the hot solution is decanted into a flask and distilled from an oil-bath, the temperature of which may be allowed to rise to 200°. The alcohol distils off at first readily, after a while with greater difficulty; finally the contents of the distilling flask solidify, and it becomes extremely difficult to drive over any more amylic alcohol. On now adding water to the contents of the flask and again distilling, amylic alcohol comes over of about half the rotating power of the alcohol employed. If the power of rotation be very small, the reduction is considerably greater; thus, operating on an alcohol rotating 1°·3 on the 385 millims., by one operation we have reduced it to 0·3. By a sufficient number of repetitions of the process, it is possible to effect a separation of the alcohols, and very easy to obtain considerable quantities of the non-rotating alcohol quite pure. No valerianic acid is formed; and the soda-solution remaining in the flask after the operation is completed is barely coloured.

The separation of the alcohols may also be effected by dissolving metallic sodium in amylic alcohol, and distilling, &c., as above described, the resulting solution of amylate of soda in amylic alcohol. The process appears to present no point of advantage over that with caustic soda.

We shall shortly publish a detailed account of differences in structure of these alcohols, together with a description of some of their principal derivatives.

III. "Note on the Heat of the Stars." By William Huggins, F.R.S. Received February 18, 1869.

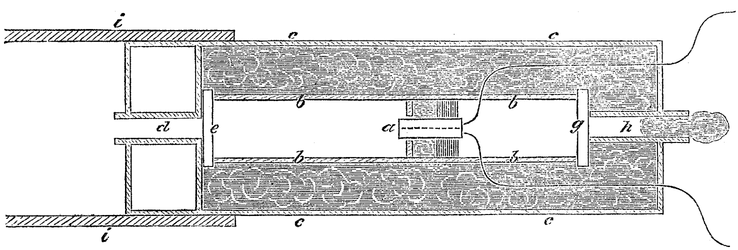
In the summer of 1866 it occurred to me that the heat received on the earth from the stars might possibly be more easily detected than the solar heat reflected from the moon. Mr. Becker (of Messrs. Elliott Brothers) prepared for me several thermopiles, and a very sensitive galvanometer. Towards the close of that year, and during the early part of 1867, I made numerous observations on the moon, and on three or four fixed stars. I succeeded in obtaining trustworthy indications of stellar heat in the case of the stars Sirius, Pollux, and Regulus, though I was not able to make any quantitative estimate of their calorific power.

I had the intention of making these observations more complete, and of extending them to other stars. I have refrained hitherto from making them known; I find, however, that I cannot hope to take up these researches again for some months, and therefore venture to submit the observations in their present incomplete form.

An astatic galvanometer was used, over the upper needle of which a small concave mirror was fixed, by which the image of the flame of a lamp could be thrown upon a scale placed at some distance. Usually, however, I preferred to observe the needle directly by means of a lens so placed that the divisions on the card were magnified, and could be read by the observer when at a little distance from the instrument. The sensitiveness of the

instrument was made as great as possible by a very careful adjustment from time to time of the magnetic power of the needles. The extreme delicacy of the instrument was found to be more permanently preserved when the needles were placed at right angles to the magnetic meridian during the time that the instrument was not in use. The great sensitiveness of this instrument was shown by the needles turning through 90° when two pieces of wire of different kinds of copper were held between the finger and thumb. For the stars, the images of which in the telescope are points of light, the thermopiles consisted of one or of two pairs of elements; a large pile, containing twenty-four pairs of elements, was also used for the moon. A few of the later observations were made with a pile of which the elements consist of alloys of bismuth and antimony.

The thermopile was attached to a refractor of eight inches aperture. I considered that though some of the heat-rays would not be transmitted by the glass, yet the more uniform temperature of the air within the telescope, and some other circumstances, would make the difficulty of preserving the pile from extraneous influences less formidable than if a reflector were used.



The pile *a* was placed within a tube of cardboard, *b*; this was enclosed in a much larger tube formed of sheets of brown paper pasted over each other, *c*. The space between the two tubes was filled with cotton-wool. At about 5 inches in front of the surface of the pile, a glass plate (*e*) was placed for the purpose of intercepting any heat that might be radiated from the inside of the telescope. This glass plate was protected by a double tube of cardboard, the inner one of which (*d*) was about half an inch in diameter. The back of the pile was protected in a similar way by a glass plate (*g*). The small inner tube (*h*) beyond the plate was kept plugged with cotton-wool; this plug was removed when it was required to warm the back of the pile, which was done by allowing the heat radiated from a candle-flame to pass through the tube to the pile. The apparatus was kept at a distance of about 2 inches from the brass tube by which it was attached to the telescope by three pieces of wood (*i*), for the purpose of cutting off as much as possible any connexion by conduction with the tube of the telescope.

The wires connecting the pile with the galvanometer, which had to be

placed at some distance to preserve it from the influence of the ironwork of the telescope, were covered with gutta percha, over which cotton-wool was placed, and the whole wrapped round with strips of brown paper. The binding-screws of the galvanometer were enclosed in a small cylinder of sheet gutta percha, and filled with cotton-wool. These precautions were necessary, as the approach of the hand to one of the binding-screws, or even the impact upon it of the cooler air entering the observatory, was sufficient to produce a deviation of the needle greater than was to be expected from the stars.

The apparatus was fixed to the telescope so that the surface of the thermopile would be at the focal point of the object-glass. The apparatus was allowed to remain attached to the telescope for hours, or sometimes for days, the wires being in connexion with the galvanometer, until the heat had become uniformly distributed within the apparatus containing the pile, and the needle remained at zero, or was steadily deflected to the extent of a degree or two from zero.

When observations were to be made, the shutter of the dome was opened, and the telescope, by means of the finder, was directed to a part of the sky near the star to be examined where there were no bright stars. In this state of things the needle was watched, and if in four or five minutes no deviation of the needle had taken place, then by means of the finder the telescope was moved the small distance necessary to bring the image of the star exactly upon the face of the pile, which could be ascertained by the position of the star as seen in the finder. The image of the star was kept upon the small pile by means of the clock-motion attached to the telescope. The needle was then watched during five minutes or longer; almost always the needle began to move as soon as the image of the star fell upon it. The telescope was then moved, so as to direct it again to the sky near the star. Generally in one or two minutes the needle began to return towards its original position.

In a similar manner twelve to twenty observations of the same star were made. These observations were repeated on other nights.

The mean of a number of observations of Sirius, which did not differ greatly from each other, gives a deflection of the needle of 2°.

The observations of Pollux $1\frac{1}{2}°$.

No effect was produced on the needle by Castor.

Regulus gave a deflection of 3°.

In one observation Arcturus deflected the needle 3° in 15 minutes.

The observations of the full moon were not accordant. On one night a sensible effect was shown by the needle; but at another time the indications of heat were excessively small, and not sufficiently uniform to be trustworthy.

It should be stated that several times anomalous indications were observed, which were not traced to the disturbing cause.

The results are not strictly comparable, as it is not certain that the

sensitiveness of the galvanometer was exactly the same in all the observations, still it was probably not greatly different.

Observations of the heat of the stars, if strictly comparable, might be of value, in connexion with the spectra of their light, to help us to determine the condition of the matter from which the light was emitted in different stars.

I hope at a future time to resume this inquiry with a larger telescope, and to obtain some approximate value of the quantity of heat received at the earth from the brighter stars.

IV. "On the Fracture of Brittle and Viscous Solids by 'Shearing.'" By Sir W. Thomson, F.R.S. Received January 2, 1869.

On recently visiting Mr. Kirkaldy's testing works, the Grove, Southwark, I was much struck with the appearances presented by some specimens of iron and steel round bars which had been broken by torsion. Some of them were broken right across, as nearly as may be in a plane perpendicular to the axis of the bar. On examining these I perceived that they had all yielded through a great degree to distortion before having broken. I therefore looked for bars of hardened steel which had been tested similarly, and found many beautiful specimens in Mr. Kirkaldy's museum. These, without exception, showed complicated surfaces of fracture, which were such as to demonstrate, as part of the whole effect in each case, a spiral fissure round the circumference of the cylinder at an angle of about 45° to the length. This is just what is to be expected when we consider that if A B D C (fig. 1) represent an infinitesimal square on the surface of a round bar with its sides A C and B D parallel to the axis of the cylinder, before torsion, and A B D′ C′ the figure into which this square becomes distorted just before rupture, the diagonal A D has become elongated to the length A D′, and the diagonal B C has become contracted to the length B C′, and that therefore there must be maximum tension every-

Fig, 1.

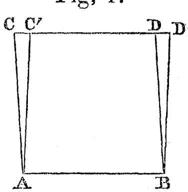
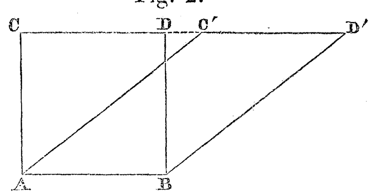
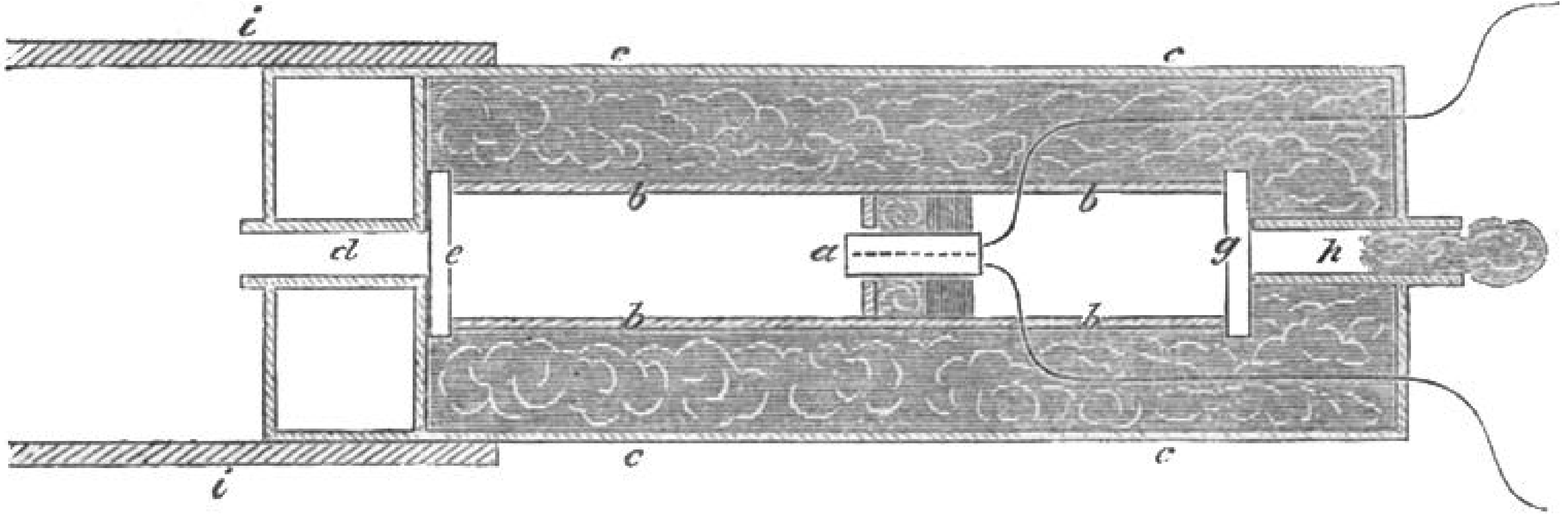


Fig. 2.



where, across the spiral of which B C′ is an infinitely short portion. But the specimens are remarkable as showing in softer or more viscous solids a tendency to break parallel to the surfaces of "shearing" A B, C D, rather than in surfaces inclined to these at an angle of 45°. Through the kindness of Mr. Kirkaldy, his specimens of both kinds are now exhibited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