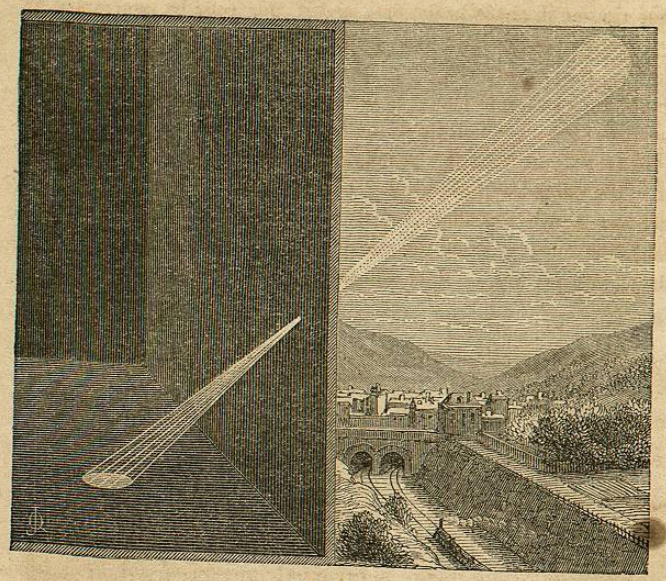

Fig. 227.

Fig. 228.

cone similar in shape to the first, and if this cone be intercepted by a screen perpendicular to the line joining the hole with the centre of the sun, the image formed will be a circle. If the rays are intercepted by an oblique plane, as in the figure, the image is elliptical, but it never takes the form of the hole when that is small.

In accordance with this principle, we find the illuminated patches of earth formed by light passing between the leaves in a forest of a circular or elliptical shape. This is illustrated in Fig. 228. In an eclipse of the sun, when the visible portion of the sun is of crescent shape, the patches of light all assume the crescent form; that is,

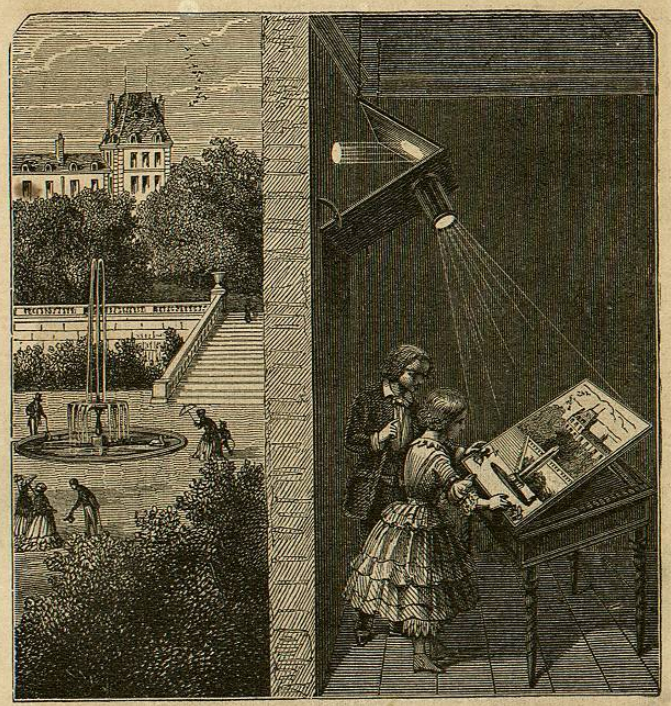

Fig. 229.

Explain the peculiar rounded form of patches of light in the shadow of a forest. What form do they take in an eclipse of the sun?

they are images of the visible part of the sun. The reason of this curious phenomenon is evident.

Manner of rendering the Image erect.

334. The manner of producing erect images of external objects in a *camera obscura*, or *dark room*, is shown in Fig. 229. A little above the hole a plane mirror is so placed as to reflect the rays which enter it upon a convex lens fixed at the extremity of a tube. This reflection inverts the beam of light and makes the image erect, which may then be thrown upon a suitable screen for observation.

Such images are perfect representations of the external objects which they represent, being perfectly faithful, not only in form and color, but in motion also. When images of street scenes, with all their life and motion, are thus formed, they are very striking as well as interesting.

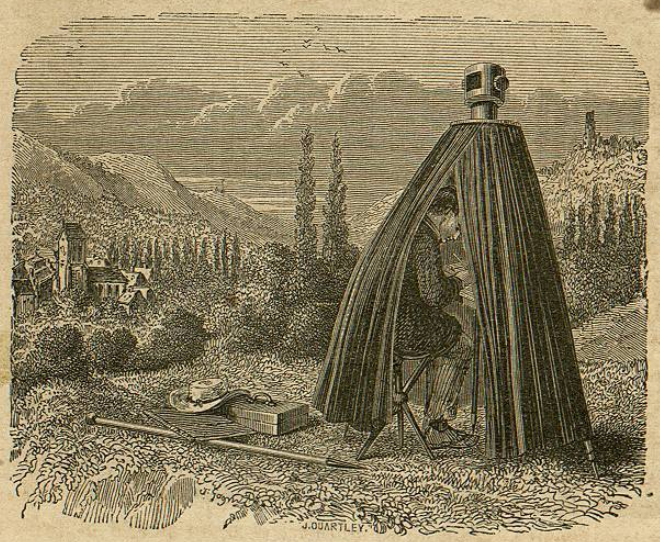

Fig. 230.

(**334.**) How are the images made erect?

The Portable Camera for Artists.

335. For taking views, the camera obscura should be light and portable. The best form is that shown in Fig. 230. It consists of a sort of portable tent of black cloth, within which is a table for receiving the image, and at the top of which is a tube bearing a prismatic lens, that produces the combined effect of the mirror and lens, as shown in Fig. 229. The figure projected upon the table may be traced out with a pencil on a sheet of white paper.

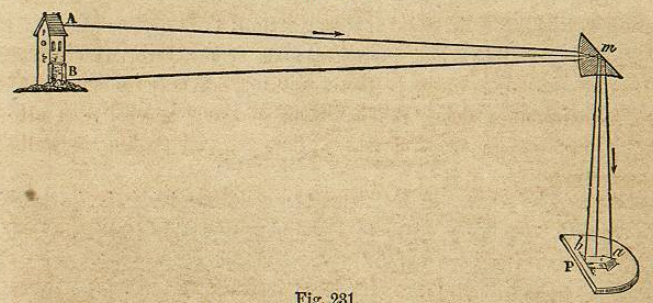

Fig. 231.

Fig. 231 shows the course of the rays in forming the image. The rays coming from the object, AB, fall upon the convex face of the lens and are converged, and in this state they reach the plane surface, m, which is inclined to the horizon. Being totally reflected from the surface, m, they emerge through the slightly concave surface below, and go to form an image, ab, on the table, P. A sheet of paper is spread on P, to receive the image, and on it the outlines may be traced.

The Daguerreotype.

336. One of the most important applications of the camera obscura, is in forming pictures upon plates of pre-

(**335.**) Explain the construction of the Portable Camera for Artists. Explain the course of the rays. (**336.**) What is the most important application of the camera?

pared metal or paper, by the *actinic* or *chemical* action of the light.

The discovery of the daguerreotyping process, like many other discoveries of magnitude, was preceded by many partially successful efforts. One of the most important of them was, perhaps, that of TALBOT, who succeeded in fixing images on prepared paper by means of solar light. The main discovery is, however, due to M. DAGUERRE, who in 1839 announced that he could, by a process occupying but a few minutes, fix the image of a camera upon a metallic plate.

During the twenty years that have elapsed, improvements have followed each other in rapid succession, until the process of daguerreotyping in all its various branches, gives remunerative employment to thousands. It is not only one of the most interesting discoveries of modern times, but bids fair to become of immense utility.

Process of Daguerre.

337. The process of Daguerre begins by receiving the image of the camera upon a proper plate, covered with a thin layer of silver, whose surface has been carefully polished and rendered sensitive to light. The polished plate is rendered sensitive by means of iodine. Iodine is solid at ordinary temperatures, but is easily converted into vapor by a slight degree of heat. The plate is held over the vapor of iodine for about two minutes, during which time a thin layer of the silver unites with the iodine, forming a coating of *iodide of silver*, which is exceedingly sensitive to light. The plate thus prepared is placed in the camera, so as to receive the image to be copied, and is acted upon by the rays forming the image. The plate is next exposed for a few minutes to the vapor of mercury. The mercury unites with the silver where it has been acted upon by the light, forming a white amalgam, giving the lights of the picture, whilst the other parts remain dark.

This process was imperfect; the plates required ten or twelve minutes' exposure to light, in order to fix an impression, which rendered the method unsuitable for portraits; the pictures formed were indistinct and easily effaced, and finally, the reflected light

Give a sketch of the history of the Daguerreotype. (**337.**) *Explain the process of* DAGUERRE.

from the plates diminished the distinctness of vision. All of these defects were remedied by a single man, M. FIZEAU.

By using bromine with iodine in preparing the plates, he rendered them so sensitive, that from six to thirty seconds formed a sufficient exposure. He fixed the images and prevented excessive reflection, by using chloride of gold and hyposulphite of soda with gentle heat. This process not only had the effects named, but it also increased the brightness of the picture. Since these, other improvements have been made, till at last in skillful hands it has reached a state of great perfection.

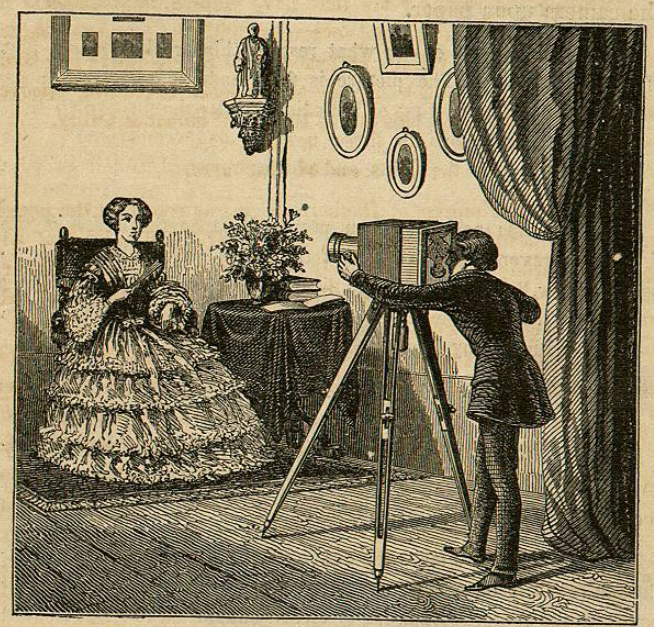

Fig. 232.

Fig. 232 represents the form of camera used in the process of daguerreotyping. It consists of a rectangular wooden box, to one

Explain the modifications of FIZEAU. *Explain the construction and method of using the camera for daguerreotyping.*

face of which is attached a tube, bearing a lens, which forms the image. The opposite face of the box consists of a sliding drawer, holding a plate of ground glass, upon which the image is thrown, and by drawing it out, or sliding it in, the picture may be rendered distinct upon the glass. When the image is clearly defined, the plate of glass is removed, and the prepared silver plate introduced, and the process above described is gone through with.

Photography.

338. PHOTOGRAPHY is the art of fixing the picture of the camera upon paper.

We shall only point out in what respect this art differs from that of daguerreotyping. The picture is first made on a plate of glass, covered with a thin coating of collodion, rendered sensitive to light by processes analogous to those used in daguerreotyping. The picture obtained has the lights and shades reversed, and is called a *negative*.

By laying this negative upon prepared paper, the action of the light again reverses the position of the lights and shadows, and the picture, after being fixed by chemical means, may be mounted and treated in all respects as an engraving. The same negative may be used in producing any number of positive pictures.

Structure of the Eye.

339. The EYE is a collection of refractive media, by means of which we are made acquainted with the external world through the sense of sight.

As an optical instrument the eye is inimitably perfect; it has not the faults either of spherical or chromatic aberration, and withal, it possesses the remarkable property of self-adaptation to great as well as small distances. No artificial instrument has any of these qualities in perfection.

The shape of the eye is spherical, with a slight protuber-

(338.) What is Photography? *How does it differ from daguerreotyping?* (339.) Of what is the Eye composed? *What are its optical properties?* Its shape?

ance in front; the average diameter of the human eye is a little less than nine tenths of an inch. Fig. 233 represents a section of an eye, with some of the coverings thrown back so as to show the position of the parts.

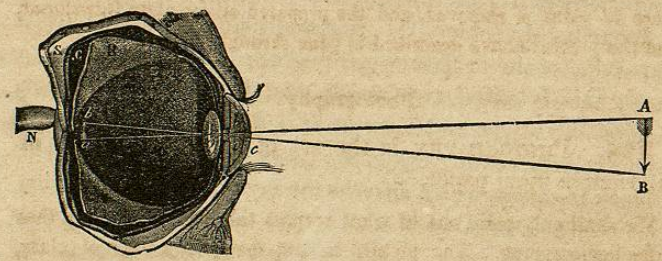

Fig. 233.

The anterior part of the eye is limited by a perfectly transparent membrane, *c*, called the *cornea*. The remainder of the exterior coating is an opaque white membrane, called the *sclerotic coat*. The cornea is set in the sclerotic coat, as a watch-glass is set in its frame.

Immediately behind the cornea is a transparent fluid, limpid as water, called the *aqueous humor*. In this floats a circular curtain, *hi*, attached by its outer edge to the sclerotic coat, and having a small circular opening at its middle. The curtain is called the *iris*, and the hole in its centre is called the *pupil*. The iris gives color to the eye, being black, blue, gray, &c.; it is muscular, and by the contraction and expansion of the fibres the pupil may be enlarged or diminished; it is through the pupil that rays of light enter the eye.

Behind the iris is a double convex lens, *o*, called the *crystalline lens*; it is of the consistence of gristle, perfectly transparent, more curved behind than in front, and is denser towards its middle than at the edges. This lens serves to

Its size? What is the character and position of the cornea? Of the sclerotic coat? Of the aqueous humor? The iris? The pupil? The crystalline lens?

converge the rays to foci behind it. Immediately behind the crystalline lens is a medium *nearly* filling the remainder of the cavity of the eye, called the *vitreous humor ;* it is of the consistence of jelly, and perfectly transparent, permitting the rays to pass through it.

Immediately behind the vitreous humor is a thin white expansion of the optic nerve, lining nearly all of the sclerotic coat; this is called the *retina*, and is the seat of vision. Behind the retina, and between it and the sclerotic coat, is a fine velvety coating called the *choroid coat*, covered with a black pigment, which absorbs the rays that pass the retina, preventing internal reflection. The sensation of sight is conveyed to the brain by the optic nerve, which goes to the brain.

The Mechanism of Vision.

340. The action of the eye is similar to that of the camera obscura, except more perfect; the *pupil* corresponds to the hole in the shutter, the *crystalline lens* forms the image, and the retina is the screen on which the image falls. The image formed is of course inverted, as shown in Fig. 233, but the mind refers objects along the rays which produce the sensation of sight, hence points appear in their proper position; that is, we see objects *erect.*

Limit of Distinct Vision. — Defects of Sight.

341. When an object is placed very near the eye, the lens has not sufficient power to bring the rays to foci on the retina, and an indistinctness of vision is the consequence. The least distance at which an object can be seen distinctly is very different in different individuals. It may, on an average, be put down at six inches. Sometimes this limit is not the same for both eyes in the same individual.

The vitreous humor? The retina? The choroid coat? The optic nerve? (**340.**) Describe the mechanism of vision. (**341.**) What is the average limit of distinct vision?

When the limit of distinct vision is much less than six inches, the individual is said to be *short-sighted ;* when it is much greater than six inches, he is said to be *long-sighted.*

Short-sightedness comes from too great convexity of the cornea, or crystalline lens, or both. The effect is to bring the rays to foci before reaching the retina, giving an indistinctness to vision. This defect is remedied by using spectacles with concave lenses, which diverge the rays before falling upon the cornea, and thus enable the media of the eye to bring them to foci upon the retina. If the eyes are unlike, the lenses should be of different power.

Long-sightedness is a defect just the reverse of short-sightedness. It arises from too great flatness in the cornea, or crystalline lens, so that rays of light are brought to foci behind the retina. This defect is remedied by using spectacles with convex lenses.

Short-sightedness is a defect of youth, and is gradually removed as the individual advances in years; long-sightedness is a defect of advanced age, and once commenced, it gradually increases with years, probably because the organs which secrete the media of the eye become feeble as life advances.

The best form of convex glasses for spectacles is the meniscus, *O*, Fig. 186, and the best form of concave glasses is the concavo-convex, *R*, Fig. 187. These glasses are called *periscopic*, because they permit a wider range of vision than other forms of lenses.

Vision with two Eyes.

342. An image of every object viewed is formed in each eye, yet vision is not double, but single. This is regarded

When is a person short-sighted? When long-sighted? What is the cause of short-sightedness? How is it remedied? What is the cause of long-sightedness? How is it remedied? What are periscopic glasses? (**342.**) How are we enabled to see clearly with two eyes?

by some as a matter of habit; others refer it to the fact that each nervous filament coming from the brain to the eye is divided into two parts, one going to each eye.

Simultaneous vision with two eyes is supposed to give us the idea of *relief*, or form of objects, a view which receives confirmation from the action of the *stereoscope*.

The Stereoscope.

343. The STEREOSCOPE is an apparatus employed to give to flat pictures the appearance of relief; that is, the appearance of having three dimensions.

It was invented by WHEATSTONE and improved by BREWSTER. At the present day it is offered for sale in a great variety of forms, and constitutes an instructive and amusing instrument.

When we look at an object with both eyes, each eye sees a slightly different portion of it. Thus, if we look at a small cube, as a *die*, for example, first with one eye and then with the other, the head remaining fast, we shall observe that the perspective of the cube is different in the two cases. This will be the more apparent the nearer the body.

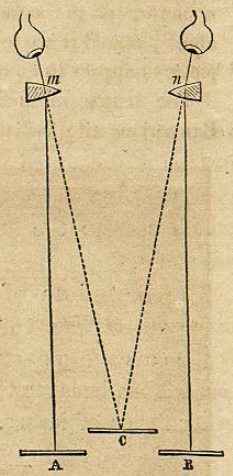

Fig. 234.

If the cube has one face directly in front of the observer, and the right eye is closed, the other eye will see the front face and also the left hand face, but not the right; if, however, the left eye is closed, the other eye will see the front face and also the right hand face, but not the left.

Whence do we derive our notion of relief in bodies? (**343.**) What is the Stereoscope? *By whom invented?* Explain the theory and construction of the stereoscope in detail.

Hence we know that the two images formed by the two eyes are not absolutely alike. It is this difference of images which gives the idea of relief in looking at a solid body.

If, now, we suppose two pictures to be made of an object, the one as it would appear to the right eye and the other as it would appear to the left eye, and then look at them with both eyes through lenses that cause the pictures to coincide, the impression is precisely the same as though the object itself were before the eyes. The illusion is so complete, that it is almost impossible to believe that we are simply viewing pictures on a flat surface.

Such is the theory of the stereoscope. Fig. 234 shows the course of the rays in this instrument as just described. *A* represents a picture of the object as it would be seen by the right eye alone; *B*, a picture of the same object as it would be seen by the left eye alone; *m* and *n* are lenses which deviate the rays so as to make the pictures appear to be coincident in *C*.

The lenses, *m* and *n*, ought to be perfectly symmetrical, and BREWSTER attained this result by cutting a double convex lens in

Fig. 235.

Explain the course of the rays in the stereoscope.

two, and placing the right hand half before the left eye, and the other half before the right eye. The pictures must be perfectly executed, which can only be done by means of the daguerreotype or photographic process. The pictures are made by using two cameras inclined to each other in the proper angle.

Fig. 235 represents two stereoscopic pictures of FRANKLIN, taken

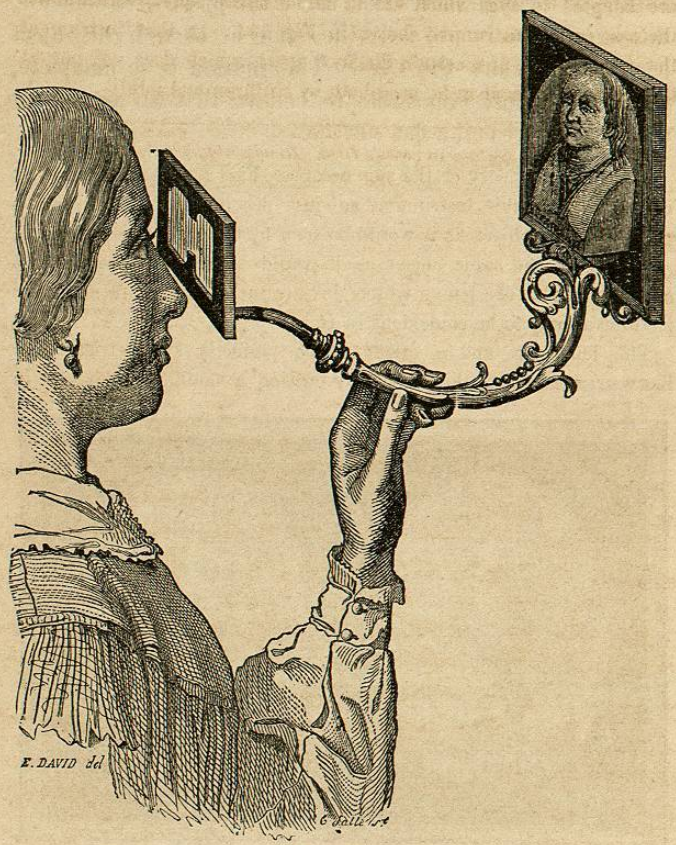

Fig. 236.

Explain BREWSTER'S *form.*

from a statue. We see the left hand one more in front, the right hand one more in profile. On placing them in the stereoscope we see a single image in relief, as shown in Fig. 236. This image stands out in relief, presenting all the appearance of the statue from which the pictures are taken.

The peculiar form of the stereoscope seen in Fig. 236 is that of DUBOSCQ. The lenses are large, and touch each other, so that they are adapted to eyes which are at any distance apart, which is not the case in the instrument shown in Fig. 234. In that instrument the eyes must be at a certain distance apart, which does not permit the same instrument to be used both by children and adults.

Explain DUBOSCQ'S *form. Its advantages.*