A Dual Efficiency Optical Instrument (Both Microscope & Telescope)

Shiva Mahdavisereshtl, Tehran/ Iran

ARTICLE INFO

Participated and was awarded in First Step to Nobel Prize as high school student (2006-2007) postgraduate in Medical Science (present)
Accepted in country selection by Ariaian Young Innovative Minds Institute , AYIMI
http://www.ayimi.org ,info@ayimi.org

ABSTRACT

Both telescope and microscope are basically constructed using 2 planoconvex lenses. However, it is considerable that in telescopes the eye piece lens focal distance is shorter than the objective one while on contrary in microscopes the focal distance in eye piece lens is longer than the other. According to this fact, it seems that these 2 devices, telescope and microscope, are operating inversely.

Keywords: *telescope, microscope, lense, focal point*

1 Introduction

By development of science, research and investigations allocated a special place to itself. This is while measurement and dimensions play an important role in science and study. As we know for investigating huge and small objects, telescope and microscope are used respectively. An instrument composed of these 2 devices will definitely make working easier for researchers.

According to the fact that by placing 2 planoconvex lenses in front of each other and adjusting the distance between them, we can construct simple microscopes or telescopes. Certainly, by composing these 2 devices in telescope and microscope, it is possible to provide a two sided instrument performs both telescopic and microscopic operations.

2 Materials and Methods

2-1 Astronomical Telescope

Astronomical telescope is made of 2 planoconvex lenses. The objective lens makes a real inverted image of the object placed in infinity, in focal distance. Astronomical telescope is usually regulated in a way that the final image gets formed in infinity. For this result, the focal distance in eye piece lens (fe) should coincide with the focal distance in objective lens (fo) . In this instrument (fo) is long and (fe) is short. The final image is virtual , inverted with regard to the object and direct in comparison with the first image (Fig.1).

The following equation yields the angle magnification of telescope (Eq.1).

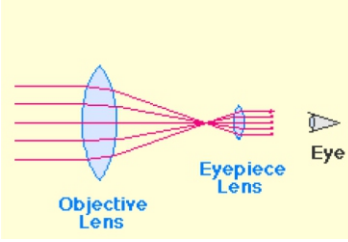

Fig. 1: Telescope

$$m = \frac{\beta}{\alpha} \qquad (1)$$

According to these description a telescope can be constructed as follows.

1. Planoconvex f=8.3cm
2. Planoconvex f=25cm as the objective lens
3. Ruler
4. Leg (pedestal)

The procedure for building this telescope is:

1. Put the ruler in a far distance.
2. Place the lens on the pedestals.
3. Use the lens with focal distance of 25cm as the objective one.
4. Place the lens with focal distance of 10cm in a distance of fe +fo=35cm .
5. While looking through the eye piece lens , adjust the distance between the objective and eye piece lens till the image become clear.
6. For better observing, we can use a light projector on the object.

Note that the final image is figurative and inverted with the object and get formed in infinity.

2-2 Microscope

This instrument is made of 2 lenses, one near to the object and the other near to our eyes. The focal distance of objective lens is indicated by fo and the object is placed between fo and 2fo. The image obtained is inverted, real and larger and get formed in the focal distance of eye piece lens . This image is as an object for the eye piece lens. So the final image is direct, figurative and larger with regard to the first image (Fig.2).

According to the description ,a microscope can be constructed.

Requirements:

1. A detracting transformer.
2. Light projector
3. Planoconvex lens f=8.3cm
4. Planoconvex lens f=25cm
5. Pedestal

The procedure for building this microscope is:

1. Connect the light projector to the transformer.
2. Draw small checkered lines on a paper and put it in front of the projector.
3. Put the objective lens in a distance of 4 cm to the paper.

4. Put the eye piece lens in a distance less than 55 cm to the first lens.

5. Look through the eye piece lens at the checkered paper and adjust the distance between lenses to obtain a clearer image.

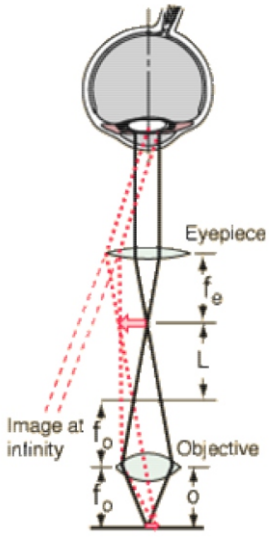

Fig. 2: Microscope

3 A Dual Efficiency Optical Instrument

As mentioned in previous sections both telescope and microscope are basically constructed using 2planoconvex lenses. However, it is considerable that in telescopes the focal distance of eye piece lens is shorter than the objective one while on contrary in microscopes the focal distance in eye piece lens is longer than the other. According to this fact, it seems that these 2 devices i.e. telescope and microscope is operating inversely. It means that by placing 2 planoconvex lenses in front of each other, in case we look through one side, this arrangement will have microscopic characteristics and if we look through the other side it will have telescopic characteristics. Of course it should be considered that distances between these 2 lenses , in 2 cases above, are not identical i.e. in telescopic case , lenses should be placed in a distance of fo+fe to each other while in microscopic case , the distance between lenses must be to some extent more. Thus, if we accumulate 2 planoconvex lenses in one device in a way that the distance between these 2 lenses become adjustable, then we will be able to obtain both telescopic and microscopic efficiency (of course basically) from device produced and through its 2 sides . So we proceed to construct a device (Fig3).

Fig 3: a dual optical instrument

The constructed device can perform in both telescopic and microscopic way (Figs. 4 and 5).

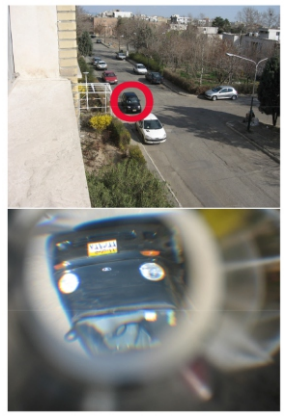

Fig 4: Image obtained from telescopic part

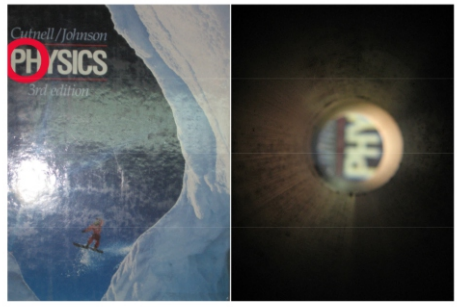

Fig. 5: Image obtained from microscopic part

4 Complementary Steps

Now, we should inspect if it is possible to use exhibited layout in progressive instruments. For this purpose, we should inspect that in basic level, how we can improve the magnification of a telescope or a microscope.

The magnification of a telescope and microscope are obtained from the equations (2 and 3) , respectively.

$$M(telescope) = \frac{-f_o}{f_e} \quad (2)$$

$$M(microscope) \approx \frac{-(L - f_e)N}{f_o f_e} \quad (3)$$

where N is human eyesight (naturally equal to 25cm) and L is the distance between 2 lenses which is always more than fo+fe.

So if L= fo+fe , then:

$$M(microscope) = \frac{cte}{f_e} \quad (4)$$

Considering equations(2) and (4), since in our device, the eye piece lens in telescope and the objective lens in microscope are the same and vice versa, in order to improve the magnification of the telescopic part of the device we should use an objective lens with a larger focal distance, while it results in decreasing the magnification of the microscopic part , considering :

$$f_e(miroscope) \equiv f_o(telesope)$$

So there would be an optimum point for our device construction , otherwise it will result in decreasing the magnification of one of these 2 parts.

5 Conclusion

1 – Using the exhibited layout and in an optimum point it is simply possible to construct a device which basically performs both telescopic and microscopic operations in a good way.

2 – In order to improve the magnification of both parts of the device (telescopic and microscopic) and to construct more progressive device , this fact should be considered that the magnification of these 2 parts are inversely related to each other . The only way to complete this device for more progressive operations is to combine microscopic and telescopic parts meanwhile the progressive equipment related to each one get applied separately in the device in a way that in each form of operation the equipment required enter into the circuit.

References

[1] Cutnell, J. D. and K. W. Johnson, (1995). Physics (3rd Edition, John Wiley & Sons, Inc.), 831-855

[2] Holliday, D. & R. Resnik, (1978). Physics, John Wiley &Sons, Inc.