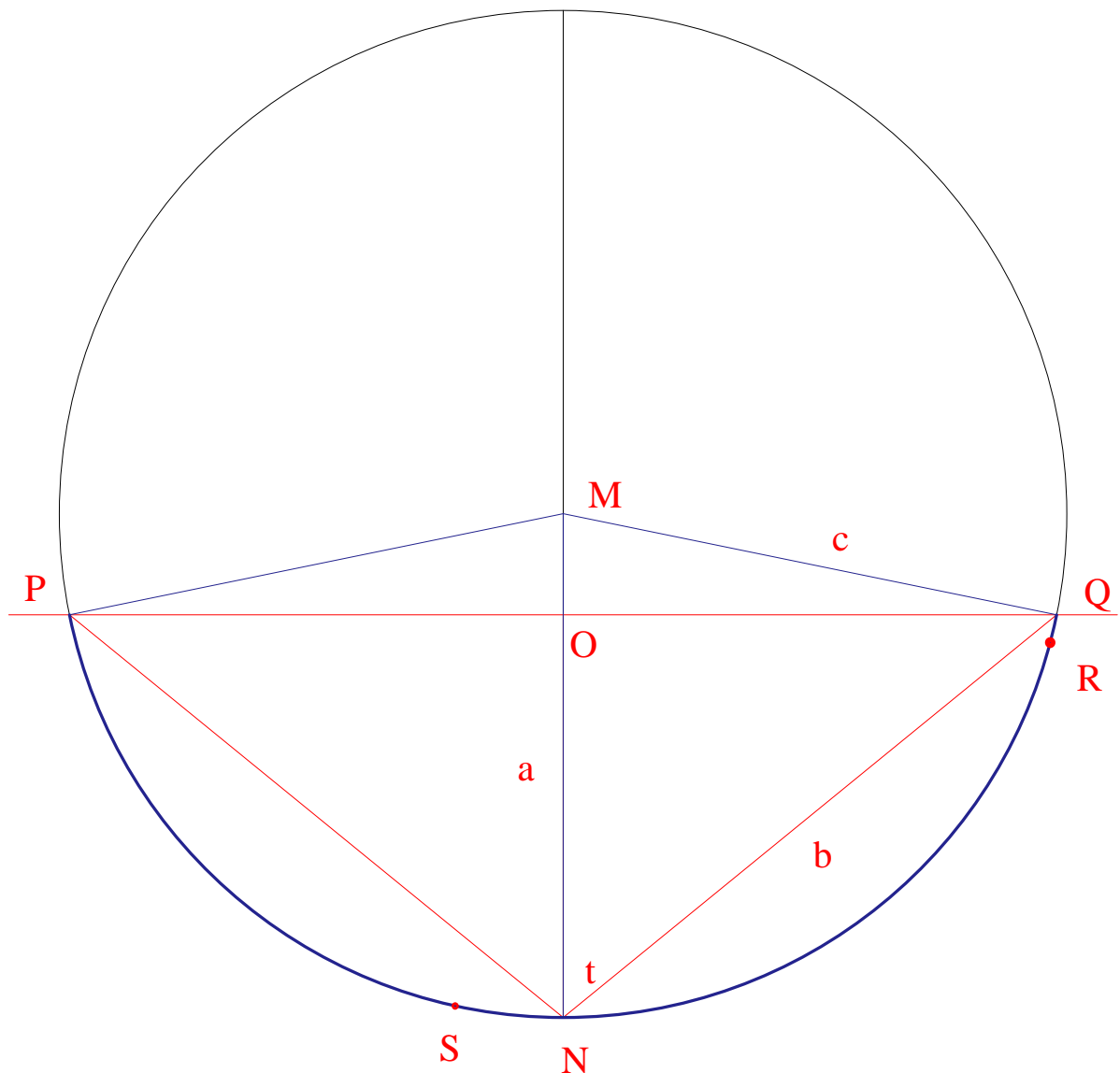


Calculating the Altitude reduction for the ‘Celano Telescope Controller’
(Jan van Gastel)

Problem with calculating the altitude reduction is, that only part of a circle is used for the altitude bearings. So it is not possible to count the grooves of the altitude timing belt over the whole circle from which the bearings are cut. If you still know the exact diameter of the circle from which the bearings are cut, you could divide that by the *pitch diameter*¹ of the drive pulley and the result will be as good as the method of counting grooves of timing belt and drive pulley. Differences will be within measurement errors. But if you don't remember that diameter, you can find it, using the *law of cosine*: $c^2 = a^2 + b^2 - 2 * a * b * \cos(\theta)$, where a, b and c are the sides of a triangle and θ is the angle between the sides a and b.



In the drawing above, M is the center of the circle. Line *c* (MQ) and *a* (MN) are of the same length, because they both define the radius of the circle. Angle *t* = theta, the fat blue arc (PQ)

¹ Which is not the same as the outside diameter of the pulley. Pitch diameter is calculated as follows:
 $Pdia = p * n / \pi$, in which p = belt pitch (distance between teeth centers), n = number of teeth on the pulley. So for a 3 mm HTD belt and a 48 teeth pulley: $Pdia = 3 * 48 / \pi = 45.84$ mm

is the altitude bearing. The timing belt is glued to the outside circumference of the bearing between the two red dots, R and S.

Proceed as follows if you want to use number of grooves of pulley and timing belt:

1. Measure the exact length of the red line PQ and divide by 2, to get OQ;
2. Mark midpoint of bearing, N, on the bearing;
3. Measure NO;
4. Calculate line $b = \text{Sqrt}(NO^2 + OQ^2)$;
5. Calculate angle $t = \arccos(NO/b)$;
6. Calculate the radius of the circle using the law of cosines. Because $a = c$, this formula simplifies to the easy to handle: $c = b / (2 * \cos(t))$;
7. Calculate the circumference of the circle from which the bearings are cut: $2 * \pi * c$;
8. Count the grooves on the timing belt RS;
9. Measure length of timing belt, RS;
10. Calculate number of grooves for the whole circle: = circumference/RS*result of 8;
11. Count the number of grooves on the pulley;
12. Calculate reduction: = result of 10/result of 11.

Using the diameter of the bearing circle and pitch diameter of the pulley:

Given the above mentioned fact that using the diameter of the whole circle from which the bearings are cut and the pitch diameter of the drive pulley, you could stop after calculating the radius of the bearing circle (at 6). Then divide the result of 2*the radius (2*c) by the pitch diameter of the drive pulley.

My results

I have used both of the above mentioned methods on the same scope and there was only a slight difference in the results. I entered the mean of the two results in the configuration file and then started finetuning with the method available in the Celano software. It turned out that the mean of the two methods was already dead on.