movement remained the same. I then divided the two nerves as high as possible, and, afraid that there might be some small blood-vessels still giving blood to the nerves, I dissected the whole length of their trunk for the second time. *Near the section, the nerves remained able to cause muscular contractions for seven hours.*

Experiments more or less similar to this one have given very nearly the same results, and I am therefore led to conclude that, with the least quantity of blood, motor nerves retain their vital property *very much longer* than muscles. If motor nerves in a limb separated from the body of a living animal seem to lose their vital property sooner than muscles, it is because, as I will prove in another paper, the transmission of the nervous force from the last nervous ramifications to the contractile elements of muscles, soon becomes impossible in the absence of blood charged with oxygen.

From the facts above related, and from many others, I think I am entitled to conclude that the vital properties of motor and sensitive nerves may last longer without blood than muscular irritability.

VII. "Ocular Spectres, Structures and Functions, Mutual Exponents." By James Jago, A.B. Cantab., M.B. Oxon., Physician to the Royal Cornwall Infirmary. Communicated by R. Were Fox, Esq., F.R.S. Received August 22, 1857.

(Abstract.)

Section I.—*Introduction.*

Our visual organs are not only capable, by an adjusting lenticular system, of painting, under varying conditions, images of luminous objects, upon a membrane in special relation with the brain, but involve many adjuvant structures; and thus it happens that they reveal to us a number of adventitious phenomena—spectres as we may call them, whether caused by light at the parts that cover the eyeballs, or within them, or by any stimulus whatever affecting the special nervous tract. These must be eliminated, if we would avoid the risk of ascribing effects begotten by subordinate parts to more integral portions of the apparatus.

Finally, they may be rendered serviceable for the solution of certain important points of ocular structure and function. Under the impression that so diversified a subject has not yet received all the elucidation of which it is susceptible, another *methodical* attempt to investigate it will be made in this memoir.

When light is an agent in the production of the spectral phenomena, they arise from certain rays being blocked from their course, at some obstacle they encounter, or turned aside by refraction, reflection or inflection. And to make *precise* observations upon them, we must use fine pencils of rays which do not return to foci upon the retina. In order to estimate the relative and actual sizes, localities, and characters, of corpuscles whose shadows or images are projected upon the retina, pencils of light which are first convergent, and therefrom, by passing through foci, divergent (such as may be conveniently obtained from a small disc of light at a sufficient distance from the eye, when viewed through a lens of an inch focal length), are mainly employed, the foci being carried from before the eye to various depths in its interior*. If we neglect ocular refractions, whether a body fall in the convergent or divergent portions, the length of its shadow will be to its own, as their respective distances from the focus. With a couple of such pencils, whether a body fall in the convergent or divergent portions, the distance between its pair of shadows is to that between the foci, as that of the object from the shadow screen (retina) to that of the object from the line (parallel

* In the Allgem. Encyklop. der Physik, s. 166 (1856), in an able article on "Entoptics," Helmholtz states, that "the more decided entoptical 'methods' were established first by Listing and Brewster (1845), who were followed still later by Donders (1846–51)." The present writer refers to a paper of his own, published early in 1845, which substantially gives the methods alluded to; which are all modifications of one idea, that of obtaining a greater parallactic deviation of shadows for objects further from the retina, by means of two pencils of rays diverging from points in front of the eye, or by one moved across the optic axis. Now we can by this device only get marked differences in parallax for small differences in ocular depth for objects very near to the points of divergence, that is, near the surface of the eye; whereas the plan now proposed not only generally secures this end in a notable degree, but by placing foci between any two objects, causes their shadows to be deflected in *opposite* directions, and the more considerably as they are nearer together; besides supplying, it is believed, a variety of aids in entoptical researches.

to the screen) which joins the foci. But the deflections of the shadow in the two sorts of rays are in *adverse* directions, so that if the axis of a single pencil were moved across the eye, whilst always kept parallel to itself, the shadows of all the objects lying in advance of the focus would travel in one direction, whilst those of objects lying behind the focus would travel in the opposite, the rate of movement being in both instances greater for objects nearer the focus. Also, whether with a couple of pencils or a single one in movement, for a given difference in ocular depth between two objects, the difference in parallactic deviation is greater as the two objects are nearer the foci or focus. Besides, generally, the picture of the contents of the eye, as shown by the convergent portion, is inverted in the divergent.

The above proportions are turned into equations which indicate, as the terms alter their values, every observed variation in the sizes of the shadows, parallactic deviations, inversions of figure, place, and movements whether of the ocular bodies with respect to the pencils, or of the foci and axes of the pencils with respect to them. Thus, in many modes, which are explained, we may at pleasure by mere inspection observe the structural and relative positions of the bodies in question, and can so manage to evade the effects of ocular refractions, as to render the proportions above stated available for calculating the sizes of the bodies, and their distances from the cornea, iris, faces of the crystalline lens, retina, or from any one of themselves —or can even measure their depths in the eye, almost without calculation, and free from any that involve the consideration of the optical qualities of the organ.

Inflective phenomena are alike in the convergent and divergent rays, but refractive differ, and afford us a useful means of detecting the nature of an object. Inflective coloration is too subordinate to the ocular chromatic dispersion to deserve particular notice. Dr. T. Young explains how narrow straight objects, viewed through a puncture, are by the influence of ocular refractions made to appear curved, unless they are seen as diameters of the projected image of the pupillary opening. It is appended, that if they are made to encroach, in a like way, laterally upon a divergent pencil, they appear not, as in the case mentioned, concave, but convex towards the centre of the pupil's image.

Diagrams and other drawings accompany these and other parts of the essay. The foregoing principles are henceforth applied to the actual exploration contemplated, in order, as follows :—

Section II.—*Apparitions from Eyelashes, Eyelids and Conjunctival Fluids.*

These phenomena are treated with an effort at greater precision than in previously existing accounts of them. Little bars of fluid along the margins of the lids are shown to occasion the long beams of light, which issue from flames regarded "with winking eyes," by their annulling the refractions of the cornea. These beams have been ascribed to reflection at the edges of the lids, but reflection only yields a very pale beam which can be distinguished easily from the other.

Section III.—*Apparitions from Iris and Crystalline Lens: with Corollaries.*

The margin of the iris, opaque and transparent bodies, and the structural stellate figure, in the crystalline lens are placed *methodically* in the order in which they lie in the depths of the eye, and the especial manifestations which they severally yield, explained. The combined effects of ocular chromatic aberration, inflection at the edge of the iris, and the limbs of the stellate figure when we look at thin objects, or black and white lines, especially if curved, render some singular illusions, which are dissected.

The method by the two sorts of pencils may be applied to test the recent doctrine advanced by Stellweg, that the iris so lies on the face of the crystalline lens, that there is no posterior chamber in the aqueous humour, and will probably be found to disprove it.

A calculation is entered into to show that unless Dr. T. Young— in estimating that the accommodation of the eye to focal distance by means of an alteration in the length of the optic diameter, would require a faculty of doing this to the extent of $\frac{1}{7}$th of the whole, taken when vision is suited to parallel rays,—exceeds the truth by *many times*; it must be easy to detect, by the parallax of the lenticular corpuscles in a couple of pencils whose foci rest near them, how and where the change is effected. And then an argument is drawn, that

the accommodation is by change in the form of the lens, producing a minute movement of its anterior face, which it is thought may be detected by the said method.

The want of symmetry in ocular refractions is glanced at, and a nebulous scattering of light in the eye,—hereafter found to be the cause of a singular supplementary version of Purkinje's vascular phantom.

Section IV.—*Apparitions from the Vitreous Humour, applied to explain its Structure.*

It can be observed that, *in the posterior chamber of the eye there exists a lax, irregular, fibrous network, springing from the hyaloid membrane, but spanning the crystalline lens, without attachment to its capsule, occupying principally the peripheral portion of the cavity, but spreading as one structure into its interior, towards an ever-lessening number of leading fibres. The whole system is of less specific gravity than the vitreous fluid, either of itself, or by being the framework of membrane, in more or less of its extent. The fibres are constituted entirely of rows of beads, which are round, or nearly so, transparent, and of greater refractive power than the fluid, and joined by passing into one another by small portions of their surface.* The dynamical and optical considerations upon which these conclusions depend, are very carefully entered into, and the nicer points illustrated with appropriate drawings *.

Section V.—*Apparitions from, or from behind the Retina; with Corollaries.*

The next object for study behind those in the vitreous, are the vasa centralia retinæ, which are imbedded in the substance of the

* The 36th vol. pp. 97–104, of the Lond. Med. Gazette, is quoted to show that the writer maintained in 1845 that the usual muscæ volitantes are but apparitions of portions of the essential structure of the vitreous body, and that he then fundamentally and clearly enunciated the view now more particularly developed. Other writers have regarded these as remnants of the fœtal eye, or as pathological fragments, floating freely, or in loculi of the vitreous humour; for the most part differing very widely from the reasonings and conclusions in this essay. The writings of Brewster, Donders, Doncan, &c., are referred to.

membrane in such a manner as to penetrate from the side of the hyaloid membrane outwards from the eye's centre, deeper as they approach the punctum aureum. They may be called into view by any pencil of rays that is in the act of sweeping over the retina. In the well-known experiment of Purkinje, of waving a candle-flame before the eye, the radiating point is the image of the flame at the back of the eye. In this experiment the vessels display a remarkable parallactic gliding over the visual field, first observed by Gudden, in 1849; but it was left for H. Müller, a few years after, to point out the cause of the phenomenon, and to calculate from entoptical observations the distance of the vessels from the "perceiving membrane" lying without them, required to account for the parallax. This essay adopts his hypothesis, but supports it by independent observations, and substitutes another mode of calculating the said distance.

The flame is made to pause successively, on opposite sides of the vessel to be observed, in an ocular meridional plane, or that of some great circle, so that the shadow may be seen to deviate equally, twice in one plane, from the retinal radius that passes through it, and this whole angle, β, is noted, as well as that, α, between the two positions of the flame, as viewed from the eye's centre. Then, if d be the perpendicular distance of the vessel from a sentient surface whose radius is r, it is found that

$$d=r\left\{1-\frac{\cos\frac{1}{4}(\alpha+\beta)}{\cos\frac{1}{4}(\alpha-\beta)}\right\}.$$

If we imagine a dark spot without the sentient surface, as the pigment of the choroid, visible through the retina at the foramen centrale, to simulate a shadow by being seen, through a second reflexion of the rays already radiating by reflexion at the flame's image on the eye's coats, by a sentient surface lying *within* it; then if d be the distance of the dark spot from such a surface, we shall have

$$d=r\left\{\frac{\cos\left(\frac{1}{4}\alpha-\frac{\beta}{2}\right)}{\cos\frac{1}{4}\alpha}-1\right\}.$$

If a vessel imbedded in the sentient surface were to have its

shadow thrown back upon that surface, through reflexion from some tunic at the distance d without it, we should have

$$d=r\left\{1-\frac{\cos\frac{1}{4}\left(\alpha+\frac{\beta}{2}\right)}{\cos\frac{1}{4}\left(\alpha-\frac{\beta}{2}\right)}\right\}.$$

And some slight modification of this equation would meet the case of a parallactic deviation by a second reflexion, should a vessel lie either a little without or within the sentient surface.

The parallaxes here suggested would all take place in the direction of those actually witnessed in Purkinje's experiment, and the calculated values of d would so far approach each other from the same values of α and β (since β is small), that we ought not to rest satisfied with the fact of these values agreeing well with the simple conception of the sentient surface lying a little without the vascular plexus; especially as there are two supplementary versions of the vascular phantom rendered manifest by the experiment, one very notable one to which attention is directed—and that were the shadows of the vessels displayed by a second reflexion, as imagined in the third equation, there would be more than one version of them; as, moreover, a dark figure of the foramen centrale is rendered visible at the same time. However, these other versions of the figure are eliminated by being traced to other sources, and with H. Müller, the central dark spot is treated as the shadow of the wall of the foramen centrale; so that the sentient surface must be without the brim of the foramen.

The essay, with as much of method as is available, now passes on in quest of the causes of other spectral phenomena, in the production of which light is not an agent. It cites Young's observation of the images of objects that press from the outside of the eye upon the sclerotic coat, being seen by *flexure* of the retina along their outline; notices, as of this type, the circles of light seen at the bases of the optic nerves on turning the eyes sharply in their sockets; touches upon the colours displayed in such experiments; and points out how that wherever the retina is so compressed as to evince quasi-lights, it comparatively or entirely fails to render us acquainted with the existence of luminous objects. It then explains how the retina is flexed and compressed by the action of the orbital muscles, always,

to some extent, when we fix the eye's axes in a given direction; and severely, whenever we wilfully strain our vision—thus astonishing us by the flitting away of objects from our sight, burying some in quasi-lucid clouds, as if they had overspread one another, and as the origin of the phenomenon was undetected, occasioning many surmises upon the inherent qualities of the special nervous structure in order to account for them. An observation upon the inverted image of a candle formed at the posterior face of the crystalline lens is mentioned, which indicates other muscular action besides that which rotates the eyeball, when the eye is vehemently strained, as if the lens becomes flattened. The phenomena which inform us of a differential structure in the retinal surface, with respect to the punctum cæcum, foramen centrale, and the elementary rods and cones, which H. Müller believes to constitute the sentient layer, are adduced; as well as the conclusions to which we are led, after eliminating the various phenomena studied, as regards the ultimate structure of the sentient surface.

VIII. "On Hourly Observations of the Magnetic Declination, made by Captain Rochfort Maguire, R.N., and the Officers of H. M. Ship 'Plover,' in 1852, 1853 and 1854, at Point Barrow, on the shores of the Polar Sea." By Major-General Edward Sabine, R.A., D.C.L., Treas. and Vice-President R.S. Received August 14, 1857.

(Abstract.)

Point Barrow is the most northern cape of that part of the American continent which lies between Behring Strait and the Mackenzie River. It was the station, from the summer of 1852 to the summer of 1854, of H.M.S. 'Plover,' furnished with supplies of provisions, &c. for Sir John Franklin's ships, or for their crews, had they succeeded in making their way through the land-locked and ice-encumbered channel by which they sought to effect a passage from the Atlantic to the Pacific. In this most dreary, and apparently uninteresting abode, Captain Maguire and his officers happily found an occupation in observing and recording, for seventeen months unremittingly, the hourly variations of the magnetic declination and of the