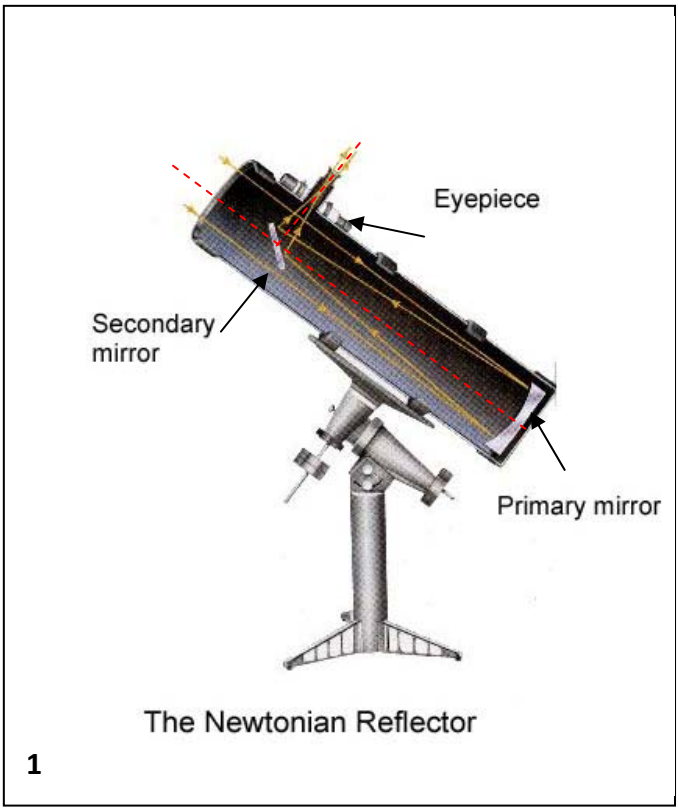
A simple guide to adjusting the optics of a Newtonian reflector telescope

The diagram on the right shows a Newtonian telescope.



The Newtonian Reflector

1

1 What's inside? (See Figure 1)

Light enters the tube at the top end of the telescope. It is then reflected from the "Primary Mirror", back up the tube and reflected from the "Diagonal", "Secondary Mirror" or "Flat".

The flat is set at 45° in order to send the light out of the tube to the "Eyepiece", through which you look.

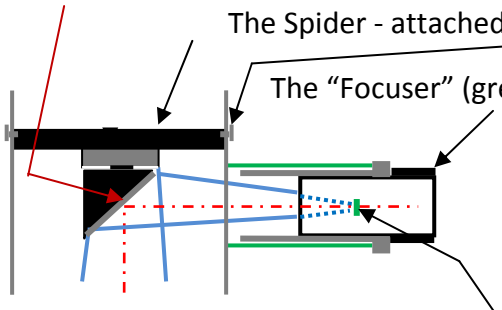
Only the primary mirror's surface is curved, as shown in the picture. This makes it form a "Real Image" of a distant object at its "Focal Plane". The eyepiece is like an ordinary magnifying glass to enable you to examine this real image closely. Figure 2 shows the top end of the optics, *as properly adjusted*. **The telescope will only give sharp images everything is properly adjusted!**

Here is a diagram of the top end of the telescope tube, as properly adjusted.

The flat, on its mounting. A bolt (inside) holds it on to a "Spider" of 4 vanes(usually).

The Spider - attached to the tube with brackets and adjusting screws.

The "Focuser" (green), eyepiece (black), in its "drawtube" (grey).



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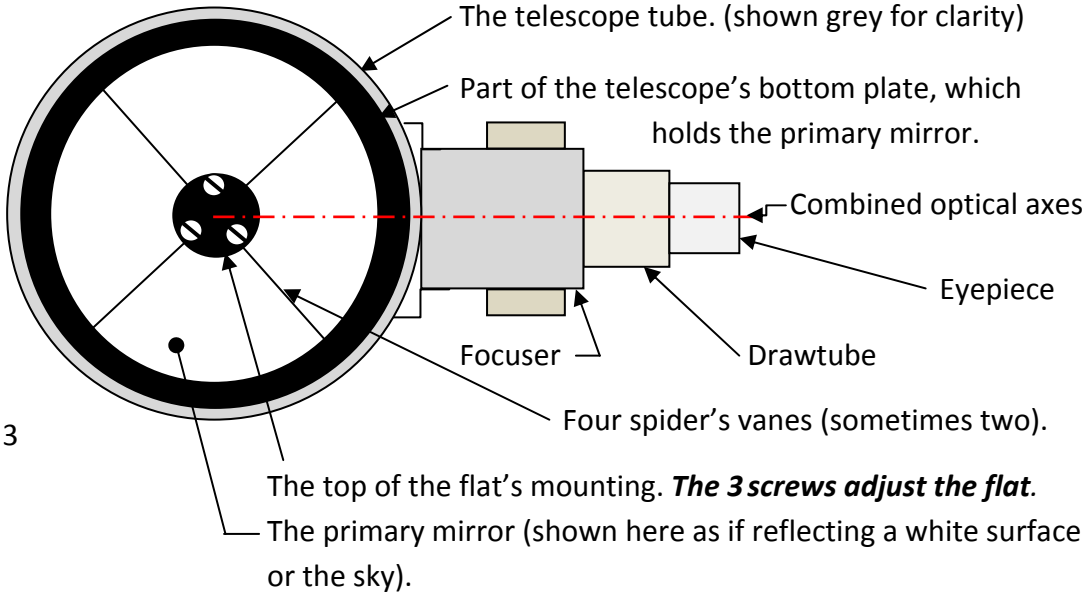
The red lines (also Fig 1) are the "Optical Axes".

The blue lines are those light rays which just hit the edges of the primary mirror, reflect from it, and the flat, and enter the eyepiece lens.

The primary mirror's focal plane and the eyepiece's focal plane must coincide for the observer's eye to focus on the image.

2 Now look down into the tube. If everything is aligned, it should look like this.



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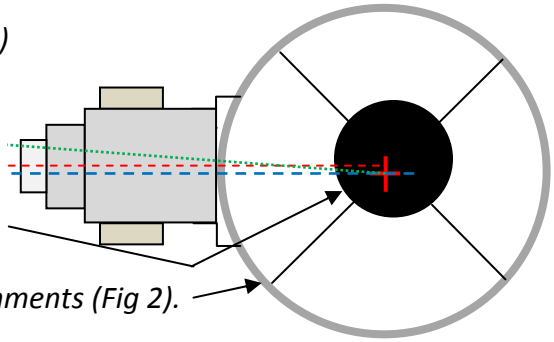
Things to check *(This view is a badly misaligned case)*

a) Does the focuser point at the centre of the tube?
If not, either shift it sideways, or tilt it (shown).

b) Is the flat, on its mounting, in the centre of the tube?

Measure it, and adjust the relevant spider arm attachments (Fig 2).



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3 Now check the view through the focuser, with no eyepiece in it.

We need a disc (of card, metal, plastic etc) in a tube which is 1¼ inches in diameter. This must fit snugly into the focuser instead an eyepiece. An old metal, 35mm film can is ideal – if you can get one! Now measure it carefully and drill a 4 -5 mm hole in the exact centre of the tin's base.

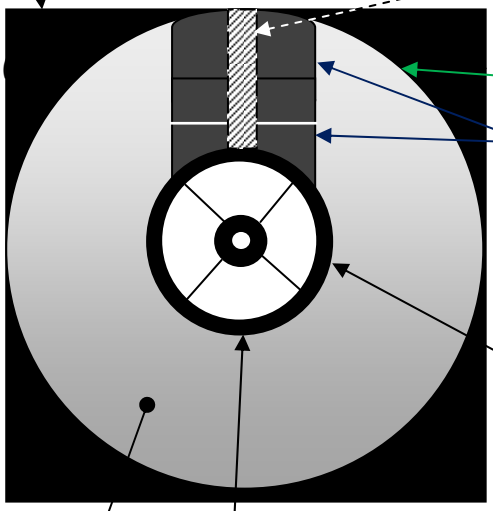
Fit this into the eyepiece focuser, small hole towards you. Rack the focuser ***fully in***, and look through the hole. This becomes your "peephole".

You can do this at night, but daylight or a bright room is far easier.

Point the telescope upwards at a white ceiling or sky.

4 Looking through the peephole.

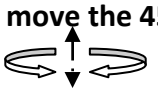
The diagram below is what you would see *if the telescope was very well adjusted. The black square is just my drawing frame. Its blackness is the inside of the drawtube.*



Note that the bolt connecting the 2 halves of the flat holder is actually inside it, and invisible.

The inner (far) end of the focuser drawtube.

The top half of the flat holder is attached to the spider. **The bottom half is the 45° half**. The gap shows the joint, and the hatched bit is the bolt (Fig 2) inside it. **This bolt can be loosened to move the 45° part up or down, or to swivel it.** →



The flat itself is this circle. The white part is its reflection of the primary mirror, which itself is reflecting the spider, the flat and the flat's reflections – ie the inside of the focuser and the peephole.

5

The black part is the flat's view of the outer parts of the blackened, bottom plate of the telescope, around and underneath the primary mirror.

The big, grey circle is your view ***past*** the flat, of the far side of the telescope tube. I have coloured it grey to avoid confusion. ***See my note below *.***

5 Adjusting the flat's angles and position in the telescope tube

The adjustments in Section 2 *should* have resulted in:-

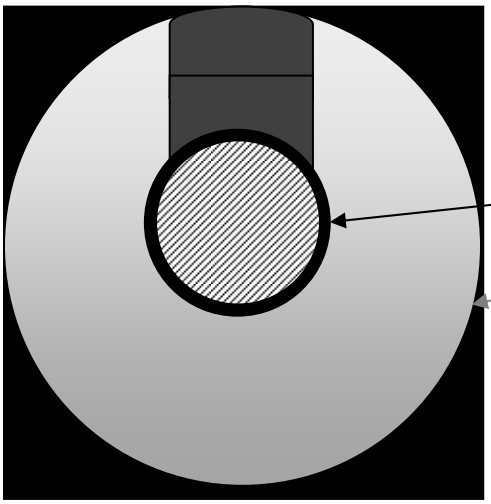
1 The flat mounting being in the centre of the tube. Its side-to-side position can also be checked by looking into the focuser.

2 The focuser should now be pointing at the centre of the flat. So the flat itself should be horizontally centred in its view, see Fig 6, next page.

Don't worry, for now, what you see reflected in the flat itself.

A possible, second, small adjustment of the flat mounting is given on the next page.

***NOTE: You will not see *anywhere near as much* of the far side of the telescope tube , past the flat, as my drawings show in this guide. Instead, you will probably only see a small bit around the flat. But I have shown this as a large area (coloured grey by me) to make things look simpler.**



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Although elliptical, the flat will *look like* a circle.

This is what you *may* see. *I have left out all reflections in the flat, shown as diagonal lines instead.*

The flat is shown here as too high up in the telescope tube ↑ and is therefore not concentric with the *focuser's* tube axis, which is the outermost circle here.

If it's too high, like this, then slightly loosen the bolt connecting the two halves of the flat mounting (Fig 5), and move the 45° half downwards.

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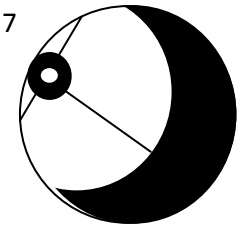

Now look at what is reflected in the flat - the primary mirror (white disc), in this example (Fig7), is shown far too much to the left and too high.

a) *So slacken the flat holder's internal bolt (Fig 5) and swivel its 45° part.*
b) To correct its being too high, look at the 3 screws on top of the flat mount. Fig 3. Loosen and adjust them to tilt the flat and bring its reflected image of the primary mirror (white circle) to the centre of your view.

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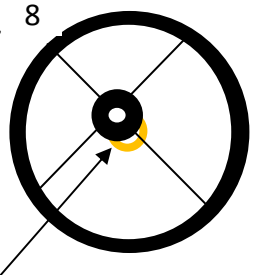

However, the reflected view of *the spider* etc may be off-centre, like Fig 8. *If so, then then the tilt of the primary mirror itself needs adjustment.*

6 Adjusting the primary mirror

If possible, at the start, *paste a paper ring at the exact centre of the primary mirror,* as partly-shown in Fig 8, to define it more clearly.
This last adjustment is to *make the drawtube **and peephole's reflection*** *sit in the ring in the ring in the primary mirror's image* (Fig 9). Do this by adjusting 3 screws you will find under the *back of the primary mirror's support plate.* Your view should now look like Fig 9.

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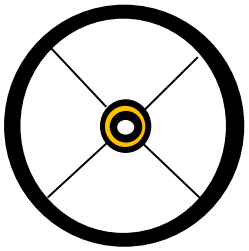

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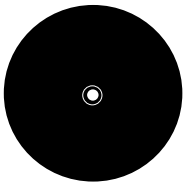
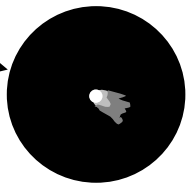


7 Star testing

As a final check, choose a night with ***low air turbulence*** and look at a magnitude 6 to 8 star, using quite a high magnification – say x50 per inch of telescope aperture. It should look like a bright disc, (Fig 10) perhaps with a fainter ring round it. If so, OK! But if it looks more like a fuzzy comet, Fig 11 then experiment with the *3 primary mirror adjustment screws* again to make it more like Fig 10. The star's "tails" point away from the "sweet spot". So adjust the screws to move the stars apparently ***in the direction of their tails.***



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Check this last, very important alignment from time to time.