gaseous state. I determined to use it principally for obtaining very stationary low temperatures by boiling it under different pressures. I prepare the ammonia as a gas by passing continuously a thread of a concentrated solution of ammonia into a copper tube enclosed in a small boiler containing water which is kept boiling by a gas-light. The ammonia flows in a spiral along the walls, and the liquid, nearly deprived of ammonia, escapes by a tube below, which enters to a depth of several decimetres into the liquid which has previously flowed out.

"The gaseous ammonia, sucked by the pump, traverses several copper recipients filled with soda-lime. The pump itself regulates the production of the gas, and delivers it into the receiver, which is buried in a freezing mixture of ice and hydrated chloride of calcium. By means of this arrangement several litres (quarts) of liquid ammonia may be obtained in a few hours.

"To submit an apparatus to a stationary low temperature, it is hermetically adjusted in the condenser, and the liquid ammonia is condensed in this receiver buried in a freezing mixture. When it is sufficiently filled with the liquid, the freezing mixture is removed and the receiver placed in communication with one of my large air-reservoirs, in which the pressure is kept rigorously stationary, either above or below that of the atmosphere.

"The ammonia thus distils under pressures as light as are desired, which are easily kept perfectly constant, provided the ammoniacal gas is prevented from reaching the air-reservoir. For this purpose, in front of this reservoir is placed a cylindrical vessel containing pieces of ice, which, as they liquefy, almost entirely re-dissolve the ammonia; and after this, another cylinder filled with large pieces of pumice stone soaked with acid.

"I thus hoped to obtain, by means of this apparatus, low temperatures which should be perfectly stationary, but I was not successful for reasons which I have explained before (p. 242). A certain amount of steadiness can only be obtained by passing a continual current of small bubbles of air through the liquid ammonia, which thus continually stirs up the liquid and destroys its viscosity. An air thermometer should be placed in contact with the apparatus experimented on, and plunged entirely in the liquid ammonia; by means of a regulating screw, the current or air-bubbles is controlled so as to keep the thermometer stationary.—*Comptes Rendus de l'Academie des Sciences de Paris*, 11 Juin, 1860.

*On Microscopic Vision and a new Form of Microscope.** By Sir. D. BREWSTER.

In studying the influence of aperture on the images of bodies as formed in the camera, by lenses or mirrors, it occurred to me that in microscopic vision it might exercise a still more injurious influence. Opticians have recently exerted their skill in producing achromatic object-glasses for the microscope with large angles of aperture. In 1848 the late distinguished optician, Mr. Andrew Ross, asserted "that

* From the Lond. Athenæum, July, 1860.

135° was the largest angular pencil that could be passed through a microscopic object-glass," and yet in 1855 he had increased it to 170°, while some observers speak of angular apertures of 175°. In considering the influence of aperture, we shall suppose that an achromatic object-glass with an angle of aperture of 170° is optically perfect, representing every object without color and without spherical aberration; when the microscopic object is a cube, we shall see five of its faces, and when it is a sphere or a cylinder, we shall see nine-tenths or more of its circumference. How, then, does it happen that large apertures exhibit objects which are not seen when small apertures with the same focal length are employed? This superiority is particularly shown with test objects marked with grooves or ridges and obliquely illuminated. The marginal part of the lens will enlarge the grooves and ridges, and they will thus be rendered visible, not because they are seen more distinctly, but because they are expanded by the combination of their incoincident images. Hence we have an explanation of the fact—well known to all who use the microscope—that objects are seen more distinctly with object-glasses of small angular aperture. In the one case we have, with the same magnifying power, not only an enlarged and indistinct image of objects, but a false representation of them, from which their true structure cannot be discovered; while in the other we have a smaller and distinct image, and a more correct representation of the object. But these are not the only objections to large angular apertures and short focal lengths.

1. In the first place, it is extremely difficult to illuminate objects when so close to the object-glass.
2. There is a great loss of light, from its oblique incidence on the surface of the first lens.
3. The surface of glass,—with the most perfect polish,—must be covered with minute pores, produced by the attrition of the polishing powder; and light, falling upon the sides of these pores with extreme obliquity, must not only suffer diffraction, but be refracted less perfectly than when incident at a less angle.
4. When the object is almost in contact with the anterior lens, the microscope is wholly unfit for researches in which mechanical or chemical operations are required, and also for the examination of objects inclosed in minerals or other transparent bodies.
5. In object-glasses now in use, the rays of light must pass through a great thickness of glass of doubtless homogeneity. It is a question yet to be solved whether or not, a substance can be truly transparent, in which the elements are not united in definite proportion; in which the substances combined have very different refractive and dispersive powers; and in which the particles are so loosely united that they separate from one another, as in the various kinds of decomposition to which glass is liable. If the best microscopes are affected by these sources of error, every exertion should be made to diminish or remove them.

1. The first step, we conceive, is, to abandon large apertures, and to use object-glasses of moderate focal length, obtaining at the eye-glass any additional magnifying power that may be required.
2. In order to obtain a better illumination, either by light incident vertically or obliquely, a new form of the microscope would be advantageous. In place

of directing the microscope to the object itself, placed as it now is, almost touching the object-glass, let it be directed to an image of the object, formed by the thinnest achromatic lens, of such a focal length that the object may be an inch or more from the lens, and its image equal to, or greater, or less than the object. In this way the observer will be able to illuminate the object, whether opaque or transparent, and may subject it to any experiments he may desire to make upon it. It may thus be studied without a covering of glass, and when its parts are developed, by immersion in a fluid. 3. The sources of error arising from the want of perfect polish and perfect homogeneity of the glass of which the lenses are composed, are, to some extent, hypothetical; but there are reasons for believing,—and these reasons corroborated by facts,—that a body whose ingredients are united by fusion, and kept in a state of constraint from which they are striving to get free, cannot possess that homogeneity of structure, or that perfection of polish, which will allow the rays of light to be refracted and transmitted without injurious modification. If glass is to be used for the lenses of microscopes, long and careful annealing should be adopted, and the polishing process should be continued long after it appears perfect to the optician. We believe, however, that the time is not distant when transparent minerals, in which their elements are united in definite proportions, will be substituted for glass. Diamond, topaz, and rock crystal are those which appear best suited for lenses. The white topaz of New Holland is particularly fitted for optical purposes, as its double refractions may be removed by cutting it in plates perpendicular to one of its optical axes. In rock crystal the structure is, generally speaking, less perfect along the axis of double refraction than in any other direction, but this imperfection does not exist in topaz.—Prof. STOKES and Mr. STONEY suggested some modifications of Sir David Brewster's theoretic views; and a member of the Section whose name we did not catch, stated that several attempts had been made to form an image of objects more removed from the first or object-glass of the microscope than at present, by using an additional lens, but hitherto without success.—*Proc. Brit. Assoc.*, 1860.

*On some Optical Illusions connected with the Inversion of Perspective.**

By Sir D. BREWSTER.

The term "Inversion of Perspective" has been applied to a class of optical illusions, well known and easily explained, in which depressions are turned into elevations, and elevations into depressions. One of the most remarkable cases of this kind, which has not yet been explained, presented itself to the late Lady Georgiana Wolf, and has been recorded by her husband, Dr. Wolf. When she was riding on a sand-beach in Egypt, all the foot-prints of horses appeared as elevations, in place of depressions, in the sand. No particulars are men-

* From the Lond. Athenæum, July, 1860.