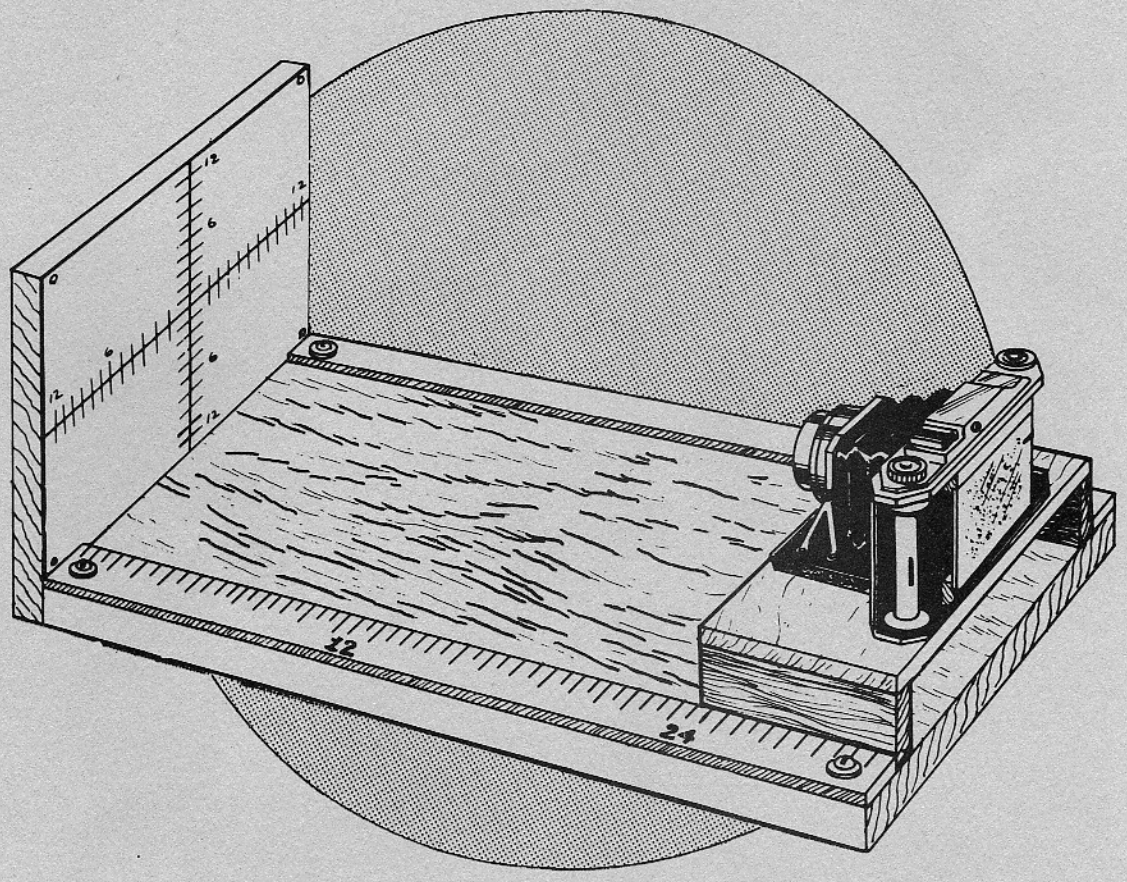
ULTRA
CLOSE UP
PHOTOGRAPHY



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EDMUND SCIENTIFIC CO., BARRINGTON, NEW JERSEY 08007

FIGURE 6

GN = LAMP GUIDE NUMBER

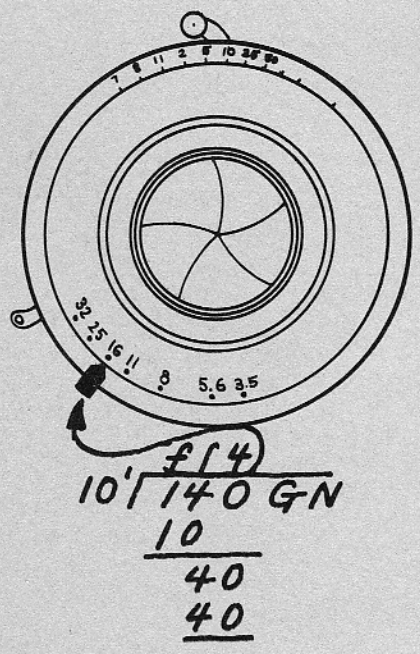


TABLE 1
DIOPTER VS FOCAL LENGTH

DIOPTER POWER	FOCAL LENGTH mms	FOCAL LENGTH ins
1	1000	40
2	500	20
3	333	13
4	250	10
5	200	8

FOCAL LENGTH (mms) = $\frac{1000}{D}$

FOCAL LENGTH (ins) = $\frac{40}{D}$

D = DIOPTER POWER

NEW! EDMUND SERIES V AND VI UNMOUNTED CLOSE UP LENSES

1/3 to 1/2 the price of ring-mounted lenses

Cash in at real savings on the tremendous fun of close up photography. Take head-and-shoulders portraits; copy prints, artwork, printed matter, etc.; shoot full-frame pictures of your favorite flowers; even take big, detailed photographs of insects, small parts. Experiment with table top photography and the fascinating lighting problems surrounding it.

These quality, crown glass lenses are precision ground and polished. Though unmounted, they are edged to fit Series V and Series VI "filter holders" perfectly. Series V lenses are 30mm in diam.; series VI 41mm. For cameras taking other sizes, step-up and step-down rings are available in local camera shops or by mail.

Most convenient to use with single lens reflex cameras (you get exactly what you see) but can be used with all cameras by measuring the field and the focusing distance or by using a simple composing frame.

Can be used singly or in conjunction (for increased magnification), require absolutely no exposure compensation and do not affect operation of automatic diaphragms. Uncoated. Table shows focusing distance applicable for each lens. Available separately or as a complete set of 6 for each series. Instructions included.

Diopter	Focuses to	Series V	Series VI
Plus 1	38"-20"	94,639	94,645
Plus 2	20"-13"	94,640	94,646
Plus 3	13"-10"	94,641	94,647
Plus 4	10"-7"	94,642	94,648
Plus 6	5½"	94,643	94,649
Plus 10	3½"	94,644	94,650

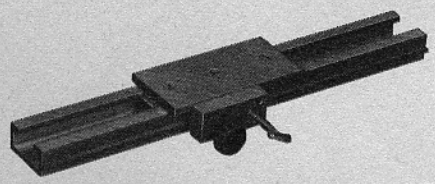
Series V (set of 6). **No. P-40,930**
Series VI (set of 6). **No. P-40,931**

TABLE TOP TRIPOD FOR CAMERAS, SCOPES, BINOCULARS OR MONOCULARS

Use this extremely portable yet sturdy tripod on a porch or other places where you prefer a light supporting base. Holds any standard camera with ¼-20 thread. Ideal for close-up photography. Use it too for mounting spotting scopes, binoculars, (see binocular holder on page 17,) monoculars, for "no shake" viewing.

Ball and socket joint allows movement in any direction. Joint can be locked in any position, and locked securely. Legs have rubber feet to prevent slipping. Excellent for the gadget bag. Height 8". **No. 60,603**

Similar to above, but not as versatile. **No. 50,229.**



NEW! MORE VERSATILE RACK AND PINION UNITS FOR PHOTOGRAPHERS, LAB MEN, HOBBYISTS

Excellent focusing device for macrophotography. Smooth running rack and pinion assembly has 2" x 4" sliding platform for holding any equipment requiring fine linear movement. Platform has through-hole for mounting camera; instructions included for mounting cameras, lights, lens holders, etc. Thumbscrew locks platform in position by forcing nylon friction stop against track; tension plate below platform allows positive lock if required.

Simply turn plastic knob with pinion to drive platform smoothly along either 12" or 24" track with full-length rack. Tracks (sold separately) have holes for mounting complete assembly, or you can drill and tap track for tripod use. Heavy-duty tracks and platform of noncorrosive aluminum.

Slide Platform only (with knob and pinion, thumbscrew lock and tension plate). **No. 40,891**
12"—long Track only. **No. 50,572**
24"—long Track only. **No. 60,573**

For Current Prices, See Latest Edmund Catalog

ULTRA CLOSE-UP PHOTOGRAPHY

Project No. 9042
Edmund Scientific Corporation
Barrington, New Jersey

There are many objects around us which are worth reproducing as large or larger than life in order to capture all their natural beauty, but which present some difficulties for those who attempt such work with an ordinary camera. Suitable subjects can be found almost anywhere, such as the tent caterpillars illustrated in Figure 1. This picture was taken with a 35 mm camera of the single-lens reflex variety with the aid of a supplementary lens and a small tripod. Leaves, flowers and insects will automatically suggest themselves as objects to photograph.

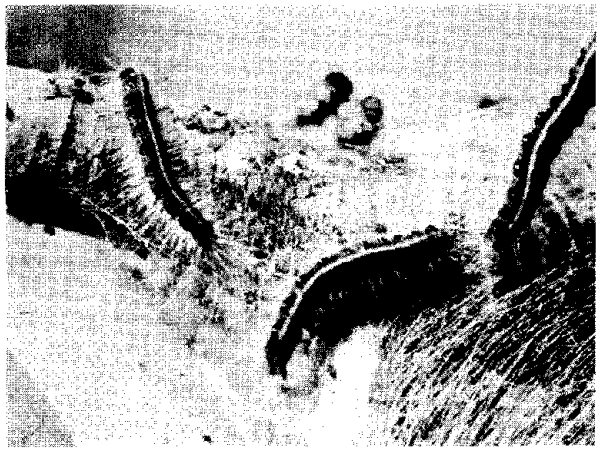


FIGURE 1

Although Figure 1 was photographed with a single-lens reflex camera, it might just as well have been taken with any camera, even a simple box camera. It is true that the reflex type of cameras are easier to adapt for close-up work but, with a little ingenuity, this difficulty can be easily overcome.

Figure 2 shows the general set-up for close-up photography indoors or in a studio. Naturally, no hard or fast rules can be applied to a camera set-up, since they will vary according to the subject matter. However, it is important to have the camera mounted or braced in such a fashion as to allow for accurate focusing with a maximum of steadiness. Allowance for lighting effects and depth of field are two factors to consider when using a supplementary lens. In fact, the limited depth of field is the only serious "bugaboo" to avoid when taking close-ups, and even that can be eliminated with practice.

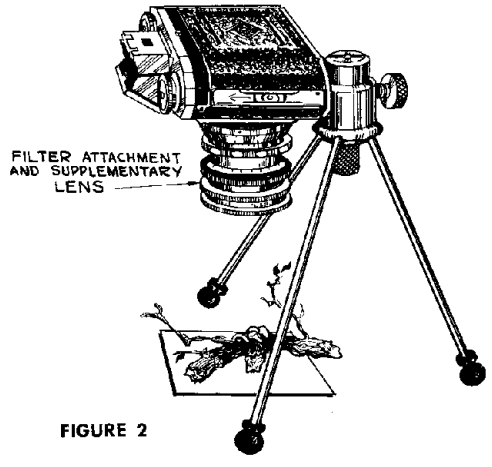


FIGURE 2

Ultra close-up photography, to the average person, is somewhat mysterious even though it is essentially the same as ordinary "snapshot" photography. Close-up photography differs from ordinary photography in three essentials:

1. The distance from the camera to the subject (lens-to-subject distance) is almost always less than in ordinary photography.

2. If no supplementary lens is used, then the lens-to-film distance is proportionately greater. However, if a supplementary lens is used, the lens-to-film distance remains the same as usual.

3. The depth of field (the distance between the nearest and farthest points that are in sharp focus in the camera) is extremely limited, thereby requiring an accurate measurement of the lens-to-subject distance.

EQUIPMENT AND LENSES

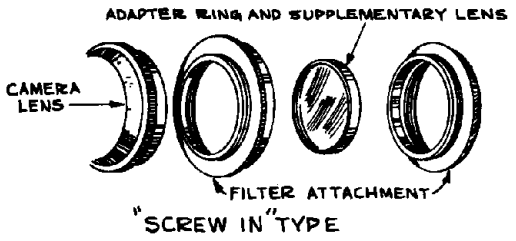
CAMERAS - The type of camera best suited for close-up photography is largely determined by the workload and the nature of the subjects themselves. If close-up photography takes up to 50% of your time, then a single-lens reflex camera will save many a headache, since the depth of field may be observed up to the time of exposure. However, if you take a few pictures now and then, any kind of a camera will do.

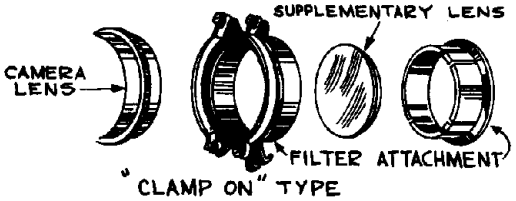
One of the best close-up cameras is one having a bellows that can be stretched out two or three times the focal length of the regular lens, and a ground-glass screen on which to focus the image. Ordinary roll-film cameras or miniature cameras may also be used by adapting supplementary lenses to the regular camera lens. A third arrangement uses an ordinary enlarger adapted to hold film, thus converting it into a flexible copying camera.

LENSES - As a subject is moved closer to a camera, the lens must be moved farther away from the film in order to focus sharply. Since the focusing range of most ordinary cameras has a minimum of about 2-1/2 to 3 feet, some means of closer focusing is necessary. This is sometimes accomplished by inserting a tube between the camera and its lens thereby increasing the separation, or by adding auxiliary lenses to the regular camera lens. Extension tubes are rather difficult to use with most cameras, although they are ideal for use with single-lens reflex cameras and single-extension bellows cameras. This booklet will deal mainly with the use of supplementary lenses.

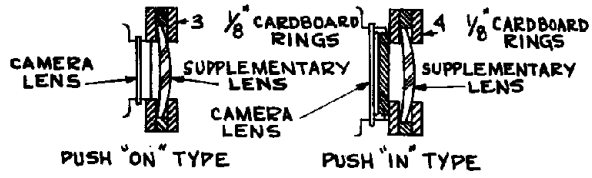
POSITIVE SUPPLEMENTARY LENSES - Positive lenses of the meniscus or spectacle-lens type are much handier than extension tubes for

taking close-ups in the majority of cases. A suitable lens mount may be easily improvised by using the camera's filter attachment, or, with a little more trouble, one can be made from heavy cardboard or sheet plastic; either to "push-on" or to "push-in" the existing lens mount.





COMMERCIAL LENS ATTACHMENTS



HOMEMADE ATTACHMENTS

FIGURE 3

Let us take first the camera's filter attachment and see how it may be fitted for a supplementary lens. Figure 3 illustrates two kinds of filter attachments, the screw-in type and the clamp-on type. Either one may be used with excellent results, and a host of lenses are available that may be used interchangeably with them. Any lens whose diameter is identical to that of the filters used with the attachments can be made to fit nicely.

If a filter attachment is not readily available to fit the camera being used, it then becomes necessary to improvise one from cardboard or plastic. Three rings should be cut out, as illustrated in Figure 3, two to fit the lens mount, and the third to accommodate the supplementary lens. To construct a push-in lens holder, a fourth ring will be necessary as shown. The rings are assembled with the supplementary lens sandwiched between the two larger rings, glued together, smoothed with sandpaper, and painted with lacquer or clear varnish. Black enamel may then be applied to give the unit a finish and, for a firmer fit to the camera lens mount, a narrow strip of flannel or velvet should be pasted around the inside of the cardboard ring. This will also serve to protect the finish of the camera lens mount.

As simple lenses are comparatively cheap, it will prove worth while to purchase an assortment of varying focal lengths, or powers, as they are sometimes rated. The power of a lens is generally expressed in diopters, and commercial portrait lenses are usually rated as plus one, plus two, and plus three diopters. A diopter is simply the reciprocal of the focal length in meters, one diopter being the power of a lens having a focal length of 1 meter (approximately 40 inches). A two diopter lens has a focal length of 1/2 meter, and so on. The relationship between diopter power and focal length is given in table I, and as may be seen from the table, it is only a matter of simple division to convert from one to another.

The meniscus shape is satisfactory for use as a positive supplementary lens. When using such a lens, it is recommended that the camera lens be stopped down to at least f/8 or f/11. At these apertures, the definition obtained with a simple lens is good, provided that focusing is done carefully.

There are those who may ask, "How about using an achromat for a close-up lens?" Actually, an achromatic lens is to be preferred as

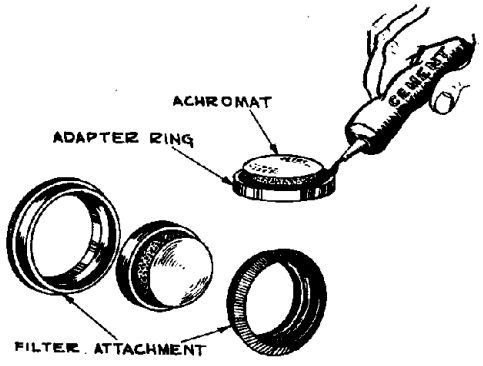


FIGURE 4

a supplementary lens, especially if the final picture is to be enlarged to an extreme size. Also in favor of an achromatic lens is the fact that the camera lens may be used at greater speed without harming picture definition. Thus, an achromat will give you greater use of your camera's abilities.

Generally, achromatic lenses are harder to adapt to a camera because of their great thickness, although by using an adapter ring and an achromat of the correct diameter to fit within the ring, the mounting difficulties can usually be eliminated. Figure 4 illustrates one method of mounting such a lens in a commercial filter attachment. The distance between a supplementary lens and the camera lens is not critical, 1/4" to 1/2" will do nicely no matter what kind of a supplementary lens is used - simple meniscus or achromat.

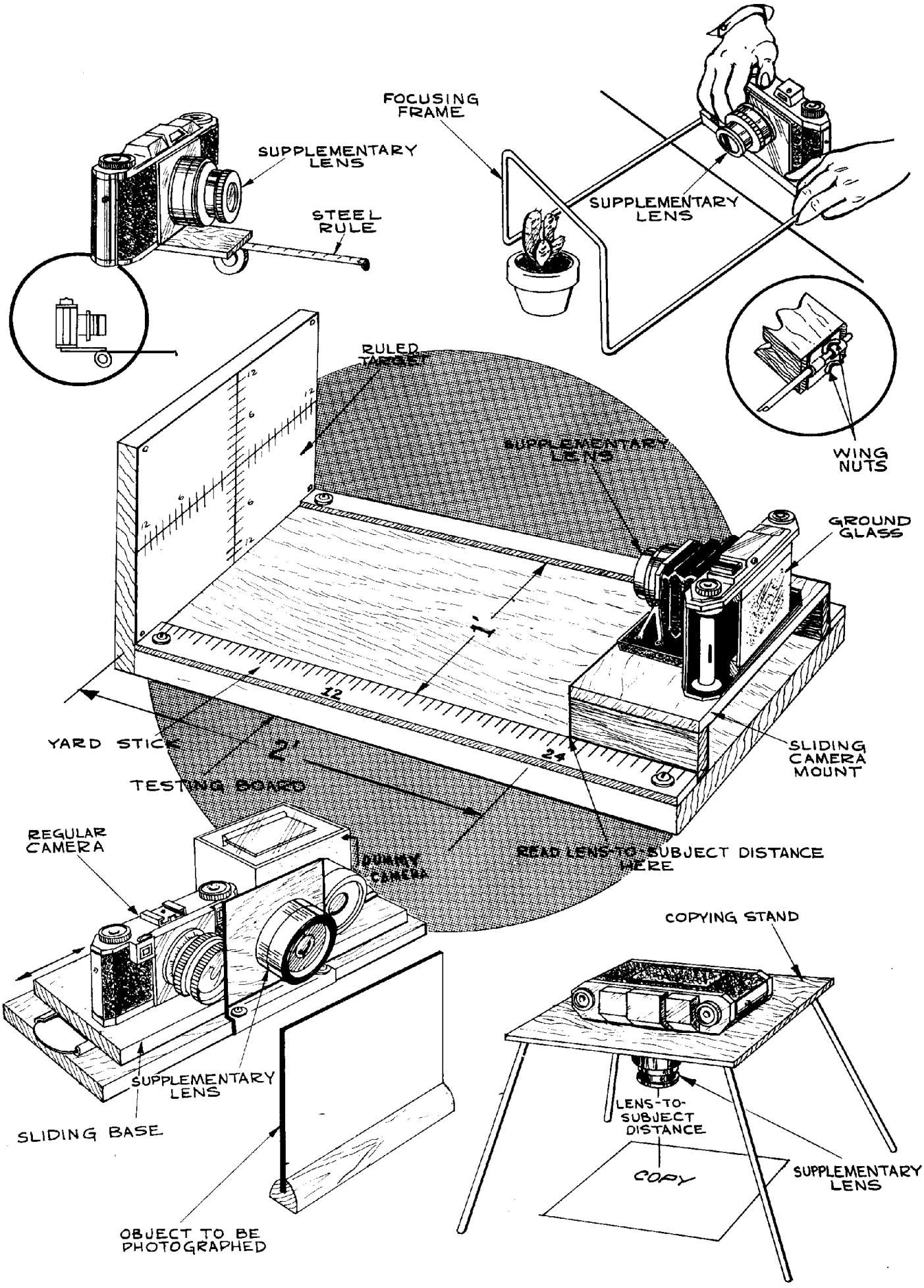

FOCUSING FRAME
SUPPLEMENTARY LENS
STEEL RULE
SUPPLEMENTARY LENS
WING NUTS
RULED TARGET
SUPPLEMENTARY LENS
GROUND GLASS
YARD STICK
TESTING BOARD
SLIDING CAMERA MOUNT
REGULAR CAMERA
DUMMY CAMERA
READ LENS-TO-SUBJECT DISTANCE HERE
COPYING STAND
SUPPLEMENTARY LENS
SLIDING BASE
LENS-TO-SUBJECT DISTANCE
COPY
SUPPLEMENTARY LENS
OBJECT TO BE PHOTOGRAPHED

FIGURE 5

The f-number markings are not generally affected by the use of a positive supplementary lens, especially if the camera is focused by its front element. In such a case, the f-numbers are correct for all focus positions and with any supplementary lens. However, if the camera is focused by moving the entire lens forward, it is good practice to use a half-stop greater than would normally be used. For example, if a certain subject would normally require a setting of f/8, then set the scale to read halfway between f/8 and f/11.

USING SUPPLEMENTARY LENSES - When a camera lens is set at the infinity mark on the focusing scale, the distance from the lens-to-the-subject in sharp focus is the same as the focal length of the supplementary lens. With fixed focus cameras, such as an ordinary box camera, the lens is not focused on infinity but usually at about 20 feet, and the correct lens-to-subject distance will therefore be less than the focal length of the supplementary lens.

In any case, it is recommended to check the lens-to-subject distance for each combination of camera and supplementary lens before it is actually put into use. A device to check lens-to-subject distance, field of view, object size to image size ratio, and the depth of field of any auxiliary set-up is illustrated in the center of Figure 5. Such a device consists of a camera mount that can be slid toward or away from a ruled target. The camera should be mounted so that its optical axis is centered upon the cross line of the target, and also in such a fashion as to allow the front surface of the supplementary lens to be even with the front of the camera mounting board. One of the two runners intended as guides for the camera mount should be calibrated in inches, starting from the target board. A piece of a wooden yardstick will do nicely for the purpose. The ruled cross-line target should also be calibrated in inches, starting at the center of the cross and working toward each of the four ends.

The correct procedure for using a testing board to determine the characteristics of any combination of camera and supplementary lens is as follows:

1. Remove the back of the camera and fasten a piece of ground glass in the film position with a length of scotch tape. Set the shutter so it will remain open, and adjust the lens to its maximum aperture.

2. Place the supplementary lens on the camera and secure the camera to the sliding camera mount. The supplementary lens must be in line with the front edge of the camera mount.

3. Set the camera's focusing scale to infinity, and illuminate the target with a bright light.

4. To find the lens-to-subject distance of the supplementary lens in question, simply slide the camera forward by means of the sliding camera mount until the image on the ground glass is in sharp focus. The lens-to-subject distance may then be read directly in inches at the front edge of the camera mount. If it is desired to find the lens-to-subject distance at camera settings other than infinity, set the camera's focusing scale at the point in question and proceed as above.

5. By observing the ground glass image, count the number of target divisions horizontally and vertically. This will be the maximum field of view in inches.

6. The object size to image size ratio, which is actually the magnification of the image, is found by dividing the lens-to-film distance by the lens-to-subject distance. For example, if the lens-to-film distance is two inches, and the lens-to-subject distance is 10 inches, the magnification would be 2/10 or about 1/5 the size of the original.

7. Provided the illumination of the target is sufficient, the depth of field at any lens aperture is easy to determine. First, set the diaphragm to the desired stop (for simple supplementary lenses this setting should be f/8 or f/11), then slide the camera carefully forward until the image on the ground glass goes out of focus. Note the lens-to-subject distance at this point and then move the camera backward until the image again goes out of focus. Note the lens-to-subject distance as before. To find the depth of field, subtract the smaller distance from the larger. For example, with a certain supplementary lens and an aperture setting of f/8, the minimum lens-to-subject distance is found to be 11-1/4 inches and the maximum lens-to-subject distance is found to be 11-5/8 inches. Subtracting 11-1/4 inches from 11-5/8 inches leaves 3/8 of an inch which is the depth of field. Since the depth of field under these conditions is extremely small, several readings should be taken using the average of these readings as the actual depth of field. It will also be helpful to observe the ground glass image through a small magnifier which may be mounted directly on the sliding camera mount.

Needless to say, a careful record should be kept for each supplementary lens tested, possibly on the envelope in which the lens is kept. If more than one camera is to be used with the same supplementary lens, the tests should be made for each combination and noted as such. If this is done correctly it will greatly simplify close-up photography, and make it more enjoyable because the element of uncertainty will be eliminated.

FOCUSING DEVICES - Perhaps the simplest focusing device for use with supplementary lenses when the correct lens-to-subject distance is known consists of a flexible steel ruler attached to the base of the camera. Such an arrangement is illustrated in the top left-hand corner of Figure 5. It will be seen from the Figure that the rule is mounted on a piece of plywood which is attached to the tripod mount of the

camera. The piece of plywood should extend directly beneath the front surface of the supplementary lens in order that the lens-to-subject distance may be measured from this point. The steel rule should be of the type that automatically retracts when a button is pushed. To use this device, extend the rule to the correct lens to subject distance, hold or mount the camera so that the end of the rule just touches the subject matter, retract the rule and snap the picture.

While the focusing device just mentioned will measure out the correct lens-to-subject distance, it will not be possible to compose the picture unless the field of view is measured beforehand. A handy device that will measure both the correct lens-to-subject distance and the field of view is illustrated in the upper right-hand corner of Figure 5. A square frame made from heavy wire or tubing is bent so that it covers an area slightly larger than the field of view measured with the testing board. The correct shape is shown in the Figure. This frame is extended from a small board by means of wing nuts or screws so that it may be adjusted to the correct lens-to-subject distance, and the camera mounted on the board with its optical axis in line with the center of the frame. In order to take a picture with this composing frame, simply rest the bottom of the frame near the subject as illustrated, move the camera into position, compose the subject as desired and snap the picture. The composing frame is made slightly larger than the field of view so that it will not show in the final picture.

There is one factor to be wary of when using the two focusing methods mentioned above, that is, the depth of field. As mentioned before, when using positive supplementary lenses, the depth of field is extremely small due to the short subject distances. It is always good practice to set the lens-to-subject distance as accurate as possible and, if the depth of field was measured on the testing board, to check and see if the desired portions of the subject will be in focus before taking the picture.

Another focusing device that may be used to good advantage, even though rather bulky, is a dummy camera. A dummy camera is made optically the same as the regular camera used for close-ups. For example, if your camera has a lens whose focal length is 50mm and is stopped down to f/8, then the dummy camera is made with a lens of the same focal length and stop setting, its focusing movement is calibrated exactly the same as the regular camera. Here the likeness stops, for the dummy camera has no shutter and no film holder, only a ground glass screen masked to cover the same picture area as that of the regular camera. From this it will be seen that any object in focus and properly composed on the ground glass of the dummy camera will be the same in the regular camera if the two are reversed in position. Therefore, to use a dummy camera for close-up photography, the supplementary lens must be mounted independent of either the dummy camera or the regular camera, as illustrated in the lower left-hand corner of Figure 5. The two cameras are mounted on a sliding board in a manner to allow them to be slid into position directly behind the supplementary lens. The dummy camera is slid into position first, and all focusing and composing is done with it. Next, the regular camera is moved in behind the supplementary lens, set to agree with the dummy camera, and the picture taken. The supplementary lens must be the same distance from the regular camera lens as from the dummy camera lens in order to prevent inaccurate focusing.

With this set-up, all four supplementary lens characteristics are automatically observed. The lens-to-subject distance is taken care of when the dummy camera is focused, the field of view can be observed on the ground glass screen, the depth of field can be seen and the object adjusted accordingly, and finally the object size to image size may be directly measured with a ruler.

There is one more handy device that can be used for focusing and composing, especially where the objects to be photographed have very little depth. It consists of a four-legged stand adapted to allow the camera to rest vertically as illustrated in the lower left-hand corner of Figure 5. The stand is adjusted in height to the correct lens-to-subject distance for a given supplementary lens, and the field of view is drawn on a piece of paper which is placed directly under the camera. The object to be photographed is then placed on the paper in the position desired and the picture taken.

FILM TYPES AND EXPOSURE TIME.

As in regular photography, there are numerous negative materials from which to choose for ultra close-up work. For 35mm miniature cameras, and for extra fine work with any camera, a panchromatic fine-grain film should be used; such as, Ansco Supreme or Plenachrome Roll, Kodak Plus-X or Verichrome Roll, Dupont Superior 2, and Gevaert Microgran. The A.S.A. exposure indices for these and several other types of films are given in Table 2.

TABLE 2
ASA EXPOSURE INDEXES

D = DAYLIGHT T = TUNGSTEN

ROLL FILMS & PACKS	D	T
ANSCO		
SUPREME	50	32
PLENACHROME	50	25
KODAK		
PLUS-X	50	40
VERICHROME	64	32
GEVAERT		
SUPERCHROME	50	25

35 mm MINIATURE	D	T
ANSCO		
SUPREME	50	32
KODAK		
PLUS-X	50	40
DIRECT POSITIVE PAN (REVERSAL)	64	50
DUPONT		
SUPERIOR 2	50	40
GEVAERT		
MICROGRAM		

FILMS FOR COPYING	T	T*
ANSCO		
PROCESS	-	8
DUPONT		
MICROCOPY (35 mm)	-	5
KODAK		
PANATOMIC-X	25	5
PORTRAIT PAN	40	8
MICRO FILE (35 mm)	16	3
FINE GRAIN POSITIVE (35mm)	3	0.6
SUPER ORTHO PRESS	50	10

COLOR FILMS	D	T
ANSCO (FOR ALL CAMERAS)		
DAYLIGHT TYPE	10	-
TUNGSTEN TYPE	-	12
KODAK		
KODACHROME DAYLIGHT TYPE	10	-
KODACHROME TYPE A	-	16
KODACOLOR DAYLIGHT TYPE	25	-
KODACOLOR TYPE A	-	20
EKTACHROME DAYLIGHT TYPE	8	-
EKTACOLOR TYPE B	-	8

* READ METER ON WHITE SURFACE IN THE COPYING POSITION

While the films listed in Table 2 are relatively slow in speed, they are fine grain and sensitive to nearly all visible light (with the exception of verichrome and plenachrome). Faster films, such as Kodak Super-XX, are not generally suitable for close-up photography because of their course grain. The reason for this is simple: Why go to all the trouble setting up your equipment in order to obtain a maximum or resolution, and then use a film that will not record it? However, there are some occasions where this cannot be helped, especially where the object to be photographed is in poor light or when it is moving fast.

Also listed in Table 2 are various types of color films, any of which will give excellent results when used as recommended by the manufacturer. Here, the most important factor to remember is correct color temperature. For example, if daylight color film is used to take a picture with artificial light, the result will generally be an orange-hued picture. The only way to correct this faulty color is to use the proper filter to change the spectral distribution of the light, such filters being available at any photo supply store.

An exposure meter should be used whenever possible for determining the correct exposure time, and for checking evenness of illumination over the subject. However, evenness of illumination is not necessary at all times and can be disregarded where it is desired to highlight the subject in order to create an illusion of depth. There are two ways of using an exposure meter for calculating close-up exposure times; (1) take the reading directly from the subject and use a normal meter setting, and (2) when readings are difficult to take directly from the subject itself, put a white paper over the subject and give about 8 times the exposure indicated by the meter. Table 2 gives the proper film speed meter settings for use with the latter method of calculating exposure times.

In some inexpensive cameras, such as box cameras, the shutter is set to one speed only and the aperture of the lens is generally limited to one or two openings. With these limitations, it becomes necessary to rely upon another factor in order to get good pictures. It is well known that box cameras yeild satisfactory pictures under a wide latitude of conditions, even though daylight variations of from 1 to 1000 occur. This other factor, well known to most photographers, is called film latitude and depends upon the subject as well as it does upon the film. Every film has an inherent ability to record a certain limited range of brightness values, but when this limit is passed, the film latitude is then exceeded. For example, if the subject's brightness range matches that of the film, then the latitude is 1, and only one exposure is possible, all others leading to inferior results. However, if the subject's brightness range is lower than that of the film, then the exposure can vary over a wide range without much effect upon the final negative. Therefore, for the best results with box cameras, all that is necessary to obtain a good close-up shot, as far as exposure time goes, is to duplicate normal daylight conditions indoors, or work outdoors. This holds true only for black and white film and not for color film, since color film has an extremely small latitude and is generally slow in speed.

Except in some cases where the home or studio has large windows to let in natural daylight, it is customary to use photoflood lamps or flash bulbs in order to obtain correct indoor lighting. Actually, many photographers prefer artificial lighting for it enables them to completely control the illumination. By being able to do so, the photographer can obtain almost any artistic effect that occurs to him. Highlighting, backlighting, or sidelighting may all be used to the subject's advantage.

Photoflood lamps are designed to obtain a higher light output than possible with a regular lamp of the same wattage, sometimes two or three times as much. The increased light output is only possible at the expense of the useful life of the lamp, and therefore, most photoflood lamps have a relatively short life. A 250 watt photoflood, with a lifetime rating of between three to five hours is generally sufficient for most all close-up work. Any fill-in lighting can almost always be accomplished with an ordinary household lamp, except in the case where color film is being used. To find the correct exposure time, simply read the directions that accompany the photoflood, allowing for extra fill lights by stopping down slightly.

Photoflash lamps are also useful in obtaining the correct illumination for close-up photography. Here, the primary requisite is to have the flash synchronized with the camera shutter. This may be accomplished either by electrical or mechanical means, or in the case of simple cameras, by the flash bulb it self. For example, if a box camera is set on TIME or BULB, the shutter opened, the lamp flashed, and the shutter immediately closed, there is no question of synchronism if the flashbulb supplies the only light. Whichever type of artificial illumination is relied upon, photoflood or photoflash, satisfactory results will always be obtained if the manufacturer's instructions are followed carefully.

Each type of photoflood or photoflash lamp is designated by a guide number intended for use in determining proper exposure times. Figure 6 illustrates the proper use of the guide number; first, the lamp-to-subject distance must be measured in terms of feet, then this value divided into the guide number. The answer will give the proper aperture setting for the shutter speed at which the guide number was calculated (generally 1/100 of a second), and for the type of film recommended.

PHOTOGRAPHIC FILTERS

Since no negative material has been developed which has the same color response as the human eye, a filter is sometimes used to bring out or to subdue certain colors. A classic example is a green tree with red apples. It is easy to tell the difference between the colors with the eye, but with panchromatic film they show only a slight difference. However, by using a red filter, the foilage becomes dark on the print and the apples light. A green filter opposes this, the apples appear dark and the foliage light. Therefore, to render a color light in a print, use a filter which transmits or is the same color as the color in the subject. To render a color darker, use a filter which absorbs that color. The following table may be of some use to those who wish to experiment with filters to improve picture quality.

COLOR OF SUBJECT	TO SUBDUE USE	TO ACCENTUATE USE
Red	Red Deep Red Deep Yellow	Blue Green
Green	Green Light Green Deep Yellow	Blue Red
Blue	Blue	Red Deep Red Yellow Green
Blue-Green	Blue Green	Red Deep Red
Magenta or Pink	Red Deep Red	Green
Purple	Blue	Green
Yellow	Red Deep Yellow	Blue
Orange	Red Deep Yellow	Blue

An important thing to remember when using filters is that all filters absorb some light, and so must be compensated for. The multiplying factor used to find the new exposure required is called the filter factor, and it may be defined as the relative increase in exposure time necessary because of the filter's selectivity. If a known exposure without a filter is calculated to be 1/100 of a second at f/6.3, and a filter is going to be used which has a factor of 2 (2X), then either the exposure time can be doubled to 1/50 of a second or the aperture can be set at f/4.5 to compensate for the filter. Do not increase both the exposure time and the aperture by the multiplying factor, but only one or the other.

NATURE STUDIES

Nature photography is, of course, a broad field and only a small portion of the subject can be covered here. The average photographer will find, as he is accumulating close-up nature photographs, that he is enjoying his camera many times more than he ever did before. In fact, many sportsmen agree that it is much more exciting to stalk specimens with a camera than to hunt them with a gun.

In order to become a nature photographer, you don't need expensive equipment. Almost any kind of camera will do, provided that the supplementary lenses are properly calibrated to it.

Of all nature studies, animal photographs rank high in human interest, although the studies are almost entirely limited to the larger animals and birds. Actually, the smaller animals and insects offer challenges not often found in the more exploited branches of photography. Of the smaller animals, including insects, there are about three-quarters of a million species. Variety of subject matter is the least of our worries.

Finding these small animals and insects is easy, because they live practically everywhere. Any garden will furnish a good supply. Sometimes even the best-kept households will harbor a few. However, when you desire to photograph a certain subject, you must know exactly where and at what time of the year to look. This information may be found in various standard textbooks intended expressly for amateur naturalists.

There are several ways to go about the business of taking small animal close-ups; first, the specimens may be collected in the field, killed, and then photographed at home, or they may be "brought back alive". Second, and perhaps more desirable, they may be photographed living in their natural surroundings. For the first method, where the specimens are collected and killed, a "gas chamber" of sorts should be used in order not to mar the specimen.

A cyanide bottle is perhaps the easiest to make. It consists of a wide-mouthed bottle into which is poured a mixture of plaster of paris and cyanide crystals. Only a few crystals are needed for the hardiest of insects. You may obtain the crystals at a chemical supply house. When the plaster of paris begins to harden, punch small holes through it with the end of a match stick or ice pick. Needless to say, extreme caution is necessary when handling cyanide crystals. Cyanide crystals emit a poisonous gas when exposed to air, and for this rea-

son they are enclosed in plaster of paris, slowing the action down considerably. Always make sure the bottle is stoppered tightly. You can buy specimen bottles from biological supply houses.

For shooting live insects, especially the quick-moving types, some type of stage must be used to limit their travels (Figure 7). For nature close-ups in the field, the portable stage arrangement as illustrated in figure 8 is excellent. Simply arrange a board with a device to clamp it to one tripod leg. This will give you excellent control over the ticklish lens-to-subject distance.

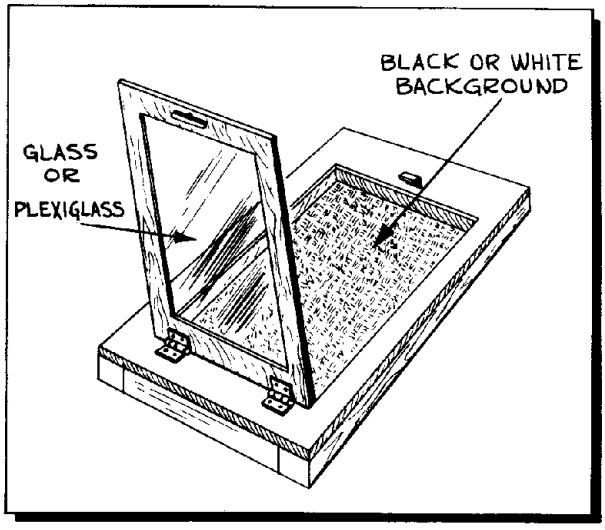


FIGURE 7

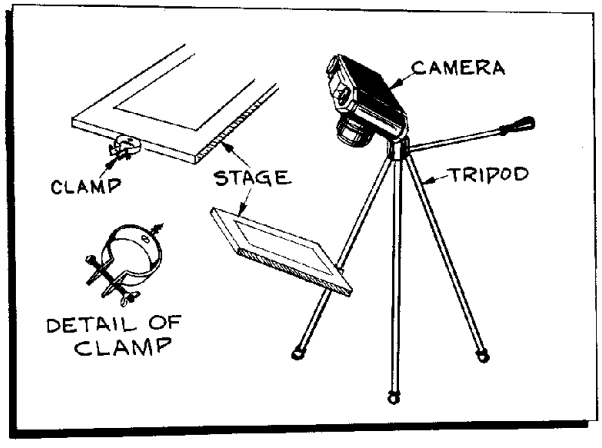


FIGURE 8

Another nature field which is of particular interest to the color fan is photographing flowers. Flowers, especially those that grow wild, offer great opportunities for artistic effects. There is little difficulty, also, except in cases where it is windy, to induce the specimens to pose for their picture.

There are two methods of obtaining flower close-ups: either as they grow in their natural habitat, or cut, taken home, and arranged indoors against a suitable background. Both methods are satisfactory, although the former may show the specimen to better advantage.

Other nature studies may include all sorts of fruits and seeds, fungi such as toadstools and mushrooms, leaves, or even grains of sand. In any case, for all nature close-ups, you must pay particular attention to the proper background for the subject. It is generally better to photograph a specimen against its natural surroundings, although sometimes such backgrounds become objectionable because of confusing or distracting details or because of a lack of contrast. Natural backgrounds may either be real or "staged" at home. If a subject cannot be photographed in the field, observe its surroundings carefully before removing it, and then collect the "props" while still on the spot. Such props may be fewer in number and variety than those where the subject was found, but they should improve the final result.

Artificial backgrounds also have a definite usefulness in the photographing of small nature studies. Such backgrounds are useful when your primary aim is to present anatomical or structural detail. When the specimen so closely matches its natural background that there is insufficient contrast to bring out detail, or when you are not familiar with the natural background and you prefer not to give misleading information. A neutral gray background may be used to furnish proper contrast without harshness, or a white background may be used to subdue shadows by reflecting light back to the specimen. A black background is excellent for light-colored or translucent subjects. For color photography, it is sometimes helpful to use a colored background which contrasts with the color of the specimen.

PHOTOMACROGRAPHY

Actually, the nature close-ups considered so far fall in a branch of photography known as photomacrography. For our purpose, the specimens encountered in this classification are all those ranging in sizes too small to produce an adequate image with a normal camera lens, to those too large to be photographed with a microscope. Photomacrography also lends itself to photographing entire microscopical specimens which, because of their size, are seen only in part when viewed through the microscope: embryo parts, whole organs, skin tissues, etc. Therefore, any specimen which requires the use of a supplementary lens in order to obtain the necessary image size falls under this classification.

PHOTOMICROGRAPHY

Now we come to specimens so small that magnifications from 5X up are necessary before they yield a suitable picture. Here, we must use a microscope coupled to a camera as illustrated in figure 9. An easily made microscope adapter is also illustrated in figure 9, consisting of several brass tubes telescoped into one another to form a coupling between the microscope draw tube and the camera's filter attachment. The camera lens should be as close to the eyepiece of the microscope as possible, or, even better, the camera lens may be removed and the eyepiece used alone. By using a piece of ground glass fastened in the film plane of the

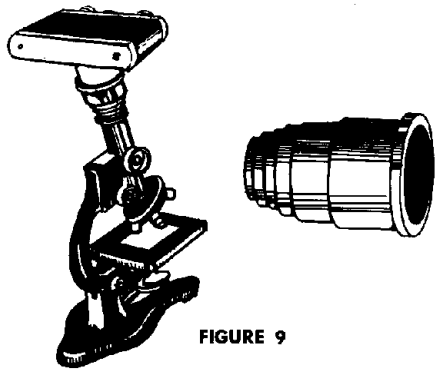


FIGURE 9

camera, it will be possible to calibrate the microscope to the camera for one magnification setting at a time, thereby eliminating any possible errors due to poor focusing. Correct exposure times are best found by the trial and error method, where a series of trial exposures are taken under the same lighting conditions until the best value is found.

MICROPHOTOGRAPHY

The words photomicrography and microphotography are sometimes confused into meaning the same thing. Actually, this is far from the truth, since microphotography is simply the copying of printed matter onto a very small piece of film, either 35, 16, or 8 millimeter film. For this kind of photography, a strong and steady copying stand is necessary, such as that illustrated in figure 10, and a pair of 250 watt photoflood lamps. The lamps are mounted so their axes form a 45 degree angle with the base of the copying stand, centered upon the document to be copied. Negative material such as Kodak Microfile, Ansco Minipan, and Dupont Microcopy are of great value here, since high resolution is required and the length of exposure is of no importance. All exposure times for microphotography may be determined exactly as mentioned previously.

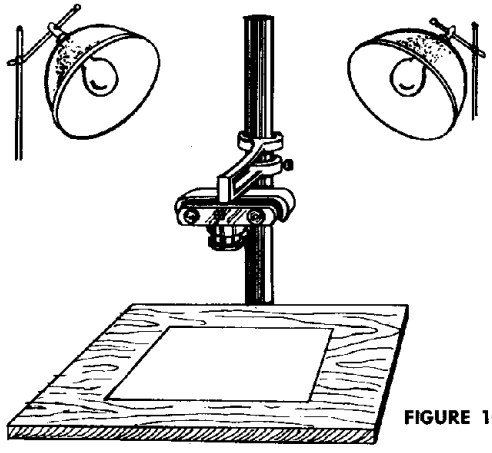


FIGURE 10

TABLE TOP CLOSE-UPS

Table top pictures are another interesting part of close-up photography. Figure 11 is a perfect illustration of what table top photography is, and as the name implies, such photography is simply pictures of small models made to look as if they were life size objects.

Various types of table top photographs might be listed as follows:

1. Realistic and illustrative.

2. Humorous and topical, where the results may be partly realistic but usually grotesque and exaggerated.

3. Decorative, which may include fantastic or dramatic qualities with rarely even a suggestion of the realistic.

The first practical step in making any table top set-up is to make a rough sketch of the idea in mind. The most important thing to remember here is the relative sizes of your props. They must agree with one another or else the

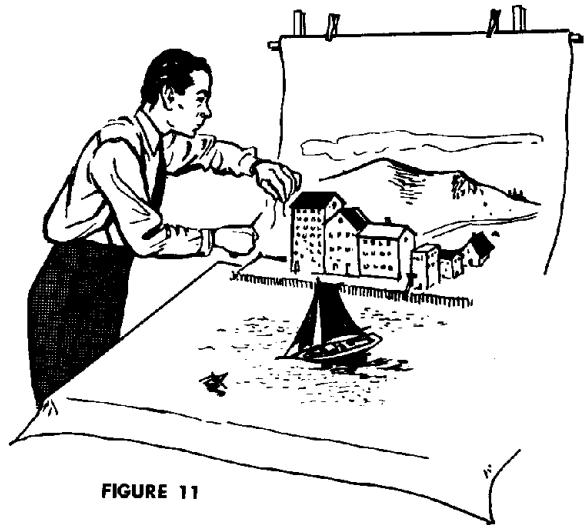


FIGURE 11

resulting photograph will be all out of proportion. A host of small models may be found in any toy shop, five and dime store, or gift shop. The only limitation to the type of props is your own imagination, and therefore almost everything goes.

As far as apparatus goes, an ordinary table will do nicely, although by far the best is a glass top table, such as that illustrated in figure 12. Lights may be installed under the glass, or hung from the cross batten which is also used to support backgrounds. Several sheets of glass may be sandwiched in layers enabling the photographer to shoot rather fantastic pictures by the simple process of laying the models on their

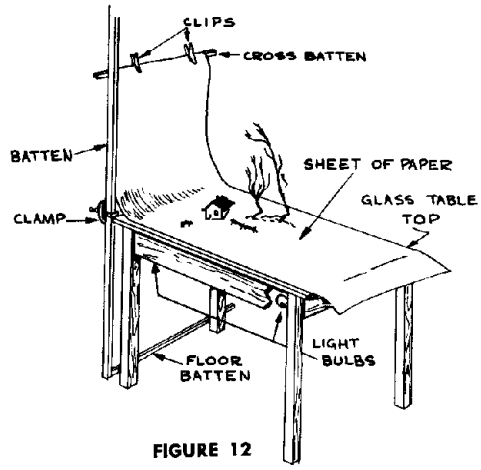


FIGURE 12

sides so that they appear to be floating in free space. In fact, there are so many possible combinations of apparatus and props that it would take volumes to describe them all.

Lighting for table-top close-ups can be a problem for certain layouts. However, the general rule is to avoid any unwanted reflections upon the backgrounds or upon the glass table top. Bear in mind, however, that these reflections may give you just the effect you were looking for, especially when photographing marine scenes or for producing weird shadow effects.

Another interesting form of table top photography does not actually exist on a table, but outdoors in nature. For instance...a mud-puddle can be dammed up and a small village constructed below the dam. If the dam is then juggled loose with a stick, you will have a realistic picture of a flood!

For table top photography it is important to select a film which is adapted for use with photoflood lamps, since it is necessary to have adequate tone rendition of the objects used. Panchromatic films such as Kodak Plus-X are ideal for this purpose and at the same time have a reasonably fine grain. When miniature studies are done out-of-doors, almost any kind of film will give good results, especially when used in conjunction with filters.

ADVERTISING CLOSE-UPS

Close-up photography may be used commercially for many purposes, one of them being in the field of advertising. This field, of course, covers a wide range of subjects and methods and only a few of the major factors can be considered here.

First, the picture must have a certain punch to it. In other words, the main subject must stand out clearly and distinctly. This is most simply done by using backgrounds in sharp contrast to subject matter. For example, if the product to be advertised consists of smooth curves, use a background made up of sharp corners or angles. Similarily, if the subject is light in color use a background that is dark, and if the subject is dark in color use a lighter background.

Second, shadows should only be used when they are helpful for establishing subject relief, otherwise they should be avoided, since they will tend to distract the eye from the main part of the picture. Good advertising photographs should be able to capture a person's attention at a glance. If long titles or captions are used to explain a picture, the reader will soon get tired and go on to something else less strenuous. Therefore, if titles or captions must be used, they should be as short as possible. The illustration should be almost self-explanatory. When advertising small articles such as the variety of objects found in an average household, nothing is as important as a good, uncrowded picture of the article. Remember the old Chinese saying that one picture is worth a thousand words.

COPYING TECHNIQUE

One of the fundamental fields encountered in close-up photography is the photographing of printed documents of illustrations and photographs. Copying differs from microphotography only in the size of the finished product, and where microfilm is generally limited to film sizes less than 35mm., copying materials vary in size from greatly enlarged copies to greatly reduced copies. In fact, it is only by the use of copying techniques that any printed illustrations, such as those in this article, become possible.

Surprisingly enough, many amateur photographers shun copying work, thinking that it is too difficult a field to enter. If anything, copying is easier than any other form of close-up photography, since the subject matter is contained in one plane only thereby eliminating the depth of field problem. Lighting, image size, and exposure times can all be standardized for given type of copy material. Therefore there are only two main factors to watch: (1) image definition, and (2) color tone rendition. Image definition depends upon the type of lens used with the camera, the type of film used, and upon the darkroom methods used to finish the prints. Color tone rendition depends upon both the type of film used and the color filter used, if any.

An easily constructed stand, similar to the one illustrated in figure 10 under microphotography, is a helpful piece of equipment to have, although equally good work can be produced by attaching the copy to a wall and using a tripod to support the camera. The important thing is that the copy must lie perfectly flat and paralell to the camera's film plane. Always make sure the copy and the camera are rigidly supported in order to minimize any vibration which could cause a fuzzy image. Figure 13 illustrates one method for supporting the pages of a book so that they may lie flat while being copied without danger of tearing. The glass sheet which is used as a press should be perfectly clean and bubble free.

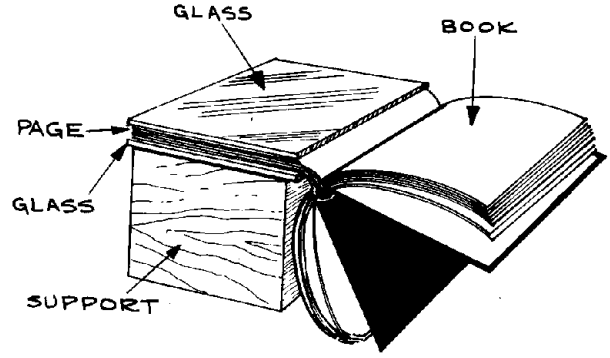


FIGURE 13

Copy illumination should be evenly distributed over the entire surface of the copy, and arranged to produce no glare. If the photoflood lamps are placed at an angle of 45 degrees to the copy, almost perfect glare-free illumi-

nation can be provided. This is provided that the copy material is perfectly flat with no bulges or ripples along its surface, and if all external lights are screened off with the use of cardboard baffles. Two 250 watt photoflood bulbs mounted in aluminum reflectors will furnish plenty of light for most copying purposes. External glare may be reduced by using a sunshade over the camera lens, and by stopping down the lens as far as correct exposure will allow. Also, when copying colored material such as maps or magazine illustrations, remember the facts given previously in this article about filters and judge accordingly. Never hesitate to use a filter for copying as sometimes it can mean the difference between a good or a poor result. In fact, a good way to copy an old battered and stained photograph is to use the proper filter to subdue the stained portions.

STEREOSCOPIC CLOSE-UPS

Stereoscopic close-ups are another extremely interesting sub-division of ultra close-up photography. Such close-ups actually give a "bug's-eye-view" of nature's miniature kingdom, and the results are indeed surprising. Imagine yourself being the size of a house fly, and looking at a large garden spider in full perspective!

Stereo photography, in general, is accomplished by taking two pictures of a subject, each from a different viewpoint. The resulting prints are viewed so that the left eye sees only the picture taken with the left objective and the right eye only that taken with the right objective. This pair of pictures is called a stereo pair, and when viewing such a pair, the brain combines or fuses the two pictures into a single, three-dimensional image. For ordinary stereoscopic photography, the two taking objectives are normally spaced a distance equal to the average distance between the human eyes, namely 2-1/2 inches. With a 2-1/2 inch objective spacing a stereoscopic range, or the depth of field in which all objects appear in relief, from about 6 to 300 feet may be obtained.

In order to increase the stereo range beyond 300 feet, wider objective spacings must be used. The impression given when viewing the resultant pair would be the same as if the viewer were a giant whose eyes were spaced a distance equal to the distance between the taking objectives. However, when the normal stereo range is so increased, any objects in the immediate foreground become impossible for the brain to fuse together. Likewise, the normal 2-1/2 inch spacing is too great for taking close-up shots, and smaller spacings must be resorted to. Thus, the resultant close-up stereo pair will give the viewer the impression that he has suddenly shrunk in size comparable to the smaller objective spacing.

The type of camera used for taking stereo close-ups need not be of the special stereo variety, and in fact, the device illustrated in figure 14 is more flexible when used with a

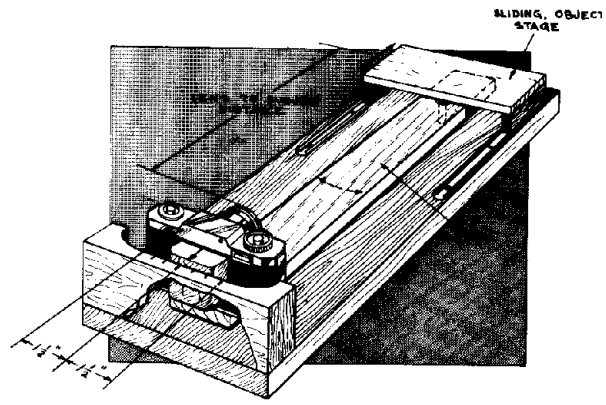


FIGURE 14

regular single lens camera. The camera is mounted on a swinging arm as shown, and the object to be photographed is placed into position on the sliding object stage. The lens-to-subject distance is then carefully measured and the object stage moved into place as required. The first picture of the stereo pair is taken by swinging the camera to one side and snapping the picture. Next, the camera is swung an equal distance to the other side, and a second picture taken. The resulting two pictures when viewed will form a stereo pair.

The total amount of camera swing or separation necessary, as measured from one side to the other, is determined by the lens-to-subject distance, and general values for this distance will be found in the following table.

For a lens-to-subject distance of:	Use a total separation of:
40"	2-1/2"
36"	2-3/16"
30"	1-7/8"
24"	1-1/2"
18"	1-1/8"
12"	3/4"
6"	3/8"
3"	1/4"

In order to measure the amount of swing accurately, it is suggested that an inch scale be ruled on the back of the close-up device as illustrated, starting with zero in the center and working to 1-1/2 inches on either side. This will give a maximum total separation of three inches which will more than cover the ranges needed.

There are several important things to remember when taking stereo close-ups. Evenness of illumination is one of these things, since deep shadows tend to be confusing when viewed and they might even obscure the main picture detail. Depth of field is also extremely important, and the subject should be arranged so that all points of interest are in sharp focus. Stopping down the camera aperture as much as possible always improves this condition by in-

creasing the depth of field.

After the finished prints or color transparencies are received, the problem of mounting them for correct viewing comes next. There are, of course, a variety of viewers available, each intended for different types of stereo pairs. Generally, however, the stereo pairs made with the device just described should be mounted with a distance between centers equal to 2-1/2 inches. The viewing lenses should both be the same focal length as the camera lens, and individual focusing is highly recommended. The distance between such lenses should also be 2-1/2 inches, as measured from their axes. In any case, it is important that the left-hand picture is mounted to be viewed with the left eye, and the right-hand picture with the right eye.

MISCELLANEOUS IDEAS

Figure 15 illustrates several miscellaneous ideas adaptable for close-up photography. The first of these is a rig for taking close-up pictures of marine life just under the surface of the water. It is designed mainly for use in a home aquarium, although it may be adapted for use in any shallow, still pond. The rig consists of a water-proof, open-topped box with a glass or plexiglass window fastened on the bottom by means of linoleum cement. A camera is then mounted on a small angle iron made from sheet metal so that it is aimed through the glass bottom, as shown in the illustration. Four legs are fastened on the bottom of the box and serve, not only as a support for the rig, but as a means of obtaining the correct lens-to-subject distance. Naturally, if different supplementary lenses are to be used with such a set-up, different legs would also have to be used and a set of four for each different supplementary lens is necessary.

The next item of interest is the use of a right-angle prism for obtai.. ng side views of small objects. The prism may be rigidly mounted in a square box, and the camera placed on top of it lens down, or by means of a special attachment, the prism may be mounted directly onto the camera lens. In either case it will be found easier to take side views with this arrangement than it is by trying to get the camera lens as close to the stage as possible. For the best results, a silvered prism is recommended although not absolutely necessary.

Next in line is the camera attachment for copying color transparencies. The attachment is simply a copying extension which fits directly on the regular camera lens by means of a filter attachment which also holds a supplementary lens. The main body of the copying extension consists of two metal boxes telescoped within each other as shown. The distance from the front of the extension to the supplementary lens should be equal to the focal length of the supplementary lens. A 45 to 58 millimeter focal length will do nicely for the majority of purposes.

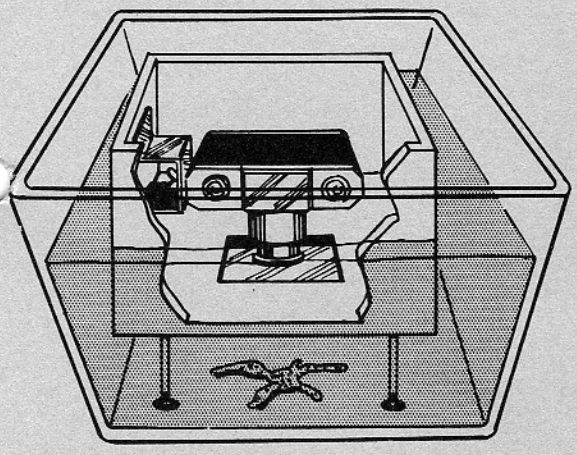
To focus the device, remove the back from the camera and fasten a piece of ground glass in the film plane. Next, set the camera's focusing scale to infinity and attach the copying extension to the main camera lens. Insert a transparency into the slots provided for the purpose, and move the telescoping sections in and out until the image comes into focus on the ground glass. The two housings may then be fastened securely into place by means of two sheet-metal screws as illustrated.

Daylight illumination is recommended when using the copying extension, and it is best to point the camera toward the northern sky, or towards a large white cloud. Exposure times are best determined by experiment, although for normally exposed transparencies, the required camera setting may be determined with an exposure meter as described previously under copying.

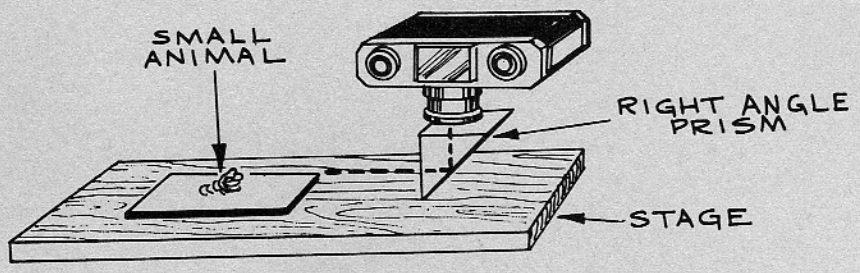
Another useful idea for copying negatives of any size is to attach your camera to an enlarger. Here, the enlarging lens acts as the supplementary lens for the regular camera lens. Focusing must be done in the same way as just described for the copying extension, except that the enlarger bellows control is used for the adjustment. Since most enlargers can be swung to a horizontal position, there will be no neck twisting to observe the ground glass image. The use of an enlarger for copying black and white negatives has several important advantages, the main one being that the negative size is governed only by the maximum size of the enlarger's negative carrier and, therefore, masking and cropping may be done at will. However, exposure times can only be determined by trial and error.

At times, it is desirable to illuminate a subject with diffuse lighting, and in the case where photoflood lamps are being used the amount of heat given off strictly limits the material from which a diffuser can be made. One solution to the problem is to use a piece of glass cloth, such as that window drapes are made of, as illustrated in figure 15. The cloth is fastened to the photoflood reflector with a piece of fine wire, and will not burn or even scorch.

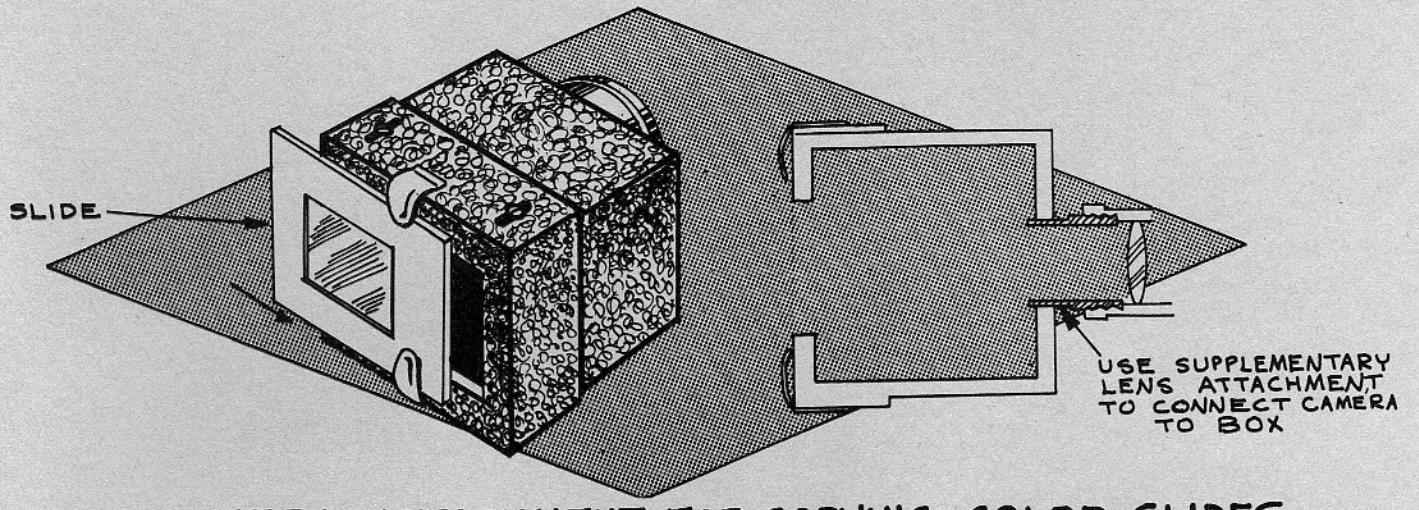
The last idea is called a "no-shadow" lighting system. It differs from a diffuser in that direct lighting is still used, but from all directions. One such system consists of a ring of 7-1/2 watt tungsten bulbs arranged around the camera lens as illustrated. If the subject is located somewhere in the middle of this ring of light, shadowless, illumination will then be obtained. Another method puts to use a circular neon or fluorescent bulb such as the type used in some kitchens. Shadowless lighting is especially good for close-up photographs used for advertising purposes.



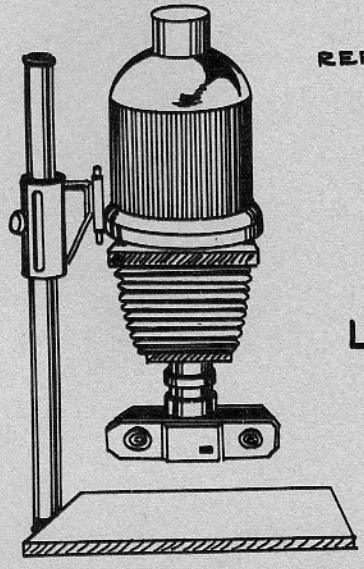
UNDER-WATER CLOSE-UPS



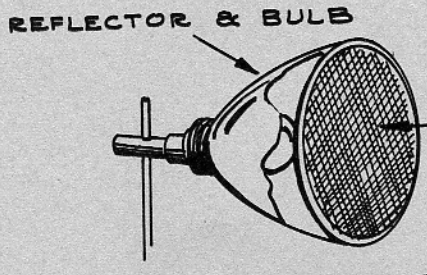
USE A RIGHT ANGLE PRISM FOR SIDE VIEWS



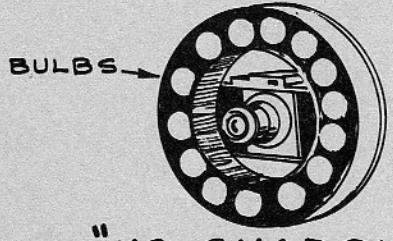
CAMERA ATTACHMENT FOR COPYING COLOR SLIDES



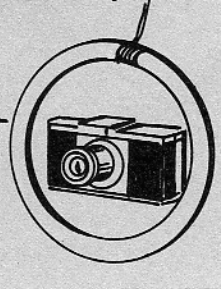
USE OF AN ENLARGER TO COPY NEGATIVES OF ANY SIZE

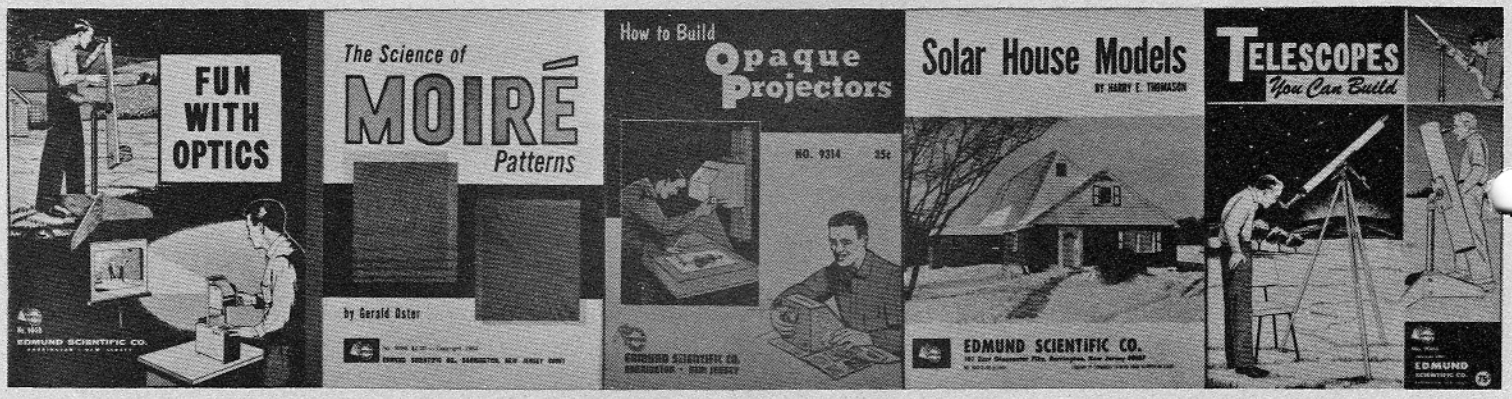


LIGHT DIFFUSER



"NO SHADOW" LIGHTING SYSTEM





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