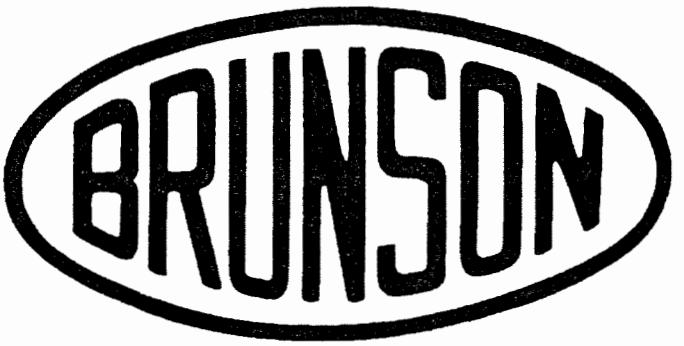


MAINTENANCE & ADJUSTMENT

OF THE

MODEL 270-BN UNIVERSAL

SHORT-RANGE CALIBRATOR

PUB270

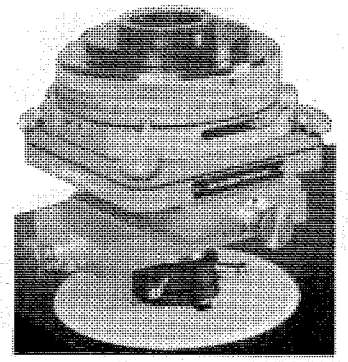
Brunson Instrument Company Model 270BN

CONTENTS

Brunson Instrument Company Model 270BN

INTRODUCTION

The Test Post



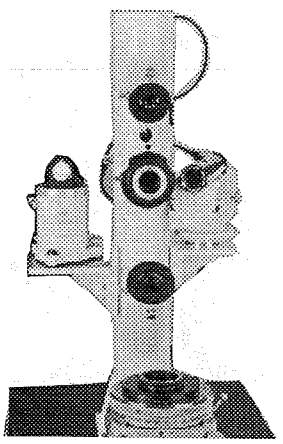
(Top to bottom) the instrument mount, the Ultradex, the leveling base, the lateral slides and the precision lift.

The Test Post consists of a precision lift, two lateral slides, a leveling base, and the Ultradex *Model A* 360° seven inch indexing table.

Together, the components of the Test Post allow you to position an instrument exactly where you want it for testing. The entire Test Post can be moved up or down with the handwheel at the left end of the unit (where the operator stands). While the Test Post gearing will not run away from you if you leave it unclamped, it will drop a little when you unclamp it. To prevent the slight drop, take up the slack with the hand wheel before you release the locking lever.

The indexing table allows repeatable azimuth positioning of test instruments in one degree increments, with accuracy of plus or minus one eighth of one arc second and repeatability of one twentieth of one arc second. It comes with several adapters to allow mounting of almost any instrument. Directly beneath the Ultradex is the Leveling Base, which allows you to level the indexing table. The entire fixture rests on two precision lateral slides and a precision lift.

The Target Post



The Target Post.

The Target Post houses two collimators, two alignment scopes and attachments for mirror and wedge placement. Together with the Optical Plummet Collimator mounted in the Test Post (not shown), these instruments provide calibration targets at a variety of focus distances and angular positions. The Model 272-15 Multiple Target Collimator, to be located in the horizontal tube, provides targets at focus distances of 4, 6, 16, 25, 50 and 75 feet, as well as infinity. The Model 272-1 Single Target Collimator, to be located in the lower inclined tube, provides a fixed infinity target. The variable focus Model 381-1 Alignment Scope, to be located in the upper inclined tube, has an auto-reflection target and provides a fixed infinity target. The Model 81 Alignment Scope, to be mounted in the adjustable Model 88-6 Leveling Base, also has an auto-reflection target and variable focus. The 287-1 Leveling Mirror provides a gravity referenced auto-reflection surface.

Lights for these instruments attach to outlets on the Target Post. Electricity for the Target Post and the Optical Plummet Collimator is controlled at the panel in the base of the Target Post.

Each of the instrument housing tubes is fitted with an adjustable mount for the Model 185 Carbide mirror or the Model 390 Wedge.

The Target Post and the Test Post are mounted in a Grade B granite Surface Plate. The Surface Plate provides a massive and rigid platform capable of holding the Target and Test Posts in motionless alignment.

The Cabinet

All these components sit on top of a reinforced steel cabinet. The cabinet houses the lower portion of the Test Post and provides storage for tools and other calibration accessories. There are five electrical outlets along the back of the cabinet (to the operator's left), just below the granite Surface Plate.

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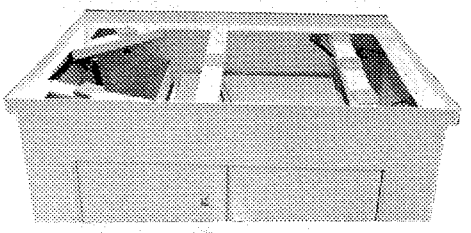
INSTALLING THE INSTRUMENTS

Leveling & Preparing the Calibrator



Level the surface plate using the two outside screws on the left and the center screw on the right.

The granite Surface Plate is supported by three leveling screws during normal use. For shipping, however, we install three extra screws, two under the corners at the right end of the plate (for a total of three on that end) and one under the center of the plate, near the base of the Target Post. These three screws help to support the granite during shipment.

After you level the cabinet, open the doors and remove the drawer for easier access to the Surface Plate leveling screws. Use the two corner screws at left and the center screw at right to lift the Surface Plate off the support screws. When the granite is resting on only three screws, level it.

Check the calibration of all the target post instruments before you install them in your Calibrator (basic calibration instructions begin on page 11). Once you have checked (and adjusted, if necessary) all the instruments, you are ready to put them into their respective housing tubes. Each tube has two locating screws (bottom and side) and two tensioning screws (top and other side) at each end to position the instruments. The Calibrator is shipped with these screws in place, so they must be backed out or removed before you can install the scopes. The mirror mounts are also shipped in place at the objective end (the end toward the operator) of each tube. Removing them will make it easier to install the scopes. Each mirror mount is attached with two Allen screws.

Installing the 272-15 Multiple Target Collimator

Take the 272-15 Multiple Target Collimator out of its case. You will notice that there are three screw heads about 5" from the objective end of the barrel, then a series of screw heads near the eyepiece end. One of the three screw heads near the objective end will exactly line up with one group of screw heads at the eyepiece end. There will probably also be a piece of tape on the barrel to mark which screws line up. The tape and the screw heads line up at the top of the reticle pattern, so be sure they're pointing straight up when you slide the instrument into its housing tube.

Insert the Collimator *eyepiece first* into the objective end of the horizontal tube. When the objective end of the scope is approxi-

mately flush with the end of the tube, reinstall all the positioning screws and center the instrument by eye.

Get the light cord from the case or the drawer and screw the light into the eyepiece. Plug the other end into the outlet directly below the horizontal tube on the Target Post. Reinstall the mirror mount on the front of the tube.

Installing the 272-1 Single Target Collimator

Take the 272-1 Single Target Collimator out of its case. You will notice that there are three screw heads about 5" from the objective end of the barrel, then some other screw heads near the eyepiece end. One of the three screw heads near the objective end will exactly line up with one of the screw heads at the eyepiece end. There will probably also be a piece of tape on the barrel to mark which screws line up. The tape and the screw heads line up at the top of the reticle pattern and should be pointing straight up when you put the instrument into its housing tube. Also notice that there is a split mounting ring on each end of the scope. The four flat places on each ring are contact surfaces for the ends of the four locating screws in each end of the tube. Before you slide the scope into the lower inclined Target Post tube, be sure that these contact surfaces are horizontal and vertical.

Insert the Collimator *eyepiece first* into the high end of the lower inclined housing tube. When the objective end of the scope is approximately flush with the end of the tube, reinstall the positioning screws at the lower end of the tube.

When the lip of the lower mounting ring is resting against the screws, the instrument will not slide out the bottom of the tube. Reinstall the positioning screws at the objective end of the tube.

Center the instrument by eye at both ends of the tube.

Get the light cord from the case and screw the light into the eyepiece. Plug the other end into the lowest outlet on the Target Post. Reinstall the mirror mount on the front of the tube.

Installing the 381-1 Alignment Scope

Take the 381-1 Alignment Scope out of its case and screw the barrel extension onto the objective end of the scope. The ring around the outside of the barrel extension will rest against the positioning screws to prevent the scope from falling out of the tube. The single knob on the side of the scope is the focusing knob, which sits just inside a hole in the mounting tube. That hole is located on the back of the mounting tube, just upward of the upright post. When you insert the alignment scope, make sure the knob and the hole line up.

Focus the 381-1 to infinity, then insert it *objective end first* into the upper end of the top inclined tube. When the objective end of the scope is near the lower end of the tube, reinstall the positioning screws so that the ring on the barrel extension rests against them. Reinstall all the remaining screws and center the instrument by eye.

Get the light cord from the case and screw the light into the

right angle eyepiece. Plug the other end into the outlet just below the upper mounting tube on the Target Post. Reinstall the mirror mount on the front of the tube.

Installing the 81 Alignment Scope

Take the 88-6 Mounting Base out of its case. Use a 3/16" Allen wrench to back off the two set screws connecting the upper assembly to the interface plate. Remove the upper assembly from the interface plate, then thread the interface plate onto the mounting platform on the near side of the Target Post. Now reinstall the upper assembly in the interface plate. Gently retighten the set screws, but stop short of scarring the bottom part of the upper assembly.

Remove the 81 Alignment Scope from its case, focus it to infinity, and put it in the vees of the Mounting Base.

Get one of the light cords from the case and screw the lighting attachment into the fixture on the eyepiece. Plug the other end into the outlet just below the mounting platform on the Target Post.

Installing the Stride Level

Take the 187-S Stride Level and its hold down strap out of the case. Pass the hold down strap under the barrel of the 81 Alignment Scope. Set the Stride Level on the barrel and secure it there with the hold down strap.

Installing the Leveling Mirror

Take the 287-1 Leveling Mirror and its base out of their case. Carefully pour the oil into the canister and put the mirror and base on the lapped platform on the back of the Target Post. Level the base according to the bulls-eye bubble over the static leg. See the 287-1 Manual (included) for maintenance, adjustment and calibration suggestions.

Installing the Ultradex & Slides

Installed, the Test Post should resemble the picture on page one.

The cross slides and the leveling plate are shipped as a unit. Installing them is very simple. Slide the unit down onto the top of the precision lift and tighten the set screws into the groove. The knobs for the slides should point one toward the front of the cabinet and one toward the operator's end.

The Ultradex itself is also a separate unit. Bolt it to the top of the leveling plate at the four corners. The release lever should be on the operator's right, toward the front of the cabinet. Positioning of these instruments is not as critical as with the Target Instruments.

Brunson Instrument Company Model 270BN

ALIGNING THE TARGET INSTRUMENTS

The object of this setup procedure is to put the Optical Plummet Collimator and the three Target Instruments into the same vertical plane, and to put the 81 Alignment Scope at 18° from that plane. When you have finished, the lines of sight through the Optical Plummet Collimator and all three Target Instruments should intersect at the same point on the vertical axis of the Test Instrument.

If you decide to use our suggestions for setting up the Calibrator, follow the sequence of calibration checks and adjustments as it is written here. These suggestions assume you will be setting the Calibrator to a calibrated reference Test Instrument whose bearings, optics and construction are at least as accurate as those of the instruments that will be set to the Calibrator.

Establish the Vertical Plane

The Optical Plummet Collimator:

Mount and precisely plumb the Test Instrument on the Test Post so that the level main scope is at the height of the Multiple Target Collimator.

Collineate the optical plummet of the Test Instrument to the Optical Plummet Collimator. For this purpose, the Optical Plummet Collimator is equipped with targets at focus distances of 4 feet, 16 feet and infinity. Because the Plummet Collimator is mounted in a fixed pivot at one end, it can't be displaced. The Test Instrument must be brought to it.

As you continue to install the Target Instruments, be sure the Test Instrument remains plumb.

After you displace the Test Instrument with the lateral slides, you should check to be sure it is still plumb. If not, plumb it up and recheck collinearity. As you continue to install the Target Instruments, be sure the Test Instrument remains plumb.

The Multiple Target Collimator:

Collineate the 272-15 Multiple Target Collimator to the level (according to the pegged coincidence vial) main scope of the Test Instrument. Remove displacement and angular error at the positioning screws in the front and back of the mounting tube. We recommend that you collimate first, then displace the 272-15 over to the Test Instrument line of sight and collineate.

Finally, to bring the reticle patterns upright, use the vertical tangent screw in the Test Instrument to move its line of sight along the vertical reticle line of the Target Instrument. Roll the Target Instrument to bring its reticle line parallel to that plane.

The Single Target Collimator:

Plunge the Test Instrument to view the 272-1 Single Target Collimator in the lower inclined mounting tube. Using the positioning screws, collimate the 272-1 to the Test Instrument as you did with the Multiple Target Collimator. Finally, use the vertical tangent screw in the Test Instrument to move its line of sight along the vertical reticle line of the Target Instrument. Roll the Target Instrument to bring its reticle line parallel to that plane.

The Alignment Scope:

Plunge up to the the 381-1 Alignment Scope in the upper inclined mounting tube. Use the positioning screws to collineate the 381-1 to the Test Instrument. Finally, bring the reticle pattern upright, as with the two instruments above.

The 81 Alignment Scope

Collimate the Test Instrument to the Multiple Target Collimator, then rotate the Ultradex eighteen degrees toward the Alignment Scope on the side platform. Collimate the Alignment Scope to the Test Instrument.

To make the initial adjustment, loosen the two Allen screws that hold the upper assembly to the interface plate and move it by hand. When the Alignment Scope is roughly aligned with the Test Instrument, tighten the Allen screws and complete the collimation using the tangent screws of the Leveling Base. Finally, bring the reticle pattern upright.

Brunson Instrument Company Model 270BN

THE 270BN OVER TIME

Maintenance

General maintenance is very limited. Occasionally wipe the instrument barrels with a lightly oiled rag to prevent any corrosion. You may notice brass powder on the Test Post intermediate tube. If so, wipe it with a lightly oiled rag.

All other mechanical components have been lubricated at the factory, and will require no further lubrication.

Operation

These are some general guidelines for operating the 270BN to best effect. If you have any problems or questions, call a Brunson Industrial Service Technician in Kansas City or Los Angeles. Numbers and addresses are on the back of this manual.

1. For strongest collimation, the centerlines of the Test Instrument and the Target Instrument should be within micrometer range of being collinear.

2. When testing Target Post instruments out of their mounting tubes, vee blocks should support the instruments in nearly the same places as the positioning screws in the mounting tubes. That way, support stresses during calibration will be nearly identical to actual use stresses.

3. On the **272-1 and 272-15 Target Collimators,** the reticle screws thread into the reticle mounting fixture to **pull the reticle** into position. Overtightening can result in a broken instrument or warped barrel. Use common sense when you have to adjust reticles.

4. On the **81 and 381-1 Alignment Scopes,** the reticle screws **push the reticle fixture** in the direction opposite of what appears to be needed. While adjusting these instruments use only enough tension to hold the reticle in place. Let common sense and experience tell you when things are too tight.

Brunson Instrument Company Model 270BN

CALIBRATING THE TARGET INSTRUMENTS

Overview

Because there are so many traps in the pursuit of accuracy, the tests and adjustments in this manual should be made only by people with proper training and experience in the use and calibration of optical measurement equipment. For the same reason, it is very important that your test results be repeatable. If you can't get the same results every time you repeat a test, the results are invalid. In that case, it is very likely that something is loose or broken somewhere–either in an instrument or in the test setup. You must find and solve that problem before you can accurately calibrate any instrument. Because optical tooling techniques are so flexible, we have provided only general suggestions for calibration. If you have any questions about these instruments, the Calibrator, or applications, feel free to call the factory for assistance at (816) 483-3187.

The 270BN has enough equipment to calibrate its own instruments. The line scopes and target scopes will require vee block instrument mounts. Use the mirror to verify infinity focus in the Reference Instrument.

In general, the Target Instruments will not have to be removed once they are installed.

Because the Target Instruments (with the exception of the Multiple Target Collimator and the Plummet Collimator) are used only at infinity, they generally do not require attention. However, if you remove one for another purpose you should certainly calibrate it. Simply put the vee block instrument mount on the Test Post and check the instrument in question against the Multiple Target Collimator. The 272-1 and 272-15 Target Scopes will have to be checked against a Line Scope in a separate setup. In either case, set the Test Instrument up so it is supported in about the same places for calibration as it will be during use.

To get the instruments out of the 270BN, follow the installation instructions backwards. To get the Optical Plummet Collimator out of the Test Post, read the instructions in the back of this manual.

Fixed-Focus Instruments

Focus:

Place the Target Collimator is a suitable mount opposite one of the Alignment Scopes included with the 270BN. Using a mirror, focus the Alignment Scope to infinity. Without changing the focus of the Alignment Scope, collimate it to the Target Collimator. If your Target Collimator does not present a clear infinity reticle image, return it to the factory for adjustment.

Reticle Position:

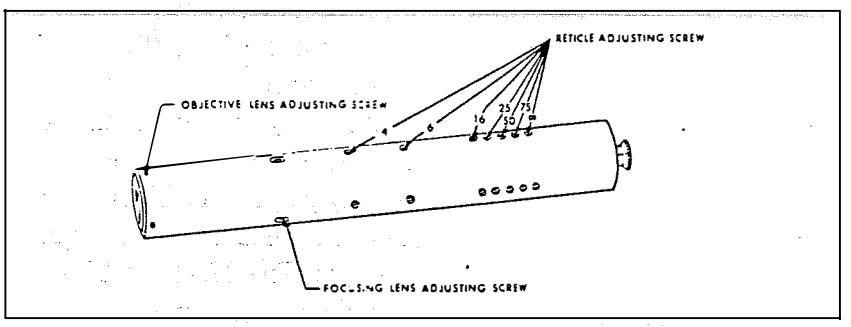
Find the focusing lens adjusting screw that lines up exactly with a set of reticle adjusting screws near the eyepiece end of the scope. This line of screws marks the top of the reticle pattern. Though instrument orientation will change, we think it's best to begin with the reticle pattern upright. We also suggest that you adjust one reticle line at a time. When you have the vertical reticle lines near its final position, begin to adjust the horizontal. Alternate between the two reticle lines until both stay in proper registration through the entire cycle. Though the axes of adjustment affect each other and can be adjusted at the same time, we think most people will find it easier to correct only one reticle line at a time.

This adjustment procedure is designed primarily for 272-15. The basic principles found here are applicable to any fixed focus instrument, provided you know the quality of the barrel surface.

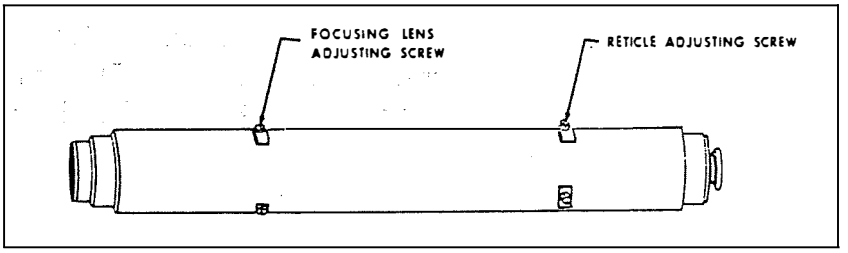
To begin, precisely collimate the Target Instrument to the Reference Instrument. Roll the Target Instrument 180° and check for registration error in the vertical reticle line. Observed error is twice the actual error. If the error found is greater than your application will allow, correct it this way:

It is possible to remove all the noticeable error from the 272-15. However, your accuracy requirements may not demand such precise target adjustment.

1. Remove half the observed error using the tangent screws in the Reference Instrument mount. Remove the other half at the reticle positioning screws of the Target



The 272-15 Multiple Target Collimator.



The 272-1 Single Target Collimator.

Instrument (see p. 12). Bear in mind that these screws thread into holes in the reticle fixture and pull the reticle into position.

2. When you have corrected the error, roll the Target Instrument to see the effects of your adjustment.

3. As you get the first reticle line close to its final position, roll the Target Instrument 90° to bring the horizontal reticle line into the vertical position.

4. Check and adjust the second reticle line exactly as you did the first.

Continue the cycle of checking and adjusting until the Target Instrument reticle image remains within the test parameters you require through the entire rotation.

The target on the objective lenses of the Multiple Target and the Single Target Collimators is inscribed directly on the objective lens. **Do not adjust these targets.** *Doing so will necessitate the recalibration and adjustment of the entire instrument.*

5. When you have finished with the infinity reticle image, focus on the nearest target of importance in your application and displace the Reference Instrument to bring its reticle image into registration with that target.

6. Correct any tilt in the target reticle line by carefully moving the reticle adjusting screws.

7. Verify that the Reference and Target Instruments are still collimated, then roll this target in as you did the infinity target, displacing (instead of repointing) the Reference Instrument to remove half the observed error.

When a near and a distant target are completely adjusted, buck in to the two targets. Assuming your Reference Instrument line of sight is straight, you can simply focus on an intermediate target and adjust it into registration with the reference. As a precaution, when you have finished adjusting the Target Instrument, roll it 180° and recheck all the targets. Observed error will be twice the actual error.

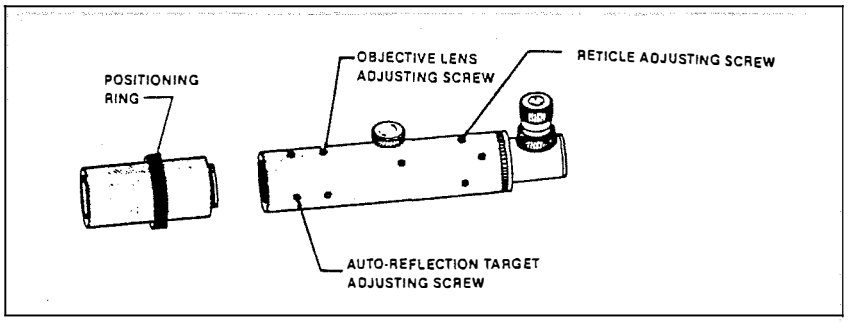
Variable Focus Instruments

The 381-1 and 81 Alignment Scopes can be checked most easily against the Multiple Target Collimator. However, only the autoreflection target and reticle of the Alignment Scopes are adjustable. Line of sight errors at intermediate focal lengths are induced by serious mishandling and must be corrected at the factory.

Check and adjust the reticle:

Set the Test Instrument to infinity and make the same tests and adjustments that you did with the fixed-focus instruments.

Look at the drawing below to see which screws to adjust. Bear in mind that these screws push against each other. Adjust the reticle by loosening one side and tightening the other. As with the target collimators, you may find it easier to adjust the reticle in one axis at a time.



Though size and eyepieces differ, the adjusting screws of both Alignment Scopes are as shown above.

Actual straightness error should not be more than one arc second (two arc seconds as observed). At focal distances shorter than 17 feet, actual error should not exceed .001".

To get to the adjusting screws in the 81 Alignment Scope, you will have to dig the protective putty out of the screw holes.

When you have checked (and adjusted if necessary) the reticle of the Alignment Scope, you can check the straightness of the line of sight.

To check line of sight straightness, buck in on the infinity reticle image and one of the near targets in the Multiple Target Collimator, then check registration with a target at an intermediate distance. For highest accuracy, check as many intermediate targets as possible. Finally, roll the Alignment Scope 180° and recheck all the tested targets.

If you observe more than two arc seconds of straightness error (actual error: one arc second or .001" at targets closer than 17 feet) return the instruments to the factory for repair.

Check the auto-reflection target:

Autocollimate the Test Instrument. Without moving the Test Instrument, focus on the auto-reflection target. If the reticle image is not registered on the auto-reflection target, use the target positioning screws to bring the target into register with the reflected reticle image.

To check, roll the Test Instrument 180°.

The Stride Level

To adjust the 187-S Stride Level to its highest degree of accuracy, mount it on the instrument it will be used to level.

The first check (below) is to be sure that the tubular vial is parallel to the axis of the Stride Level legs. When that's true, you can check and adjust the relationship of the vial to gravity.

Check vial parallelism:

1. With the adjusting openings facing you, put the Stride Level on the barrel of a suitable instrument. Use the

bullseye bubble to position the Stride Level at top dead center over the arc of the instrument barrel. Use the tangent screws in the instrument mount to bring the Stride Level into coincidence.

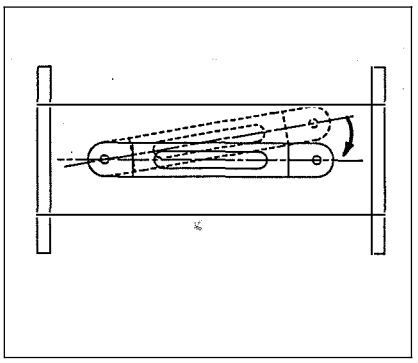
The bullseye bubble in the top of the Stride Level will move 0.1" for each 15 arc minute change in its attitude. Push the Stride Level over just far enough to move the bubble out of the bullseye.

2. With the adjusting openings facing you, push the Stride Level away from you enough to move the bubble out of the bullseye. In its new position, the tubular vial should still be level. If not, make a note of which side of the split bubble is higher and remove the Level.

Correct vial parallelism:

On the right end of the Stride Level (as you look at the side with the adjusting openings) there are two positioning screws that hold the coincidence vial parallel to the vees. One screw is on the front, through a small hole in the face plate. The other screw, which is the same size, is about half an inch inside the back of the casing, under a larger Allen head cover screw. The vial is very sensitive, so a little adjustment goes a long way. The positioning screws don't need to be much tighter than snug.

To make this adjustment, the top brass nut on that right stud has to be loosened.



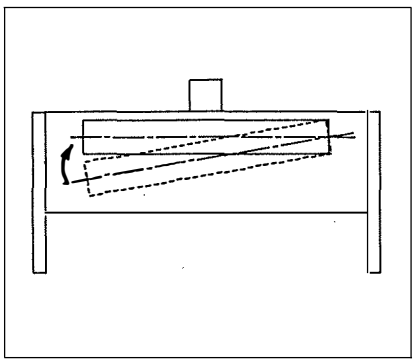
The first adjustment will bring the vial parallel to the longitudinal axis.

1A. If the bubble was higher on the left side, bring the right side toward you by loosening the back positioning screw and tightening the front positioning screw.

1B. If the vial was higher on the right side, push the right side away from you by loosening the front positioning screw and tightening the back one.

2. To check your adjustments, put the Stride Level back on the instrument and repeat the test.

3. Gently snug the brass nuts on the right side and re-check to verify parallelism.



Use the round brass adjusting nuts on the left end to level the vial over the vees.

When the bubble stays in coincidence in both the top dead center and the off positions, you can check the vial with respect to the vees.

1. Put the Stride Level in the top dead center position on the instrument barrel, then bring it into coincidence using the tangent screws in the instrument mount.

2. Reverse the Stride Level on the barrel of the instrument (again bringing it to top dead center with the bullseye level) and record any observed error in coincidence.

To correct error:

1. Remove half the error with the tangent screws in the instrument mount. To remove the other half, tighten and/or loosen the brass adjusting nuts located at **the left end** of the vial.

Do not use the nuts at the right end to adjust the vial. The set screws you adjusted in the parallelism check (above) bear against the right stud and thus prevent level adjustment at that end.

2. Reverse the Stride Level and recheck the coincidence bubble.

Repeat the cycle of checks and adjustments until the Stride Level stays in coincidence in either position on the instrument. Finally, recheck parallelism.

The Remaining Instruments

The **Leveling Mirror** is shipped with its own manual, which includes calibration suggestions. The **Variable Wedge** can't be adjusted in the field. Send the wedge back to the factory for calibration and certification.

After all the other instruments are set up, check the orientation of the **Micrometer Target** by bringing a Test Instrument into focus on it. If the Target lines are not horizontal and vertical, correct them simply by turning the front of the housing.

The **Ultradex** can't be adjusted in the field. Return it to AA Guage in Ferndale, Michigan for calibration every two years.

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APPENDIX

Removing the Optical Plummet Collimator

Before you begin, you will need a platform to hold up the motor assembly while the Collimator is removed from the bottom of the Intermediate Tube.

1. Unplug the 270BN to avoid shock hazard.

2. Unscrew the lighting attachment from the Optical Plummet Collimator and disconnect the motor wiring. Mark each connection so you can put it back when you're finished.

Remove the cabinet bottom for easier access to the Allen screws.

3. Use an Allen wrench to loosen the eight cap screws holding the motor mounting plate to the bottom of the plummet adapter tube. Support the motor assembly from below as you remove these screws.

4. Gently lower the motor assembly, tilting it around the gears to avoid damaging them.

5. Mark the orientation of the bottom of the Intermediate Tube and the top of the tube holding the Collimator (called the adapter tube) so you can put it all back together exactly as it is now. Also note the orientation of the eyepiece end of the scope.

The lock ring should be no more than hand tight.

6. Loosen the lock ring above the plummet adapter tube and unscrew the entire tube and collimator assembly. Be careful as you unscrew the inch or so of thread from the Intermediate Tube. It's heavy.

7. Mark the orientation of the Optical Plummet Collimator in the adapter tube so you can put them back together exactly as they are now.

8. Remove the positioning screws and spring-loaded tensioning screws from the end of the adapter tube.

9. Rest the adapter tube objective-end down on a workbench and remove the four socket head cap screws holding the spherical mount in the objective end of the adapter tube. Remove the Collimator from the tube.

10. Before you remove the positioning ring from the eyepiece end of the Collimator, mark its position so you can put it back the way it is. Next, unscrew the entire light adapter assembly from the barrel, loosen the four set screws holding the positioning ring on the barrel, slide the ring off and replace the light adapter.

11. Unscrew the cap ring from the objective end of the barrel and slide the spacer ring off.

12. Loosen the two set screws and remove the Spherical Mount from the Collimator.

Brunson Instrument Company Model 270BN

PARTS LISTS

Table of Figures

Included with your 270BN you should have:

Target Post	Model 81 Alignment Scope	2600-G2	1
	Model 88-6 Mounting Base	2979-G5	2
	Model 381-1 Alignment Scope	3200-G1	1
	Model 272-15 Multiple Target Collimator	4475-G4	1
	Model 272-1 Single Target Collimator	8865-G1	1
	Model 390 Variable Wedge	11362-G1	1
	Model 185 Chrome Carbide Mirror	5202-G1	1
	Model 187-S Stride Level	5740-G1	1
	Model 287-1 Leveling Mirror	9390-G1	1
Test Post	AA Gage Ultradex	13202	1
	Model 235-5 bronze instrument mount	6384	1
	Model 235-14 white instrument mount	11025	1
Accessories	Spanner Wrench	12618-1	1
	Adjusting Wrench, Precision Lift	12816-G1	1
	Power Cord	11130-G1	1
	Collimation Lights:		
	81	7868-G5	
	381-1	7868-G5	
	272-15 & Micrometer Target	7868-G6	
	272-1	7868-G4	
	Miscellaneous Pieces included with each instrument		

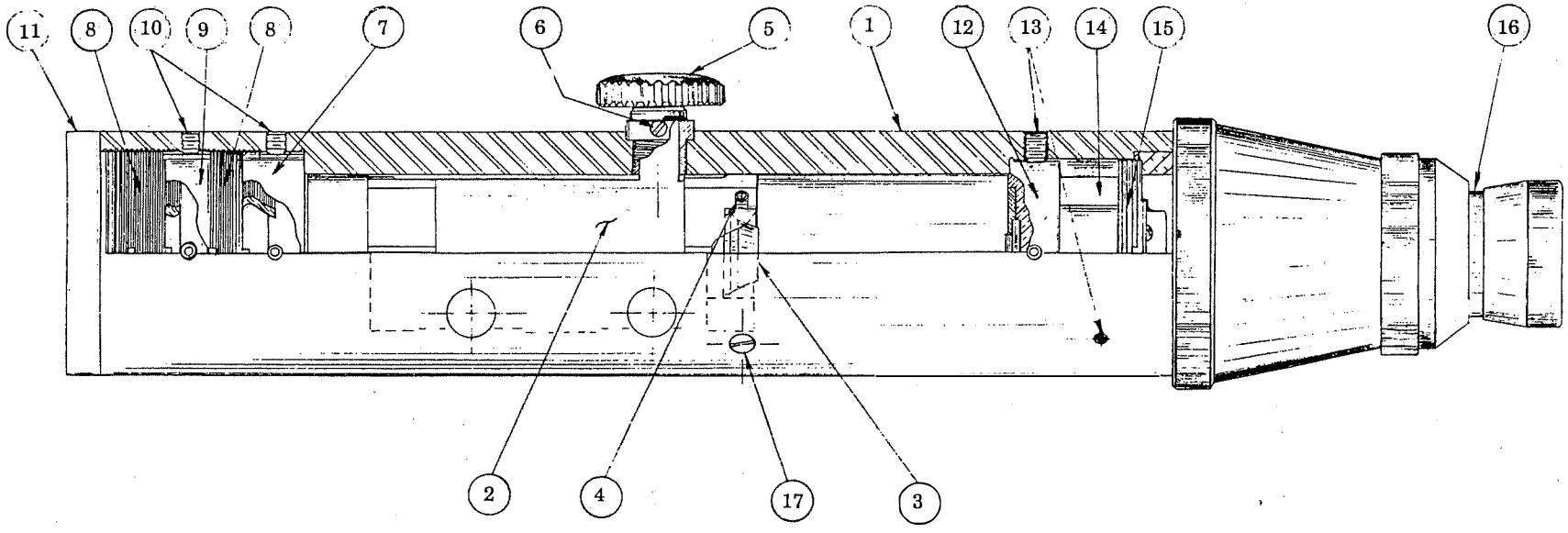


figure 1

Model 81 Alignment Scope

1.	Barrel & Pinion Ass'y.	2632-G1	1
2.	Focus Slide Ass'y.	2615-G1	1
3.	Focusing Lens Ass'y.	2770-G1	1
4.	Screw: 4-48 X 1/4 SHFP	Comm.	4
5.	Pinion Ass'y.	5051-G2	1
6.	Screw: 2-56 x 1/8 FHB	5022	1
7.	Objective Lens Ass'y.	2620-G1	1
8.	Retainer	2604	2
9.	Auto-reflection Target Ass'y	2621-G1	1
10.	Adjusting Screws	2613	8
11.	Objective Cap	2629	1
12.	Reticle Ass'y.	2769-G2	1
13.	Adjusting Screws	2614	8
14.	Erector Lens Ass'y.	2622-G1	1
15.	Retainer	2628	1
16.	Eyepiece Ass'y.	2450-G1	1
17.	Cover Screw, focusing lens adj.	5199	4

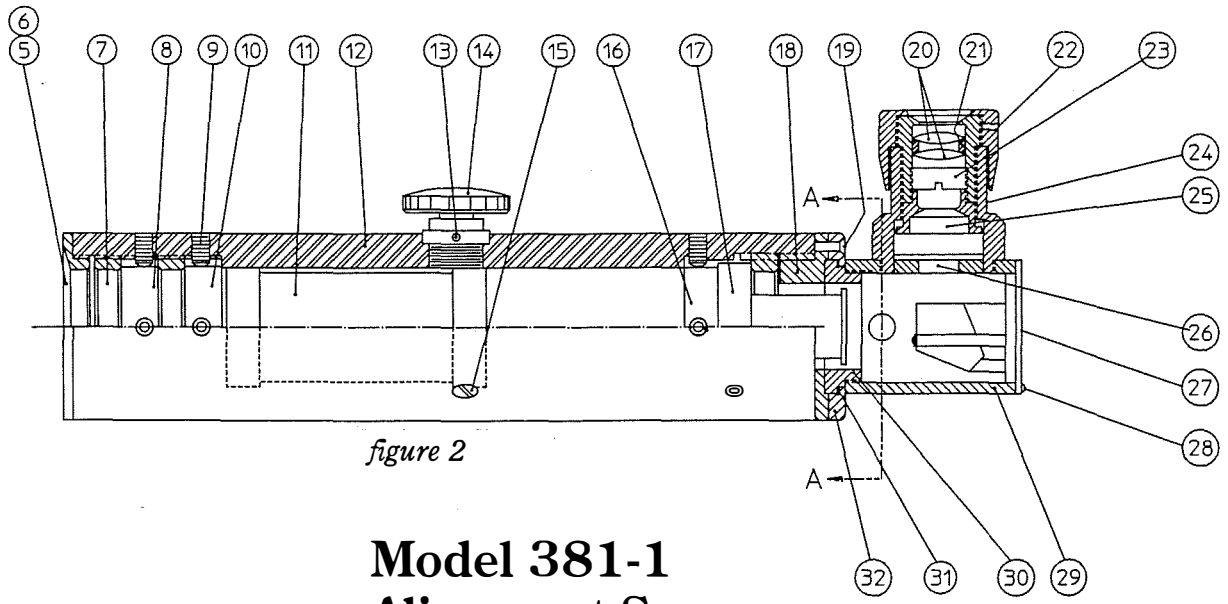


figure 2

Model 381-1 Alignment Scope

1-4	*not shown*		
5.	End Cap	2901	1
6.	Barrel Extension (not shown)	11176	1
7.	Retainer	2902	3
8.	Auto-reflection Target	2903-G1	1
9.	Screw: 8-36 x 1/4 SHS	Comm.	16
10.	Objective Lens	2908-G1	1
11.	Focusing Slide	2910-G1	1
12.	Barrel	2919-G1	1
13.	Screw: 1-72 x 1/8 SHS	Comm.	1
14.	Focusing Pinion Ass'y.	2922-G1	1
15.	Cover Screw	5199	4
16.	Reticle Ass'y.	6538-G1	1
17.	Erector Lens Ass'y.	3201-G1	1
18.	Adapter	3206	1
19.	Screw: 2-56 x 1/4 FH	Comm.	4
20.	Lens	5293	2
21.	Spacer	2493	1
22.	Screw: 0-80 x 1/16	Comm.	1
23.	Retainer Ring	2820	1
24.	Lapping Ass'y.	5593-G4	1
25.	Diaphragm	2821	1
26.	Light Stop	3204	1
27.	Prism Mount	5932-G4	1
28.	Screw: 0-80 x 3/16 RH	Comm.	4
29.	Prism Housing	6540	1
30.	Bearing	2499	1
31.	Spring	2538	1
32.	Retainer	2496	1

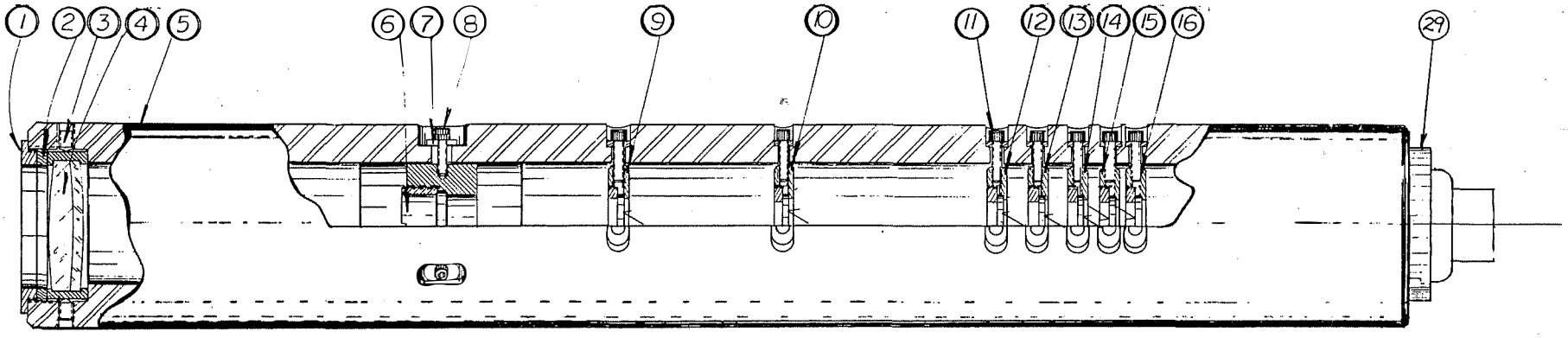


figure 3

Model 272-15
Multi-Target Collimator

1.	Cap Nut	4473	1
2.	Lock Ring	4470	1
3.	Objective Lens Adjusting Screw	2614	4
4.	Objective Lens Mount Ass'y.	4474-G1	1
5.	Barrel	4429	1
6.	Focus Lens Ass'y.	4424-G1	1
7.	Reticle Collet	4451	31
8.	Screw: 4-40 x 7/16 SHCS	Comm.	3
9.	4' Reticle	11529-G1	1
10.	6' Reticle	11529-G3	1
11.	Screw: 4-48 x 9/16 SHCS	Comm.	28
12.	16' Reticle	11529-G9	1
13.	25' Reticle	11529-G5	1
14.	50' Reticle	11529-G6	1
15.	75' Reticle	11529-G7	1
16.	Infinity Reticle	11529-G8	1
29.	Light Adapter	13750-G1	1

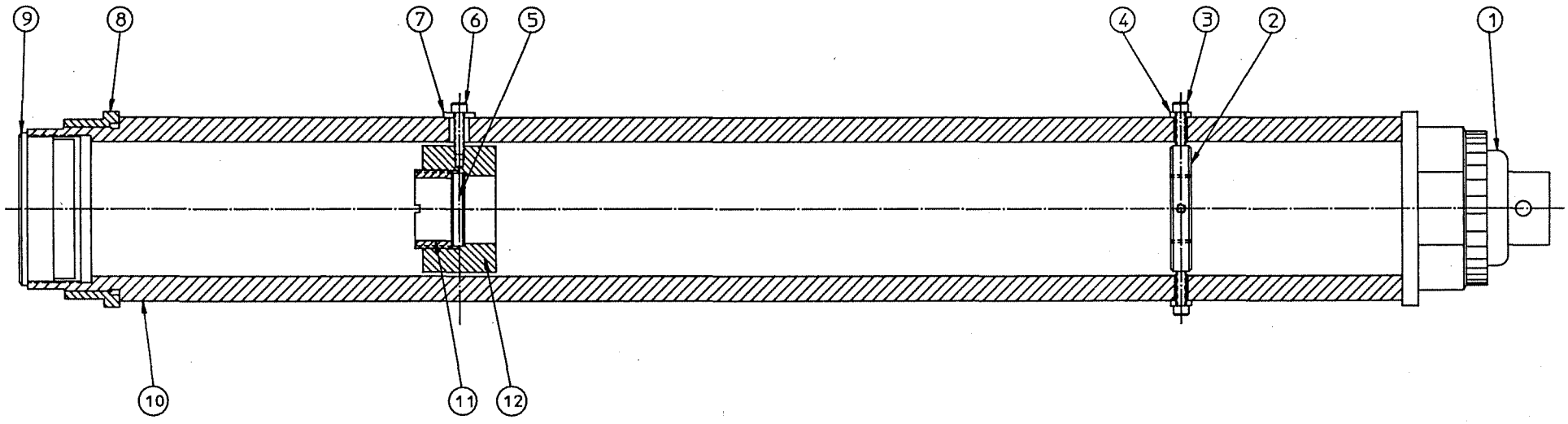


figure 4

Model 272-1
Single Target Collimator

1.	Light Adapter	13750-G1	1
2.	Infinity Reticle	11529-G8	1
3.	Screw: 4-48 x 1/2 SHC	Comm.	4
4.	Reticle Collet	8870	4
5.	Focusing Lens	5060	1
6.	Screw: 4-40 x 1/2 SHC	Comm.	3
7.	Focus Lens Collet	8871	3
8.	Adjusting Ring	3544	2
9.	Objective Ass'y.	5074-G1	1
10.	Barrel	8866-1	1
11.	Retaining Ring	5039	1
12.	Focusing Slide	8867	1

Leveling screws for cabinet and surface plate

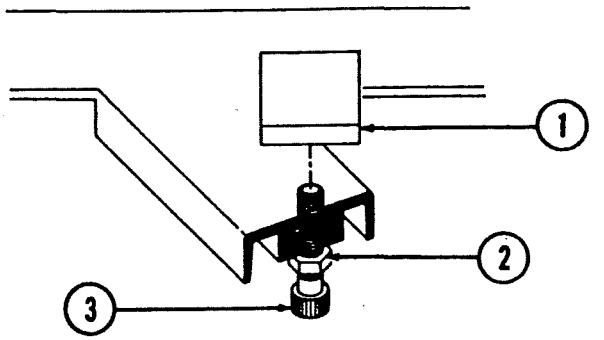


figure 5

Surface Plate

1.	Level Pad	11005	6
2.	Jam nut: 1/2-20	Comm.	6
3.	Screw: 1/2-20 x 1 3/4 SHC	Comm.	6

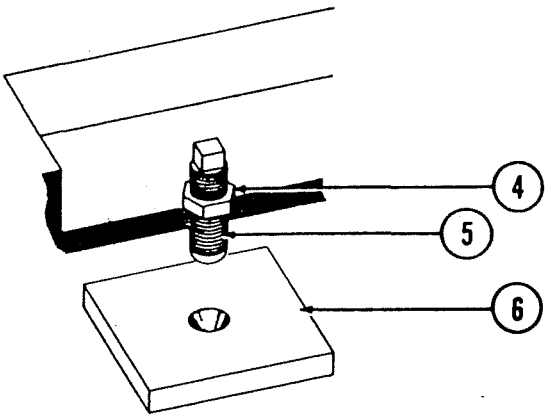


figure 6

Cabinet

4.	Jam nut: 3/4-16 NF-2	Comm.	3
5.	Leveling screw	11017	3
6.	Leveling foot	11006	3

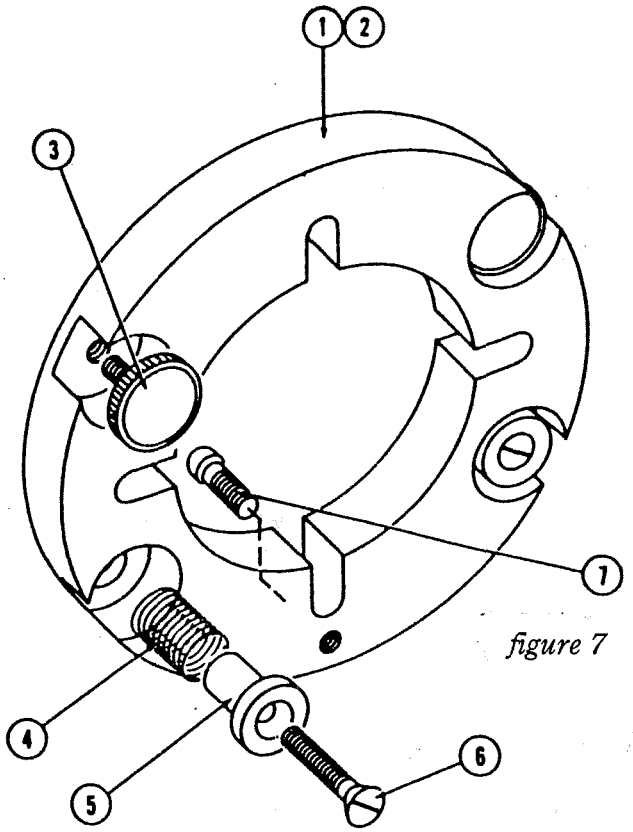
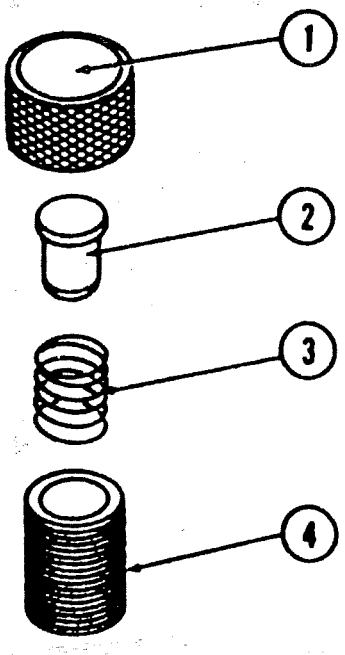


figure 7

Mirror Mount

1.	Adapter, 30 degree tube	11171	1
2.	Adapter, 45 and 90 degree tubes	11170	1
3.	Adjusting Screw	11172	2
4.	Spring	11173	2
5.	Spring Retainer	11174	2
6.	Screw: 5-40 x 1 FH	Comm.	2
7.	Pivot	11175	2
(not shown)	Roll Pin 1/8 x 1/2	Comm.	2



Spring Loaded Screw

(8 long, 4 short)

1.	Cap	11165	1
2.	Plunger		
	(long)	11168-2	1
	(short)	11168-1	1
3.	Spring	11167	1
4.	Body	11166	1

figure 8

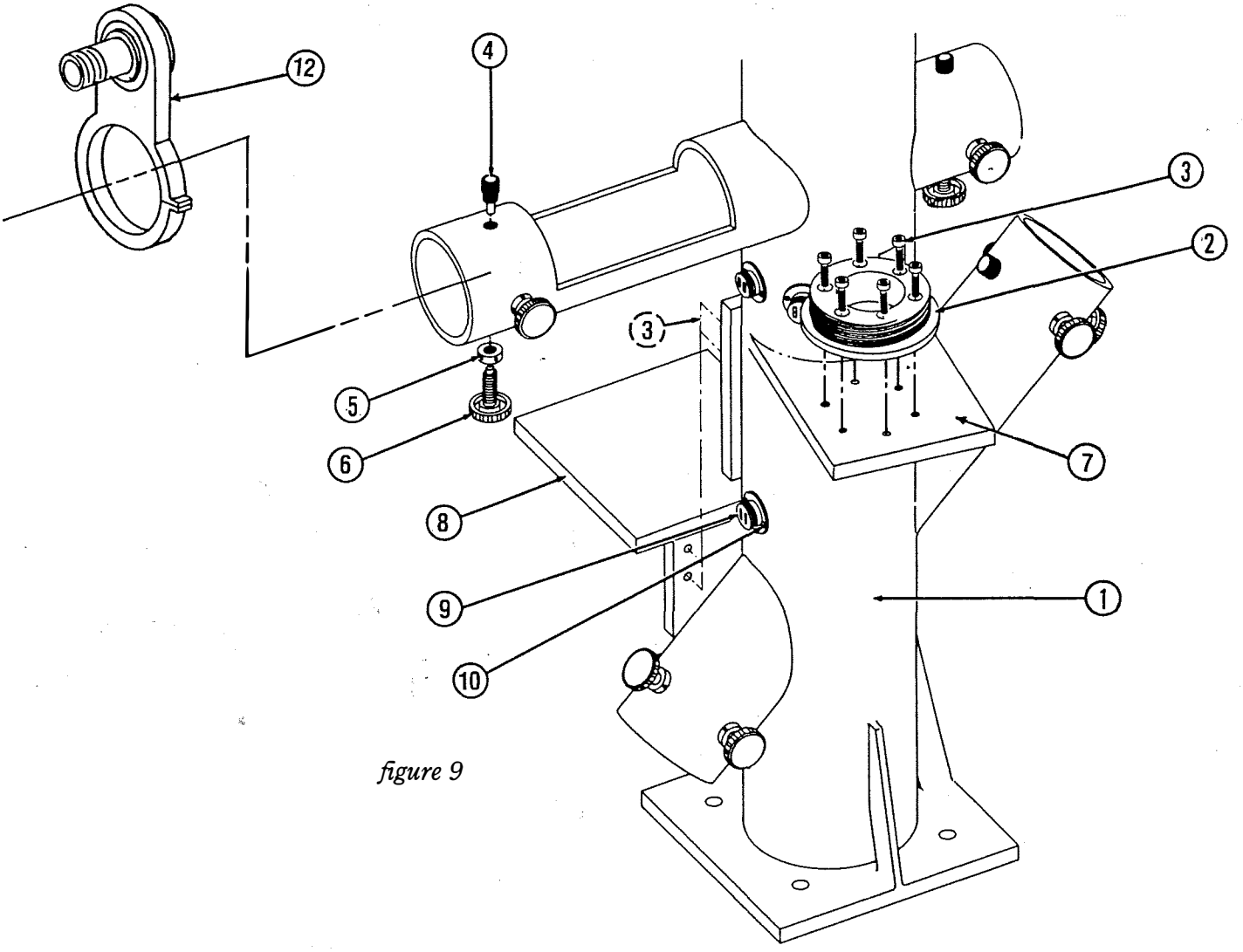


figure 9

Target Post

1.	Target Post	11151-G1	1
2.	Mounting Ring: 3 1/2-8	2552	1
3.	Screw: 1/4-20 x 1 SHC	Comm.	4
4.	Spring Loaded Screw:		
	A) short	11164-G1	4
	B) long	11164-G1	8
5.	Adjusting Nut	3561	12
6.	Leveling Screw	11143	12
7.	Inst. Support bracket	11155	1
8.	Inst. Support bracket	11156	1
9.	Electrical Socket	13206	4
10.	Screw: 5-40 x 3/8 FH	Comm.	8
11.	Screw: 1/4-20 x 1 SHC	Comm.	8
12.	Micrometer Target	13083-G2	1

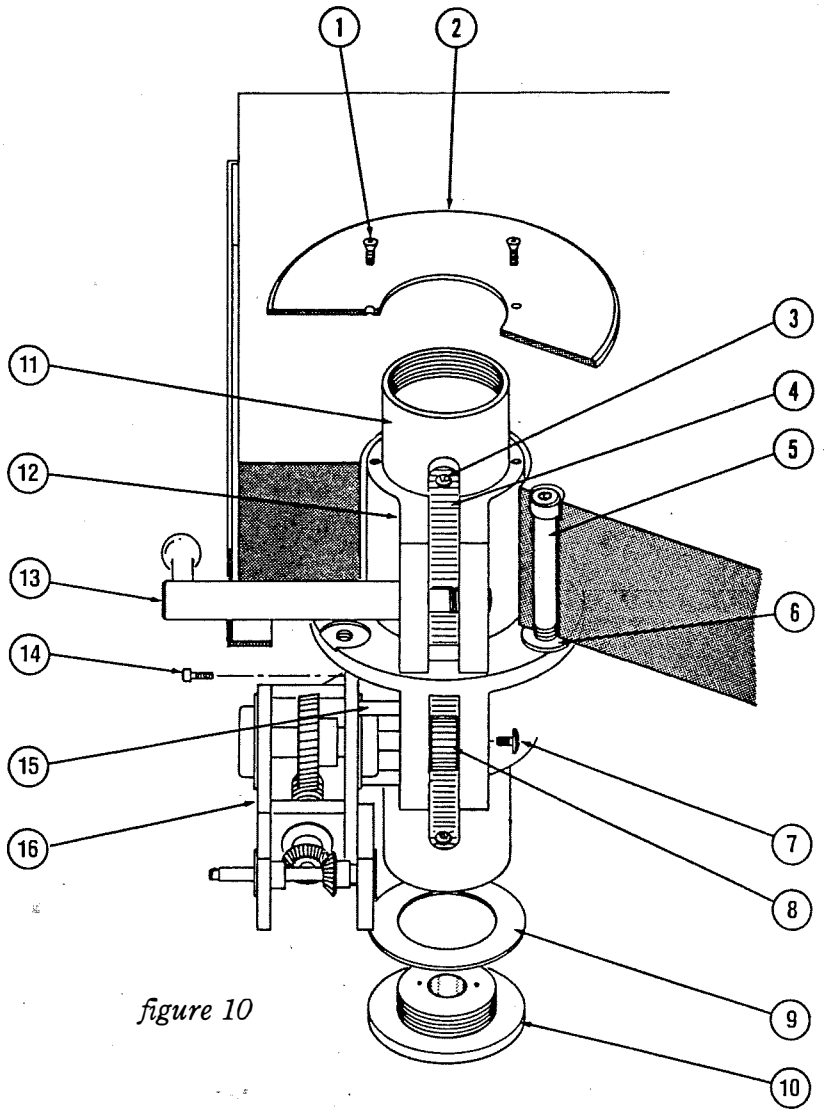


figure 10

Lift Assembly

1.	Screw: 8-32 x 1 FHC	Comm.	2
2.	Lift Stand Cover	11145	1
3.	Screw: 10-32 x 1/2 SHC	Comm.	4
4.	Rack	3666-1	1
5.	Screw: 1/2-13 x 4 SHC	Comm.	5
6.	Spacer: .025 thick (as req'd.)	13562	
7.	Hub Retainer Screw	3611	1
8.	Pinion	3610	1
9.	Rubber Stop Washer	11129	1
10.	Stop Plug	11133	1
11.	Intermediate Tube	11128	1
12.	Lift Collar	11132	1
13.	Clamp Arm Ass'y.	11131-G1	1
14.	Screw: 1/4-20 x 3/4 SHC	Comm.	4
15.	Screw: 1/4-20 x 1 1/2 SHC	Comm.	2
16.	Gear Box Ass'y.	11111-G1	1

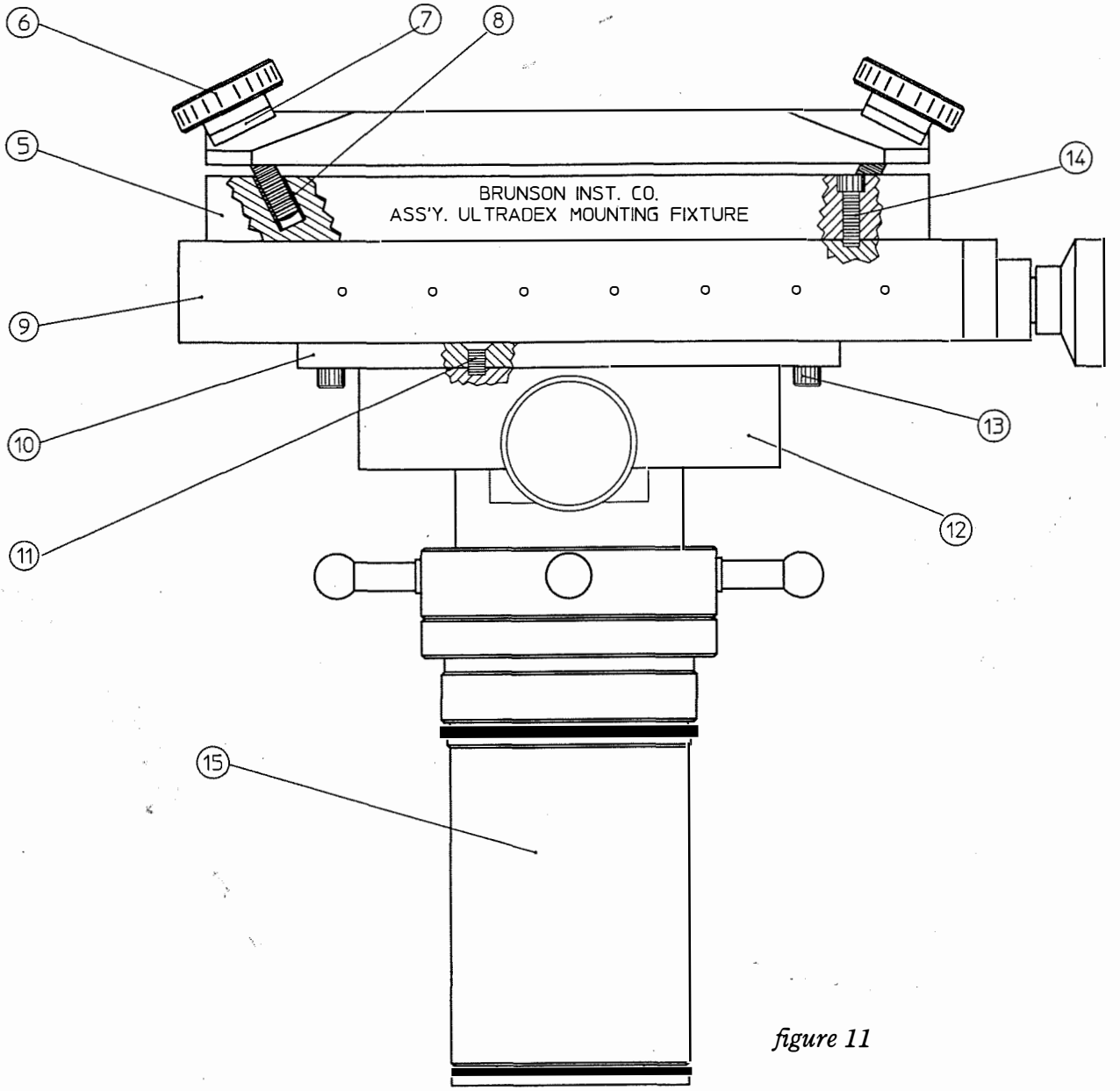


figure 11

Cross Slides Assembly

1-4	not shown		
5.	Ultradex Leveling Plate	13551-G1	1
6.	Leveling Screw	13557	4
7.	Washer	13558	4
8.	Helicoil: 1/4-28 x 5/8	Comm.	4
9.	Lateral Slide (upper)	12450-G3	1
10.	Adapter	13556	1
11.	Screw: 10-32 x 5/8 FHS	Comm.	4
12.	Lateral Slide (lower)	12450-G1	1
13.	Screw: 10-32 x 5/8 SHC	Comm.	4
14.	Screw: 10-32 x 3/4 SHC	Comm.	4
15.	Precision Lift	12604-G4	1

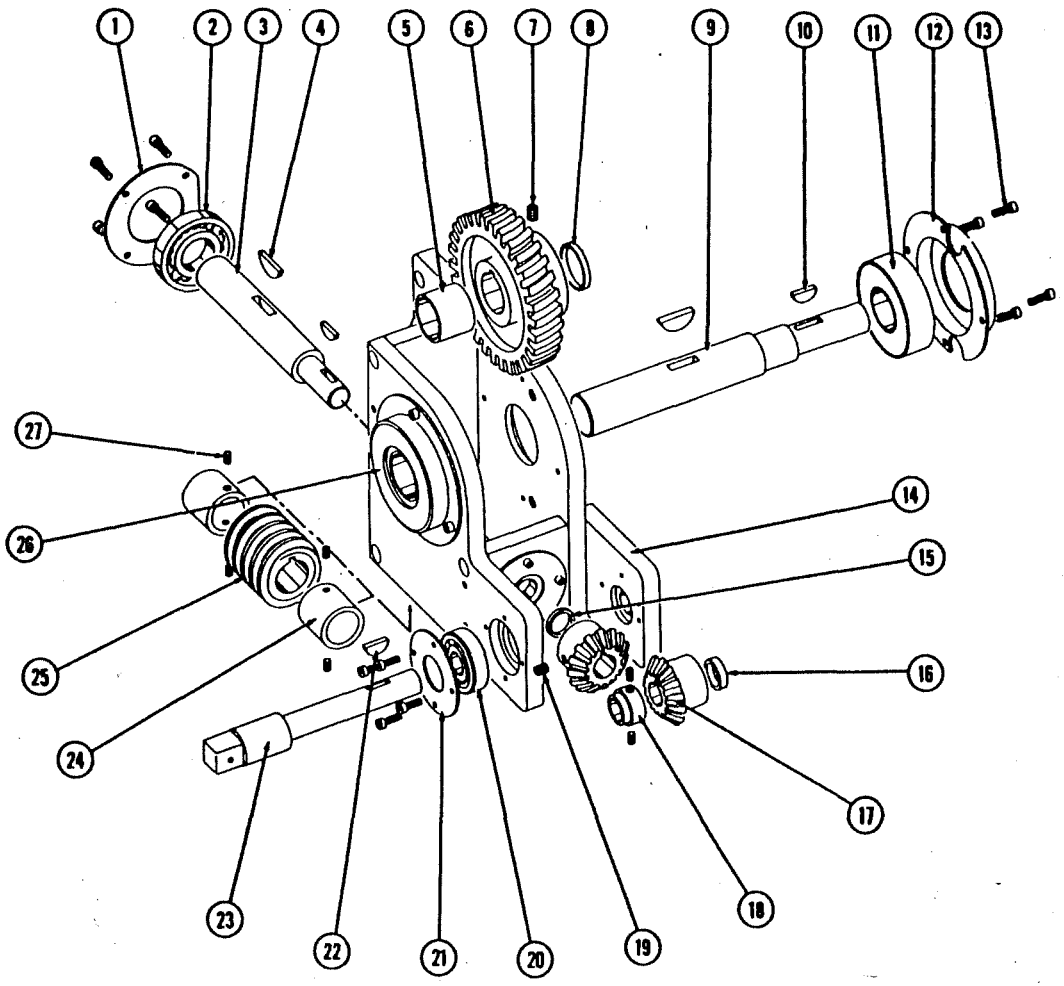
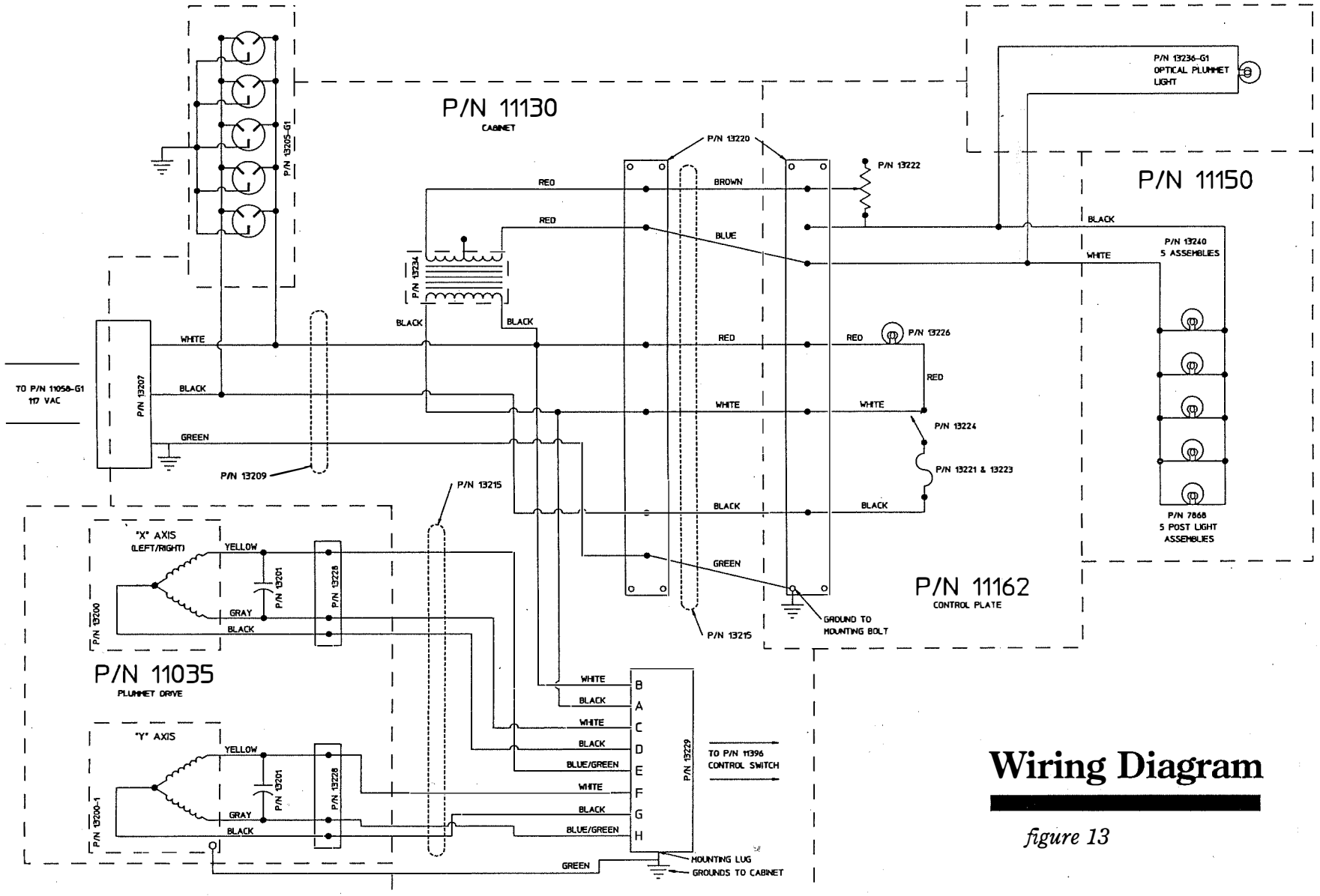


figure 12

Gear Box Assembly

1.	Keeper Ring: 3/4"	11112	1
2.	Bearing	13264	1
3.	Intermediate Shaft	11020	1
4.	#9 Woodruff Key	Comm.	2
5.	7/8" Thrust Collar	11078	1
6.	Driven Gear	11116	1
7.	Screw: 1/4-20 x 1/4 SHS	Comm.	1
8.	7/8" Thrust Washer	11018	1
9.	Upper Shaft	11120	1
10.	#6 Woodruff Key	Comm.	1
11.	Bearing	13265	2
12.	Bearing Holder Cup	11118	1
13.	Screw: 4-40 x 3/8 SHC	Comm.	24
14.	Gear Box	11125	1
15.	Thrust Washer	11144-1	1
16.	Thrust Washer	11144	1
17.	Miter Gear	13261	2
18.	1/2" Thrust Collar	11117	1
19.	Screw: 1/4-20 x 1/4 SHS	Comm.	2
20.	Bearing	13263	3
21.	1/2" Keeper Ring	11113	3
22.	#3 Woodruff Key	Comm.	2
23.	Input Shaft Ass'y.	11115-G1	1
24.	Thrust Spacer	11126	2
25.	Worm	13262	1
26.	Bearing Holder Cup	11118-1	1
27.	Screw: 4-40 x 1/8 SHS	Comm.	6



Wiring Diagram

figure 13

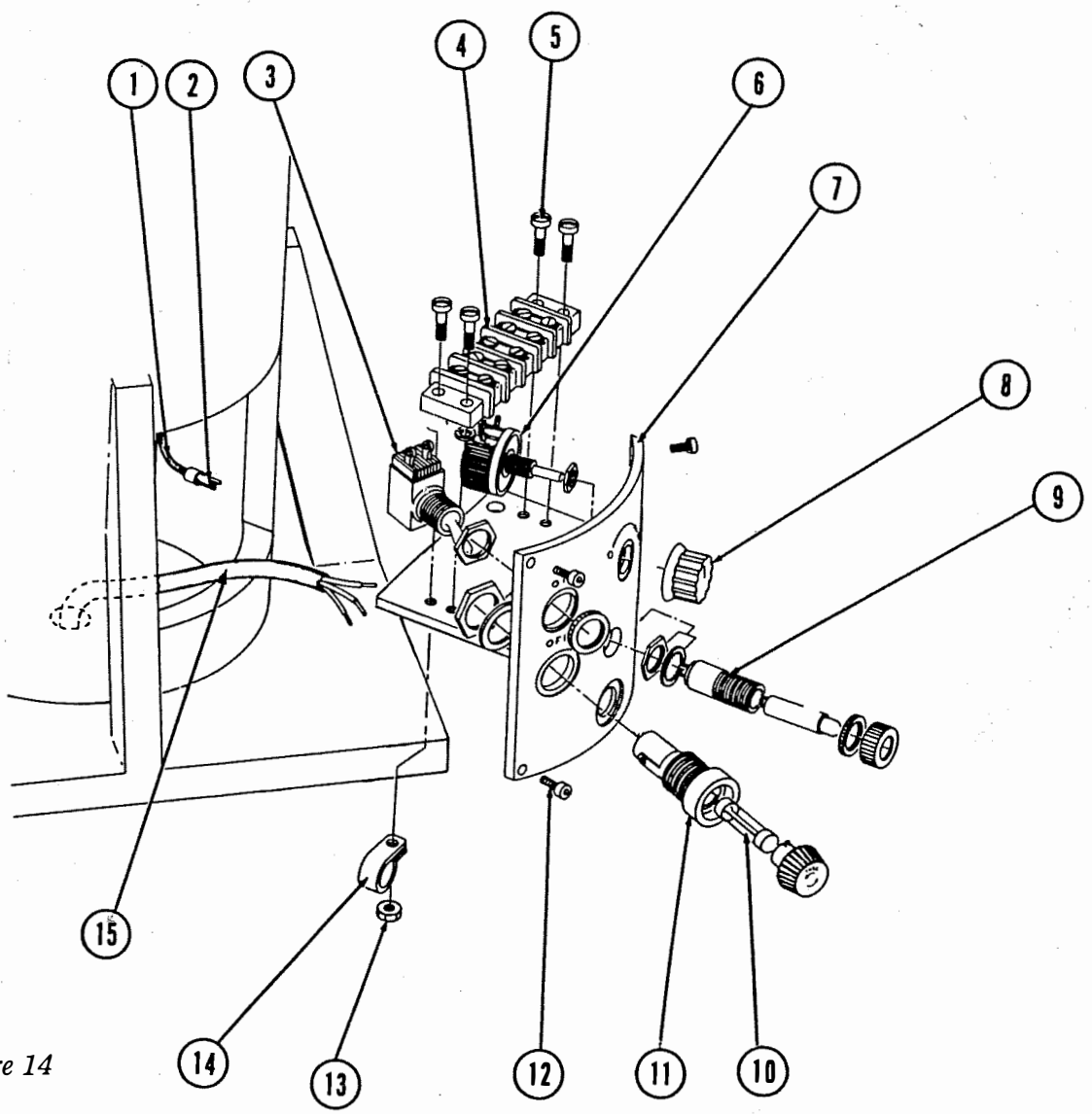


figure 14

Control Panel

1.	Wire (to inst. lights)	13219	
2.	Spade Lug	Comm.	8
3.	Toggle Switch	13224	1
4.	Barrier Strip: 6 lug	13220	1
5.	Screw: 6-32 x 3/4 RH	Comm.	2
6.	Rheostat	13222	1
7.	Control Unit Mount	11157	1
8.	Rheostat Knob	13225	1
9.	Pilot Light	13226	1
10.	Fuse: 3/4 amp, 250V AC	13221	1
11.	Fuse Holder	13223	1
12.	Screw: 5-40 x 3/8 FHC	Comm.	3
13.	Hex Nut: 6-32	Comm.	1
14.	Cable Clamp	13227	1
15.	Ref: Power Wire	13209	1

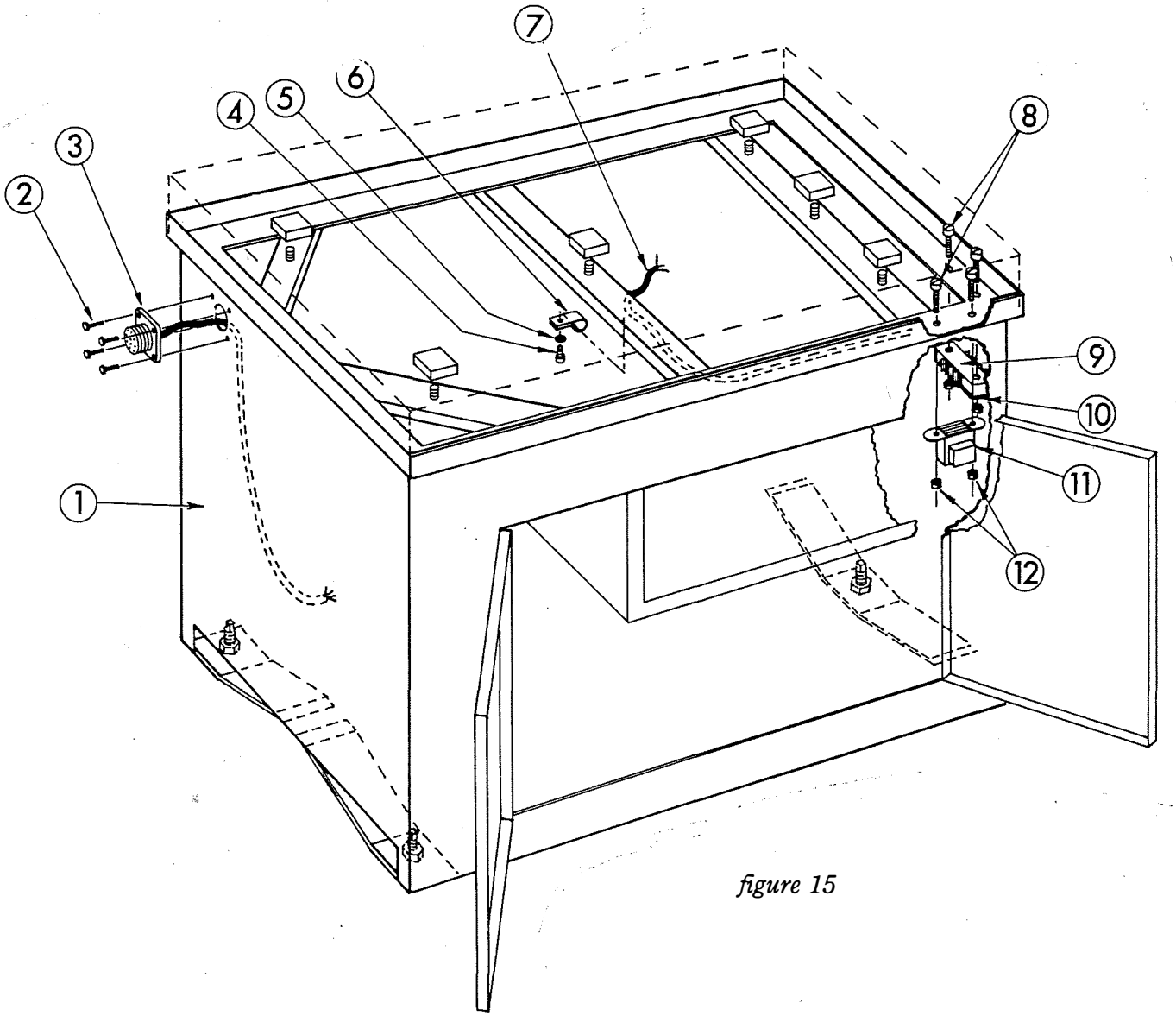


figure 15

Internal Cabinet Wiring

1.	Cabinet	13241	1
2.	Screw: 4-40 x 1/2 FH	Comm	4
3.	Connector:	13229	1
4.	Screw: 6-32 x 1/2 BH	Comm.	6
5.	Flat Washer	Comm.	6
6.	Cable Clamp	13233	6
7.	Multiple Conductor Wire	13215-1	54"
8.	Screw: 6-32 x 1/2 BH	Comm.	4
9.	Terminal Strip	13220	1
10.	Hex Nut: 6-32	Comm.	2
11.	Transformer	13234	1
12.	Hex Nut: 6-32	Comm.	2

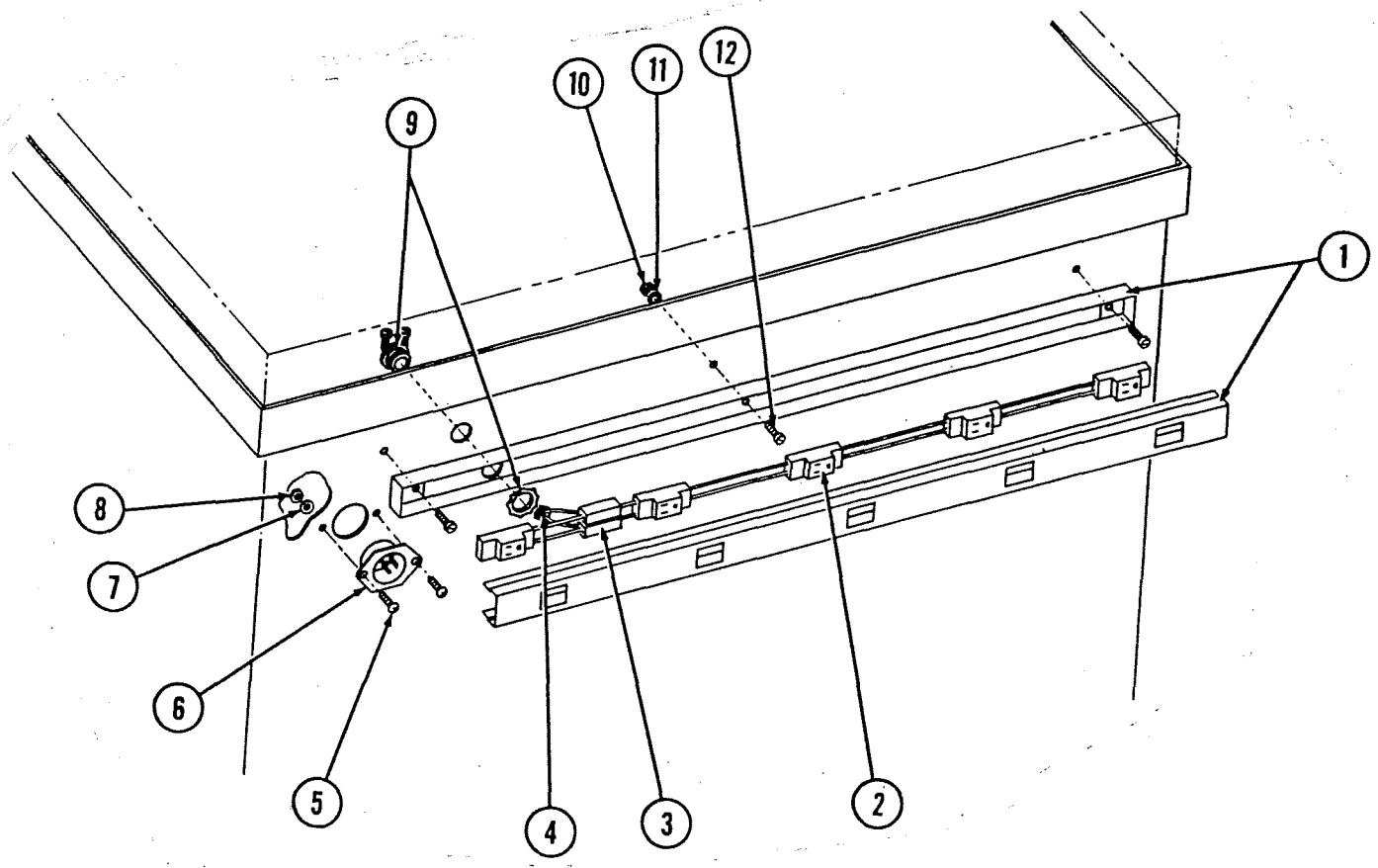


figure 16

External Cabinet Wiring

1.	Outlet strip and end cap	13205-G1	1
2.	Solderless connector	13238	2
3.	Screw: 6-32 x 3/4 RH	Comm.	2
4.	Power supply socket	13207	1
5.	Lock washer: #6	Comm.	2
6.	Hex nut: 6-32	Comm.	2
7.	Screw: 10-32 x 1/2 BH	Comm.	2

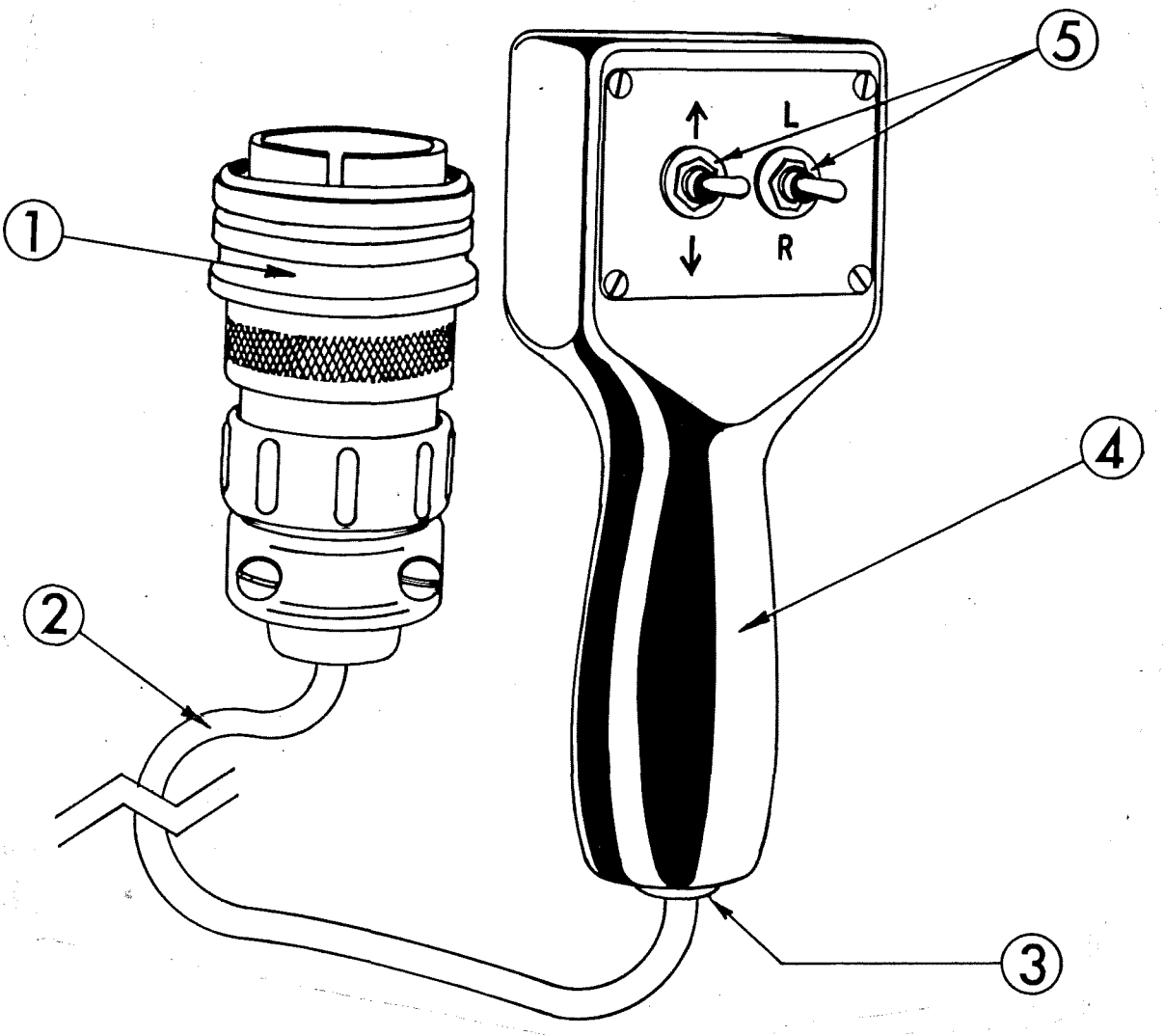


figure 17

Plummet Collimator Control Handle

1.	Cannon plug	13212	1
2.	Wire	13215	6'
3.	Rubber Grommet	2639-1	1
4.	Control Handle	11394	1
5.	Switches	13216	2

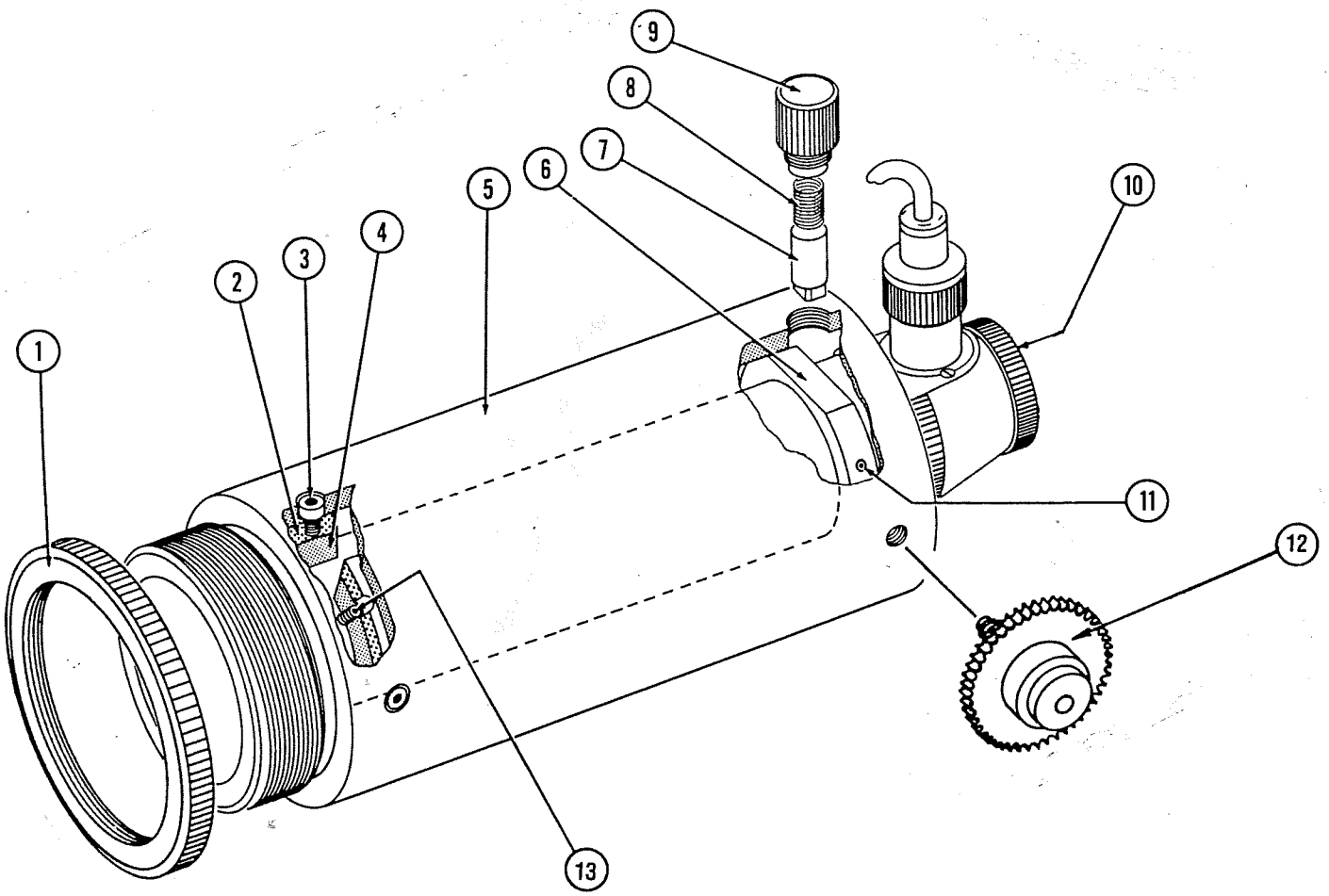


figure 18

Plummet Assembly

1.	Lock Ring	11033	1
2.	Spherical Mount Ring	11034	1
3.	Screw: 10-32 x 1/4 SHC	Comm.	1
4.	Spherical Mount Assembly	6768-G1	1
5.	Plummet Adaptor Tube	11032	1
6.	Axis Ring	11036	1
7.	Plunger	11038	2
8.	Spring	11039	2
9.	Spring Body	11037	2
10.	Optical Plummet Collimator	11196-G1	1
11.	Screw: 5-40 x 1/4 SHS	Comm.	4
12.	Gear and Clutch Ass'y.	11534-G1	2
13.	Screw: 4-40 x 1/8 SHS	Comm.	4

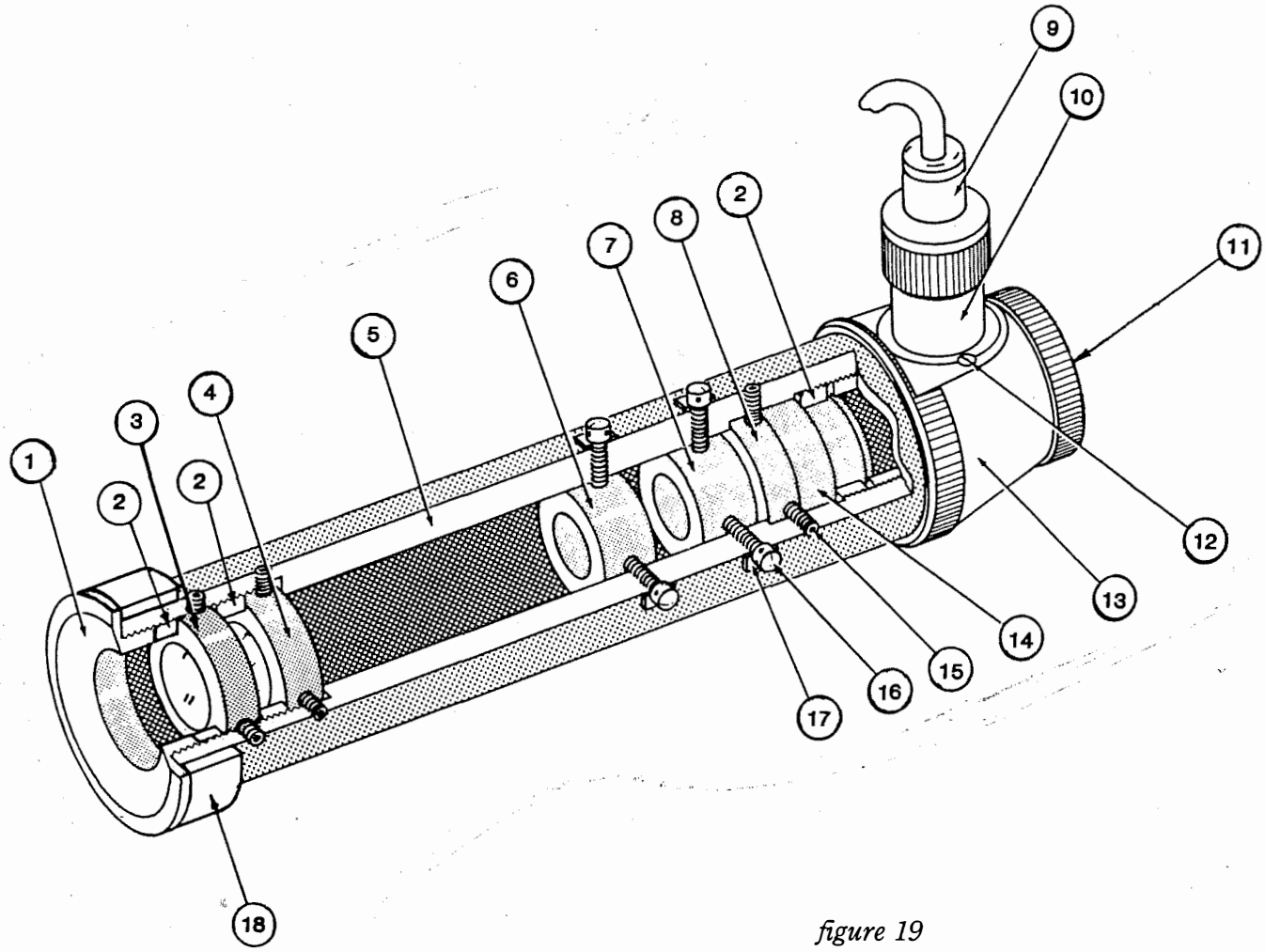


figure 19

Optical Plummet Collimator

1.	Objective cap	11194	1
2.	Retainer	2902	3
3.	Auto reflection target	2903-G1	1
4.	Objective lens	2908-G1	1
5.	Telescope barrel	11197	1
6.	Reticle assembly	11213-G1	1
7.	Reticle assembly	11213-G2	1
8.	Reticle assembly	6538-G5	1
9.	Light housing assembly	2630-G1	1
10.	Light reflector assembly	2631-G3	1
11.	End cap	11149	1
12.	Screw: 1-72 x 1/8 FH	Comm.	3
13.	Straight eyepiece adaptor	2932	1
14.	Erector lens and mount Ass'y.	2928-G1	1
15.	Reticle adjusting screws	2613	16
16.	Reticle adjusting screws	5021	8
17.	Collet	5043	8
18.	Spacer ring	11555	1

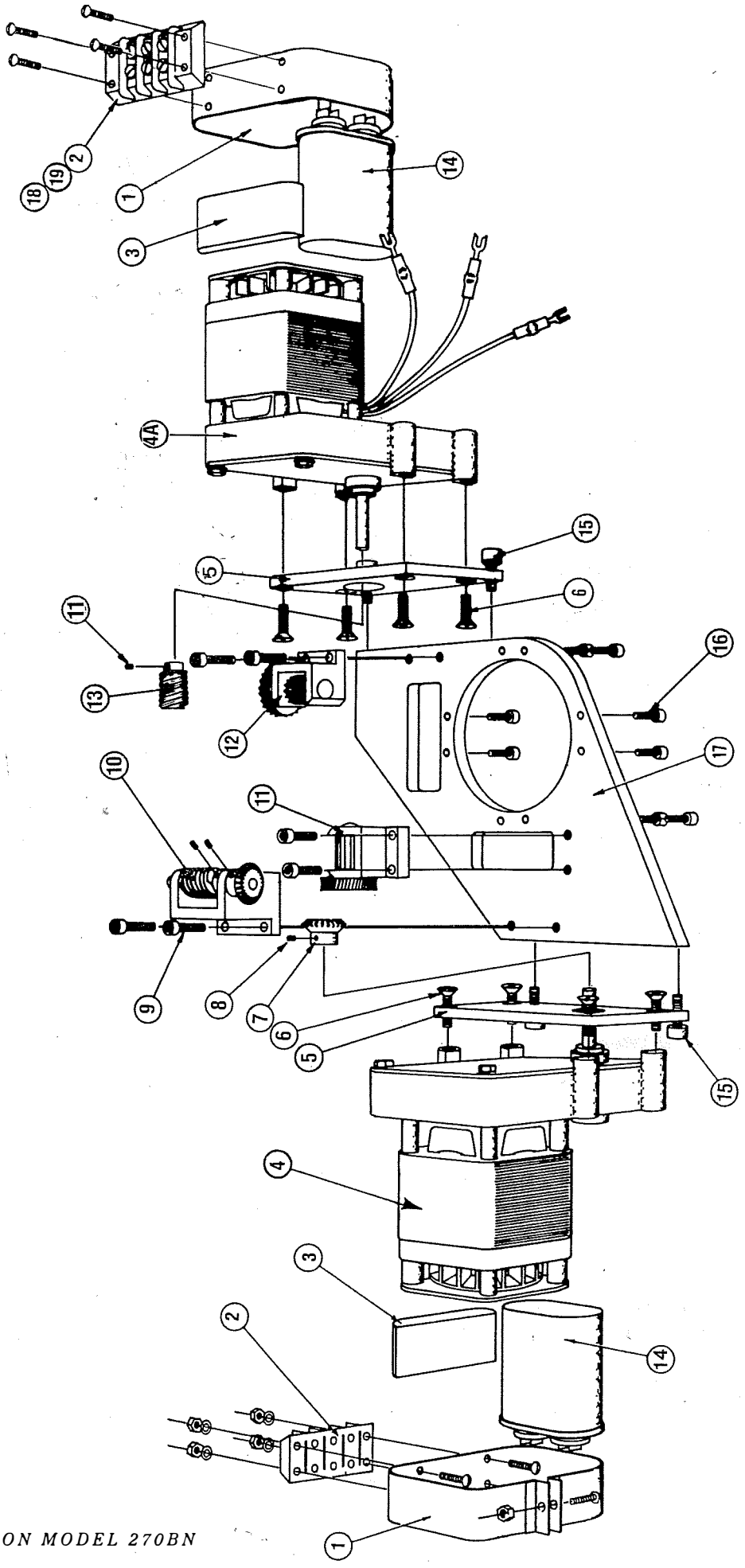


figure 20

Plummet Drive Assembly

1.	Clamp	13570	2
2.	Terminal Board	13228	2
3.	Terminal Block Cover	30371	2
not shown:	Terminal Block Support Plate	13568	2
4.	Motor	13200-1	1
4A.	Motor	13200	1
5.	Motor Mount	11533	2
6.	Screw: 10-32 x 5/8 FH	Comm.	8
7.	Miter Gear	11552-2	1
8.	Screw: 4-40 x 1/8 SHSS	Comm.	4
9.	Screw: 8-32 x 1/2 SHCS	Comm.	6
10.	Worm and Miter Gear Ass'y.	11554-G1	1
11.	Worm Gear Ass'y. (right hand)	11540-G2	1
12.	Worm Gear Ass'y. (left hand)	11540-G1	1
13.	Worm Gear	11553	1
14.	Capacitor	13201	2
not shown:	Capacitor Terminal Cap	13567	2
15.	Screw: 8-32 x 1/2 SHCS	Comm.	4
16.	Screw: 4-40 x 5/8 SHCS	Comm.	8
17.	Motor Mount Bracket	11530	1
18.	Cover	13569	2
19.	Jumper Wire	30405	2