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opposite side; for I could plainly observe a difference afterward, if I neglected to mind both these circumstances, or indeed either of them \*.

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XXVII. *A Description of a Contrivance for measuring small Angles, by Mr. John Dollond; communicated by Mr. J. Short, F. R. S.*

Read May 10, 1753. **L**ET an object-glass, of any convenient focal length (being truly ground and well center'd) be divided into two equal parts or segments, by cutting it strait through the center; and let a piece of machinery be so contriv'd, as to hold these two segments in the same position to each other, as they stood in before they were cut asunder; and to be capable at the same time of drawing them to different distances from that position, in the manner, as is represented in the figure.

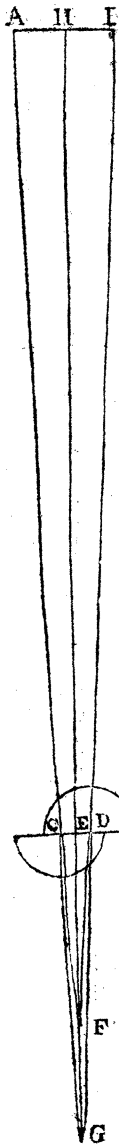
Each of these segments will form a distinct image of any object, to which they are directed; differing in nothing from that, which might have been made by the whole glass before it was cut, except in brightness. And while these segments are held in their original position, the images will coincide, and become one single image as at first; but, in proportion as they

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\* Dr. Smith, in his Complete System of Optics, published in 1738, has described a very accurate and ready method of centering object-glasses, which was always used by the late Mr. George Graham, from whom the doctor had it.

they are drawn off from that situation, the images will separate more or less, according to the distance they are drawn to. By this means the images of two different objects, or of different parts of the same object, not very far from each other, may be brought to a contact or coincidence at the focus: and this coincidence may be view'd to a very great nicety with a proper eye-glass.

The measure of the angle subtended by the two objects, whose images are thus brought to a coincidence, depends upon three things: First, a careful observation of the coincidence of the images: Secondly, an exact measure of the distance, which the glasses are drawn out to from that situation, which makes the image single: And, lastly, a true knowlege of the focal distance of the glass. How the angle is to be found from these measures, and how it may likewise be come at, by viewing two land-objects at a convenient distance, will be shewn hereafter in the explanation of the figure. It is easy to understand, in the mean time, that the angle will be measur'd with more accuracy, in proportion to the length of the glass, which is used for that purpose; but the difficulty of managing long telescopes is no less apparent. Therefore the most practicable method of using this micrometer to advantage, is, to apply the divided object-glass to the object-end of a reflecting telescope: for, as the apertures of these sort of telescopes are large in proportion to their lengths, they will admit of very long glasses; nor will the measures be any way affected by the metals or glasses, which the reflector is composed of: and the angles will be found in the same manner, as though the images were view'd with a



single eye-glass, in the manner of a common refracting astronomical telescope; but with this advantage, that, as the images will be exhibited larger and distincter by the reflecting telescope; and as every part thereof will be much more manageable than a long refracting telescope; so the contact or coincidence of the images will be more accurately observ'd.

It would be however unnecessary now, as well as improper, to say much about the advantages of this method above those, which have hitherto been put in practice; because, as a machine is now making for this purpose, the experiments, which will shortly be tried, will be more convincing, as well as more intelligible, than any thing that might be offer'd at present.

*Explanation of the Figure.*

The two semicircles represent the two segments of the object-glass, whose centers *C* and *D* are drawn off to the distance *CD*, and the points *A* and *B* are two objects, or different parts of the same object; therefore the lines *ACG* and *B DG* represent two rays that pass thro' the centers or poles of the segments, and are therefore not at all refracted, but go strait through to *G*, where they intersect; and *G* being the respective focus to the distance of the objects from the glass, the two images will coincide at that point. It appears from the figure, that  $AB : CD :: GH : GE$ ; and from a common proportion in optics,  $GH : GE :: HE : EF$ . Therefore,  $AB : CD :: HE : EF$ ; *F* being the focus of parallel rays; and consequently

consequently the angles  $AEB$  and  $CFD$  are equal. That is, the angle subtended by the distance of the centers of the segments from the distance of the focus of parallel rays is equal to the angle subtended by the distance between the objects  $A$  and  $B$  from the end of the telescope.

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XXVIII. *A Letter to Sir Peter Thompson; Knt: F. R. S. containing Experiments on the Copper Springs in Wicklow in Ireland, and Observations thereon, by John Bond, M. D.*

S I R,

Read May 10,  
1753.

**Y**OU may remember I had the honour of spending an evening with you in June last, and happen'd to mention a spring in the county of Wicklow in Ireland, which was supposed to have the surprizing quality of changing iron into copper. But your constant love of truth, and strong aversion to vulgar errors, made you doubt the fact, which, at that time, I could only affirm on the report, which prevailed among the curious in that country. You then proposed several judicious queries, and seem'd desirous of being further inform'd concerning it, which rais'd my curiosity to take the first opportunity of inquiring more particularly into the foundation of that marvellous account.

Having soon afterwards occasion to go to Dublin, I went to the spring, which is from thence about thirty-eight miles, and made several experiments on  
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