



Maintenance  
& Adjustment of  
Line Scopes &  
Target Collimators

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# LINE OF SIGHT MAINTENANCE

## **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, or their applications feel free to call a Brunson measurement engineer at (816) 483-3187.

The 272-1 and 272-15 Target Collimators should be checked using a line scope. Line scopes can be checked using line scopes, targets, or target collimators. The device chosen is a matter of convenience, because these instruments are being rolled in using the outside diameter of their barrels as a reference. In any case, set the Test Instrument in vee blocks so it is supported in about the same places for calibration as it will be during use.

**Maintenance** of Brunson target collimators and line scopes is limited to wiping the barrels occasionally with a light oil. The barrels are stainless steel, so no other protectant is required.

**Calibration** should be performed regularly with any precision measurement instrument. The interval of calibration will vary with the environment in which you're using these instruments. Temperature variations are sufficient to move the instruments out of adjustment over time. Handling and shipment are also likely to produce slight changes in instrument adjustment. Ultimately, the accuracy requirements of your application should dictate the frequency with which you calibrate these instruments. And between calibrations, working procedures should include rolling the instrument 180° on whatever target you're using in your setup.

# Fixed-Focus Instruments

## Focus:

Place the fixed-focus collimator in a suitable mount opposite a focusable instrument such as an alignment scope, or transit. The focusable instrument will be called the Sighting Instrument. The collimator will be the Test Instrument.

Using a mirror, focus the Sighting Instrument to infinity. Without changing the focus of the Sighting Instrument, collimate it to the collimator. If your 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 line 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.

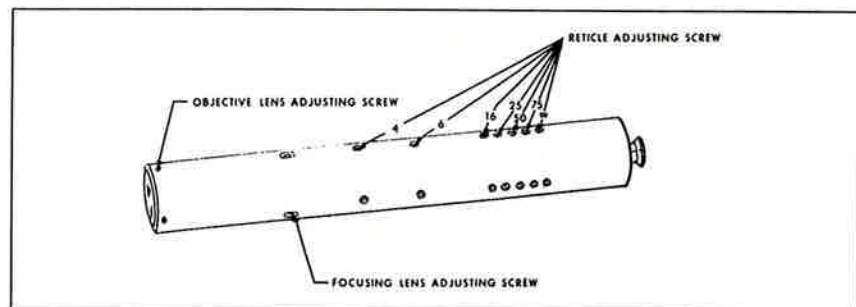
*This adjustment procedure is designed primarily for 272-15. The basic principles found here are applicable to any fixed focus instrument, provided you know the quality of the barrel surface.*

*It is possible to remove all the noticeable error from the 272-15.*

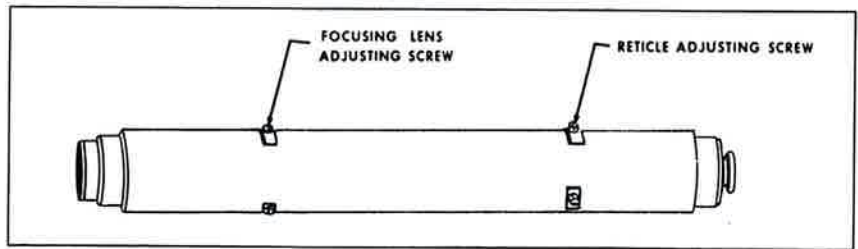
*However, your accuracy requirements may not demand such precise target adjustment. If you wish to measure observed error precisely, use an optical wedge for angular measurements, and a micrometer for displacement.*

To begin, precisely collimate the Test Instrument to the Sighting Instrument. Roll the Test Instrument 180° and check for registration error in the vertical reticle line. You can measure it exactly with a wedge placed between the two instruments. If you are adjusting the instrument to obtain no noticeable error, no measurement is necessary. Observed error is twice the actual error. If the error found is greater than your application will allow, correct it this way:

1. Remove half the observed error using the tangent screws in the Sighting Instrument mount. Remove the other half at the reticle positioning screws of the Test Instrument (*see drawings*). Bear in mind that these screws thread into holes in the reticle fixture and pull the reticle into position. Do not overtighten the screws.



*The 272-15 Multiple Target Collimator.*



*The 272-1 Single Target Collimator.*

*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.*

2. When you have corrected the error, roll the Test Instrument 180° to see the effects of your adjustment.
3. As you get the first reticle line close to perfect concentricity, roll the Test Instrument 90° to bring the horizontal reticle line into the vertical position.
4. Remove all the observed error, then check and adjust the second reticle line exactly as you did the first.

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

5. When you have finished with the infinity reticle image, focus on the next target of importance in your application and displace or repoint the Sighting Instrument to bring its reticle image into registration with that target.
6. Correct any tilt in the target reticle image by carefully moving the reticle adjusting screws.
7. Roll this target in as you did the infinity target, again displacing or repointing the Sighting Instrument to remove half the observed error.

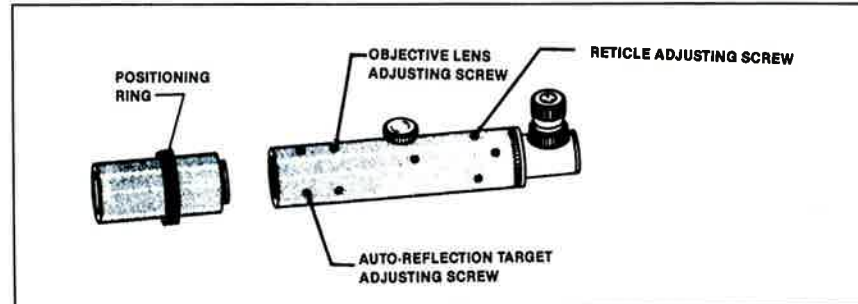
When a near and a distant target are completely adjusted, buck in to the two targets. Assuming your Sighting Instrument line of sight is straight, you can simply focus on an intermediate target and adjust it into registration with the reference. As a precaution, when you have finished adjusting the Target 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 a Multiple Target Collimator. However, only the auto-reflection 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



*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".*

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

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. Again, do not overtighten the adjusting screws.

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.

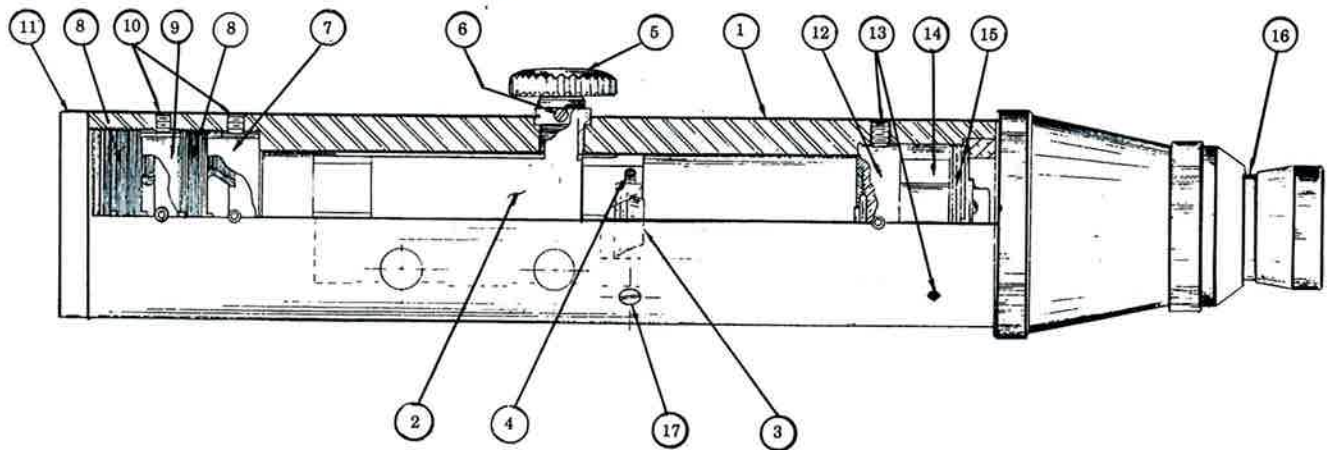
To check line of sight straightness, buck in on the infinity reticle image and one of the near targets in the Multiple Target Collimator, then check registration with a target at an intermediate distance. For highest accuracy, check as many intermediate targets as possible. Finally, roll the Alignment 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 instrument to the factory for repair.

### Check the auto-reflection target:

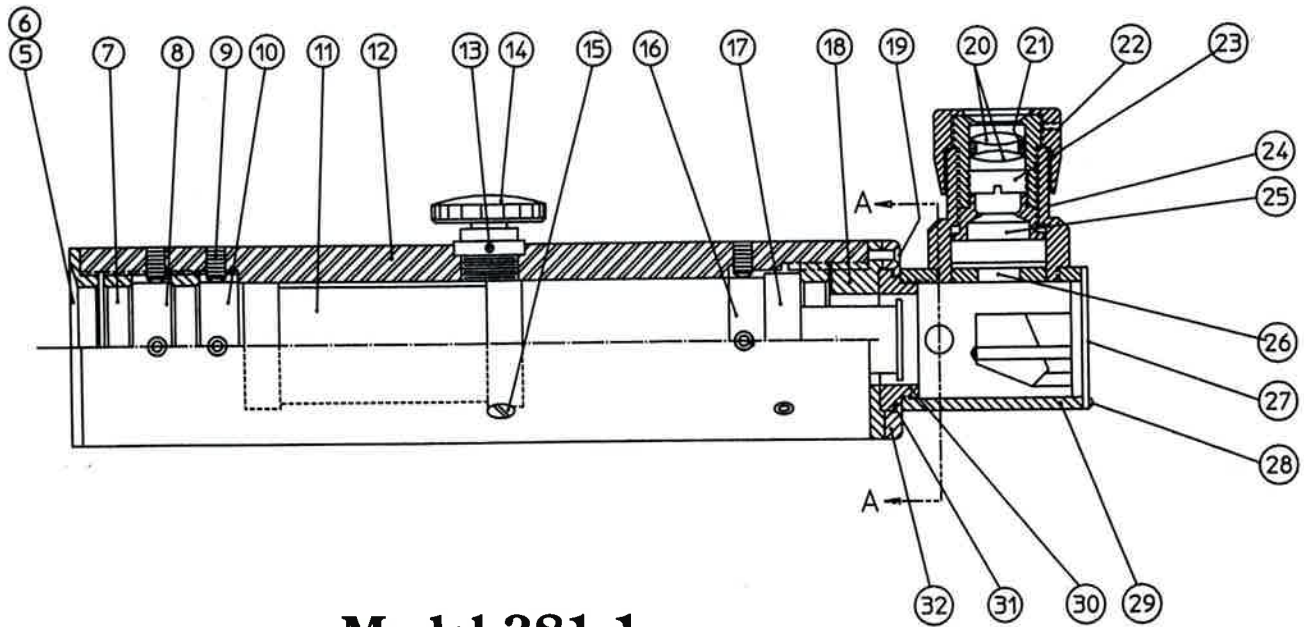
Autocollimate the Test Instrument. Without moving the Test Instrument, focus on the auto-reflection target. If the reticle image is not registered on the auto-reflection target, use the target positioning screws to bring the target into precise registration with the reflected reticle image.

To check, roll the Test Instrument 180°. tolerances mentioned in this manual, actual error at this target should be no more than one arc second, or .001" at targets closer than 17 feet.



## 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



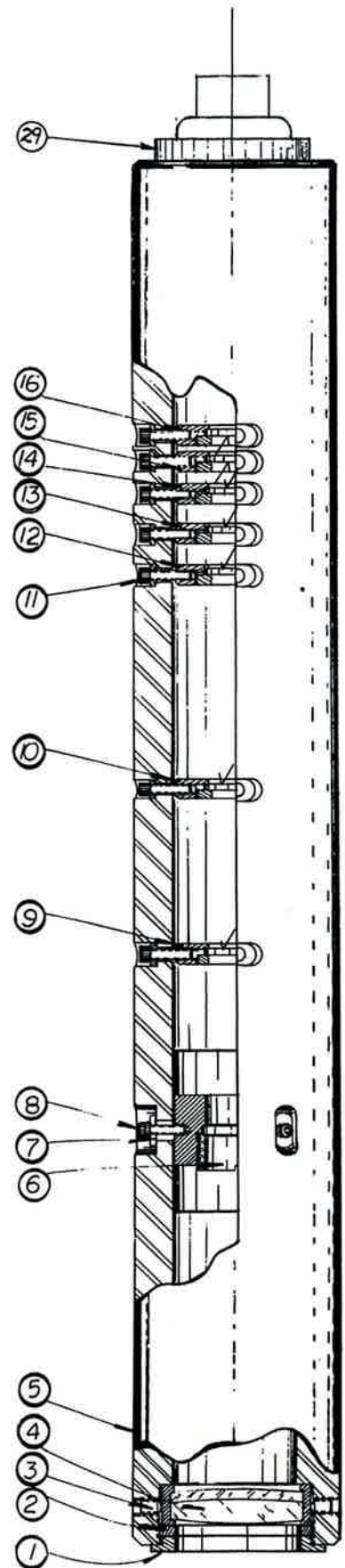
## Model 381-1 Alignment Scope

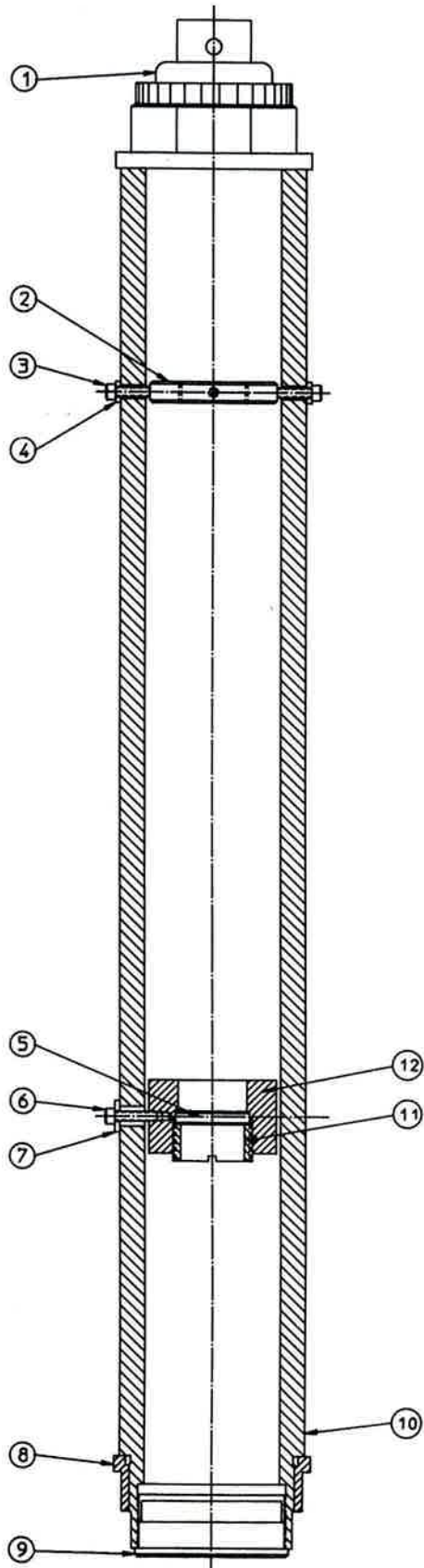
1-4	<i>not shown</i>		
5.	End Cap	2901	1
6.	Barrel Extension (not shown)	11176	1
7.	Retainer	2902	3
8.	Auto-reflection Target	2903-G1	1
9.	Screw: 8-36 x 1/4 SHS	Comm.	16
10.	Objective Lens	2908-G1	1
11.	Focusing Slide	2910-G1	1
12.	Barrel	2919-G1	1
13.	Screw: 1-72 x 1/8 SHS	Comm.	1
14.	Focusing Pinion 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.	Comm.	4	
29.	Prism Housing	6540	1
30.	Bearing	2499	1
31.	Spring	2538	1
32.	Retainer	2496	1



## Model 272-15 Multi-Target Collimator

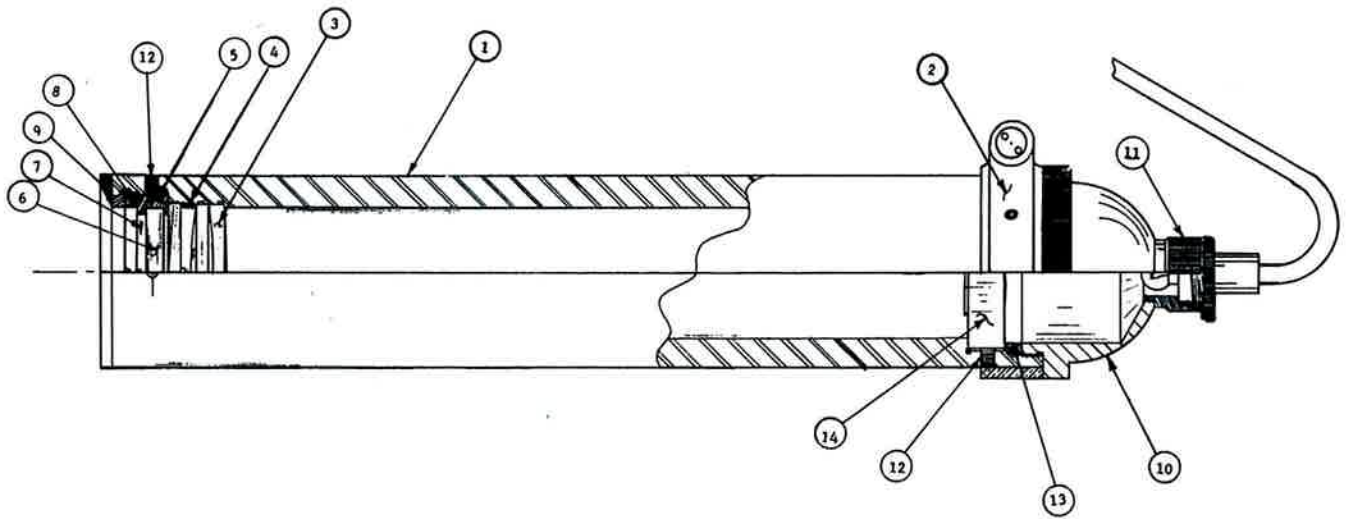
1.	Cap Nut	4473	1
2.	Lock Ring	4470	1
3.	Objective Lens Adjusting Screw	2614	4
4.	Objective Lens Mount Ass'y.	4474-G1	1
5.	Barrel	4429	1
6.	Focus Lens Ass'y.	4424-G1	1
7.	Reticle Collet	4451	31
8.	Screw: 4-40 x 7/16 SHCS	Comm.	3
9.	4' Reticle	11529-G1	1
10.	6' Reticle	11529-G3	1
11.	Screw: 4-48 x 9/16 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





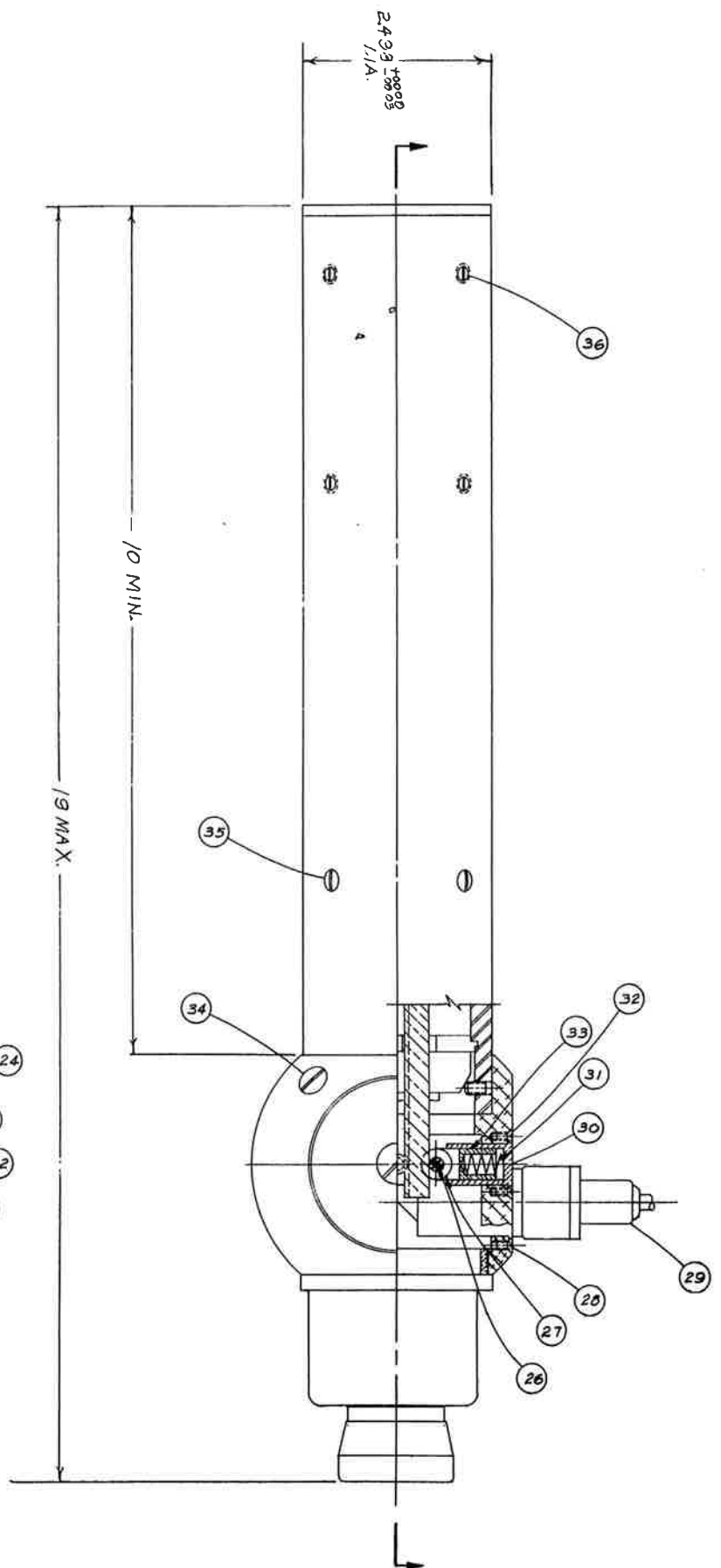
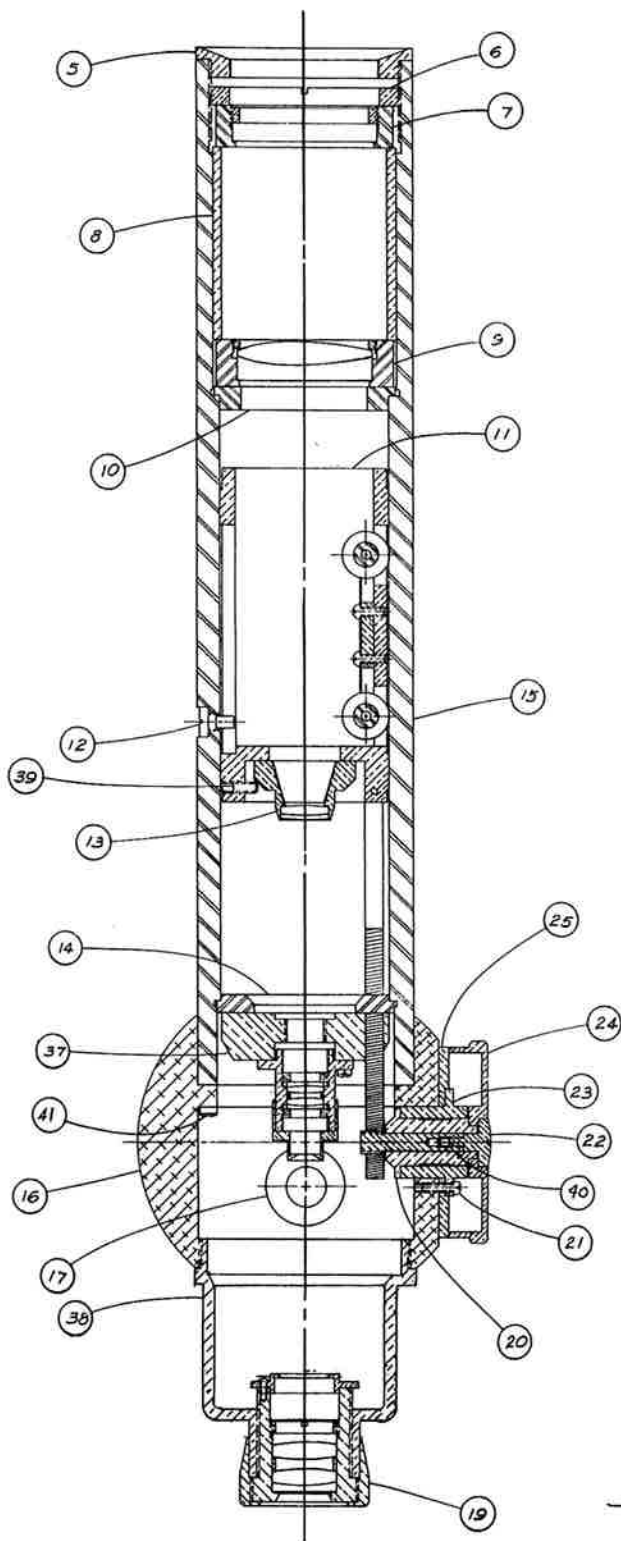
## Model 272-1 Single Target Collimator

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	7871	3
8.	Adjusting Ring	544	2
9.	Objective Ass'y.	5074-G1	1
10.	Barrel	8866-1	1
11.	Retaining Ring	5039	1
12.	Focusing Slide	8867	1



## Model 271 Tilt Collimator

1.	Barrel	2798	1
2.	Vial Assembly	2793-G1	1
3.	Objective Lens	2855	1
4.	Retainer Ring: Objective Lens	2795	1
5.	Mount: Auto-reflection Target	2603	1
6.	Auto-reflection Target	2640-1	1
7.	Retainer: Auto-refl. Target	2605	1
8.	Spacer: Auto-refl. Target	2796	1
9.	Cap: Objective End	2794	1
10.	Lighting Adapter	2790	1
11.	Light Assembly	2630-G1	1
12.	Positioning Screw	2614	8
13.	Retainer: Infinity Reticle	2786	1
14.	Infinity Reticle Assembly	4929-G1	1



## Model 82 Alignment Scope

1-4	<i>not shown</i>		
5.	End Cap	2856	1
6.	Target Mount Retainer	2841	1
7.	Target Mount Assembly	2858-G1	1
8.	Spacer Tube	7790	1
9.	Objective Mount Assembly	2861-G1	1
10.	Objective Thrust Plate	2644	1
11.	Focusing Slide	2862-G1	1
12.	Slide Stop Pin	2783	1
13.	Focusing Lens Assembly	2863-G1	1
14.	Reticle Thrust Plate	2643	1
15.	Barrel	2634	1
16.	Control Housing	2889	1
17.	Condenser Assembly	2631-G1	1
18.	<i>not shown</i>		
19.	Eyepiece Assembly	6060-G1	1
20.	Pinion Bushing	2777	1
21.	Screw: 2-56 x 5/16 FH	Comm.	3
22.	Screw: Focus Drum Ret.	2846	1
23.	Camshaft Bearing	2662	1
24.	Focusing Drum	2665	1
25.	Index Plate	2866	1
26.	Tension Roller Shaft	2654	1
27.	Rack Thrust Roller	2651	1
28.	Screw: 3-56 x 1/8 FH	Comm.	2
29.	Light Housing Assembly	2630-G1	1
30.	Thrust Guide Sleeve	2652	1
31.	Spring	2833	1
32.	Screw: 2-56 x 3/16 FH	Comm.	3
33.	Roller Guide	2650	1
34.	Cover Screw: Reticle	2826	4
35.	Cover Screw: Focus Lens	2845	4
36.	Adjusting Screw	2613	12
37.	Reticle Assembly	2864-G1	1
38.	Eyepiece Adapter	4407-G1	1
39.	Focus Adjusting Screw	2416-2	4
40.	Pinion	5041	1
41.	Control Housing Screw	2828	4