



**Model 287-1 LEVELING MIRROR**  
**Maintenance and Adjustment Manual**

**Helping the World Measure**



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Model 287-1*

# LEVELING MIRROR

## **Introduction**

*Be careful when handling the Leveling Mirror. Mineral oil on the leveling plate will prevent the mirror from balancing.*

It is important to use only 12 fluid ounces of U.S.P. heavy mineral oil in the canister of the 287-1 Leveling Mirror. Use of the wrong oil, or too much oil may interfere with the accuracy of the instrument. Once the oil is inside the canister, don't tilt the leveling mirror beyond the range of adjustment of its mounting base. Any film of oil on the leveling plate will prevent the knife edges from seating, and the mirror will not balance accurately. Aside from cleaning the leveling plate, maintenance is limited to cleaning the mirror. Use a non-abrasive lens cleaner and a non-scratching lint-free cloth to wipe it on both sides.

If you get some oil on the leveling plate and knife edges, unscrew and remove the cap ring from the top of the canister. Carefully lift the mirror assembly out of the top of the canister. The balancing knives will be found in the underside of the mirror assembly. The leveling plate is a flat lapped ring in the top of the canister. Clean both the knives and the lapped leveling plate with acetone or a similar solvent capable of removing the oil without leaving a film, either of oil or of solvent. Gently put the leveling mirror back into the canister and replace the cap ring.

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 the instrument or in the test setup. You must find and solve that problem before you can accurately calibrate the leveling mirror.

## **Caution**

To protect the knife edges, always retract the mirror into the locked position before moving it off its base. When releasing the mirror from its locked position, never drop the knife edges onto the lapped leveling plate—release the locking lever gently. Never

## Adjusting the Leveling Mirror

pick up and move the leveling mirror with the knife edges on the leveling plate—retract the mirror into the locked position to protect the knife edges from shock.

In general, the final equilibrium attitude of the mirror can be changed by moving the counterweight backward or forward over the balance point of the mirror. Simply thread the counterweight toward or away from the Test Instrument, as the test results indicate.

1. Place the 287-1 Leveling Mirror on a level surface plate and gently release the locking lever, allowing the mirror to balance.
2. Auto-collimate a suitable test instrument (we use a Kollmorgen model K222 Autocollimator) to the leveling mirror.
3. When the reticle images are in register (the horizontal reticle lines must be precisely in register, though the vertical lines may be slightly off), retract the mirror to the locked position and turn the entire canister of the leveling mirror 180°. Gently release the mirror and use the tangent screw on the side of the canister to bring the vertical reticle lines approximately into register. Record any registration error in the horizontal reticle lines.
4. Repeat the test to validate the accuracy of your readings. Observed error in this test is twice the actual mirror error.

*Remember to lift the knife edges into the locked position before making gross movements.*

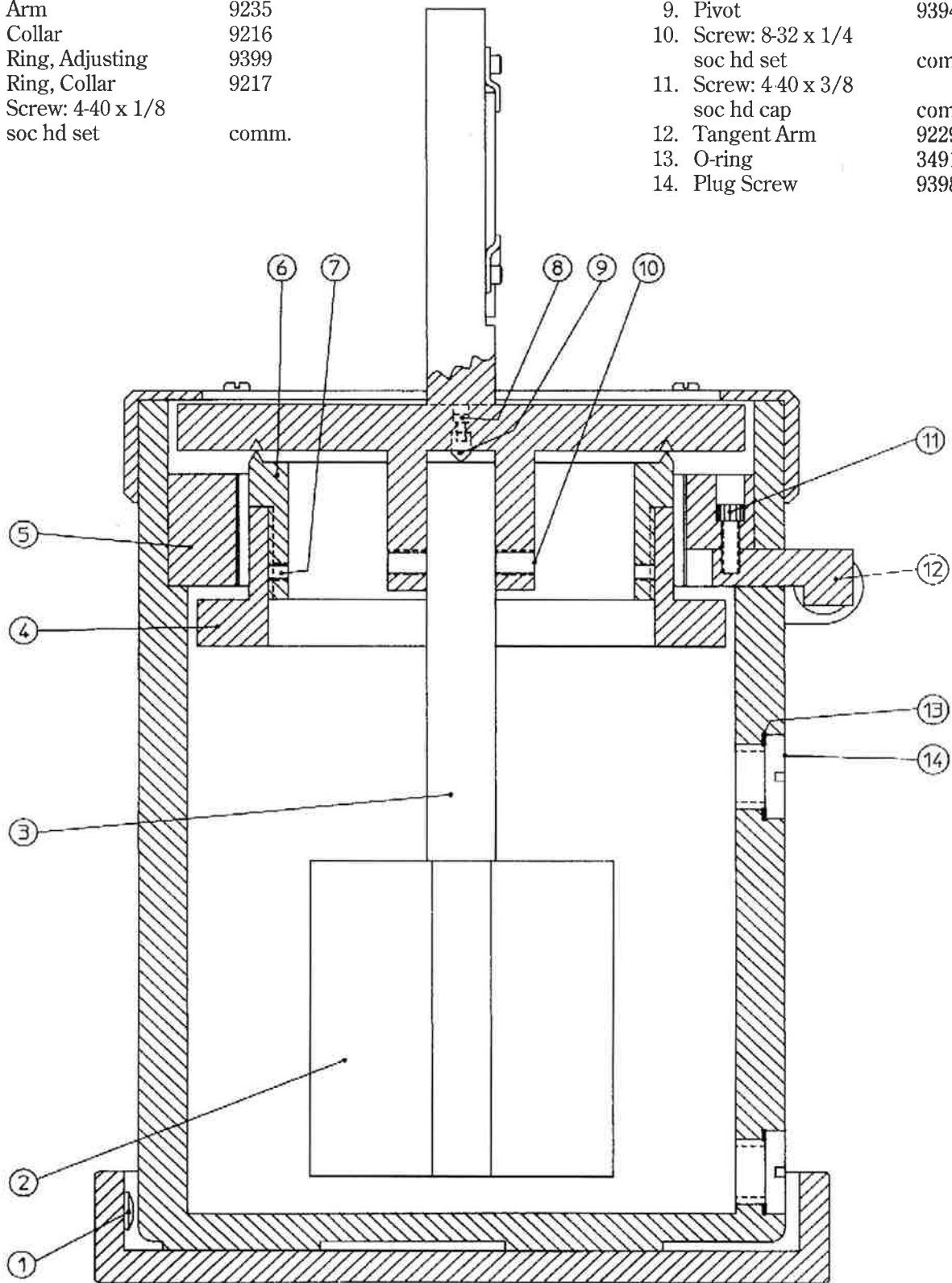
If the error observed is greater than two arc seconds (actual error greater than one arc second), correct it this way:

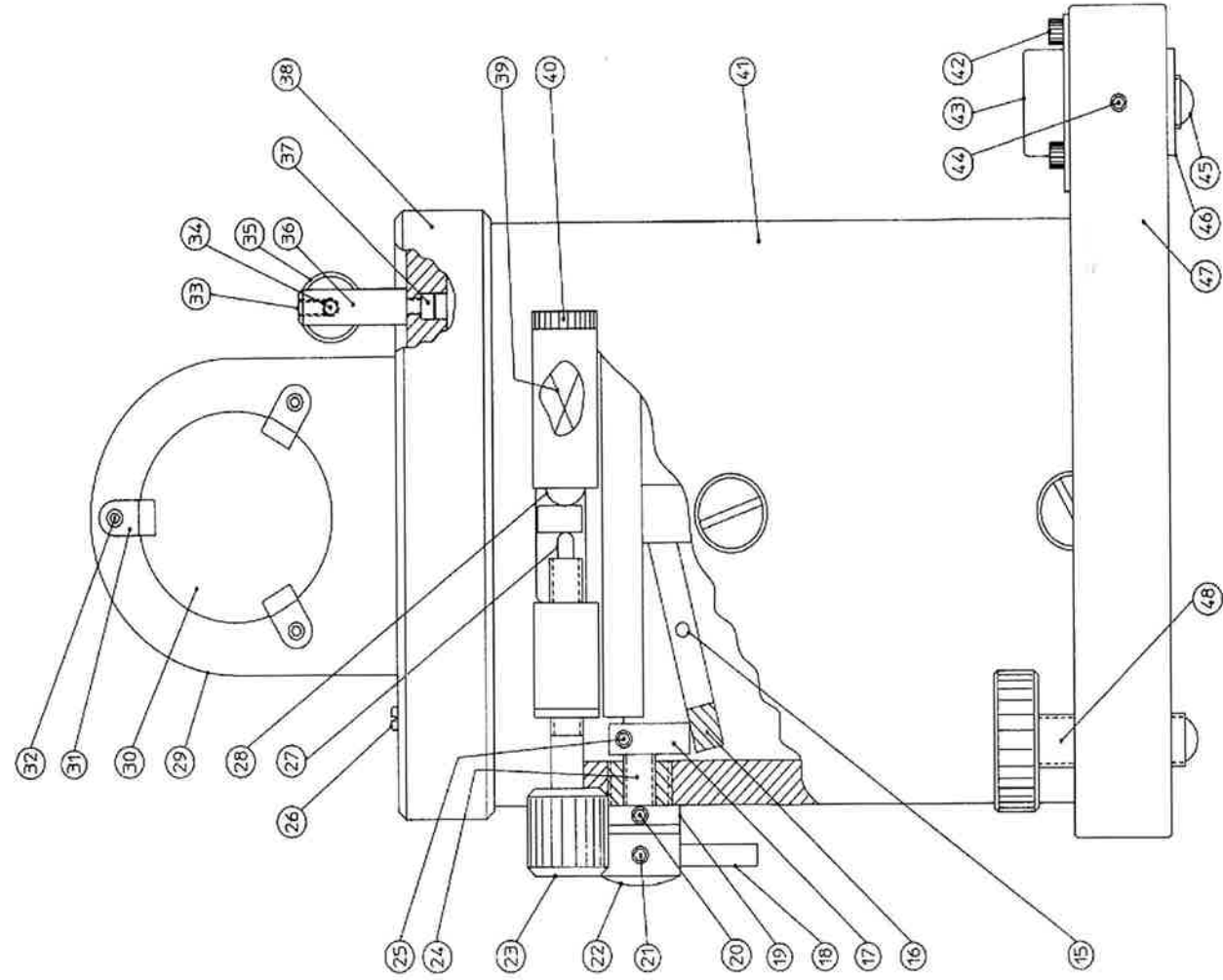
1. Correct half the error using the tangent screw of the test instrument—bring the horizontal reticle lines closer together by half the distance separating them.
2. Remove the remaining error by threading the counterweight toward or away from the collimator until the horizontal reticle lines are exactly in register when the mirror is at rest.
3. Repeat this entire calibration procedure. If error still exists, continue the cycle of checking and adjusting (always removing half the error at the test instrument and half at the leveling mirror) until the reticles stay in precise register on both sides of the mirror. Observed error should be less than two arc seconds.

If you find you cannot repeat your test results, and if you have thoroughly assessed the accuracy of your test setup, call the factory in Kansas City for assistance at 816-483-3187.

# Parts List

1. Contact Foot	4654	8. Screw: 0-80 x 1/8	
2. Weight	9230	soc hd cap	comm.
3. Arm	9235	9. Pivot	9394
4. Collar	9216	10. Screw: 8-32 x 1/4	
5. Ring, Adjusting	9399	soc hd set	comm.
6. Ring, Collar	9217	11. Screw: 4-40 x 3/8	
7. Screw: 4-40 x 1/8		soc hd cap	comm.
soc hd set	comm.	12. Tangent Arm	9229
		13. O-ring	3491
		14. Plug Screw	9398





- 15. Pin: 1/8 x 1 comm. 9210
- 16. Yoke, Lifter comm. 9211
- 17. Cam comm. 9215
- 18. Lock Lever comm. 9212
- 19. Bushing comm.
- 20. Screw: 6-32 x 1/8 nylon soc hd set
- 21. Screw: 5-40 x 3/16 soc hd set
- 22. Lock Knob comm. 9213
- 23. Tangent Screw Assy 2443-G1
- 24. Shaft, Cam 9214
- 25. Screw: 5-40 x 1/8 comm.
- 26. Screw: 2-56 x 1/4 soc hd set
- 27. Wobble Pin pan hd stainless steel
- 28. Plunger comm. 5063
- 29. Mirror Mount 5010
- 30. Window 9386
- 31. Clip 2993
- 32. Screw: 2-56 x 3/16 2382
- 33. pan hd cap comm.
- 34. Balance Rod comm. 9393
- 35. Counterbalance 9392
- 36. Post 9391
- 37. Screw: 4-40 x 3/8 soc hd set
- 38. Cover Ring comm. 9227
- 39. Tangent Spring 5018
- 40. Clamp Cap 5009-2
- 41. Housing 9239
- 42. Screw: 4-48 x 3/8 soc hd cap
- 43. Vial Assy comm. 1749-G1
- 44. Screw: 8-32 x 1/4 soc hd set
- 45. 1/4" Steel Ball comm. 8019
- 46. Stud Screw 9208
- 47. Base 9206
- 48. Leveling Screw 9207
- 49. Carrying Case (not shown) 9389-G1