



Operation
& Maintenance
of the
470 and 470_{NA}
Calibration Sine Bars

Helping the World Measure



Since 1927

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SINE BAR

Introduction

This manual covers both the 470 and the 470NA Calibration Sine Bars. The differences are clearly discussed in the procedures where there is a difference, but if you have any questions, feel free to call a Service Technician at (816) 483-3187.

General Description

As its name implies, the Brunson Model 470/470NA is basically a sine bar. The distance between the support points is such that a change in reading of 0.001 inch of the micrometer thimble causes a change in the attitude of the sine plate of 1 arc second of angle. The instrument is constructed to generate angles over a range of 1000 arc seconds in 0.1 arc second increments. Thus, the angle generator is very valuable and versatile for checking and adjusting devices used to measure or detect small angular movements.

The Differences between the 470 and the 470NA

Functionally, the 470 and the 470NA are identical, but the 470NA has some added features: banking ("stop") plates on the granite block and a lift mechanism to lift the granite off its support structure when not in use. The NA version also has a stop pin to hold the actuating arm in place when the unit is being moved or serviced.

The Base Assembly

The base is made of a dimensionally stabilized Meehanite casting. It is ribbed for rigidity and stability. A ground and lapped bearing block is used to support the two 3/4 inch balls, which functions as the fulcrum of the Sine Bar.

The micrometer and its mount are also attached to the base. The micrometer provides both the measurement of travel and the actuating mechanism for the Sine Plate Assembly. For assured accuracy, the micrometer is built with a carbide tipped spindle. The micrometer mount is open (once you remove the rest pad) so that gauge blocks can be used to verify the micrometer's accuracy. An adjustable eccentric Ball Rest Assembly in the Actuating Arm makes correcting Sine Bar calibration relatively simple. The Intermediate Lever Arm transmits movement of the micrometer spindle to the Sine Plate.

The Sine Plate Assembly

The Sine Plate is black granite. The top surface of the plate is 5 1/2 inches wide, by 24 inches long. It has been finished to a flatness of 0.0002 inches.

Holes drilled into the material have bushings epoxied in place to provide for mounting the ball rest assembly at the micrometer end of the block. The rear pivot ball mount studs are epoxied into the block as well.

The 470NA is equipped with banking plates on the pivot end and rear side to provide an accurate reference for test object placement.

The Sine Plate is removable from the base assembly and a hardwood case is provided for storage of both components.

Theory

In essence, the angle generator is a sine plate with a limited range. Unlike the sine plate, however, it is not necessary to use calibrated gauge blocks and trig tables to set the angles required. Also the angle generator is continuously variable, whereas the sine plate is variable in discrete steps only.

Tables of trig functions and gauge blocks are not required with the Brunson Angle Generator.

In the Brunson Angle Generator, the hardened steel balls resting in the bearing block are equivalent to one of the cylinders of a conventional sine bar.

The actuating arm carries a ball, which takes the place of the other cylinder. A ball rest assembly on top of this ball maintains a fixed distance between the center of the ball and the plate. When properly adjusted, the longitudinal distance between the balls is 20.625 inches. At this distance, 0.0001 inch of vertical travel on one end of the plate results in a 1 arc second change in the pitch of the plate.

The actuating arm carries two balls. The center of one is 5 inches from the pivot of the arm, and the center of the other is .5 inches from the pivot. The long portion of the arm ends under the micrometer and the short portion under the end of the sine plate assembly. Since there is a 10 to 1 ratio between the two lengths, a .001 inch vertical movement of the micrometer spindle results in a .0001 inch movement of the sine plate.

Since the micrometer is graduated in .0001 increments and accurate to less than 0.000050 inches, we are able to set the surface of the Sine Plate to 0.1 arc seconds (± 0.2 arc seconds) anywhere within the micrometer range. When the micrometer dial indicates zero in the top position, the total range of the instrument is 1000 seconds, or 16 minutes, 40 seconds of arc.

Setup and Operation

Before you remove the Base Assembly, loosen the leveling screws to release the tension on the foot pads. The three leveling screws [13] have been extended so that the leveling screw foot pads are in contact with the side of the storage case to minimize movement inside the case. Loosen the leveling screw foot pads and remove the base assembly [8, Fig 1] from the storage box.

Place the base assembly on a surface plate so that the micrometer [3] is to your right. Carefully clean the lapped surfaces of the bearing block [14], the exposed 3/4 inch and 3/8 inch ball surfaces, and the micrometer spindle tip.

Remove the Sine Plate assembly [2] from the storage box. Wipe the two exposed 3/4 inch ball surfaces and the exposed surface of the Ball Rest Assy.

Carefully rest the Sine Plate fulcrum balls on the bearing block [14] at the left end of the base. Do not allow the Sine plate assembly to fall onto the bearing block. Any impact could damage both the 3/4 inch balls and the lapped ball rest surfaces of the bearing block. Be particularly careful with the balls in the Actuating Arm.

Carefully bring the Ball Rest Assembly at the right end of the Sine Plate into contact with the 3/4 inch ball on the actuating arm [7]. Continue to lower the Sine Plate gently until the Actuating Arm comes into contact with the tip of the micrometer spindle.

Be Careful!

If you let go of the granite before it is fully at rest, the Actuating Arm will swing up and put a dent in the micrometer spindle or the 3/8 inch ball. Be sure the balls at both ends of the Actuating Arm are seated before you let go of the Sine Plate.

Set the micrometer at 0.5000 inches and place a calibrated vial level the long way on the Sine Plate. Use the leveling screws [13] in the base to bring the granite level.

Rotate the vial 90° to check the transverse axis. Use the leveling screw on the back side of the base to center the bubble.

If you can't use gravity as a reference, you can set the Sine Bar on a surface plate and use a vernier height gauge with a dial indicator.

When it's set up and leveled, the Calibration Sine Bar is ready for use. Each numbered graduation on the micrometer thimble is equivalent to 1 arc second. The intermediate graduations are equivalent to 0.1 arc second.

Disengaging the Sine Plate

(470NA only)

To protect the bearings from impact while the unit is not in use, the 470NA is equipped with lift mechanisms to hold the Sine Plate off the gauge balls. Engage them this way:

Pull out the lift arm lock pins [10] and rotate the lift arms [9] 180°. Release the lock pins and allow them to slide into the holes in the base – securing the Sine Plate in its disengaged position. The Actuating Arm can now be secured with the lock pin [6]. Figure 4 shows a breakdown of the plate lifting and stop pin mechanisms.

Maintenance

(refer to figure 2)

Very little maintenance is required. Wiping the bearing block surfaces [17] and ball rest [30] with a lightly oiled cloth, (followed by a wipe with a dry cloth to remove excess oil) is all the maintenance required. The chrome steel 3/4 inch balls and the 3/8 inch chrome steel ball under the micrometer spindle should also be wiped with a dry cloth to keep them clean.

If you ever drop the Sine Plate onto the bearing block, remove it completely from the mounting base. Unscrew the tempered brass ball retainers [35] and rotate the balls [34] to a new position. Do the same thing with the 3/8 inch ball [6] beneath the micrometer spindle.

Cleaning

(refer to figure 2)

Lift the Sine Plate assembly from the Base Assembly and place it on its side.

One at a time, unscrew the two ball retainers [35] and remove the 3/4 inch pivot balls [34] from the Sine Plate. Clean each ball, retainer and ball mount/rest [42 & 30] with an approved cleaning solvent. Lightly oil the ball mounts and the precision balls. Set the balls and retainers aside, but do not interchange them.

Unscrew the ball retainers [6 & 35] holding the balls to the actuating arm [10]. Clean the ball mounts and balls with a suitable solvent, oil them lightly, remove any excess and reassemble them.

After cleaning the granite (if necessary) wipe any excess oil from the ball mounts and rest [42 & 30], and replace the balls [34].

To clean the top surface of the Sine Plate itself, set it on a stable surface with sufficient padding to prevent damage to the pivot ball mounts or the front ball rest. If you have a 470NA, don't remove the banking plates unless you have a way to reposition them accurately. They are set perpendicular to each other to within .005 inches.

Clean the granite with a non-abrasive cleanser, then dry it and put the banking plates back on.

Clean the bearing block [17] with a suitable solvent, oil it and wipe off any excess.

Wipe off the tip of the micrometer spindle, lightly oil and remove the excess.

Gently, replace the Sine Plate Assembly on the Base Assembly.

The Micrometer

Under any but the most extreme circumstances, the micrometer will need no maintenance or adjustment. However, if something unforeseen should happen, a Brunson Service Technician will be happy to help. Call (816) 483-3187.

Calibration

(refer to figure 2)

Before you attempt the calibration of your Sine Bar, clean it thoroughly as in the preceding section.

To check and adjust the Sine Bar you'll need something capable of measuring angles more accurately than the Sine Bar itself. We use a laser.

Assuming no mechanical damage to the Sine Bar bearings or to the micrometer itself, only the ratio of movement of the Actuating Arm [10] may go out of adjustment.

When you have checked the Sine Bar at several points over the range of the micrometer (we check every 25 seconds starting at one end of the micrometer range and working to the other), evaluate the data this way:

If the readings are consistently longer than what the micrometer says they should be, loosen the set screws [11] holding the eccentric bushing [37] and use an adjusting pin to rotate it counter-clockwise.

If the readings are consistently shorter than what the micrometer says they should be, rotate the bushing clockwise.

Regardless of which way you move the bushing, a little bit goes a long way.

If the readings are not consistent, there is a mechanical problem in the bearing surfaces, the micrometer, or the test setup itself. Check all the ball retainers, rests, and the balls themselves to be sure they're not damaged. Also check all four set screws in the Actuating Arm to be sure they're snug.

When you have made an adjustment, reset your Test Instrument and retest some or all of the calibration points to assess the effects of your adjustment.

Specifications

Actuating Ratio:	10:1; micrometer spindle ball is 5.0 inches from the fulcrum; Sine Plate ball is 0.5 inches from the fulcrum.
Accuracy:	Range: 0.4 arc seconds total range error from 0 to 1000 arc seconds. Incremental: 0.2 arc seconds per 25 arc second interval.
Adjustment Point:	Eccentric bushing under 0.75 inch ball of Actuating Arm
Banking Plate Position:	Perpendicular to each other to within 0.005 inches
Bar Length:	20.625 inches between bearing contact points
Granite Flatness:	Grade B
Maximum Load:	25 pounds
Micrometer:	Accuracy: 0.000050 inches Graduations: 0.0001 inches Model: Boeckler Instruments model 4-3 CR
Range (top to bottom):	1.0000 inch, or 1000 arc seconds
Zero (Level) position:	0.5000 inches

*Brunson
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Company
Model 470*

PARTS LISTS

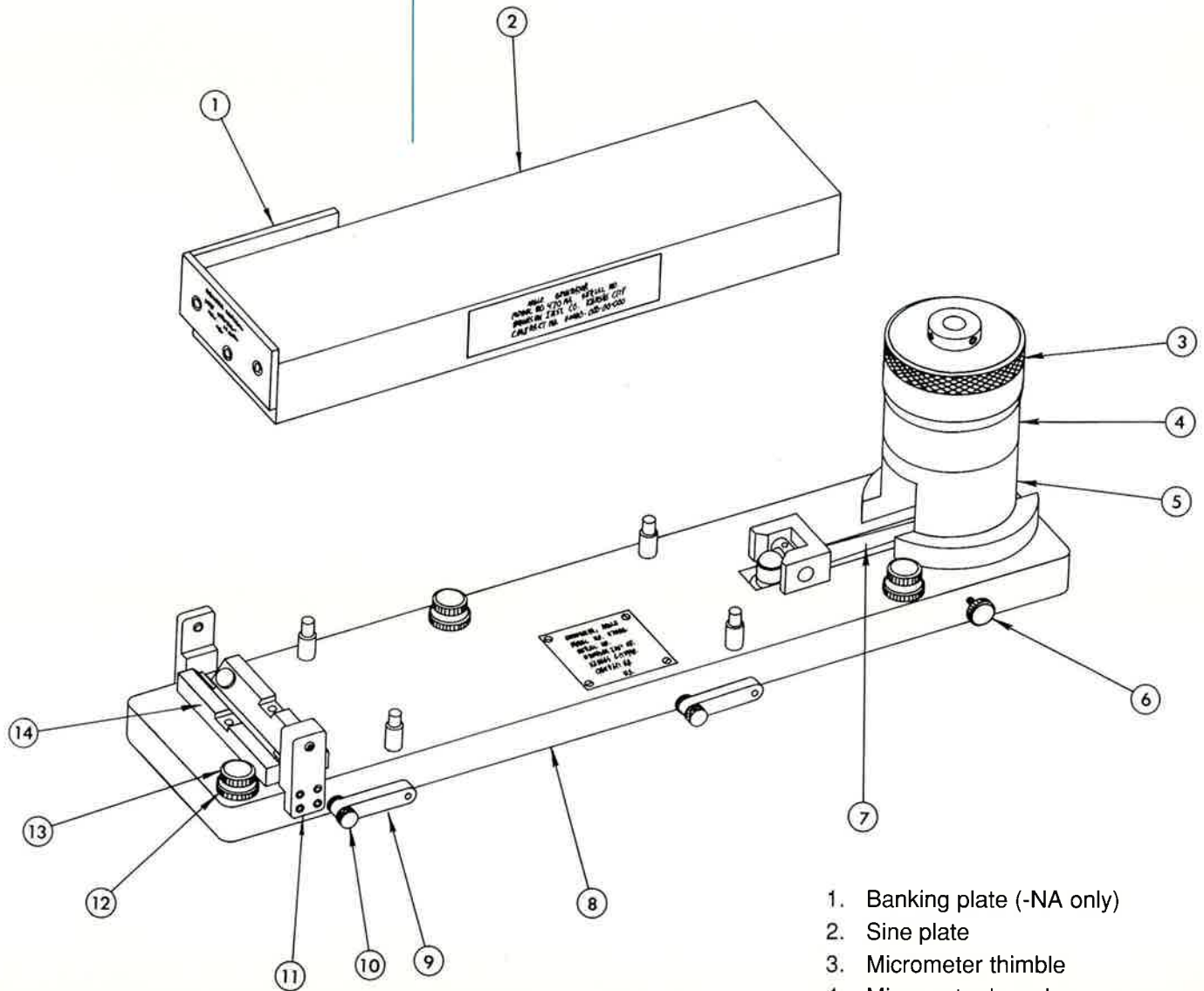


Figure 1
Nomenclature

1. Banking plate (-NA only)
2. Sine plate
3. Micrometer thimble
4. Micrometer barrel
5. Micrometer mount
6. Stop pin (-NA only)
7. Actuating arm
8. Base
9. Lift arm (-NA only)
10. Lock pin ass'y (-NA only)
11. Plate retainer
12. Lock nut (leveling)
13. Leveling screw
14. Bearing (vee) block

Figure 2

Parts

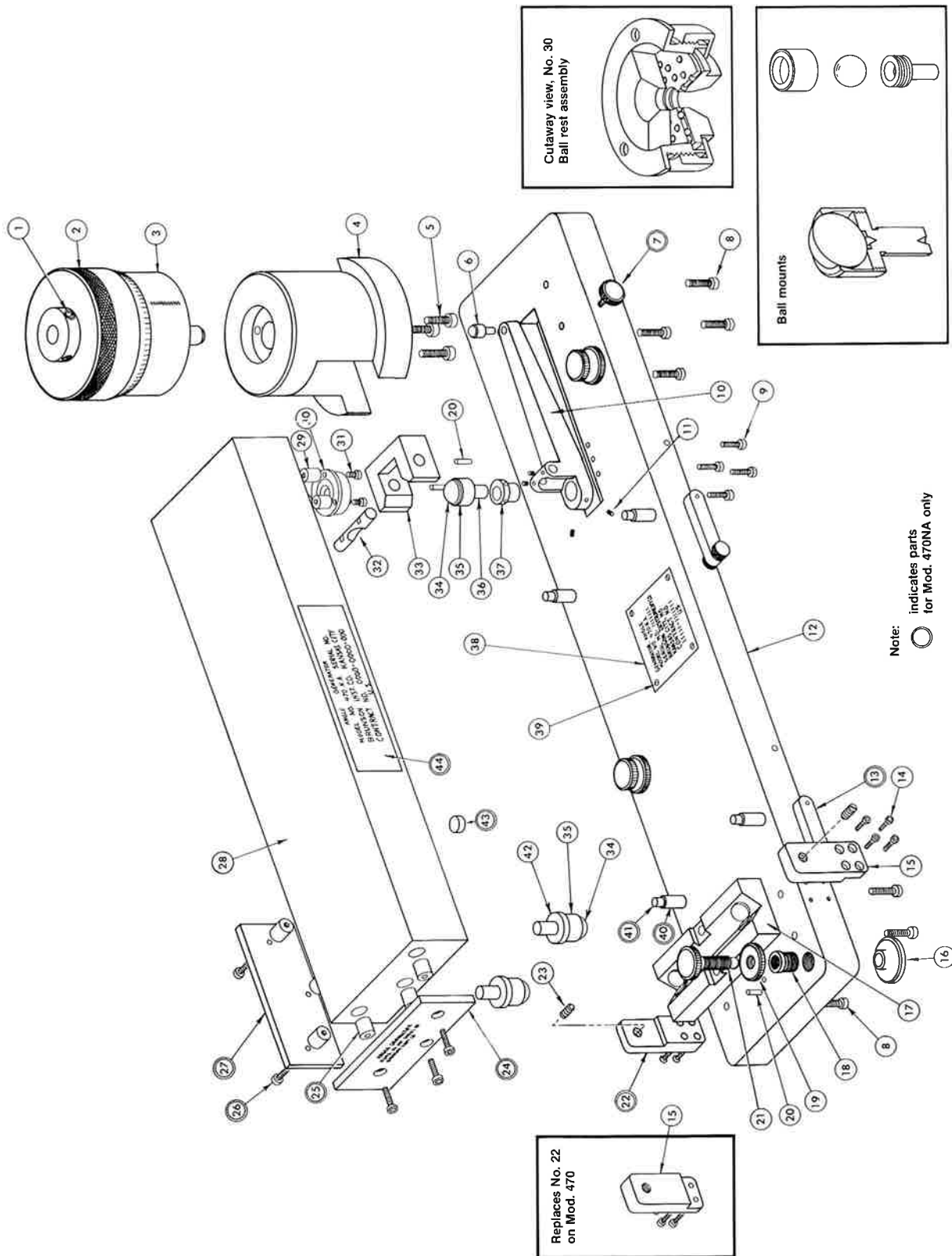
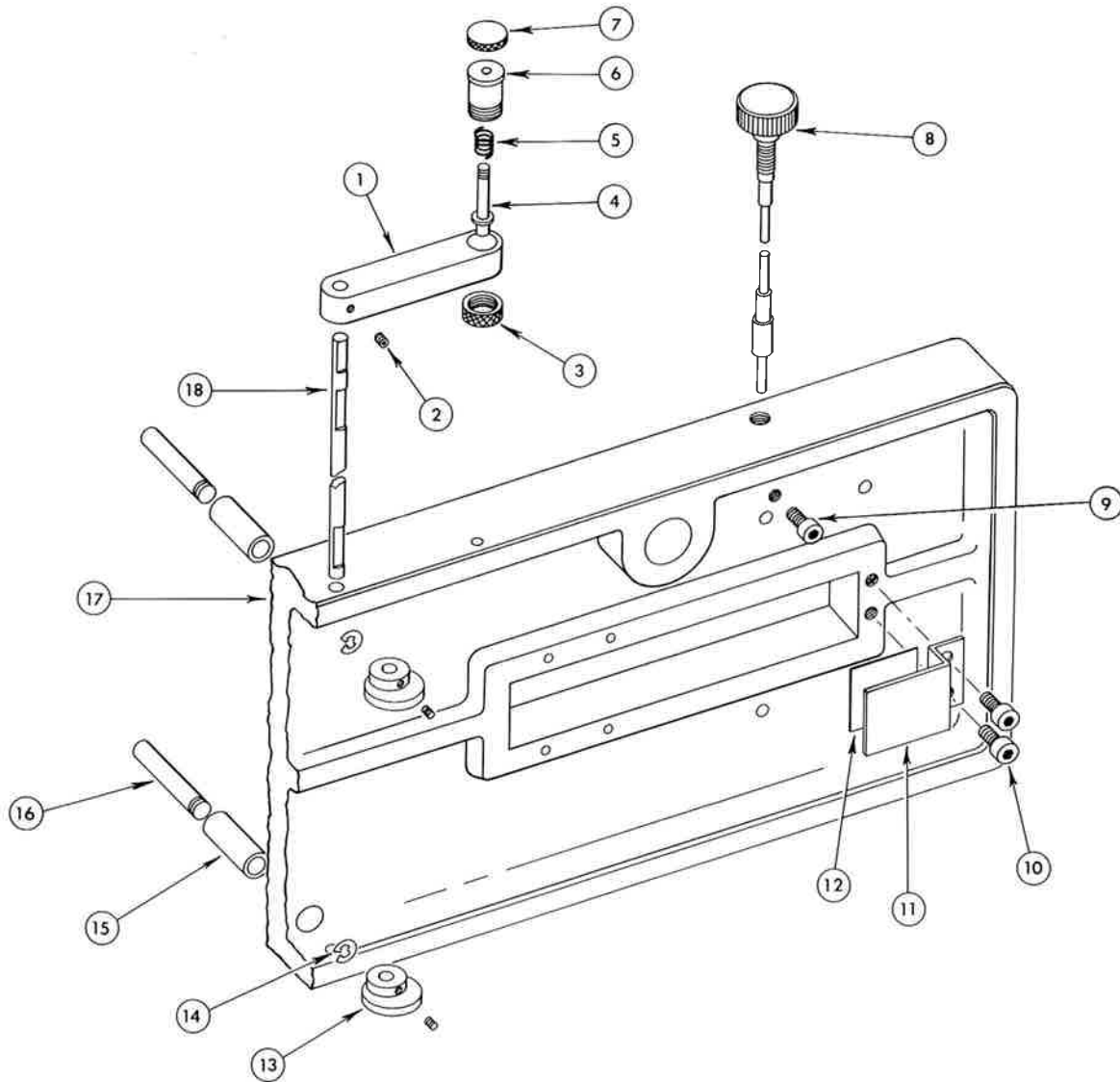


Figure 2 *Parts*

REF NO.	ITEM	PART NO.	QTY.	REF NO.	ITEM	PART NO.	QTY.
	Micrometer Assembly (1-3 below)	4682	1	25.	Insert - threaded (470NA only)	4673	6
1.	Setscrew - Thimble	3		26.	Screw - bhc #10-32 x 1/2"	comm	6
2.	Micrometer thimble	1		27.	Plate - banking side (470NA only)	4663	1
3.	Micrometer head	1		28.	Plate - sine (470NA) (470)	4661	1
4.	Micrometer mount	4656	1			6686	1
5.	Screw - shc #8-32 x 3/4"	comm	3	29.	Insert - threaded	4673-1	3
6.	Assembly - ball rest Ball - .375" dia. Retainer - .375" ball	comm	1	30.	Assembly - ball rest	4595-G1	1
		4678	1	31.	Screw - shc #5-40 x 3/8"	comm	3
7.	Pin - stop (470NA only)	4676	1	32.	Dowel	4647	1
8.	Screw - shc #10-32 x 3/4"	comm	8	33.	Block - pivot	4671	1
9.	Screw - #6-32 x 3/4"	comm	4	34.	Ball - .750" dia.	comm	3
10.	Arm - actuating	4670	1	35.	Retainer - .750" ball	4926	3
11.	Screw - shs #4-40 x 1/8"	comm	4	36.	Rest - .750" ball	4677	1
12.	Base (470NA) (470)	4668	1	37.	Bushing - eccentric	4669	1
		6447	1	38.	Plate - identification (470NA) (470)	4649	1
13.	Arm - lift (470NA only)	2151	2			11369	1
14.	Screw - shc #4-40 x 1/2"	comm	8	39.	Screw - #2 x 1/4" drive	comm	4
15.	Plate - retainer	6450	2	40.	Bushing - .250" ID x 1" drill (470NA only)	comm	4
16.	Pad - special rest	4643	3	41.	Rod - push (470NA only)	4928	4
17.	Block - bearing (vee)	4672	1	42.	Rest - upper ball	4716	2
18.	Bushing - leveling screw	6448	3	43.	Cup - rest (470NA only)	2157	4
19.	Nut - lock	2155	3	44.	Plate - ident., (470NA only) long	2158	1
20.	Dowel 1/8" x 1"	comm	4		short	2158-1	1
21.	Screw - leveling	4659	3	45.	Case - carrying	6965-G1	1
22.	Plate - retainer (470NA only)	4675	1				
23.	Plunger - spring, #10-32 x 1/2"	comm	2				
24.	Plate - banking end (470NA only)	4664	1				

Figure 3

Base - 470NA



REF NO.	ITEM	PART NO.	QTY.	REF NO.	ITEM	PART NO.	QTY.
1.	Lift arm	2151	2	11.	Stop plate	2159	1
2.	Screw - #5-40 x 1/8 shs	comm	6		(470 also)		1
3.	Nut (lock pin ass'y)	4761	2	12.	Stop rubber	2154	1
4.	Lock pin	4760	2		(470 also)		1
5.	Spring (lock pin ass'y)	4762	2	13.	Lift cam	2152	4
6.	Body (lock pin ass'y)	4758	2	14.	Snap ring (1/4" ID)	12938-2	4
7.	Knob (lock pin ass'y)	4759	2	15.	Drill bushing .250" ID x 1"	comm	4
8.	Stop pin	4676	1	16.	Push rod	4928	4
9.	Screw - stop	3149	1	17.	Base	4668	1
10.	Screw - shc #10-32 x 3/8"	comm	2	18.	Drive shaft	2153	2
	(470 also)		2				