegible]	Plug, Pipe (1/16-27NPTF)	Com	5
18	55156	Plug, Orifice (1/8-27NPTF)	Tru	1
17	15205	Plate, Mounting •	Tru	1
16	207-26	Pin, Groove (Type "D" 3/32 x [illegible])	Com	1
15	15151	Spring	Tru	1
14	195-06	Pin, Dowel (3/32 x 3/4)	Com	1
13	150-05	Screw, Cap-Hex.Soc. (1/4-20NC x 5/8)	Com	8
12	152-55	Set Screw (#10-32NF x 3/8)	Com	1
11	20028	Plug, Locking	Tru	1
10	15207	Pin, Anti-Rotation	Tru	1
9	15156	Boot, Dust	Tru	1
8	15205	Screw, Adjusting	Tru	1
7	15238	Nose	Tru	1
6	224-19	Set Screw (#10-32NF x 3/16)	Com	2
5	15203	Spindle	Tru	1
4	15239	Trough, Oil	Tru	1
3	212-15	Ball, Chrome (.500 Dia.)	Com	1
2	15273	Gasket	Tru	2
1	92882	Body, Sleeve & Spool Assy. (Matched Set)	Tru	1
	92317	Valve, Tracer (Model 1066-07 - Lot 6)	Tru	

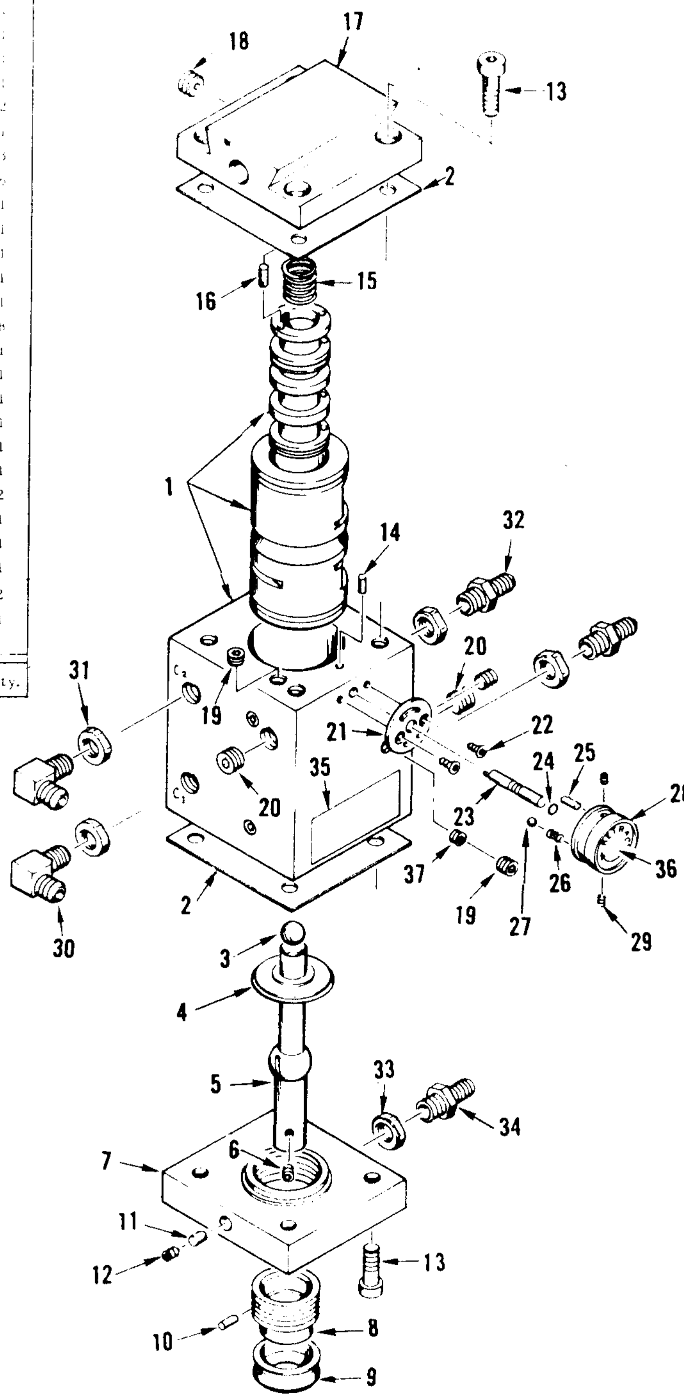
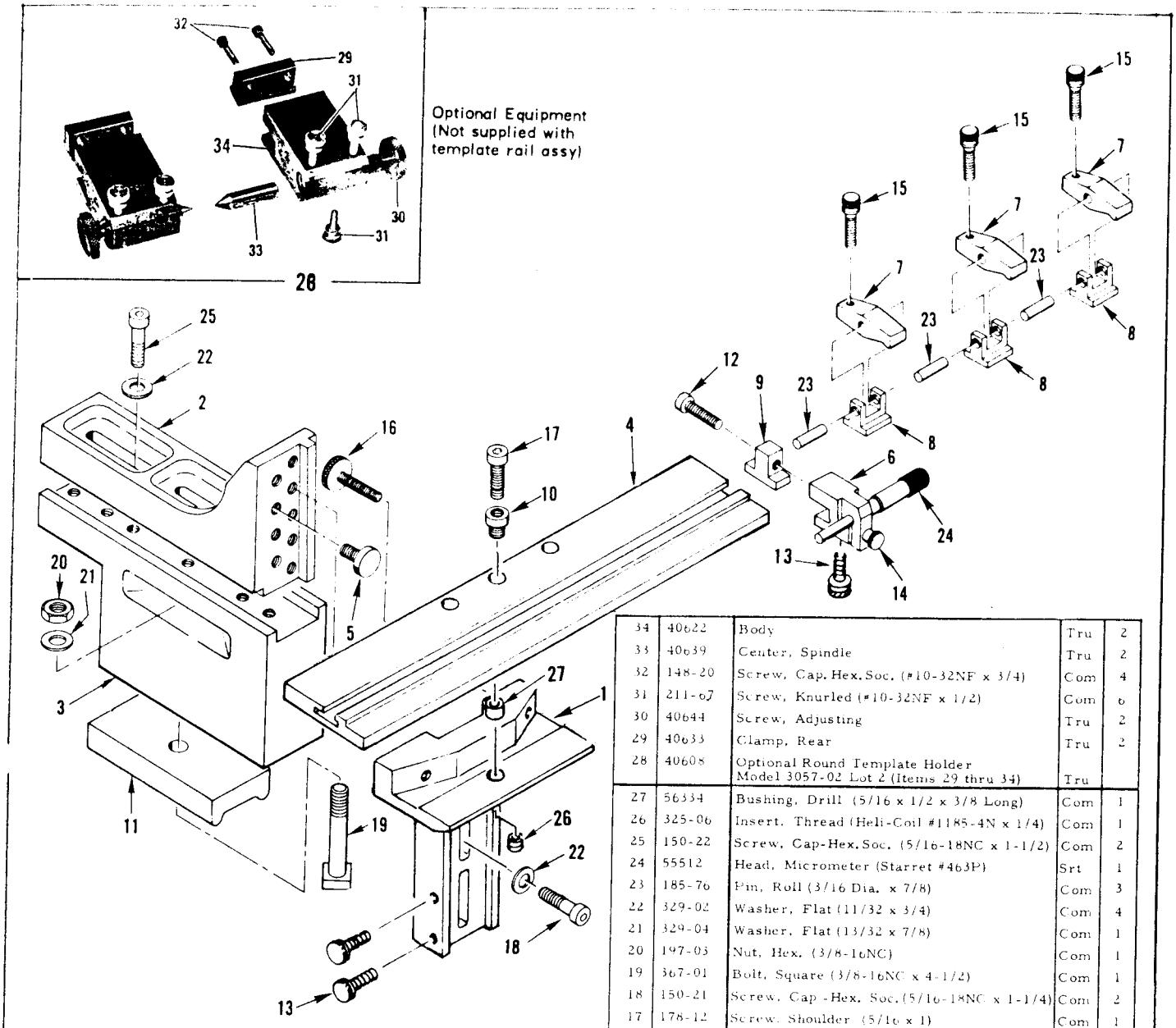
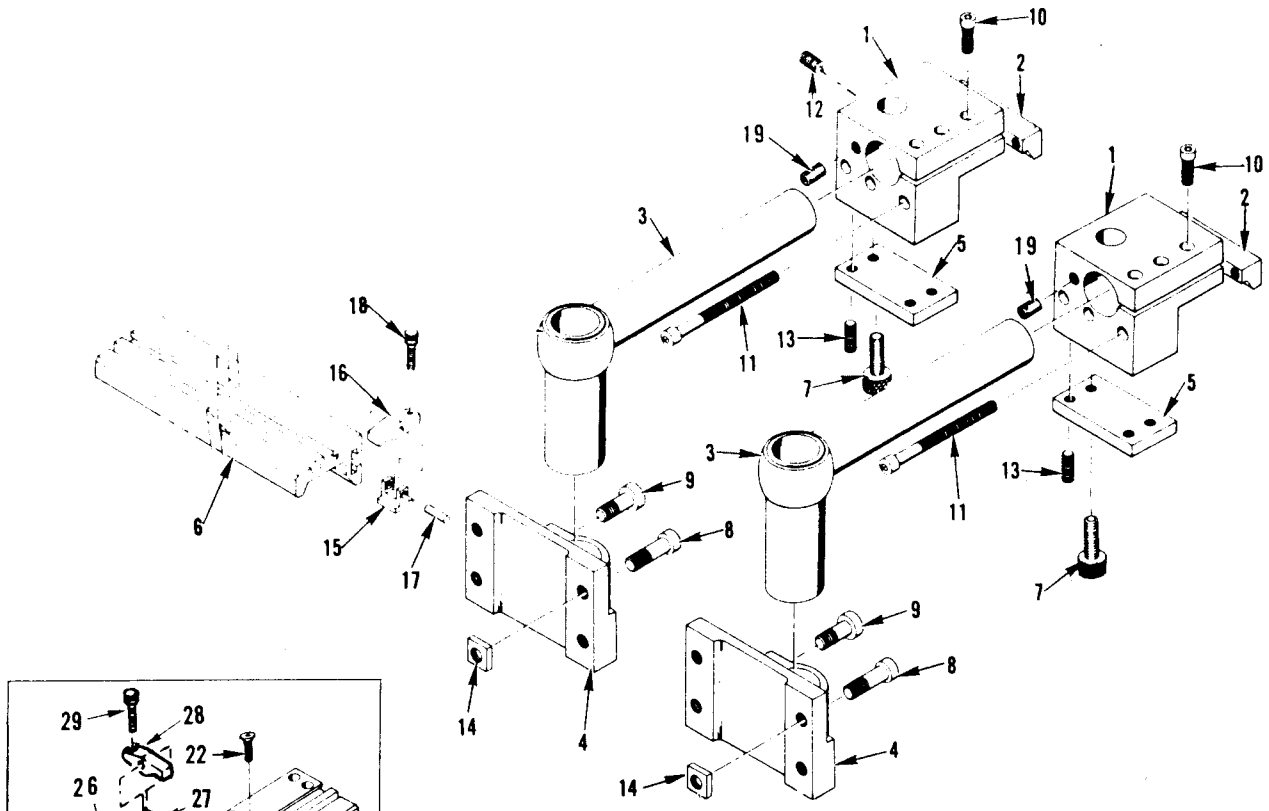


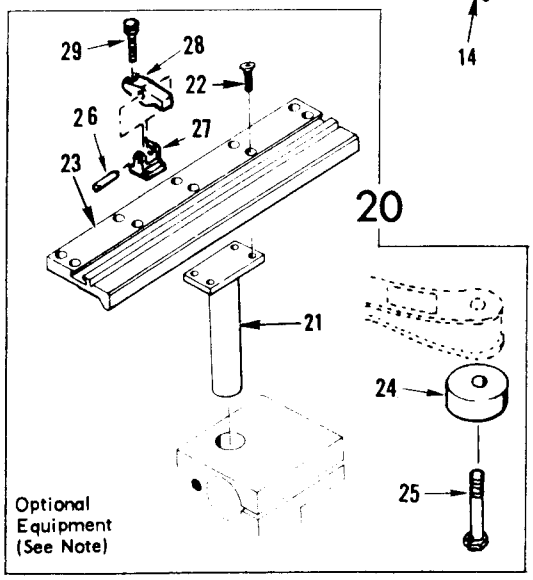
Figure 5-8. Exploded View and Replaceable Parts List for Model 1066-07 Tracer Valve. (Used with Mark IV, V and VI Series)

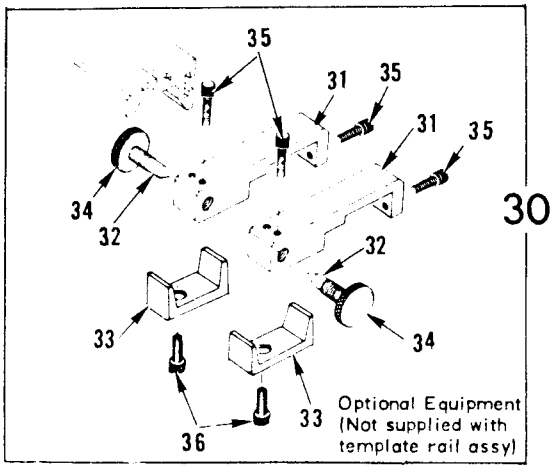


Index	Part No.	Description	Mfr.	Qty.
34	40622	Body	Tru	2
33	40639	Center, Spindle	Tru	2
32	148-20	Screw, Cap, Hex.Soc. (#10-32NF x 3/4)	Com	4
31	211-07	Screw, Knurled (#10-32NF x 1/2)	Com	6
30	40644	Screw, Adjusting	Tru	2
29	40633	Clamp, Rear	Tru	2
28	40608	Optional Round Template Holder Model 3057-02 Lot 2 (Items 29 thru 34)	Tru	
27	56334	Bushing, Drill (5/16 x 1/2 x 3/8 Long)	Com	1
26	325-06	Insert, Thread (Heli-Coil #1185-4N x 1/4)	Com	1
25	150-22	Screw, Cap-Hex.Soc. (5/16-18NC x 1-1/2)	Com	2
24	55512	Head, Micrometer (Starret #463P)	Srt	1
23	185-76	Pin, Roll (3/16 Dia. x 7/8)	Com	3
22	329-02	Washer, Flat (11/32 x 3/4)	Com	4
21	329-04	Washer, Flat (13/32 x 7/8)	Com	1
20	197-03	Nut, Hex. (3/8-16NC)	Com	1
19	367-01	Bolt, Square (3/8-16NC x 4-1/2)	Com	1
18	150-21	Screw, Cap-Hex. Soc. (5/16-18NC x 1-1/4)	Com	2
17	178-12	Screw, Shoulder (5/16 x 1)	Com	1
16	366-04	Screw, Knurled (1/4-20NC x 1/2)	Cl	2
15	211-08	Screw, Knurled (#10-32NF x 3/4)	Com	3
14	211-01	Screw, Knurled (#8-32 x 1/2)	Com	1
13	211-07	Screw, Knurled (#10-32 x 1/2)	Com	3
12	148-20	Screw, Cap-Hex.Soc. (#10-32NF x 3/4)	Com	1
11	40630	Clamp, Template Rail Base	Tru	1
10	40690	Bushing, Sine Bar	Tru	3
9	40643	Clamp, Micrometer Body	Tru	1
8	40688	Base, Template Clamp	Tru	3
7	40689	Clamp, Template	Tru	3
6	40642	Body, Micrometer Head	Tru	1
5	40641	Button, Pivot	Tru	1
4	40686	Rail, Template	Tru	1
3	40685	Base	Tru	1
2	40644	Slide, Transverse	Tru	1
1	40687	Slide, Rail	Tru	1
	40685	Template Rail Assembly (Items 1 thru 27)	Tru	

Figure 5-9. Exploded View and Replaceable Parts List for #40685 Template Rail Assembly. (Used with Mark "O-A" Series)



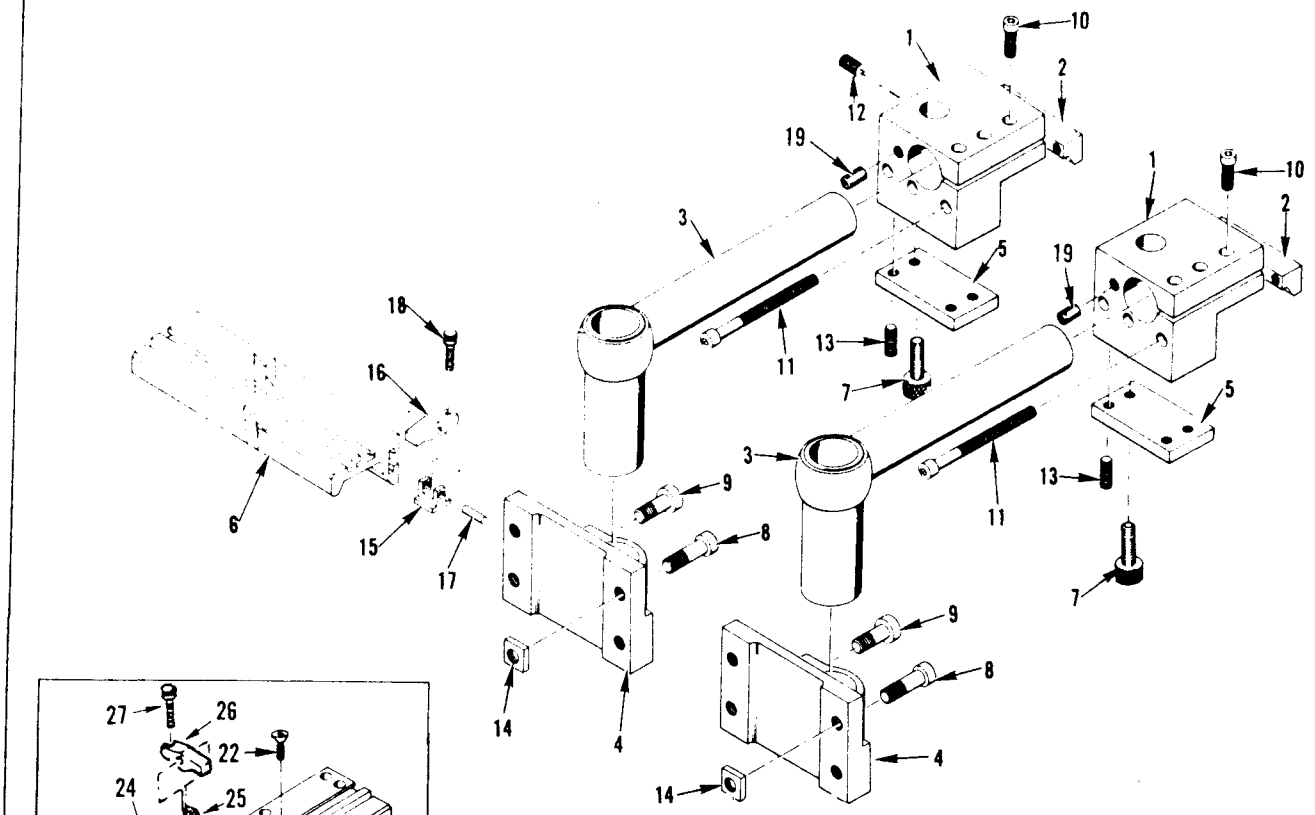


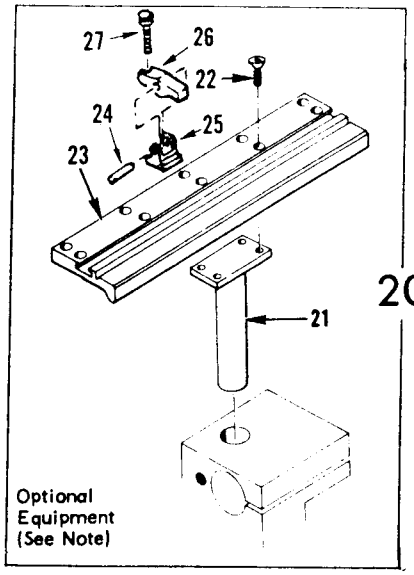


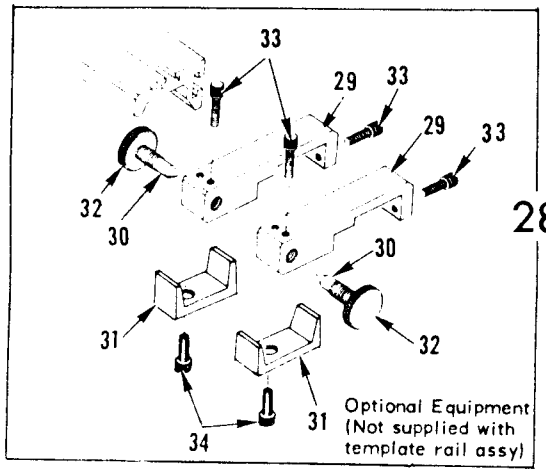
Index	Part No.	Description	Mfr.	Qty.
36	150-07	Screw, Cap Hex.Soc. (1/4-20NC x 1-1/4)	Com	2
35	211-67	Screw, Knurled (#10-32NF x 1/2)	Com	8
34	40644	Screw, Adjusting	Tru	2
33	48727	Clamp	Tru	2
32	40639	Center	Tru	2
31	48726	Body	Tru	2
30	48725	Optional Round Template Holder Model 3057-03 - Lot 2 (Items 31 thru 36)	Tru	
29	211-68	Screw, Knurled (#10-32NF x 3/4)	Com	2
28	40689	Clamp, Template	Tru	2
27	40688	Base, Template Clamp	Tru	2
26	185-76	Pin, Roll (3/16 Dia. x 7/8)	Com	2
25	33180	Bolt, Swivel	Tru	1
24	48855	Riser	Tru	1
23	43564	Rail, Template	Tru	1
22	160-04	Screw, Cap (1/4-20NC x 3/4)	Com	4
21	43563	Spud Assy.	Tru	1
20	92529	Optional Facing Template Rail Model 3058-01 - Lot 2 (Items 21 thru 29)	Tru	
19	157-35	Set Screw (1/2-13NC x 1)	Com	2
18	211-68	Screw, Knurled (#10-32NF x 3/4)	Com	4
17	185-76	Pin, Roll (3/16 Dia. x 7/8)	Com	4
16	40689	Clamp, Template	Tru	4
15	40688	Base, Template Clamp	Tru	4
14	43577	Nut, Square - Template Rail	Tru	4
13	157-36	Set Screw (1/2-13NC x 1-1/4)	Com	4
12	157-32	Set Screw (1/2-13NC x 1/2)	Com	2
11	150-29	Screw, Cap-Hex.Soc. (5/16-18NC x 3-1/4)	Com	6
10	150-06	Screw, Cap-Hex.Soc. (1/4-20NC x 1)	Com	6
9	150-22	Screw, Cap-Hex.Soc. (5/16-18NC x 1-1/2)	Com	4
8	150-18	Screw, Cap-Hex.Soc. (5/16-18NC x 3/4)	Com	4
7	150-71	Screw, Cap-Hex.Soc. (1/2-13NC x 1-1/2)	Com	4
6	33175	Rail, Template (4 ft.)	Tru	1
5	48715	Clamp	Tru	2
4	43576	Mount, Template Rail	Tru	2
3	48728	Extension Assy., Template Rail	Tru	2
2	43573	Clamp, Wedge, Crowder	Tru	2
1	43572	Base	Tru	2
	43570	Template Rail Assy. (Mark IIA & III) (Items 1 thru 19)	Tru	

Figure 5-10. Exploded View and Replaceable Parts List for #43570 Universal Template Rail Assembly. (Used with Mark IIA and III Series)

F3957







Index	Part No.	Description	Mtl.	Qty.
34	150-07	Screw, Cap-Hex.Soc. (1/4-20NC x 1-1/4)	Com	2
33	211-67	Screw, Knurled (#10-32NF x 1/2)	Com	8
32	40644	Screw, Adjusting	Tru	2
31	48727	Clamp	Tru	2
30	40639	Center	Tru	2
29	48726	Body	Tru	2
28	48725	Optional Round Template Holder Model 3057-03 - Lot 2 (Items 29 thru)	Tru	
27	211-68	Screw, Knurled (#10-32NF x 3/4)	Com	2
26	40689	Clamp, Template	Tru	2
25	40688	Base, Template Clamp	Tru	2
24	185-76	Pin, Roll (3/16 Dia. x 7/8)	Com	2
23	43564	Rail, Template	Tru	1
22	160-04	Screw, Cap (1/4-20NC x 3/4)	Com	4
21	43563	Spud Assy.	Tru	1
20	92530	Optional Facing Template Rail Model 3058-02 - Lot 2 (Items 21 thru 27)	Tru	
19	157-35	Set Screw (1/2-13NC x 1)	Com	2
18	211-68	Screw, Knurled (#10-32NF x 3/4)	Com	4
17	185-76	Pin, Roll (3/16 Dia. x 7/8)	Com	4
16	40689	Clamp, Template	Tru	4
15	40688	Base, Template Clamp	Tru	4
14	43577	Nut, Square - Template Rail	Tru	4
13	157-36	Set Screw (1/2-13NC x 1-1/4)	Com	4
12	157-32	Set Screw (1/2-13NC x 1/2)	Com	2
11	150-29	Screw, Cap-Hex.Soc. (5/16-18NC x 3-1/4)	Com	6
10	150-06	Screw, Cap-Hex.Soc. (1/4-20NC x 1)	Com	6
9	150-22	Screw, Cap-Hex.Soc. (5/16-18NC x 1-1/2)	Com	4
8	150-18	Screw, Cap-Hex.Soc. (5/16-18NC x 3/4)	Com	4
7	150-71	Screw, Cap-Hex.Soc. (1/2-13NC x 1-1/2)	Com	4
6	33176	Rail, Template (6 ft.)	Tru	1
5	48715	Clamp	Tru	2
4	43576	Mount, Template Rail	Tru	2
3	48728	Extension Assy., Template Rail	Tru	2
2	43575	Clamp, Wedge, Crowder	Tru	2
1	43572	Base	Tru	2
	43585	Template Rail Assy., Mark IV, V & VI (Items 1 thru 34)	Tru	

Figure 5-11. Exploded View and Replaceable Parts List for #43585 Universal Template Rail Assembly. (Used with Mark IV, V and VI Series)

F3958

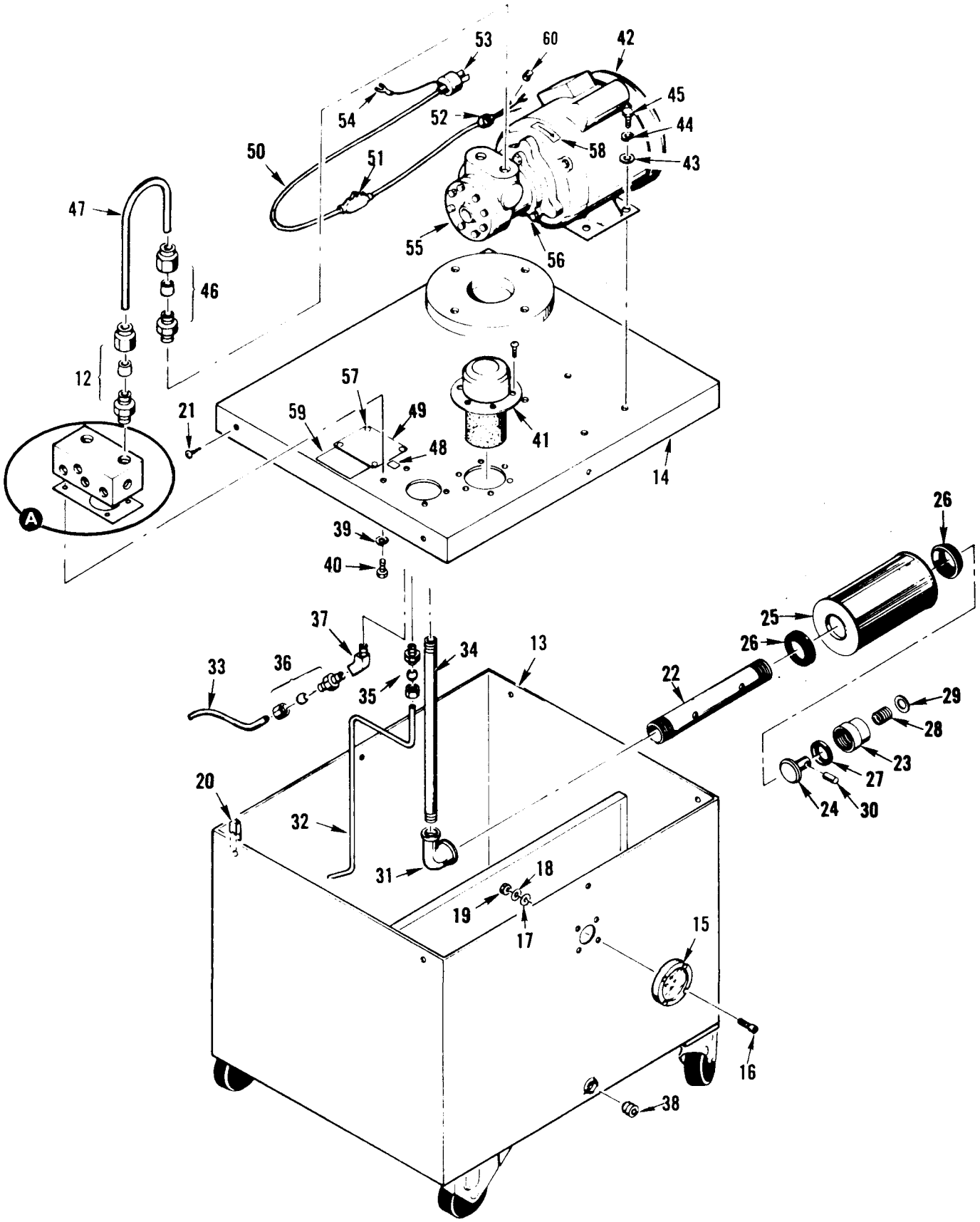
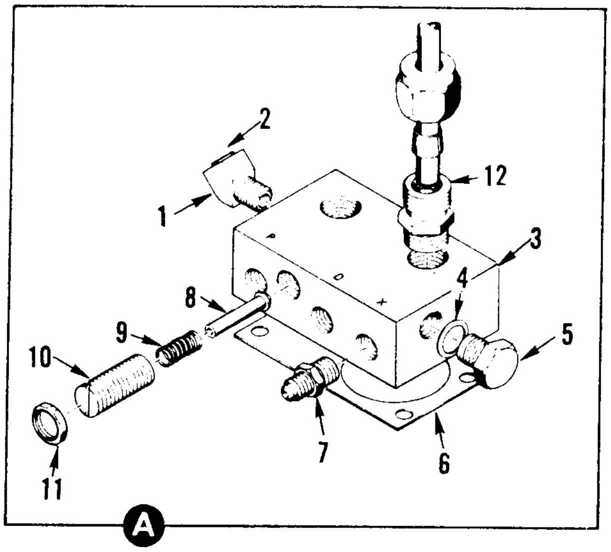


Figure 5-12. Exploded View of Model 5013-07 Hydraulic Power Unit and . . . . . .

F3959



60	163-01	Connector, Wire (#16/18 Wire)	Com	2
59	31220	Label, Model	Tru	1
58	55005	Label, Rotation	Tru	1
57	166-08	Screw, Drive (#2 x 3/16)	Com	4
56	183-02	Screw, Cap (1/4-20NC x 5/8)	Com	3
55	55002	Pump, Gear	Tru	1
Index	Part No.	Description	Mfr.	Qty.

54	[illegible]	Terminal [illegible]	[illegible]	2
53	[illegible]	Plug, Cap, Male [illegible]	Com	1
52	[illegible]	Connector, Relief [illegible]	[illegible]	1
51	[illegible]	Switch, Feed Thru (5A-250V)	Com	1
50	55191	Cord, Electric (SV-300V, 18 Str. [illegible])	Com	1
49	[illegible]	Plate, Fluid Instruction	Tru	1
48	55004	Tag - Test Port	Tru	1
47	501-7	Tube	Tru	2
46	194-12	Connector (1/2 Tube to 1/2 Male Pipe)	LZ	2
45	183-23	Screw, Cap (5/16-18NC x [illegible])	Com	4
44	147-10	Washer, Lock-Spring	Com	4
43	170-04	Washer, Flat (11/32 Dia.)	Com	4
42	55576	Motor, Electric (1/2 H.P.)		1
41	55003	Cap, Filler, Breather (PMH #A-100 w/Screws	PMH	1
40	183-01	Screw, Cap (1/4-20NC x 1/2)	Com	4
39	147-09	Washer, Lock Spring (1/4 Dia.)	Com	4
38	169-06	Plug, Pipe (3/4 Pipe)	Com	1
37	127-01	Elbow, 45° Street (1/8 NPT)	Wh	1
36	104-09	Connector (1/8 Male Pipe to 3/8 Tube, Flare-less)	Wh	1
35	104-08	Connector (1/4 Male Pipe to 3/8 Tube, Flare-less)	Wh	1
34	213-80	Nipple, Pipe (1/2 x 10 Long)	Com	1
33	31151	Tube, Vacuum - Drain	Tru	1
32	31152	Tube, Exhaust	Tru	1
31	171-04	Elbow, Reducer (3/4 x 1/2)	Com	1
30	185-32	Pin, Roll (3/32 Dia. x 1/2 Long)	Com	1
29	165-12	Washer (#14)	Com	1
28	55187	Spring (OC 62 x 299)	Tut	1
27	365-03	Packing, U-Cup (Buna-N-Rubber)	Com	1
26	365-20	Packing, U-Cup (Buna-N-Rubber)	Com	2
25	55142	Filter (Pur #P-92)	Pur	1
24	50031	Piston	Tru	1
23	50030	Body	Tru	1
22	50017	Nipple, Filter	Tru	1
21	162-48	Screw, Sheet Metal	Com	6
20	55134	Nut, Speed (Tin #C844-14A-4)	Tin	6
19	203-03	Nut, Hex (#8-32NC)	Com	4
18	165-07	Washer, Flat (#8 Large)	Com	4
17	116-02	Washer, Seal (Stat-O-Seal #600-001-8)	Pk	4
16	149-29	Screw, Cap (#8-32NC x 5/8)	Com	4
15	55062	Gauge, Sight	Gits	1
14	50186-1	Cover, Reservoir	Tru	1
13	50106	Reservoir	Tru	1
12	192-07	Connector (1/2 Tube to 3/4-16 Str. Thrd.)	LZ	2
11	199-55	Nut, Tru-Seal (9/16-18)	Fr	1
10	50198	Screw, Adjusting Relief Valve	Tru	1
9	55066	Spring, Relief Valve	Tru	1
8	50200	Plunger	Tru	1
7	110-04	Connector (1/4 Male Pipe to 1/4 Tube, flare)	Wh	3
6	50176	Gasket, Manifold	Tru	1
5	55064	Cap, Valve (Tut #30F56 x 201)	Tut	1
4	55065	Gasket, Valve Cap (Tut #30F64x201A)	Tut	1
3	50184	Manifold	Tru	1
2	169-03	Plug, Pipe (1/4 NPT)	Com	1
1	127-02	Elbow, 45° Street (1/4 NPT)	WH	1
	92485	Hydraulic Power Unit - Model [illegible] Lot 5 (Items 1 thru [illegible])	Tru	
Index	Part No.	Description	Mfr.	Qty.

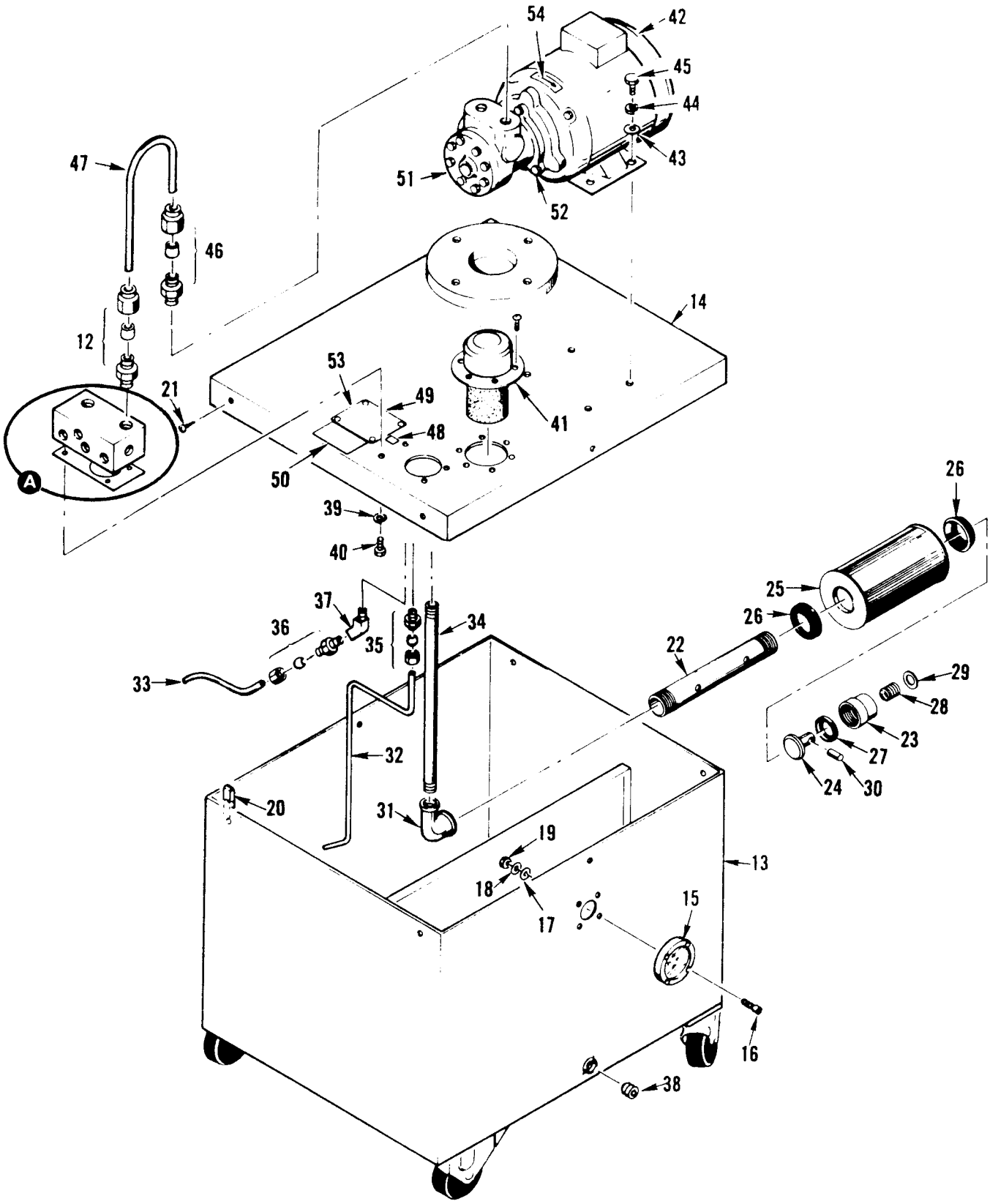
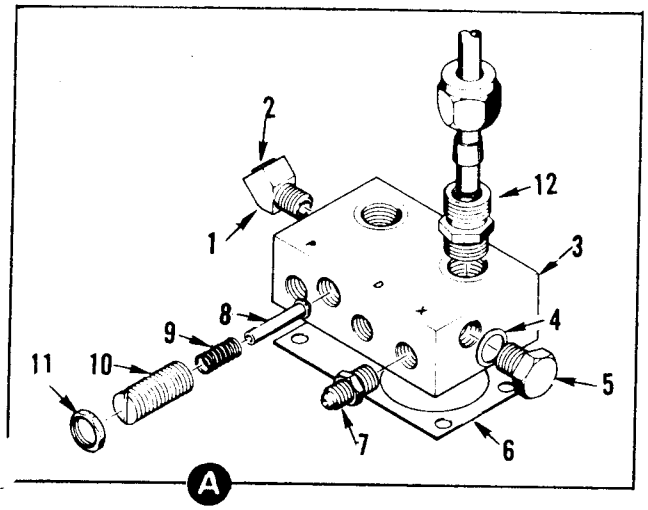


Figure 5-13. Exploded View of Models 5013-19 and -22 Hydraulic Power Unit and . . .

F3961



Index	Part No.	Description	Mfr.	Qty.
54	55005	Label, Direction of Rotation	Tru	1
53	166-08	Screw, Drive (#2 x 3/16)	Com	4
52	183-02	Screw, Cap (1/4-20 NC x 5/8)	Com	3
51	55255	Pump, Gear	Tru	1
50	31220	Label, Model	Tru	1
49	50013	Plate, Fluid Instruction	Tru	1
48	55004	Tag, Test Port	Tru	1

Index	Part No.	Description	Mfr.	Qty.
47	50157	Tube	Tru	2
46	194-12	Connector (1/2 Tube to 1/2 Male Pipe)	Lz	2
45	183-24	Screw, Cap (5/16-18NC x 5/8)	Com	4
44	147-10	Washer, Lock, Spring	Com	4
43	173-04	Washer, Flat (11/32 Dia.)	Com	4
42	55193	Motor	Tru	1
41	55006	Cap, Filler - Breather (FMH #A-136 W Screws)	FMH	1
40	183-07	Screw, Cap (1/4-20 NC x 1-1/2)	Com	4
39	147-04	Washer, Lock Spring (1/4 Dia.)	Com	4
38	168-06	Plug, Pipe (3/4 Pipe)	Com	1
37	127-01	Elbow, 45° Street (1/8 NPT)	Wh	1
36	104-04	Connector (1/8 Male Pipe to 3/8 Tube flar- less)	Wh	1
35	104-06	Connector (1/4 Male Pipe to 3/8 Tube, flare	Wh	1
34	213-80	Nipple, Pipe (1/2 x 10 Long)	Com	1
33	31151	Tube, Vacuum - Drain	Tru	1
32	31152	Tube, Exhaust	Tru	1
31	171-04	Elbow, Reducing (3/4 x 1/2)	Com	1
30	185-32	Pin, Roll (3/32 Dia. x 1/2 Long)	Com	1
29	165-12	Washer (#14)	Com	1
28	55187	Spring (OC 62 x 299)	Tut	1
27	365-03	Packing, U-Cup (Buna-N-Rubber)	Com	1
26	365-20	Packing, U-Cup (Buna-N-Rubber)	Com	2
25	55142	Filter (Pur #P-92)	Pur	1
24	50031	Piston	Tru	1
23	50030	Body	Tru	1
22	50017	Nipple, Filter	Tru	1
21	162-48	Screw, Sheet Metal	Com	6
20	55134	Nut, Speed (Tin #C844-14A-4)	Tin	6
19	203-03	Nut, Hex (#8-32NC)	Com	4
18	165-07	Washer, Flat (#8 Large)	Com	4
17	116-02	Washer, Seal (Stat-O-Seal $b00-001-8)	Pk	4
16	149-29	Screw, Cap (#8-32NC x 5/8)	Com	4
15	55062	Gauge, Sight	Gits	1
14	50186-1	Cover, Reservoir	Tru	1
13	50106	Reservoir	Tru	1
12	192-07	Connector, (1/2 Tube to 3/4-16 Str. Thrd.)	Lz	2
11	199-55	Nut, Tru-Seal (9/16-18)	Fr	1
10	50198	Screw, Adjusting Relief Valve	Tru	1
9	55066	Spring, Relief Valve	Tru	1
8	50200	Plunger	Tru	1
7	110-	Connector, (1/4 male pipe to flared tube) (-19) 110-04 (Pipe to 1/4 Tube) P, X, D. (-22) 110-07 (Pipe to 3/8 Tube, P, X,) 110-04 (D)	Wh	3
6	50176	Gasket, Manifold	Tru	1
5	55064	Cap, Valve (Tut #30F-6 x 201)	Tut	1
4	55065	Gasket, Valve Cap, (Tut #30F04 x 201A)	Tut	1
3	50184	Manifold	Tru	1
2	169-03	Plug, Pipe (1/4 NPT)	Com	1
1	127-02	Elbow, 45° Street (1/4 NPT)	Wh	1
	92085 -19)	Hydraulic Power Unit, Model 5013, Lot 5	Tru	1
	92085(-22)	(Items 1 thru 54)		

section VI
turret lathe application

6-1. GENERAL.

6-2. When a Mark Series Lathe Tracer Attachment is to be installed on a turret lathe, the attachment is custom fitted for each specific lathe by modifying existing attachment parts.

a. Figure 6-1 shows the measurements that should be made on the lathe when ordering a Lathe Tracer Attachment for a specific lathe, or when converting a Lathe Tracer Attachment for turret lathe applications.

b. Figure 6-2 shows a typical installation of a Mark Series Lathe Tracer Attachment on a turret lathe. Note that when additional height is required, a special riser is installed under the swivel arm. The special swivel plate may be attached to the lathe cross slide by two or three special T-nuts. The push-pull control on the remote retract shut-off assembly is connected to the retract shaft on the tracer valve so that the valve may be operated from the front side of the lathe. The remote metering valve is connected in the C2 hydraulic line between the cylinder and the tracer valve and is used in place of the metering valve on the attachment cylinder. For this application, the metering valve on the cylinder is turned to its full open position.

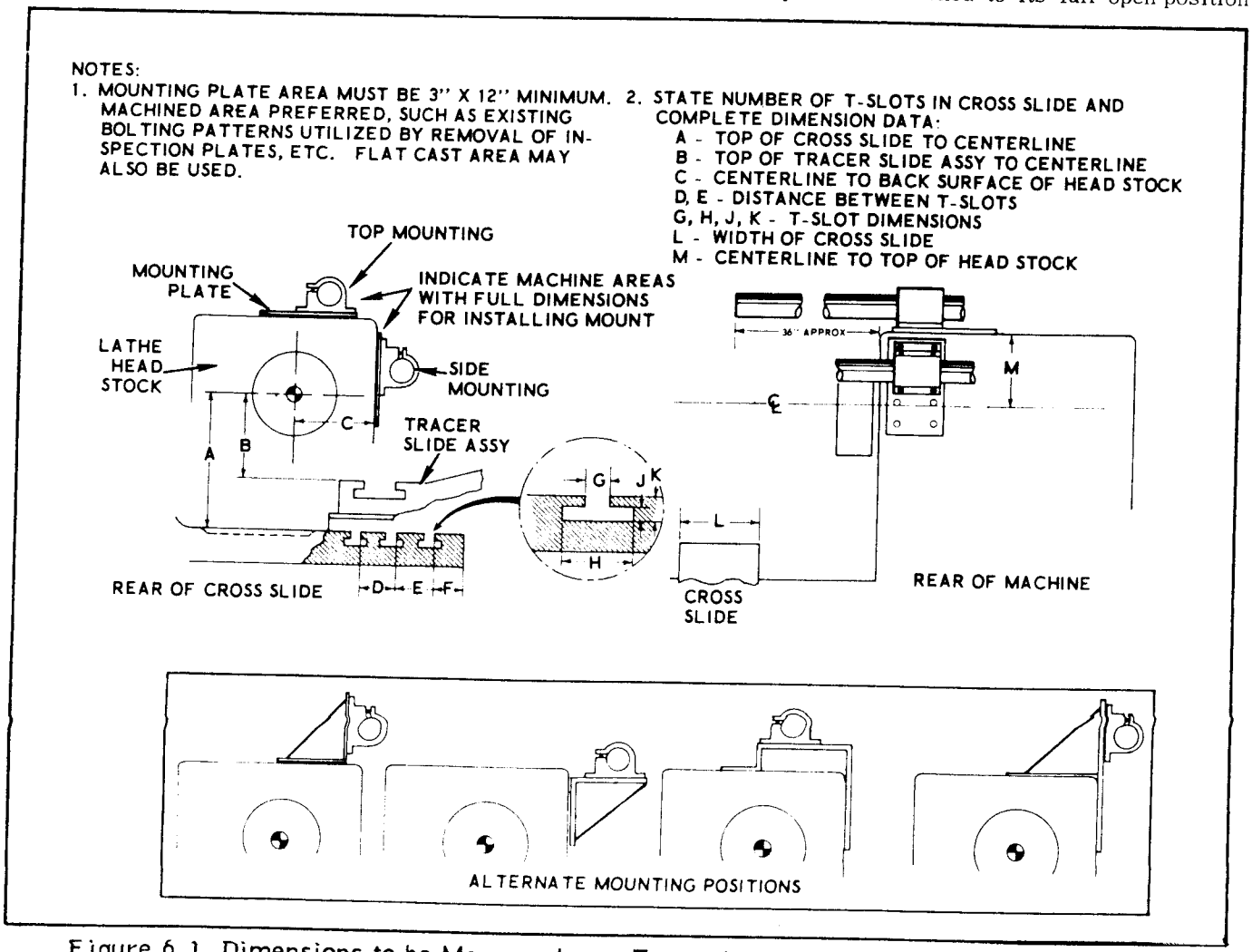


Figure 6-1. Dimensions to be Measured on a Turret Lathe for Ordering a Lathe Tracer Attachment for Turret Lathe Application

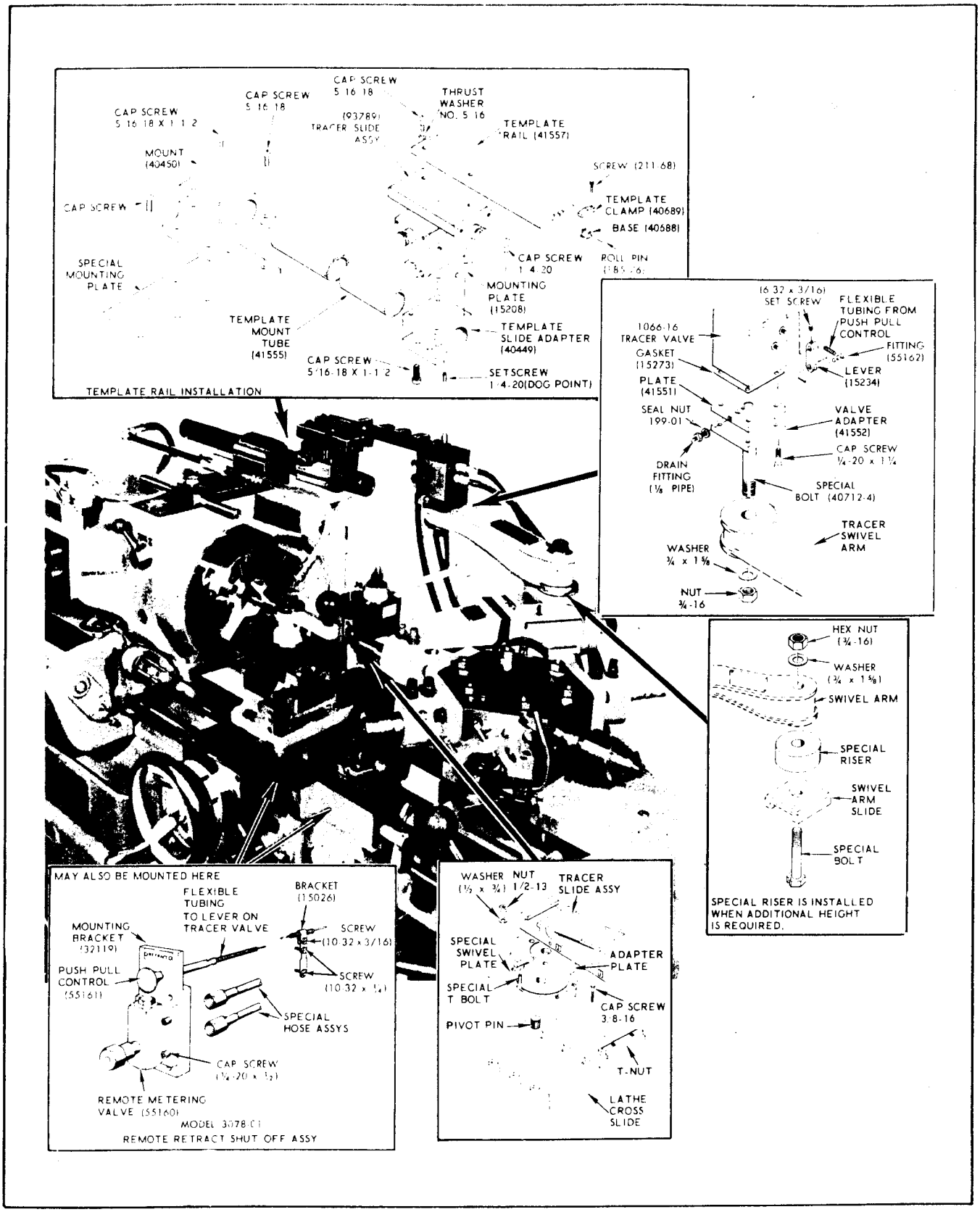


Figure 6-2. Typical Installation of a Mark Series Lathe Tracer Attachment on a Turret Lathe