The Camera Obscura:

Its Uses, Action, and Construction

by H. C. Standage

An Except from *Amateur Work Illustrated, Vol. IV,* pages 67-71, 1885
This periodical for amateur craftsmen was published in London, England
during the late 19th and early 20th centuries.
edited by the Author of *Every Man His Own Mechanic*

This article, from a bound volume of the periodical in our collection, has been scanned, processed with optical character recognition, and corrected to the best of our ability. We can not guarantee the absolute accuracy of the transcription since we are dealing with 19th century sentence style and word use as well as the differences in English and American spelling.

The full page illustration that accompanies the article is reproduced on page 2 and the figures are inserted into the text for reference. Since important measurements correspond to letters on the diagrams we have also included an appendix with enlarged versions of each illustration to make the placement of the key letters more readable.

The directions may appear wordy and convoluted to 21st century readers but should be detailed enough to be used or adapted by an experienced craftsman. We suggest that a prototype be made in cardboard to test the function of the camera with your lens before committing to a final design.

With best wishes for your success at camera obscura construction. If you are successful in building a camera obscura from these instruction please send us an email at studio@brightbytes.com with a picture and. we will post it on our website.

Jack and Beverly Wilgus
http://brightbytes.com/cosite

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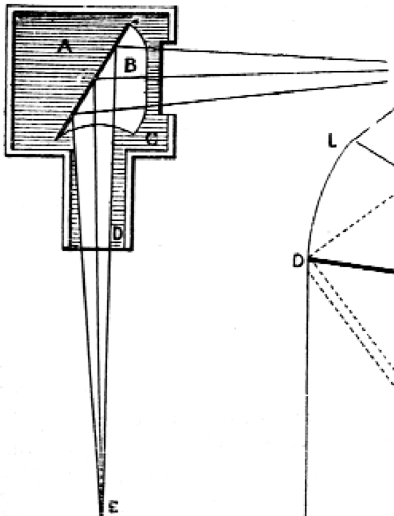
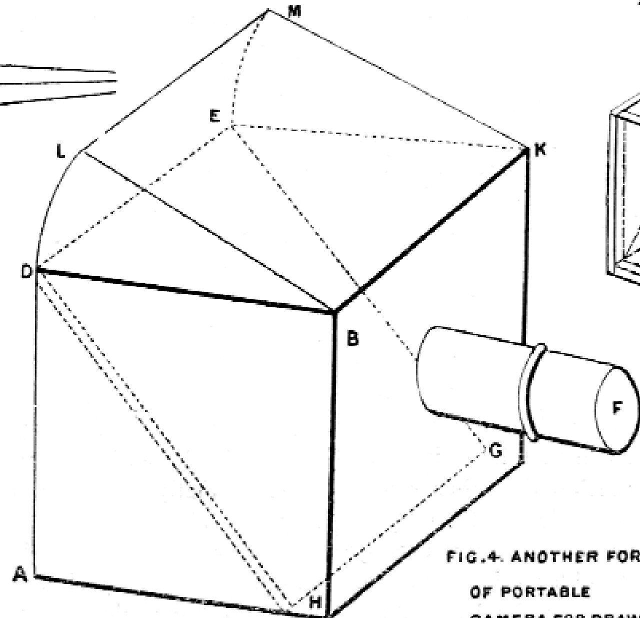


FIG. 1. CAMERA TO RECEIVE IMAGE ON HORIZONTAL TABLE



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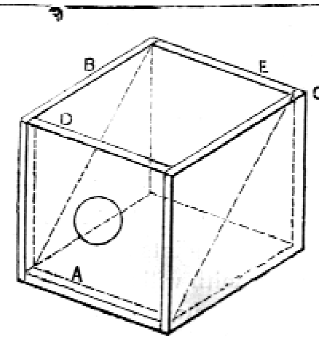


FIG. 5. FORMATION OF CUBIC BOX FOR CAMERA.

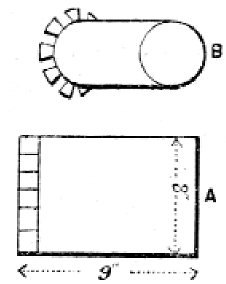


FIG. 6. INNER TUBE FOR FOCAL ADJUSTMENT

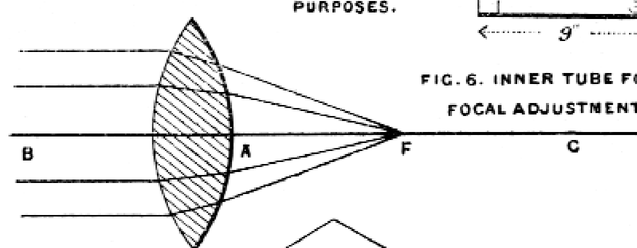


FIG. 7. DIAGRAM EXPLAINING FOCAL LENGTH.

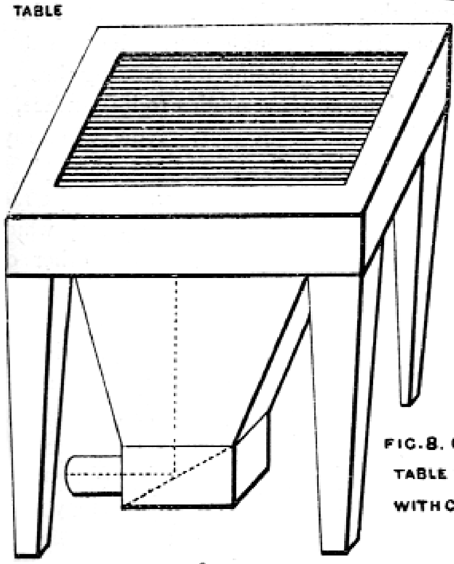


FIG. 8. ORDINARY TABLE FITTED WITH CAMERA

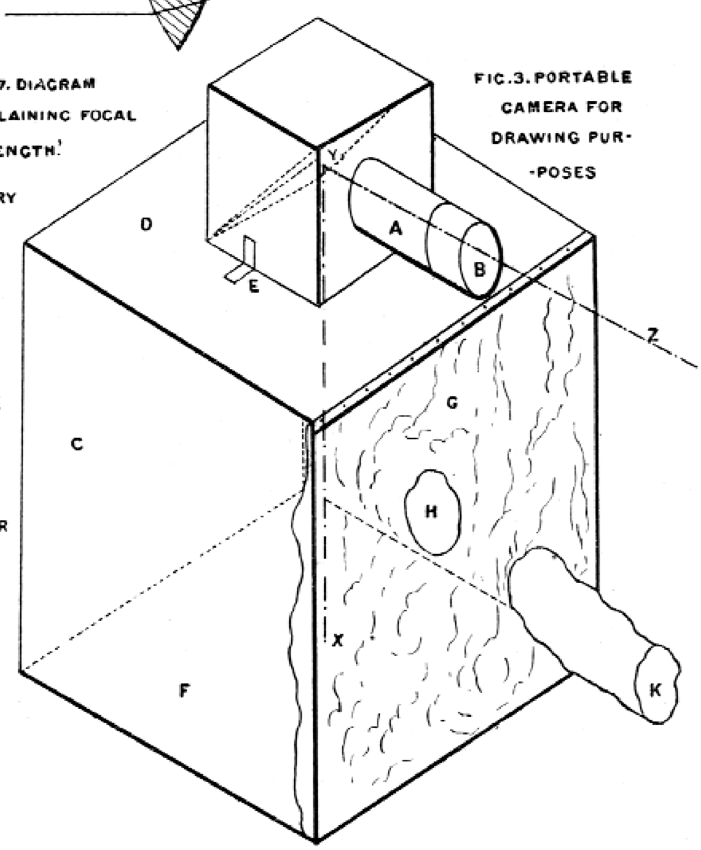


FIG. 3. PORTABLE CAMERA FOR DRAWING PUR-POSES

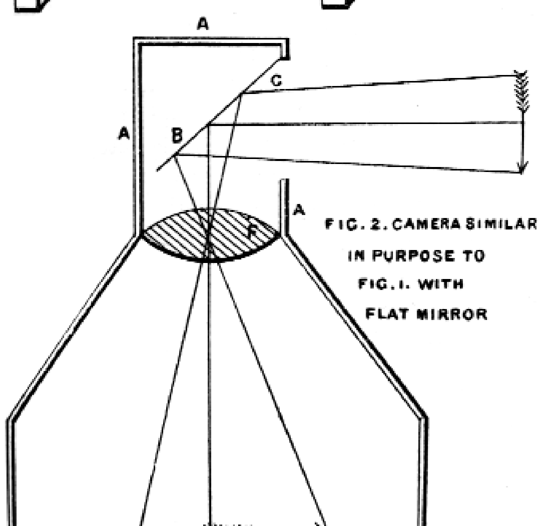


FIG. 2. CAMERA SIMILAR IN PURPOSE TO FIG. 1. WITH FLAT MIRROR

Note: Enlarged examples of these illustrations are found on pages 9 – 14.

THE CAMERA OBSCURA: ITS USES, ACTION, AND CONSTRUCTION:

By H. C. STANDAGE

THE use to which a camera obscura is now put is chiefly that of affording amusement to children. Such for instance, as the dark chamber at the Crystal Palace. Doubtless, all of my readers are familiar with the picture depicted on the plaster table in the centre of this chamber, where a tableau of all the objects in the Palace grounds is shown in their natural colour and motions. But formerly this apparatus was used for drawing and photographic purposes. Its disuse for such purposes is chiefly due to better and vastly superior instruments; although, should anyone wish to trace an accurate outline of a landscape on a miniature scale, the camera obscura holds its own, in the matter of convenience, against all comers.

There are several forms of apparatus, but the principles of their action are the same in all instruments.

To easily comprehend the action of the camera obscura, it will be better to describe the principles which refer to any one form of the apparatus. Turning then to Fig. 1, we notice the following peculiar properties. ***A*** is the wooden case or box for holding the lens ***B***, of the shape shown in the figure. ***C*** is an opening in the side of this box; this opening is for the purpose of allowing light rays from the distant landscape to impinge on the convex surface of the mirror; while ***D*** is another opening at the bottom of the box to allow these rays-which are reflected from the back of the lens, which is plane-to pass through this opening on to the table or sheet of paper ***E***, placed ready to receive them. For the purpose of collecting these rays, so that they shall not scatter, but define the external landscape with distinctness, the bottom of the lens is concave, but with a larger radius of curvature than the first surface.

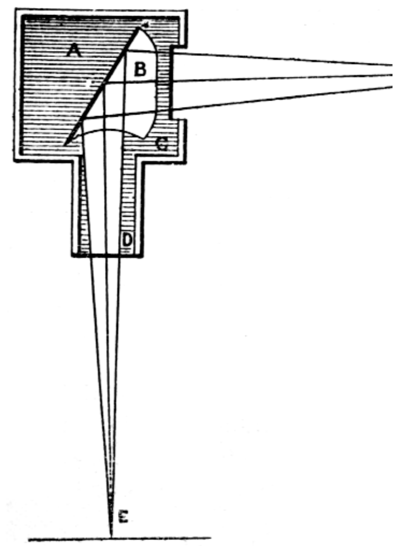


FIG. 1. CAMERA TO RECEIVE IMAGE ON HORIZONTAL TABLE

The box ***A*** may be square or cylindrical, and it can also be made to revolve horizontally. The inside of it should be blacked with lampblack, so that the full effect of the lens may be utilized by the lens.

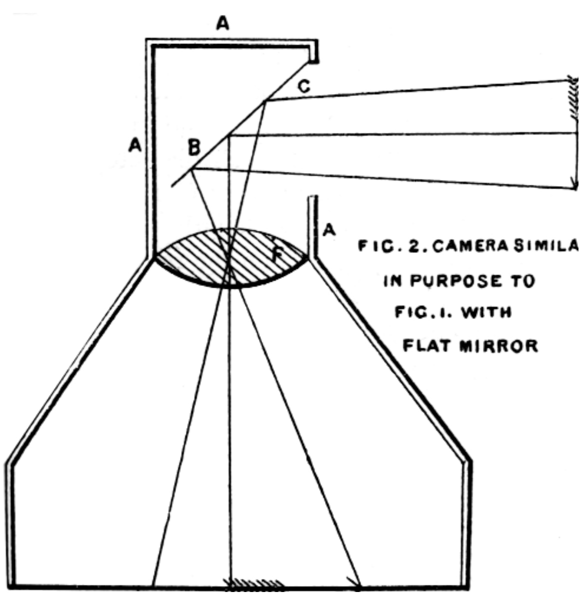


FIG. 2. CAMERA SIMILA IN PURPOSE TO FIG. 1. WITH FLAT MIRROR

The mirror ***B***, in Fig. 1 is of a peculiar shape, and consequently not always obtainable; in such cases the following method (Fig. 2) of constructing the camera will answer the same purpose, since the action is precisely the same.

A, ***A***, ***A***, are the sides and top of the box holding the lens, ***C*** is the opening for the passage of the rays from the external landscape, while ***B*** is a plane mirror placed at an angle of 45° with the opening, and consequently with the convex lens ***F***, which is fixed horizontally. In this construction we see that the rays strike directly on a plane surface, from which they are reflected, and pass through a convex lens. This is the form of apparatus we shall adopt in the instrument we shall now describe how to construct.

One essential point, however, must be attended to in the construction of the camera, else the instrument will not work satisfactorily. It is this, the drawing paper or table which is to receive the image must be at a definite distance only from the lens, otherwise the picture represented will be blurred and confused. This distance is determined by the *focal length*,* as it is termed, of the lens. A greater sharpness of outline is also obtained by having the receiving surface hollowed out to the same curve as the lens; thus, the table at the Crystal Palace camera obscura is made of plaster of Paris, hollowed out to a concave form, the curvature being similar to the convexity of the lens.

(*To render this paper intelligible to those who know nothing of the principles of optics, I will explain the meaning of this term presently.)

The simplest form of a camera may be made by fixing a convex lens in a hole in the window shutter. This lens should have a focal length of five or six feet, and at nearly half the focal length of the lens place a looking-glass (ie., a plane mirror ; a sheet of ordinary glass covered on one side with lampblack will answer the same purpose, provided the unpainted side be turned towards the lens) at an angle of 45˚ with the axis of the lens. If then a sheet of paper, or a white cloth, be held at a distance from the looking-glass equal to the distance the latter is from the lens, an exact picture of the external landscape and all the objects outside, whether in motion or not, will be represented on the paper or cloth. Every colour and movement of the animate objects will be seen as if the spectator were looking at them direct. Note that the objects are in a reverse position to what they are in nature, unless the spectator looks at them with his back towards the lens in the shutter; to anyone in such a position they will appear correct.

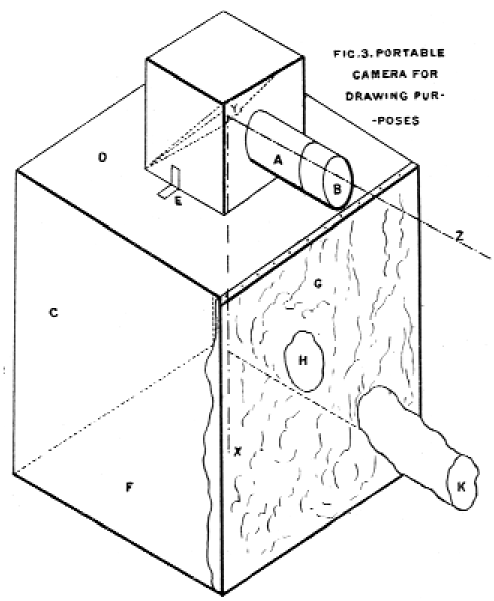


FIG. 3. PORTABLE CAMERA FOR DRAWING PURPOSES

For greater distinctness the lens should be fixed in a tube a few inches long, and the tube fastened into the shutter. Of course, no light must enter the room except that coming through the lens.

There are two very good forms in which a portable Camera Obscura for drawing purposes can be made, which I will proceed to describe.

With regard to the *construction* of the camera shown in Fig. 3, in order to make a cubic box measuring 9 inches every way on the outside, plane up a piece of board 9 inches wide and 1/4 inch thick, and then saw off five pieces, two of which are 9 inches by 9 inches, or 9 inches square, which we will call ***B*** and ***C***; one piece 9 inches by 8 1/2 inches, which we will call ***A***; and two pieces 8 3/4 inches by 8 1/2 inches, which we will call ***D*** and ***E***.

Take one of the pieces measuring 8 3/4 inches by 8 1/2 inches, and cut a circular hole in it, 2 inches in diameter; this hole is to receive the tube ***A*** containing the lens ***B***. Next nail the five pieces together into the form of a box. Since there are six sides to a box, we shall have one side open ; this open part is to cover the aperture in the larger box ***C***.

To nail the nine pieces of wood together into box form proceed thus:– Nail the pieces ***B***, and ***C*** (Fig. 5), which are 9 inches square, to opposite edges of the piece ***A***, which is 9 inches by 8 1/2 inches. We now have three surfaces of the box of equal areas, namely, 9 inches by 9 inches, because the breadth of ***A***, namely 8 1/2 inches, is supplemented by the thickness of the sides ***B*** and ***C*** that are nailed to it, and thus brought up to 9 inches, because 8 1/2 inches + 1/4 inch + 1/4 inch = 9 inches. The pieces ***D*** and ***E***, which have been cut to the size, 8 3/4 inches by 8 1/2 inches, are now slipped in between the boards that have been already nailed together, so that one of the short ends of each rests on ***A***, the long ends abutting against ***B*** and ***C***, when it will be found that the edges of ***B***, ***C, D, E***, at the opening of the box, will be flush with each other. It is necessary to take care that they are exactly flush, in the construction of the camera, else, when this small box is secured to the larger one, it will not fit close, and consequently light will enter the apparatus.

When this box is made, place a plane mirror with the reflecting surface opposite to the circular aperture. This mirror is to be inclined to the side of the box where this circular aperture is, at an angle of 45˚. Since our box is cubical, the mirror will divide the box diagonally, as shown by the surface indicated by dotted diagonal lines in Fig. 5. To keep this mirror in its place, it should rest on a strip of wood (about 1/8 inch thick), at the end ***E***. This strip of wood is 8 1/2 inches long, and should be glued in after the mirror is placed in position. The size of the mirror will be as nearly as possible 12 inches long by 8 1/2 inches wide, the diagonal of a square (not of a cube) of 8 1/2 inches being very nearly 12 inches. Remember the length of the mirror is only equal to the diagonal of one side (as ***C***) of the cubical box (see Fig. 5).

The next proceeding is to construct the larger box ***C*** (Fig. 3). This has five sides, and is constructed after the manner of that described in Fig. 5. The top, ***D***, of Fig. 3, has a hole 8 1/2 inches square cut out, over which the smaller box is placed. This hole should be cut out of ***D*** previous to joining the sides together. The easiest way to cut out this square is to use a keyhole saw; thus, mark off on ***D***, with pencil, the part to be cut out, then at each corner bore a hole with a gimlet large enough to let the end of the keyhole saw enter; insert the saw in one of these holes, and follow the pencil mark for one side of the square to be cut out; when the next corner is reached, the gimlet hole will permit the saw being reversed and follow the next pencil mark, ie., that at right angles to the first. Follow the other pencil marks until the hole where the saw first entered is reached. This hole is half an inch less than the size of the small cubical box, so as to allow a foothold for the latter to rest on. The smaller box is secured to the top ***D*** by means of four angle brackets ***E***; these brackets should be about 1 1/2 inch long in each limb and 1/2 inch wide, screws 3/8 inch long being used, care taken that the holes for them are not bored too deep nor penetrate through the wood.

The floor of the larger box forms the bed or table on which the sheet of drawing paper is laid. The open side of this larger box is covered with a cloth ***G***, having a hole, ***H***, for the operator's head to pass through, and another, ***I***, for his arm. When the instrument is in position, the operator inserts his head through ***H*** and his right arm through ***I***, and sketches off on the drawing paper the picture represented thereon. This cloth should be stretched across the box tight enough to exclude all light. On two sides, it should be nailed permanently to the box (say at the top and right side), while at the other sides it is secured by eyelets in the edge of the cloth being fastened on to nails or hooks fastened on the sides of the box. This cloth or curtain is purposely made to open so as to permit the insertion or removal of the drawing paper. A piece of baize or cloth impervious to light is the best to use. For the purpose of focal adjustment the tube ***A*** should be double – that is, one holding the lens should slide in an outer casing; This tube is best made of sheet brass, with the joints soldered or brazed together; any tinman or smith will make this tube for a trifling sum. Should the amateur desire to construct it himself, he must proceed thus :

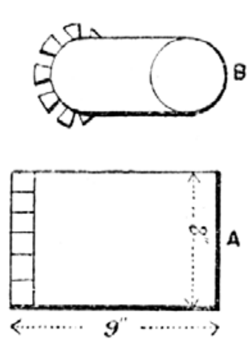


FIG. 6. INNER TUBE FOR FOCAL ADJUSTMENT

Take a piece of sheet brass, or zinc (the latter will do equally as well), 7 inches by 7 inches, and bend this over a wooden roller or piece of gas-pipe, or some other cylindrical article that is 1 7/8 inch in diameter. One edge will overlap the other something less than an inch. This edge is then to be soldered. Next take a brass curtain ring exactly 1 7/8 inch outside diameter, and solder this in one end of the tube. This ring is to prevent the lens falling out at this end of the tube. After this ring is soldered in, insert the convex lens from the other end of the tube, push it close up to this ring, and then put another one behind it. The latter one it is impossible to solder in, but the roughness of the inner part of the tube will not allow it to fall out easily. Make the soldered joint of the tube as thin and even as possible, else when it slides in its outer casing a ray of light will penetrate into the box along side this joint. The outer tube is constructed in the same manner as the first, the internal diameter of it being just equal to the external diameter of the inner tube. The sheet of metal of which this outer tube is made should be about 9 inches long by 8 inches for bending into tube form. But across one end of the 9-inch length the metal should be slit at intervals of about an inch (shown in Fig. 6, ***A***), so that when the metal is bent into cylindrical form these slits will allow the metal to be bent back at right angles to the axis of the tube (as shown by ***B***, Fig. 6). These flange pieces are for the purpose of fastening this outer tube to the smaller box in Fig. 3, so as to cover the circular aperture therein.

Now comes one special point to attend to, and that is, the focal length of the lens. This "focal length" should be equal to the length of the dotted lines, ***X Y***, ***Y Z*** – that is, it should be equal to the distance between the lens at ***Z*** to the mirror at ***Y***, and from the mirror at ***Y*** to the bottom of the box at ***X***. If the pictorial image at ***X*** is blurred, the tube holding the lens ***B*** should be adjusted (by drawing it out, or vice versa) until the image is distinct. Should the image then remain unsatisfactory, make a false bottom on which to place the drawing paper. This is easily accomplished by putting a drawing board or a smooth surface inside the box, and raising it to the required height by placing books or blocks of wood, etc., underneath. The plane mirror in the small box should be distant from the lens ***B***, not quite equal to half the focal length of the lens, while, at the same time, the sharpest picture will be represented at a distance from this mirror at a like distance. The size of our box will take a lens having a focal length of 3 feet, when the most distinctly outlined picture will be represented at about 11 inches above the bottom of the box. By making, the tube ***A*** longer than the dimensions given, a lens of 3 feet 6 inches to 4 feet focus may be used; but in no case should the focal length be too great for the size of the apparatus – that is, the length should not be so great as to depict the picture most distinctly below the bottom, as it were, of the larger box.

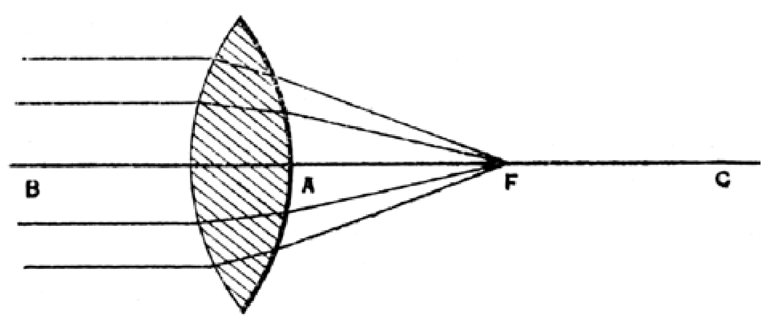


FIG. 7. DIAGRAM EXPLAINING FOCAL LENGTH.

A few words of explanation of "focal length" will prevent all confusion in the minds of all such as have no knowledge of optics. In, Fig. 7 I have represented a section of a double convex lens (such as is used in our camera); the line ***B***, ***C***, passing through the centre of the lens at right angles to its surface, is called the principal axis of the lens. Now, when rays parallel to this principal axis pass through a convex lens, the effect of the two refractions (refraction means bent or broken out of its course) which they undergo – one on entering, and the other on leaving the lens-is to make them all converge approximately to one point, ***F***, which is called the *principal focus*. The distance, ***A F***, of the principal focus from the lens is called the *principal focal distance*, or more briefly and usually, the focal length of the lens. Every school-boy, when be converges the rays of the sun on to the skin of his wrists (for raising a blister, as some young rascals do, so that they shall be unable to do their writing lessons), or to light a match or paper, knows the principal focus, for it is that point where the heat is most intense, or the spot of light formed is the most minute. The focal length depends on the convexity of the surface of the lens. Consequently, a lens 1 7/8 inch diameter which is thicker in the middle than another of the same diameter, will have a greater focal length than the latter. The focal length also depends on the refractive power of the material of which it is composed, being shortened either by an increase of refractive power, or by a diminution of the radii of curvature of the faces.

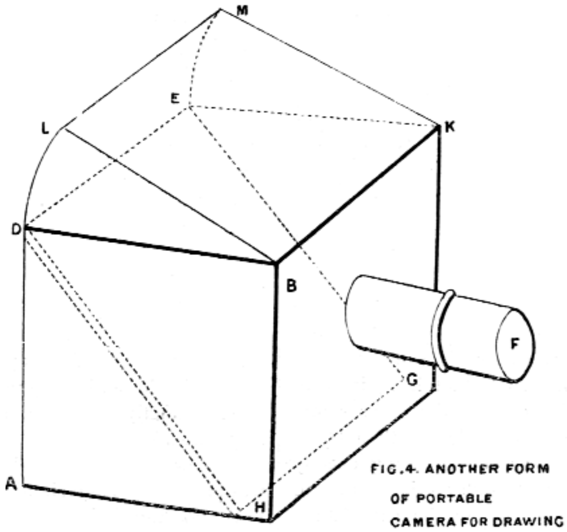


FIG. 4. ANOTHER FORM OF PORTABLE CAMERA FOR DRAWING PURPOSES.

Another form of a camera obscura for drawing purposes is shown by Fig. 4. This form is perhaps the handier of the two. In this figure the box, ***A B***, is cubical, and the focal length of the lens is equal to the distance ***F*** is from the side, ***A D E***, of the box. By placing the mirror, ***D E G H*** at an angle of 45° to the axis of the mirror, the picture instead of being depicted on the side, ***A D E***, is reflected into the top, ***D E K B***. This top is formed of a sheet of glass ground on one side, the smooth side being undermost. On this ground surface, the landscape, etc., is represented in all its natural colours. The objects represented can be drawn on the glass with a pencil, and afterwards copied off thus: Let this glass top be movable, then, when the picture is sketched on it in pencil, remove it, and lay it on a reflecting surface, such as a looking-glass, or brightly-polished sheet of metal. Then, if a piece of tracing paper is laid on the Ground glass, the design will be rendered deep enough to be traced on the paper. If this paper be used, the design can be copied off the ground glass when the latter is in position in the camera.

In Fig. 4, ***B L M K*** is a lid, and ***B D L***, ***K E M***, side pieces that hinge on the box for the purpose of excluding extraneous light falling on the ground glass thus the picture represented thereon is rendered doubly intense.

This last form of the camera obscura may be turned into a source of amusement, and will cause astonishment and wonder to anyone not acquainted with the construction of a camera. Thus, Fig. 8 represents an ordinary table with a piece of the top cut out, and a sheet of ground glass let in in its place. The camera is fixed beneath the table as shown. The way to use it is as follows: Let the table stand against the shutters when they are closed, a large table-cover being placed on it, and falling about its legs so as to hide the camera. A hole must be made in the shutter just suitable to admit the tube containing the lens (the lens need only just cover this hole). When you wish to astonish the company present by telling them you can show them all that is passing outside the house without the necessity of them leaving the room, all you have to do is to place them round the table, darken the room, and withdraw the

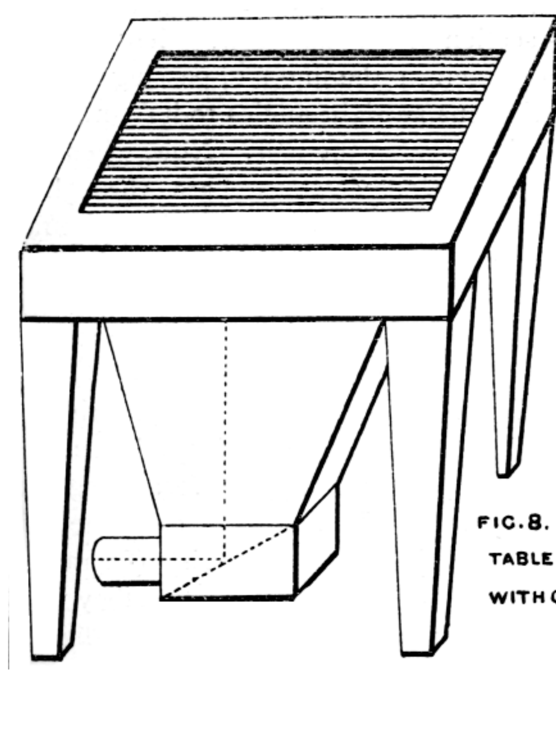


FIG. 8. ORDINARY TABLE FITTED WITH CAMERA

table-cover. The company will be highly amused by the verification of your words, for on the table top will be represented a faithful picture of all external objects,

Instead of the external landscape, the doings of the party in an adjoining room can be shown to the company if the lens be placed against a hole cut in the folding- doors between the apartments. There are many other ways in which such a table can afford amusement to a company during the dull winter evenings. Thus, the following is suggestive of many others. Have two or three confederates, and let them absent themselves from the company silently. After a short time commence operations by asking where they are, or if anyone knows what they are doing. When the excitement for their appearance is eager, and some wish to go in search of the fugitives, offer to call in the aid of spiritualism for their discovery. Some will doubt your ability to do so. So to verify your power, get them to stand round the table (of course they can only stand round three sides of it), and take each other's hand. Darken the room, and then ask one of the company present which of the absentees it is desired to know about. On her name being given, call for her in a loud voice, "Spirit of Alice, come forth and show what Alice is doing." At that moment pull away the cloth, and Alice will be represented on the table top, either at needlework, dancing, skipping, etc. In a few seconds replace the cover, and ask which other absentee shall appear, and repeat the question and operation.

Since the person will be represented on the table top in her natural colour and motions, extraordinary astonishment will be caused, and almost a belief in your power of spiritual agencies. Of course, you must have previously told the absentee confederates what to do, and whenever one is called (you must call her name loud enough for her to hear it in the next compartment), the other absentees must place themselves out of the camera's range. To produce greater mystery, so that the company shall not recognize what room the absentees are in, let a screen or two form a background to the confederate persons and their movements. A sliding top to the table instead of the cloth is a still better arrangement.

Appendix of enlarged examples

Fig. 1 Camera to Receive Image on Horizontal Table

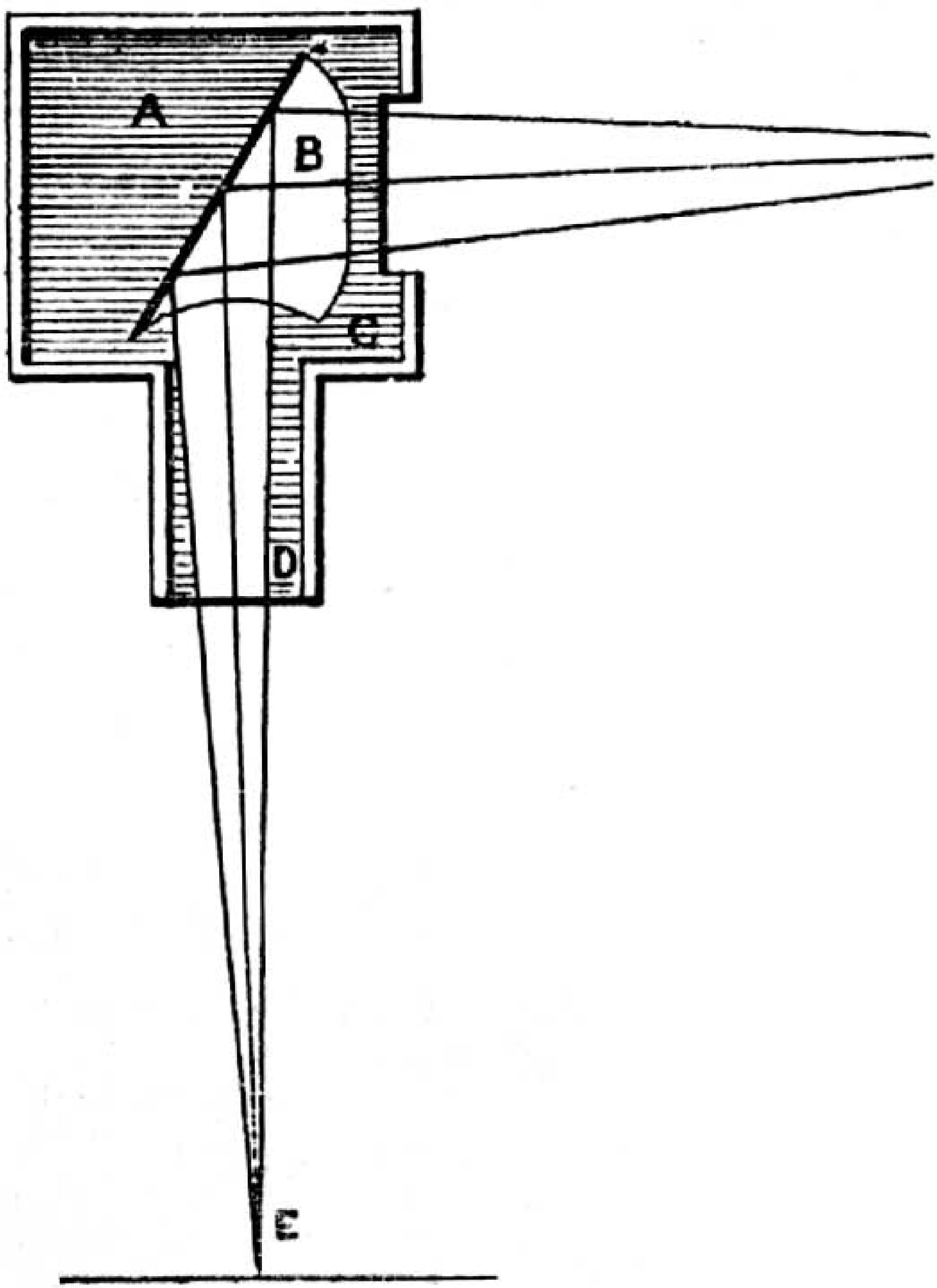


Fig. 2 Camera Similar in Purpose to Fig.1 with Flat Mirror

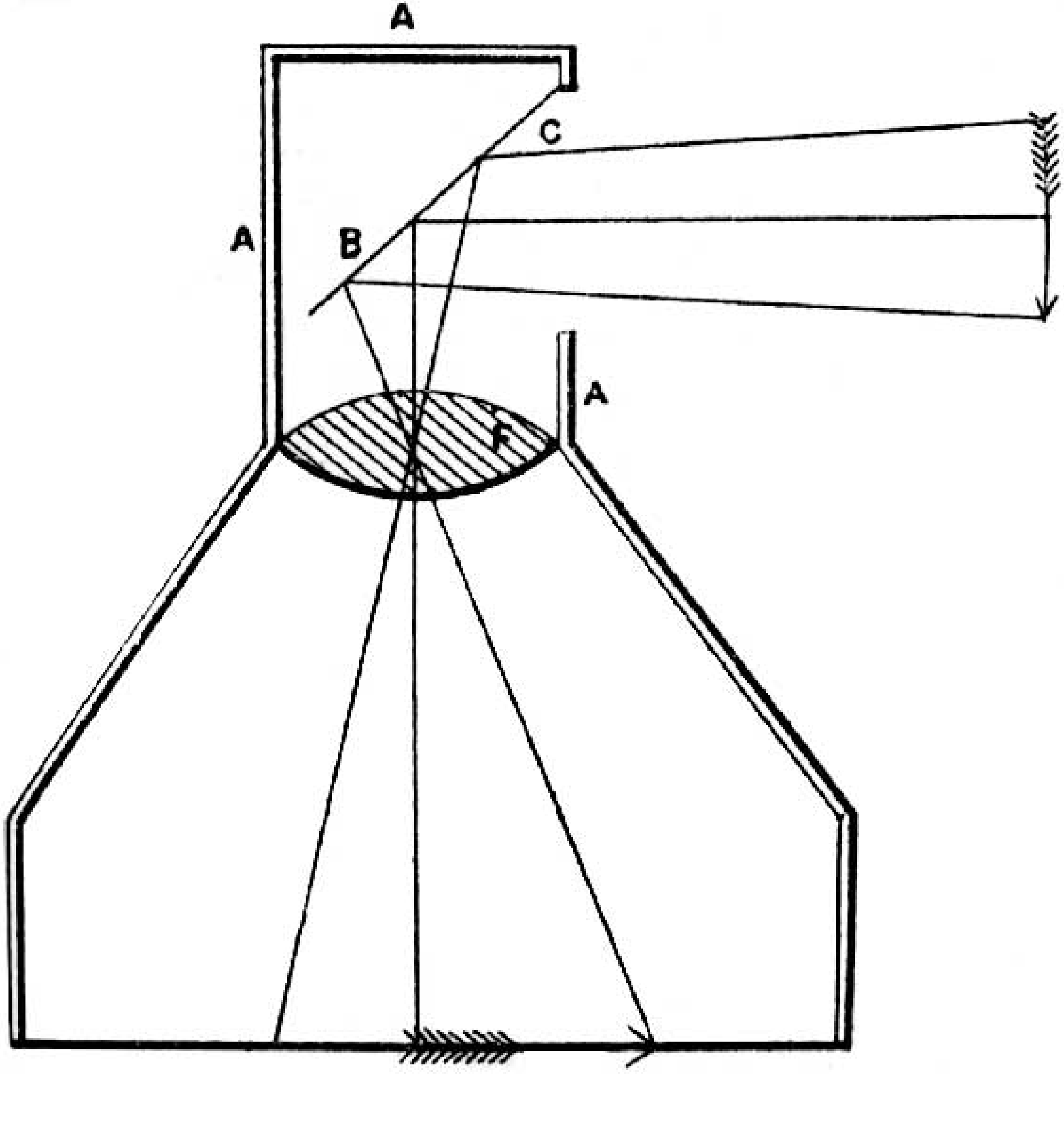


Fig. 3 Portable Camera for Drawing Purposes

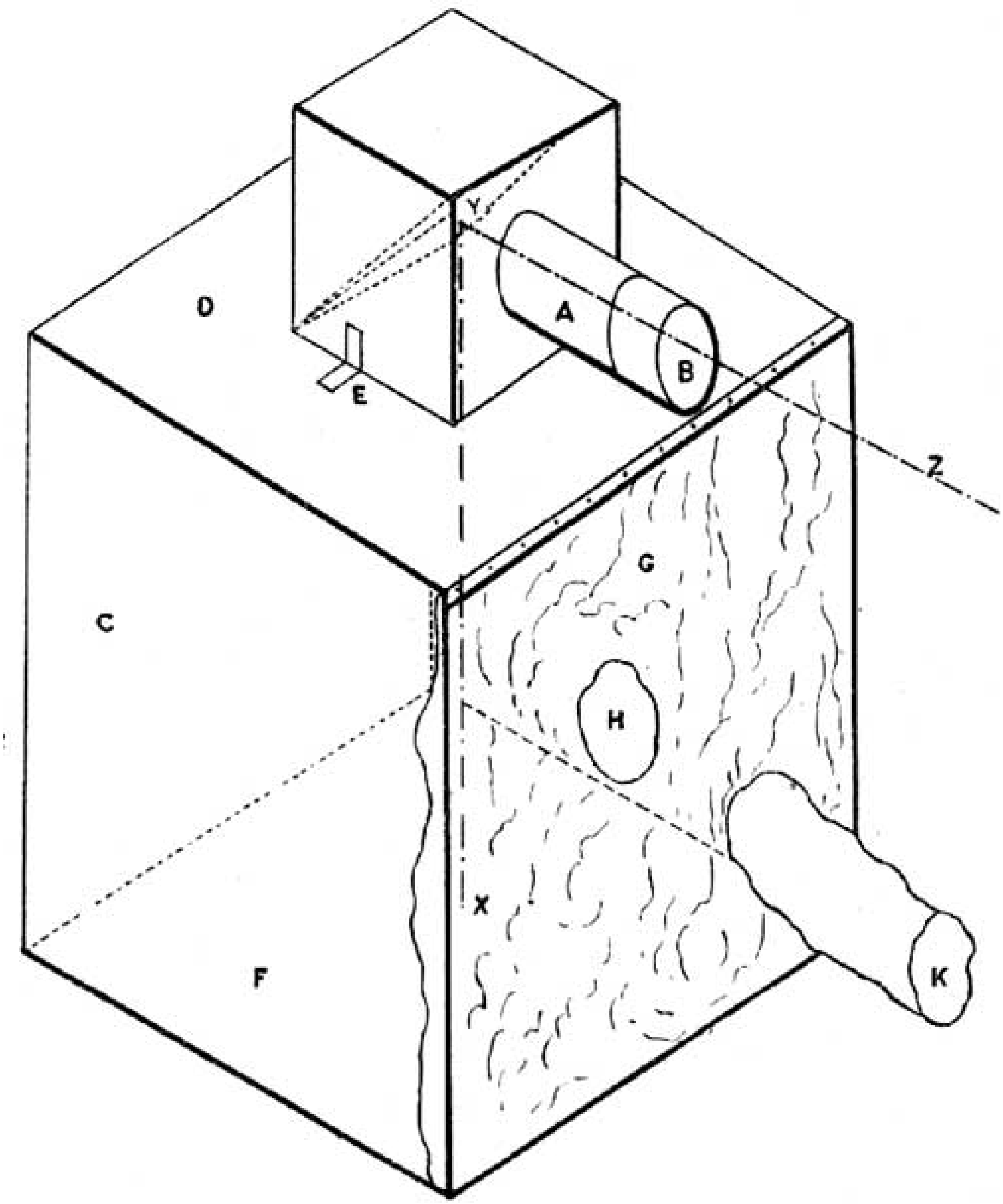


Fig. 4 Another Form of Portable Camera for Drawing Purposes

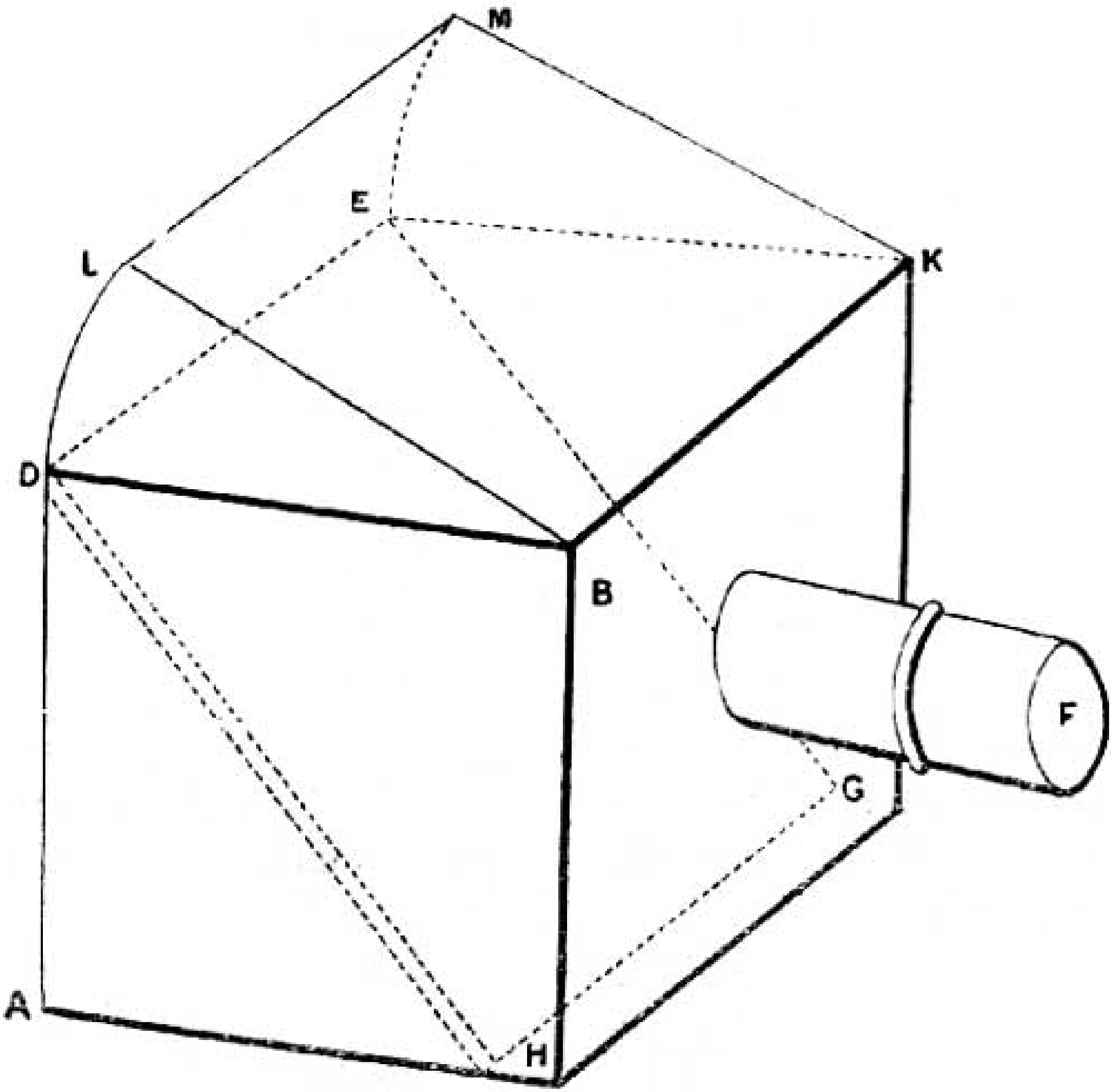


Fig. 5 Formation of Cubic Box for Camera

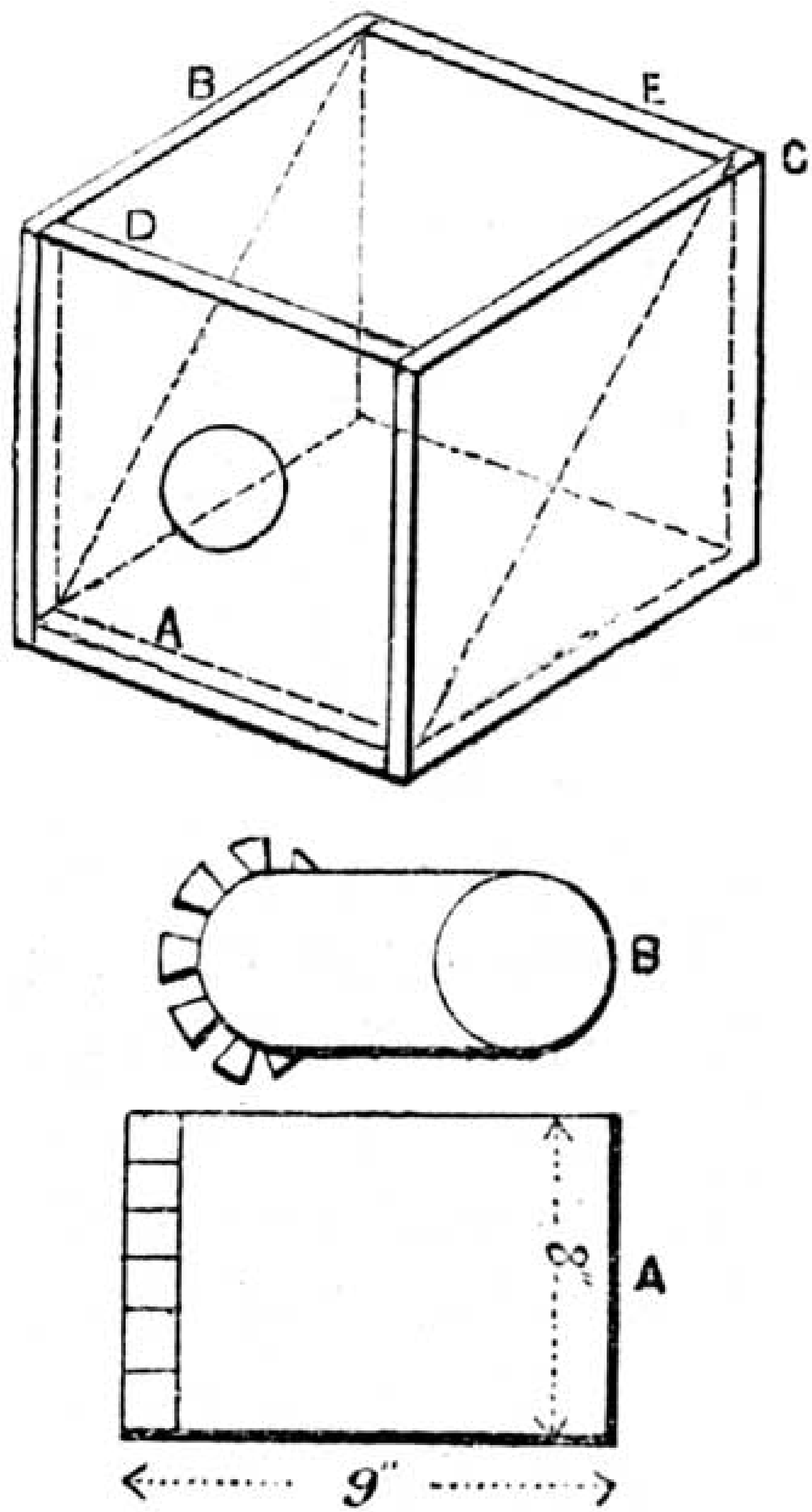


Fig. 7 Diagram Explaining Focal Length

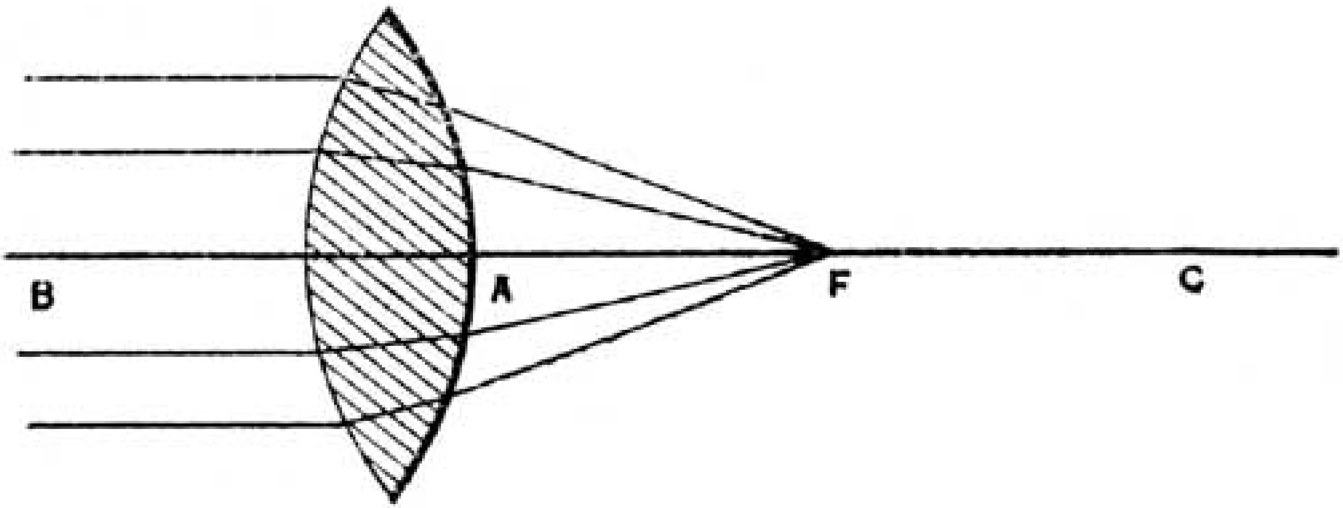
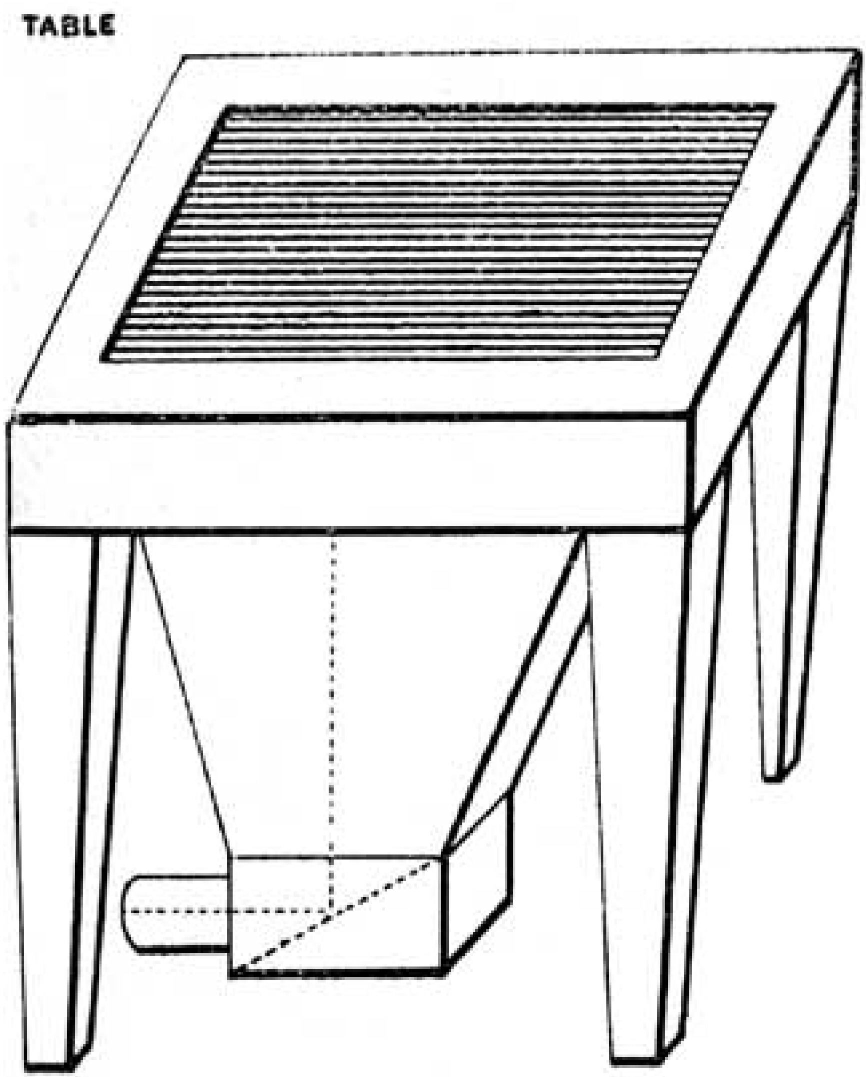


Fig. 8 Ordinary Table Fitted with Camera



Possible sources for optics

We have not purchased optics for any of the suppliers below except American Science & Surplus and Edmund Scientific, both of which we found very reliable. We can not give any other endorsement or guarantee the availability of the websites.

Surplus optics are available from:

American Science & Surplus: http://www.sciplus.com/category.cfm?category=18
Edmund Scientific: http://scientificsonline.com/category.asp?c=421191
Sterling Resale Optic: http://sro-optics.com/
Surplus Shed: http://www.surplusshack.com/
Anchor Optical Surplus: http://www.anchoroptics.com/

High quality custom lenses for camera obscuras are available from:

*David Sindon: http://www.sinden.org.uk

* We know Sindon by reputation as the maker of the optical components of several very impressive camera obscuras we have visited. If you need and can afford very special lenses we suggest you contact David Sindon.

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