Description of a New Optical Instrument called the "Stereotrope." By WILLIAM THOMAS SHAW, Esq. Communicated by WARREN DE LA RUE, Esq.

This instrument is an application of the principle of the stereoscope to that class of instruments variously termed thaumatropes, phantascopes, phenakistoscopes, &c., which depend for their results on "persistence of vision." In these instruments, as is well known, an object represented on a revolving disc, in the successive positions it assumes in performing a given evolution, is seen to execute the movement so delineated; in the stereotrope the effect of solidity is superadded, so that the object is perceived as if in motion and with an appearance of relief as in nature. The following is the manner in which I adapt to this purpose the refracting form of the stereoscope.

Having procured eight stereoscopic pictures of an object—of a steam engine for example—in the successive positions it assumes in completing a revolution, I affix them, in the order in which they were taken, to an octagonal drum, which revolves on a horizontal axis beneath an ordinary lenticular stereoscope and brings them one after another into view. Immediately beneath the lenses, and with its axis situated half an inch from the plane of sight, is fixed a solid cylinder, 4 inches in diameter, capable of being moved freely on its axis. This cylinder, which is called the eye-cylinder, is pierced throughout its entire length (if we except a diaphragm in the centre inserted for obvious reasons) by two apertures, of such a shape, and so situated relatively to each other, that a transverse section of the cylinder shows them as cones, with their apices pointing in opposite directions, and with their axes parallel to, and distant half an inch from, the diameter of the cylinder. Attached to the axis of the eye-cylinder is a pulley, exactly one-fourth the size of a similar pulley affixed to the axis of the picture-drum, with which it is connected by means of an endless band. The eye-cylinder thus making four revolutions to one of the picture-drum, it is evident that the axes of its apertures will respectively coincide with the plane of sight four times in one complete revolution of the instrument, and that, consequently, vision will be permitted eight times, or once for each picture.

The cylinder is so placed that at the time of vision the *large* ends of the apertures are next the eyes, the effect of which is that when the *small* ends pass the eyes, the axes of the apertures, by reason of their eccentricity, do not coincide with the plane of sight, and vision is therefore impossible. If, however, the position of the cylinder be reversed end for end, vision will be possible only when the small ends are next the eyes, and the angle of the aperture will be found to subtend exactly the pencil of rays coming from a picture, which is so placed as to be bisected at right angles by the plane of sight. Hence it follows that, the former arrangement of the cylinder being reverted to, the observer looking along the upper side of the aperture will see a narrow strip extending along the top of the picture; then, moving the cylinder on and looking along the lower side of the aperture, he will see a similar strip at the bottom of the picture; consequently, in the intermediate positions of the aperture, the other parts of the picture will have been projected on the retinæ. The width of these strips is determined by that of the small ends of the apertures, which measure ·125 inch; and the diameter of the large ends is 1·5 inches, the lenses being distant 9 inches from the pictures. The picture-drum being caused to revolve with the requisite rapidity, the observer will see the steam engine constantly before him, its position remaining unchanged in respect of space, but its parts will appear to be in motion, and in solid relief, as in the veritable object. The stationary appearance of the pictures, notwithstanding the fact of their being in rapid motion, is brought about by causing their corresponding parts to be seen, respectively, *only* in the same part of space, and *that* for so short a time that while in view they make no sensible progression. As, however, there is an actual progression during the instant of vision, it is needful to take that fact into account—in order that it may be reduced as far as practicable—in regulating the diameter of the eye-cylinder, and of the apertures at their small ends; and the following are the numerical data involved in the construction of an instrument with the relative proportions given above:—

The circumference of picture-drum = 22·5 inches (A).

The circumference of eye-cylinder = 12 inches $\times$ 4 revolutions = 48 inches (B).

The diameter of apertures at large ends = 1·5 inch (C).

The diameter of apertures at small ends = ·125 inch (D).

While the large end is passing the eye, the picture under view progresses $\frac{1\cdot5\ (C)}{48\ (B)}$ of 22·5 (A), or ·703 inch.

This amount of progression (·703 in.), if perceived at one and the same instant, would be utterly destructive of all distinctness of definition; but it is evident that the total movement brought under visual observation at any one moment is $\frac{\cdot125\ (D)}{1\cdot5\ (C)}$ of ·703 inch, or ·058 inch. This movement must necessarily occasion a corresponding slurring, so to speak, of the images on the retina; and the fact of such slurring not affecting, to an appreciable extent, the distinctness of definition, seems to be referable to a faculty which the mind has of correcting or disregarding certain discrepant appearances or irregularities in the organ of vision; as a further illustration of which I may cite the fact, mentioned by Mr. Warren de la Rue in his "Report on Celestial Photography," that the retinal image of a star is, at least under some atmospheric conditions, made up of "a great number of undulating points," which, however, the mind rightly interprets as the effect of the presence before the eye of a single minute object. That this corrective power is, as might be supposed, very limited, may be proved experimentally by this instrument; for if the small ends be enlarged in only a slight degree, so as to increase this slurring on the retinæ, a very marked diminution in clearness of definition is the immediate result.

That form of the stereotrope, in which Professor Wheatstone's reflecting stereoscope is made use of, and which is better adapted for the exhibition of movements that are not only local but progressive in space, it is needless to describe here, because the principles it involves are essentially the same as those which are stated above.

Proceedings of the Royal Society, Jan. 10, 1861.

New Blasting Powder.

From the London Builder, No. 952.

Some blasting powder, made by Mr. Laurence Geoghegan, gunmaker, Galway, from tanner's waste bark, nitrate of soda, and sulphur, is spoken of by the *Galway Vindicator*. Mr. Samuel U. Roberts, Engineer to the Board of Public Works, under whose superintendence the extensive drainage works in the Galway district were carried to completion, says, in a certificate as to Mr. Geoghegan's powder: "In my presence he inserted a small quantity of it (much less than would be required of the ordinary blasting powder) into a jumper-hole 1 inch in diameter and 15 inches deep, in a very solid boulder rock of hard granite containing about 30 cubic feet. On being ignited in the ordinary manner with a fuse, it burst the rock into fragments without making a report or causing spawls to fly from it; so that a person might safely stand within a short distance without incurring danger. Mr. Geoghegan states that this powder can be sold at half the price of the ordinary blasting powder. I am of opinion that it is much stronger than that which is now generally in use for blasting purposes."

The Conduction of Heat by Gases. By G. Magnus.*

From the Lond. Engineer, No. 267.

The cooling of a body *in vacuo* depends simply on the exchange of heat by radiation between the cooling mass and the encircling envelope. If the space contains gas, an ascending current is formed, which accelerates the cooling, added to which the property which the gas has of transmitting heat, or its diathermancy, concurs in producing cooling, provided the gases can conduct heat. Dulong and Petit, in enunciating their law of the loss of heat, have neglected the last two actions, manifestly because they are infinitely small compared with the influence of the ascending currents. Since then, it has been universally admitted that the differences in the cooling of the different gases depend on the different mobility of their particles. Cooling takes place much more rapidly in hydrogen than in other gases. With the same amount of heat, this gas expands not more, but less, than atmospheric air; the changes in density in the former gas are less than the latter. But it is the difference of specific gravity which pro-

* Translated from the *Bericht der Berliner Akademie*, 1860, p. 485.