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HOW TO MAKE ENLARGEMENTS

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How To Make Enlargements

What is an Enlargement?—The amateur who has not tried it generally has an idea that the making of enlargements is a complicated process. He has no especial difficulty in making a print on, for instance, gaslight paper; therefore, he should have no difficulty in making enlargements, for the principal difference between enlargement and contact printing, aside from the increased size of the resultant print, is in the method used to convey the image to the paper, and in the local manipulation for technical or artistic improvement of the print which the process permits.

The optical arrangement of an enlarging system is similar to that of the ordinary magic lantern, which is familiar to most people. In this, light from a suitable source passes through the lanternslide to form an illuminated image. By properly focusing the projecting lens, this image is sharply projected in enlarged size on a screen some distance from the lantern. The image in this case appears as a positive on the screen, because the lanternslide is a positive. In making an enlargement the image is formed in the same way, except that a negative is used instead of the lanternslide, and the image is received upon a sheet of sensitive paper which is placed at the proper distance from the lens, comparatively close in this case, and exposed after the proper focus has been obtained. Photographically, the image we see upon the enlarging easel is a negative image, but just as a negative placed in contact with the paper in a printing-frame produces a positive image, so we get a positive print on developing the exposure for an enlargement. Generally speaking, we focus by inspection, but in making enlarging apparatus it is always necessary, and in using enlarging apparatus it is generally convenient, to be able to calculate at least approximately the relative position of negative, lens, and paper, to secure an enlargement of the size desired. For this purpose we must know the equivalent focal length of the lens.

Enlargement Calculations—The two distances of importance in enlarging are those between the negative and the lens and between the paper and the lens. To find the distance from the negative to the lens for any given degree of magnification, divide the focal length by the number of times of enlargement and add one focal length thereto $\left[u = f\left(\frac{1}{n} + 1\right)\right]$. To find the distance from the lens to the paper, multiply the focal length by the number of times of enlargement and add one focal length to this $[v = f(n + 1)]$. For example, suppose we desire to make a 16 x 20 enlargement from a 4 x 5 negative, with a lens of 6 inches' equivalent focus. The degree of magnification, or the number of times enlargement, is 4, as each dimension of the enlargement is 4 times that of the negative. Then the distance from the negative to the lens should be: $\frac{6}{4} + 6 = 7\frac{1}{2}$ inches, and the distance from the lens should be $(6 \times 4) + 6 = 30$ inches.

When we say that the distance from the lens to the negative and from the lens to the paper should be measured, the question arises: What point in the lens should be selected? As a matter of fact, this point is a difficult one to determine without knowing a great deal more about lenses than is necessary for the purpose of this book. The point to be used is not, generally speaking, the physical center of the lens, and so the adjustment cannot in practice usually be exactly made from the computed distances without focusing. It is therefore advisable to place the negative and the paper at a distance from each other equal to the sum of the calculated distances (37½ inches in the case we have given) and then move the lens forward and backward until the image is sharp on the paper.

The Optical System—The optical system necessary for enlarging in its simplest form consists of a projecting lens so placed between negative and enlarging easel that its optical axis passes through the center of the negative and the center of the easel. In an efficient enlarging device, provision is made to allow alteration of the distances of the negative and the easel from the lens. The image can be increased in size by moving the easel away from and the negative toward the lens, and can be decreased in size by moving the easel toward and the negative away from the lens. The exact positions of the negative and the easel are determined by the rules already explained, and are what are known as conjugate foci.

In any type of enlarger these factors remain unchanged, and the apparatus must be so constructed that the negative and easel can be placed at the calculated distances from the lens. The following table shows the conjugate foci for the production of images of given degrees of enlargement such as are commonly used in practical work with ordinary lenses.

Reducing and Enlarging Tables

All figures in table are in ins.	Reductions											
	Same size	½ size	⅓ size	¼ size	⅕ size	⅙ size	1/7 size	⅛ size	1/9 size	1/10 size	1/11 size	1/12 size
Focus of lens used	Enlargements											
	Same size	2 times	3 times	4 times	5 times	6 times	7 times	8 times	9 times	10 times	11 times	12 times
3	**6**	**9**	**12**	**15**	**18**	**21**	**24**	**27**	**30**	**33**	**36**	**39**
	6	4½	4	3¾	3⅗	3½	3 3/7	3⅜	3 3/9	3 3/10	3 3/11	3 3/12
3½	**7**	**10½**	**14**	**17½**	**21**	**24½**	**28**	**31½**	**35**	**38½**	**42**	**45½**
	7	5¼	4⅔	4⅜	4⅕	4 1/12	4	3 15/16	3 8/9	3 17/20	3 9/11	3 19/24
4	**8**	**12**	**16**	**20**	**24**	**28**	**32**	**36**	**40**	**44**	**48**	**52**
	8	6	5⅓	5	4⅘	4⅔	4 4/7	4½	4 4/9	4 4/10	4 4/11	4⅓
4½	**9**	**13½**	**18**	**22½**	**27**	**31½**	**36**	**40½**	**45**	**49½**	**54**	**58½**
	9	6¾	6	5⅝	5⅖	5¼	5 1/7	5 1/16	5	4 19/20	4 10/11	4⅞
5	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**	**65**
	10	7½	6⅔	6¼	6	5⅚	5 5/7	5⅝	5 5/9	5½	5 5/11	5 5/12
5½	**11**	**16½**	**22**	**27½**	**33**	**38½**	**44**	**49½**	**55**	**60½**	**66**	**71½**
	11	8¼	7⅓	6⅞	6⅗	6 5/12	6 2/7	6 3/16	6⅑	6 1/20	6	5 23/24
6	**12**	**18**	**24**	**30**	**36**	**42**	**48**	**54**	**60**	**66**	**72**	**78**
	12	9	8	7½	7⅕	7	6 6/7	6¾	6 6/9	6 6/10	6 6/11	6½
6½	**13**	**19½**	**26**	**32½**	**39**	**45½**	**52**	**58½**	**65**	**71½**	**78**	**84½**
	13	9¾	8⅔	8⅛	7⅘	7 7/12	7 3/7	7 5/16	7 2/9	7 3/20	7 1/11	7 1/24
7	**14**	**21**	**28**	**35**	**42**	**49**	**56**	**63**	**70**	**77**	**84**	**91**
	14	10½	9⅓	8¾	8⅖	8⅙	8	7⅞	7 7/9	7 7/10	7 7/11	7 7/12
8	**16**	**24**	**32**	**40**	**48**	**56**	**64**	**72**	**80**	**88**	**96**	**104**
	16	12	10⅔	10	9⅗	9⅓	9 1/7	9	8 8/9	8⅘	8 8/11	8⅔
9	**18**	**27**	**36**	**45**	**54**	**63**	**72**	**81**	**90**	**99**	**108**	**117**
	18	13½	12	11¼	10⅘	10½	10 2/7	10⅛	10	9 9/10	9 9/11	9¾
10	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**	**110**	**120**	**130**
	20	15	13⅓	12½	12	11⅔	11 3/7	11¼	11⅑	11	10 10/11	10⅚
11	**22**	**33**	**44**	**55**	**66**	**77**	**88**	**99**	**110**	**121**	**132**	**143**
	22	16½	14⅔	13¾	13⅕	12⅚	12 4/7	12⅜	12 2/9	12 1/10	12	11 11/12
12	**24**	**36**	**48**	**60**	**72**	**84**	**96**	**108**	**120**	**132**	**144**	**156**
	24	18	16	15	14⅖	14	13 5/7	13½	13⅓	13⅕	13 1/11	13

Bold figures are distances of lens from easel in enlarging, or from lens to photo being reduced in copying. Light figures are distances from lens to negative being enlarged, or camera extension in case reduced size copies are being made. The outer end of lens (cap end) should face bromide paper in enlarging, and in reducing should face object being copied. Distances are measured from nodal points, not diaphragm of lens, and while measuring these distances from diaphragm will give satisfactory results in many cases when enlarging with large apertures or at great distances final focusing should be done by inspection. Data not given in the table may be calculated as follows:

Conjugate Foci—Let u = distance of object from lens, v = distance of image from lens, F = focal length of lens.

$$\frac{1}{F} = \frac{1}{u} + \frac{1}{v}\text{, e.g., } \frac{1}{3} = \frac{1}{12} + \frac{1}{4},$$

or $$F\,(u+v) = uv\text{, e.g., } 3\;(12+4) = 12 \times 4.$$

If object is reduced n times upon the focusing screen, u is $(n+1)$ times the focal length of the lens, and v is the focal length plus $\frac{1}{n}$ of the focal length. Thus 12 inches photographed down to 1 inch with a 6-inch lens gives $u = 13 \times 6$, and $v = 6 + (1/12 \times 6) = 6\frac{1}{2}$.

The Light—In considering the optical system, no mention was made of the source of illumination. This is one of the most important factors in enlarging. The illumination over the entire negative must be even and of such a character that from every point in the negative a ray of light passes directly through the lens to the easel, each ray being of practically equal intensity. This condition of ideal lighting may not always exist with some light sources, unless what for the moment may be called a "light-equalizer" is employed.

There are many forms of light sources that are suitable for enlarging: daylight; the electric arc; the mercury-vapor lamp; the Nernst lamp; concentrated-filament tungsten lamps, both ordinary and nitrogen-filled; Welsbach burners, upright and inverted; acetylene split-flame burners; and mantle lamps burning gasoline or kerosene vapor. All these forms will enable the worker to make enlargements, but the choice of an illuminant must be made not only with respect to its convenience, but also to its ability to produce results under the conditions and with the speed that different workers demand because of the nature of their work or because of business requirements. With any of the illuminants mentioned there will be no difference in the quality of the results if the enlarger is suitably constructed.

Daylight—Daylight offers the large advantage of furnishing even illumination without a light-equalizer, but it possesses the enormous disadvantage of varying intensity at different times of the year, and different times of the day, and, more important to the professional worker who is called on to make several duplicate prints of the same depth, will often vary within a few minutes. As its intensity is so variable, the commercial worker should avoid it when possible, as artificial light will, by reason of economy of material, prove as cheap in the long run, and far more satisfactory. For use with daylight, there are two general types of enlargers on the market. The simpler forms, such as the Brownie enlarger, are of fixed focus, usually collapsible, and consist in the main of a lightproof box, with a negative holder at one end, a printing-frame at the other, and a slow meniscus lens in a septum between. This type of enlarger is cheap and fairly efficient, but the degree of enlargement is fixed, and there is no chance to work between the lens and paper — a decided disadvantage. The exposure with bromide paper will be from thirty seconds to two or three minutes, while with fast gaslight paper it will average between twenty and forty minutes, using a medium negative, with the enlarger pointed to the north sky in midsummer between 9 A.M. and 3 P.M. This type of enlarger is suited to the use of the worker who makes only an occasional enlargement, and for whom the purchase of an expensive enlarger using artificial light would not therefore be a profitable investment. For professional use, where artificial light is not available, the larger manufacturers of photographic goods supply very complete daylight equipment of double bellows type, so that the distance from the negative and paper to the lens can be varied to place the degree of enlargement at the command of the operator. The negative holder is supplied with kits to hold negatives of all sizes, and the printing-frame is fitted with adjustments to make focusing both simple and rapid.

Arc Light—Among commercial workers the arc light is most used for enlarging. It is intense, concentrated, and can be had in sizes to fit the needs of the worker. In addition, specially manufactured carbons productive of a light rich in the ultra-violet rays that are photographically active have been perfected. The drawback to the use of the arc is that it is subject to "flicker," which at times proves very annoying, even to an operator skilled in trimming the lamp. Yet the arc is sufficiently reliable to make the worker independent of the light conditions outside, and is powerful enough to permit the use of gaslight papers when enlarging — a desideratum. The heat evolved by the arc is considerable, so that probably the most satisfactory method of using it is to place the light outside the enlarging room, centered opposite the enlarging camera, which is fastened inside against an opening in the wall. Condensers may or may not be used, a combination of diffusers and reflectors, such as the Graphic Enlarger, having proved productive of even illumination over 8 x 10 negatives when using such apparatus. A projection apparatus of this type is made for use in the enlarging room in case it is impossible to fasten the arc outside. The lamp is encased in a lightproof jacket, and the camera and cone with diffusers project from the jacket. Smaller arcs are generally built into lamphouses, designed much on the plan of a high-grade magic lantern, suitable means being provided for accurately centering the arc and changing its distance from the condensers. Smaller lanterns designed for projecting lantern-slides, and also suited for enlarging, can be had equipped with arc lamps, although the concentrated-filament tungsten lamps are gradually coming into greater favor. The Balopticon, Viopticon, Miopticon, and Delineascope rank well among this latter type.

Mercury-Vapor Light—Mercury-vapor lamps — M-shaped — are now supplied to meet the demands of the enlarger, and are proving very successful. They furnish an even illumination, requiring but slight diffusion, without the need of condensers, and evolve practically no heat. The quality of the light is particularly well suited for enlarging, as it is rich in the violet rays. The Cooper-Hewitt Electric Co. supply a complete outfit, consisting of an M-tube, auxiliary stand, and special lamp-holder, bringing this illuminant up to a high efficiency. Other companies, realizing the value of the light, have designed and supply, for commercial workers, outfits for enlarging with the M-tube. These lamps are sufficiently powerful to permit the use of gaslight papers as well as the special enlarging and bromide emulsions.

The Tungsten Lamp—Concentrated-filament, nitrogen-filled tungsten lamps have proved their value in the enlarger, and our own experiments indicate to us that they furnish an ideal illuminant for the amateur at home. With a 250-watt lamp, enlargements can be made on any of the medium rapid gaslight emulsions, using a lens that works at *f*: 8, and for bromide and special enlarging papers the light is almost too rapid. Condensers should be used with this type of lamp to get maximum illumination, although very good results can be had by using an illuminator built with the Parallax Condenser. This lamp not only provides suitable illumination for use by the worker who has no opportunity to use daylight, and who wishes to make enlargements on gaslight papers, but it is simple in operation, needs no attention other than to turn the switch, gives off little heat in proportion to the brilliancy of the light it furnishes, and consequently permits the use of a compact lamphouse with small space allowed for ventilation. In simple forms of enlarging illuminators these lamps may be used to advantage without condensers or reflectors, provided a sheet of flashed opal glass is used to sufficiently diffuse the light. For large negatives this is not a practical form of illuminator, as above 4 x 5 the illumination will fall away at the corners and edges.

Welsbach Light—The Welsbach mantle gas-burner, or one burning oil vapor, furnishes a satisfactory light for enlarging with condensers or with paraboloidal reflectors. By interposing a sheet of ground glass between the burner and condensers, entirely even illumination may be produced, although not of sufficient intensity to permit the use of gaslight papers. Unfortunately, the American market does not offer much in the line of enlargers using this illuminant, although the Ingento lanterns may be had equipped for it, and paraboloidal reflectors may be secured for use with the worker's camera.

Acetylene—The acetylene flame is concentrated and very intense, and as such is well suited for use with condensers. The light is hardly powerful enough to handle gaslight papers, but is satisfactory with the special enlarging papers and bromide papers. It is an ideal illuminant for the country man who has neither gas nor electricity in his house. With the Ingento enlargers a generator and special triple burner and reflector can be secured, thus assuring an unusually strong and even illumination. The use of compressed acetylene in tanks, such as is used for automobile headlights, is to be preferred to generating one's own gas.

These various types of illuminants are entirely satisfactory for enlarging, and within their respective scopes will produce equally good results. It will be appreciated that the choice of the illuminant must depend on what the worker demands of his equipment, whether it must be ready for use at all times, regardless of daylight conditions, whether it must be powerful enough to enlarge on gaslight papers so as to have the advantage of their greater snap and brilliancy, or whether bromide enlargements only, now and then, are required.

Condensers and Diffusers—Upon the light source employed depends the selection of what we have previously referred to as "light-equalizers." Practically these may be divided into four general classes—condensers, diffusers, reflectors, and reflecting condensers. The most satisfactory of all is the condenser, although where the source of illumination is extremely brilliant, the diffuser may prove equally efficient. Before considering these different types, it is necessary to understand why some means must be furnished for even illumination. If a negative is illuminated by daylight, light will pass through *every* point in the negative through the lens to the easel, and the extreme edges of the negative will be projected upon the easel with exactly the same intensity as other points nearer the center of the negative. If a point source of light such as an arc is used, only the portion of the negative cut by a cone of light from the arc to the edges of the lens sends *direct rays* of light through the lens to the easel. The illumination will be bright at the center of the negative and run down sharply toward the edges. Some means must therefore be adopted to make the illumination more uniform over the whole surface of the negative.

Condensers—A condenser is a pair of lenses, the function of which may be regarded as the opening out of the cone of light-rays coming from a single source, and then the bending of them back as a cone of light with the apex on the opposite side of the condenser. Ordinarily there are two plano-convex lenses in the condenser; more complicated systems do not need to be considered to make its function clear. The curved surfaces of the lenses face each other, and the diameter of the condenser is greater than that of the diagonal of the negative from which the enlargement is to be made, or greater than the diagonal of the portion of the negative that is to be enlarged. The negative should be placed close to the surface of the condenser, so that the entire surface of the former will lie within the cone of light refracted by the latter to the enlarging lens. Thus every portion of the negative gets practically equal illumination. The light source must be so placed that it will refract the light rays back to the optical center of the projecting lens when the latter has been adjusted to project an image of the desired size upon the easel. If this is not done, the illumination will be uneven. When enlarging, the usual procedure is to focus as sharply as possible with the light in any position and a negative in place. The negative is then removed and the light adjusted so that the field of illumination is entirely even over the area that is to be occupied by the enlarged image. In order to secure ideally even illumination when working the condenser to the limit of its field, it is usually necessary to place a sheet of ground glass between the light source and the condenser, thus introducing a diffuser that will prevent the formation of light circles of different colors on the edges of the area illuminated. The more intense and concentrated the light source, the less need of the ground glass. It will thus be seen that the arc light, acetylene, and concentrated-filament tungsten lamps are best suited for use with the condenser.

Diffusers—If the flame is large, or of uneven shape, such as an upright mantle, a diffuser is most practicable, because the aperture of the projecting lens will not be great enough to make use of the cone of illumination formed by a condenser and a large light source. By using a diffuser the intensity of the light is greatly diminished, but the illumination may be made practically even within the limits needed for enlarging. The diffuser consists of a series of ground glasses, two or more as may be necessary; light from the large light-source strikes the first sheet of ground glass and passes through, at the same time being refracted and diffused in all directions. Thus, light traveling in all directions strikes every point on the surface of the second ground glass and is re-refracted and re-diffused. The result is that the illumination of the negative is practically even. The larger the light-source, the fewer glasses are needed. It is permissible to make use of reflectors in conjunction with diffusers. This system works well with the enclosed arc lamp, the mercury-vapor lamp, the Welsbach mantle burner, and the high power tungsten lamps, although suited only to bromide work with the two latter light sources.

Reflectors—There are some forms of reflectors in which the light-source is not within the field of view of the lens. With such reflectors in some cases a single sheet of ground glass is used as a diffuser and in some cases not. Most reflectors take the form of a paraboloidal surface or surfaces, and the light-source—most often the Welsbach mantle burner or a tungsten lamp—is placed nearly at the principal focus of the curve. Reflectors of this type may be secured in this country for use with the operator's camera, but complete enlargers embodying the reflector can be secured only in Europe. Another form of reflector is much similar to the parabolic mirror used in automobile headlights, and can be used by those who are able to employ electric lamps.

Reflecting Condensers—A further form of reflector, which the designer describes as a reflecting condenser, is made up of a series of mirrors which not only reflect the light, but also converge the rays toward a point on the axis of the mirror. The center of the projecting lens should be placed near the point at which the rays converge, if the highest efficiency of the apparatus is to be obtained. With this type of reflector a high-candle-power nitrogen-filled tungsten lamp gives the best results, and it must be focused with a fair degree of accuracy, as is the case with the condensers. If not well focused, there is a likelihood that the mirrors will project a series of images of the lamp filament upon the easel, as well as produce an uneven field of illumination.

The Negative—The negative is placed between the light-equalizer and the lens, with the film side nearer the lens, and the image inverted. As the lens reverses the image when projecting it, an upright image will be thrown on the easel. The planes of the negative and the easel must be perpendicular to the optical axis of the lens, so that the image will be sharp all over and every object will be enlarged in the same ratio. On rare occasions it is permissible to incline the negative at an angle with the optical axis, and make a corresponding inclination of the easel, to correct convergence of verticals in the negative, due to not holding the camera horizontal. In this case it is essential to stop down the enlarging lens to secure sharp focus. It is best at all other times to fix the negative rigidly in a perpendicular plane, especially as a slight inaccuracy in thus placing it may cause an area of unsharpness when enlarging with a lens of large aperture. Further, the negative should be placed with its center, or the center of the portion being enlarged, on the optical axis of the projecting lens, so that only the center of the field of the latter will be used for projection. This is not as necessary when using an anastigmat lens as when using other types, as the field of the former is quite flat and will not need flattening by stopping down. The image on the negative should be in a plane, so that film negatives should be placed between two sheets of clear glass to keep them perfectly flat. It is also essential that the negative be introduced into the system so that it will not be subject to movement or vibration during the period of exposure; this point is so important that we hope it will not be passed over as a minor detail.

The Lens—Although lenses designed for projection are well suited for enlarging, the lens on the operator's camera will be satisfactory for making enlargements. In general, it may be said that any photographic lens may be used for enlarging, provided its covering power is sufficient to fully illuminate the entire negative. In other words, a lens fitted to a 5 x 7 camera, whether meniscus achromatic, rapid rectilinear, or anastigmat, is capable of making enlargements from negatives 5 x 7 or smaller. It is perfectly clear that of the three mentioned, the anastigmat is the best suited for enlarging, because its field is flatter and definition over the entire negative better than that of the others. This means that the anastigmat can be used wide open, or at least at a larger aperture than the others, under most circumstances, and so the exposure may be considerably shortened. With the other types of lenses the aperture can seldom be larger than *f*: 16, which will often necessitate too long an exposure and increase the likelihood of blurred images due to the movement of any one part of the enlarging system. In the case of the box daylight enlargers, the chance of movement of any of the parts of the outfit is slight, but the meniscus lens is stopped down so far that the exposure is much prolonged.

The lens must occupy such a position in the optical system that the light it collects from the negative will be even in intensity. As explained when describing a condenser, the apex of the cone of light refracted by the light-equalizer through the negative should be at the optical center of the projecting lens. If the lens is not placed at this point, a series of colored circles will appear on the easel. With a very powerful light-source such as the arc lamp, the diffusion and refraction in the condenser may be sufficient to make adjustment of the light-source unnecessary when slightly altering the position of the projection lens.

In making use of the lens on the camera, it is usually most convenient to remove the back and place the negative so that it occupies the same position that the plate does when being exposed. Oftentimes it is easier to remove the lens from the camera and fasten it in the enlarger with an extra flange. Our own experience is that it is most satisfactory to have an extra lens for the sole purpose of enlarging; this is especially true in the case of the user of films, who may find the greater part of a film unexposed in his camera on the day when he desires to make enlargements, and must postpone enlarging or else waste the film on subjects that are of no particular value to him, unless he has a darkroom in which he can remove and store the film. An old-type rectilinear lens, fitted with Waterhouse stops, will do very nicely for the enlarger and is advantageous for those who use the arc lamp, as the intense heat generated by the arc will often burn out the fiber diaphragms in the modern shutters. A long-focus lens is advisable if room will permit, because the center of the field may then be used with the lens wide open, covering power and definition then being entirely satisfactory. When condensers are used, an added advantage is that the light must be moved closer to the condenser with a long-focus lens than with one of short focus, with the result that the illumination is more intense and more even. A lens of the old type can be picked up for a small sum in almost any supply store where second-hand goods are sold, or in a pawnshop.

Choice of the Enlarger—With the commercial worker this is a matter of expediency; with the amateur worker it is more likely to be a matter of choice. The former must have an outfit that will make enlargements on gaslight or bromide papers at any time. To do this the outfit must be equipped with an arc, mercury-vapor, or high-candle-power nitrogen-filled tungsten lamp. If electric current is unavailable, daylight is the next choice, as it permits the making of enlargements on gaslight papers on bright days and bromide enlargements on dull days. A lantern of the Ingento type is a good choice if bromide enlargements are satisfactory and current not available, as it can be equipped for illuminating or acetylene gas until the time comes when an arc or tungsten lamp can be fitted to it.

The amateur worker is not confronted by such a problem, since his work does not need to be turned out on schedule. An electric lantern is the best equipment he can own, as with it he can make enlargements on both gaslight and bromide papers, giving him a wide range of mediums for artistic work. On the other hand, if current is not available, a window-type enlarger will be entirely satisfactory, as dodging and vignetting can be done as with the lantern, and a bright, sunny day can be chosen at the convenience of the worker. For bromide work any of the forms of projection lanterns or illuminators, with which the operator's camera may be used, will be satisfactory. As a last choice, box enlargers should be chosen — but only when no other type of enlarger can be afforded, because, although they will make good enlargements from good negatives, they offer no opportunity to make good enlargements from defective negatives, which can often be done with an enlarger of the projection type, as will be understood when the operation of different types of enlargers is considered.

Homemade Enlargers—In designing and constructing an enlarger at home, bear these facts firmly in mind: The projection lens and condensers, if any, should have coincident optical axes, to which the centers of the negative and enlargement should be perpendicular. The lens must be capable of covering the plate on which the negative has been made. The position of lens, paper, and negative are determined by the focal length of the lens and the desired degree of enlargement. With these facts in mind, anyone should be able to design his own apparatus, provided he has read the preceding paragraphs, to fit his own individual needs.

The simplest form of home-constructed enlarger is a fixed-focus box; any makeshift will do, provided it is lightproof and fills the conditions outlined above. Simply make a box of wood and pasteboard, so that it will be fairly rigid. Build in or fasten a printing frame in one end, and a negative holder at the other. Divide the box into two parts by means of a lightproof partition, in the center of which the lens is placed so as to project the image of the negative upon the paper in the printing frame. The approximate position of the lens and partition can be calculated in the manner described on page 7, and carefully adjusted by trial and error. When making the final adjustment, focusing for the sharpness of the image can be accomplished by laying a piece of ground glass face down on the sheet of plain glass in the printing frame and using it as a viewing screen. Although it is a somewhat tiresome job to fix the lens in place, once adjusted the focus of the enlarger is assured for all time and no further effort is necessary.

By expending a little more energy a much more effective piece of apparatus may be constructed. This is shown in section in Diagram A and is a variable focus enlarger permitting different degrees of enlargement. We will not give dimensions, as the drawing is entirely clear, and nearly every one would necessarily change our figures to suit his own requirements. In its essentials the device consists of two telescoping chambers, fastened end to end as shown in the diagram. An opening is cut in the center of the ends that are fastened together, in which the lens is placed. In the outside end of the smaller telescoping chamber a suitable groove is provided in which a plate negative and a sheet of plain glass, or two sheets of plain glass with a film negative between them, can be placed. In the outside end of the larger telescoping chamber there is also a groove large enough to accommodate a reconstructed printing frame. The alteration of the printing frame is merely the addition of a grooved slot in the front, such that a pasteboard slide can be run into it — like a plateholder slide — so that when making enlargements the frame holding the paper may be carried to and from the dark-room instead of the entire enlarger, when inserting and removing the paper. To calculate the dimensions of

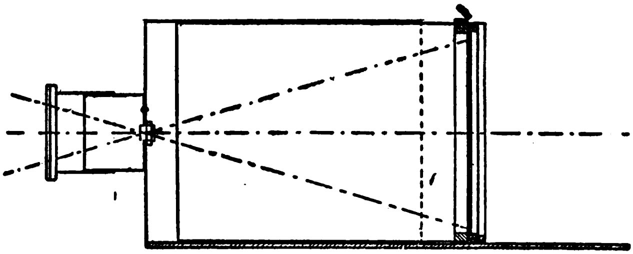

Diagram A — Telescoping Box Enlarger

Note—In case the worker wishes to use his camera, not having an extra lens to place in the enlarger, it may be fastened — back removed, against an opening cut between the two chambers. The method of fastening the camera in place may be similar to that shown in Diagram B, page 24. Whereas it is advisable to construct a groove for the printing frame, with a hinged lid as shown in the diagram, if the worker wishes to economize and do without the printing frame, a homemade frame may be built solidly into the back.

the two chambers, proceed as follows: As explained on page 7, figure the distance from the lens to the paper for the greatest degree of enlargement that will ever be demanded of the enlarger. Divide the distance thus calculated by two and add one inch. This will give the length of the sides of the telescoping box which forms the chamber holding the paper. To find the length of the sides of the chamber holding the negative, find the distance of the negative from the lens for a 2x enlargement and for the degree decided as a maximum, and plan the lengths of the side pieces so that the negative may be adjusted between the two extremes; this sounds difficult, but when the figures are on paper it is very, very simple. The other dimensions of the side pieces will be determined by the size of the negative and that of the printing frame. The smaller chamber, holding the negative, must have end dimensions slightly greater than the negative. The section which telescopes into the negative-holder should fit snugly *on the inside.* In building the paper-holder, the printing frame should first be altered as suggested, although it may be built right into the enlarger if preferred. In making the grooved slot into which the altered frame fits, use strips of wood one-half inch thick fitted snugly to the holder. Then build one section of the telescoping chamber forward from the grooved slot, having the length as figured. This section can be made wholly of heavy pasteboard gummed together at the edges with black paper, with which it should also be well lined. Around this section another section should be snugly fitted, the end being a solid wooden piece, and the bottom a strip of inch stock, forming a rigid support on which the inner section can be extended, as shown in the drawing. The wooden front of this outside section is pierced in the center to provide an opening in which the lens is fitted, and the negative-holder chamber is centered and fastened against this so that the negative, lens, and printing frame are centered. In case the worker's camera is to be used for enlarging, it can be fastened against the opening in the end of the printing-frame chamber. Focus is obtained by placing a sheet of ground glass, ground side in, against the clear glass in the printing frame. A focusing cloth thrown over the large chamber will prevent any light leaking into it between the two sections. The beauty of this type of enlarger is in its all-round adaptability and its cheapness, as it can be made from odds and ends and need not cost a penny except for glue and hardware.

Homemade Window Enlarger—Any one who can commandeer the bathroom occasionally, or enjoys the use of a room solely for photographic purposes, can construct a daylight enlarger that will be the equivalent in efficiency, on a bright day, of a high-class commercial outfit. A room with one window is best suited for the work. Half the window should be made lightproof by

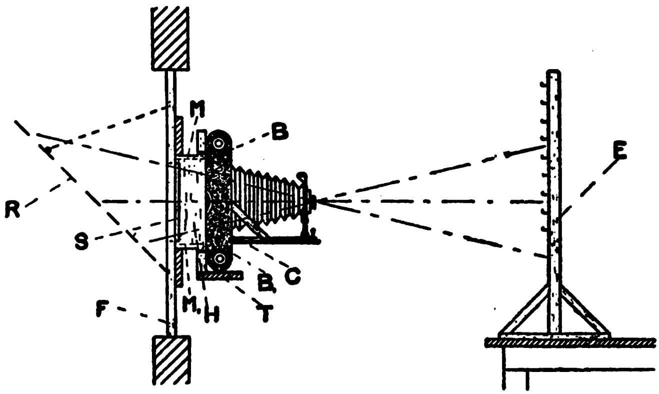

Diagram B — Window Enlarger

Note—Alterations in this design are permissible in case the worker's camera is of the box type. In such event a casing may be built around the camera and fastened opposite the opening in the frame so that the camera may be moved back and forth in the casing, just as the two casings telescope together in the negative-holding chamber of Diagram A, page 22.

covering it with pasteboard or focusing cloth. To fill the other half a frame must be built like Diagram B; this must be edged with felt or velvet to make it lightproof. The frame itself must be covered with some opaque material, except at the center, where an opening slightly larger than the negative is cut. Against this opening a holder for the camera should be fastened. A side view of this is shown in the drawing. The side pieces of the holder should be of the same length as the camera: their width should be about 3 inches for cameras of the 3A size. The width of the end pieces, shown by the dotted lines M and M_1, is the same as that of the side pieces. A shelf T should be fastened to the lower end of the side pieces to support the camera C which is fastened against the holder with two rubber bands B and B_1. A slot S must then be cut in the holder; it should be a trifle wider than two thicknesses of ordinary negative glass, and the length slightly greater than that of the negatives which will be used in the enlarger. The holder should be fastened against the frame so that the opening back of the camera will center against the opening in the frame, thus centering the lens opposite the opening also. A cleat above and below the holder will hold it in this position when once adjusted. All joints should be lightproof, so that no light can enter the room except through the lens, after having passed through the opening provided for the negative. By edging the holder with velvet, no light will leak around the body of the camera. The easel E, shown at the right, is made very simply of two braced uprights into which a series of right-angled curtain hooks have been fastened at graded heights. The uprights are just far enough apart to allow a large printing frame to rest against them between the hooks. On each side of the printing frame at the top is a screw-eye that fits over whichever curtain hook is selected, so that the printing frame may be fastened at any desired height. Its lateral position may be adjusted by moving the uprights from side to side.

Under these conditions the illumination on the easel will not be even because the light coming from the sky, illuminating the lower half of the image on the easel, is much stronger than the light coming from below the horizon, which illuminates the upper half of the image on the easel. To equalize the light in this case, a reflector should be placed as at *R*, extending from a point about eight inches below the negative to such a height that direct illumination from the sky will not illuminate the upper half of the negative. The angle at which this reflector should hang can be determined by inspection of the illumination upon the easel, and should not be arbitrarily fixed at 45 degrees from the vertical. It will usually need to be inclined slightly more. By running a pair of strings through the frame, the reflector can be easily adjusted. The reflecting surface should be a sheet of matte white paper—*not a mirror.*

Homemade Enlarging Lantern—The construction of an enlarging lantern is no more difficult than the building of the adjustable daylight enlarger just described. The plans we are giving are for a lantern fitted with 6½ inch condensers, which will nearly cover a postcard size or 4 x 5 negative if a sheet of ground glass is used for diffusing the light, while a 3¼ x 4¼ negative will be fully covered without the diffuser. As the full image on the negative is seldom enlarged, a lantern of this size will prove efficient in practically all cases for users of hand cameras, but if it is desired to use larger condensers, dimensions may be easily changed, as the diagrams make the construction entirely clear. This lantern is so designed that it may be used for electric, illuminating gas, or acetylene light-sources of various forms, equally well.

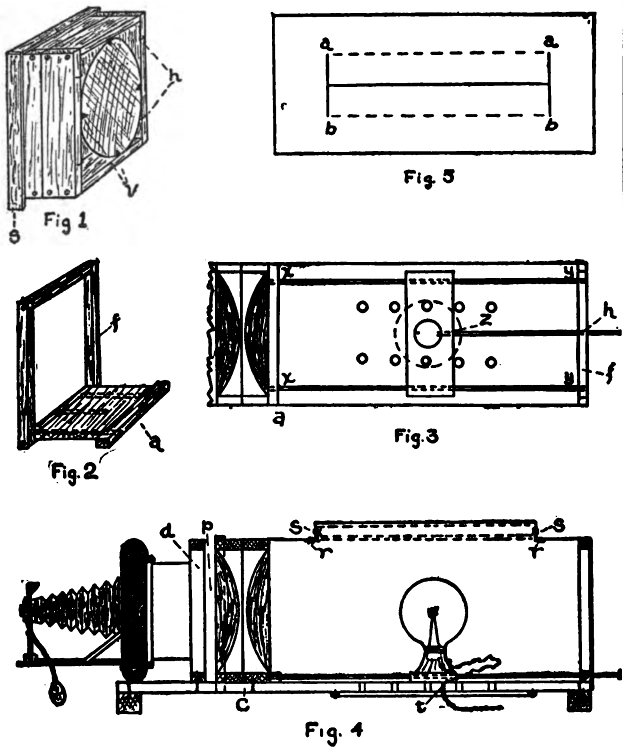

Diagram C — Enlarging Lantern

In Figure 4 construction is indicated for use with an ordinary hand camera, such as is used by the majority of readers. The model built for description was constructed so that a view camera with long bellows was placed in front of the negative holder, so that it is possible to make use of long and short focus lenses, and those of the soft focus type when need arises. This advantage is so distinct that those who wish to make the lantern of the utmost efficiency are advised, in case they have no view camera and do not care to obtain one, to buy or make a long bellows and fasten it forward of the negative holder, mounting the lens standard on a sliding base similar to that used for adjusting the lamp.

Before beginning construction, get the layout of the lantern well in mind, and, if necessary, alter the dimensions to suit the size of the condensers. These, by the way, constitute practically the entire cost of the lantern, except the lamp.

Construction begins around the condensers. Take eight strips of wood, ¾ inch thick and 1½ inches wide, and make two frames whose inside dimensions are 6⅝ inches, and whose outside dimensions are consequently 8⅛ inches. Use screws in making them, so that they will be rigid. Hinge them together at the bottom, setting in the brass hinges so that they are flush with the frames. Figure 1 shows how they appear when hinged. On the inside of the frames, near the top of the sides, fasten a pair of hook and eye latches—lightweight brass ones preferred, so that the frames are held together rigidly. Around the top and sides of one end of the frame fasten, with brads, a strip of cardboard, ½ inch wide and not more than 1-16 inch thick. Over this, fasten, with brads, strips of ¼ inch wood, 1 inch wide, having their edges flush with the edges of the frame. Have the ends of the side pieces project 1 inch below the sides of the frame, as shown in Figure 1. This construction forms a narrow slot, the purpose of which will be seen later. Take four small curtain rod hooks and fasten them on the other end of the frame as shown in Figure 1, so that a sheet of ground glass may be cut to size, and dropped into the slot formed by the hooks, being easily removable. Cut the glass and tape the edges. Then take eight pieces of light weight tin, 1 x 1 inch, and fasten one piece in the middle of the inside of each edge of the frame, with the diagonal of the tin piece along a line drawn ⅛ inch from the edge. Drive two brads through the diagonal of each piece. The condensers may now be inserted and fastened firmly, by bending the tin pieces to a V shape along the diagonal, as shown in Figure 1*v*.

For the base of the lantern, take a strip of 1 inch wood, cutting it to 8⅛ x 30 inches. Beneath each end fasten a piece of wood 2 x 2 x 8⅛, which will lift the base from the table, and help to make it rigid.

Make a frame of 1 x 1 inch wood, with outside dimensions of 8⅛ x 8⅛ inches. Take this frame, and with it two strips of 1 inch wood, 4 x 6 inches, and 1 x 8⅛ inches, respectively, and place them as shown in Figure 2. Two inches from each end, bore a ¼ inch hole way through all three, as shown by the dotted lines, taking care to have it perpendicular to the frame. Bore a third hole through the frame and half way into the 4 x 6 piece as shown. Place the frame, as shown at *f*, Figure 3, with the lower edge flush with the end of the base. Fasten it with two screws. Fourteen inches from *f* fasten the small strip *a*, making sure that it is square with the edges of the base—*absolutely sure*. Take the 4 x 6 piece, plane a few shavings from the bottom, and run a round file through the holes a few times. Then take two ¼ inch brass curtain rods, and run them through the holes in the three pieces of wood as shown at *xx*, *yy* in Figure 3. The 4 x 6 block should easily slide along the two brass rods, which form a track. This must be carefully adjusted, so that the light-source mounted on the movable block will always be on the optical axis of the condensers even though shifted back and forth. This is accomplished, of course, by having the brass rods parallel with the edges of the base, and placing the frame of the condensers against the piece *a* which has been squared, as warned above. The position of the 4 x 6 block—which we will hereafter call the lamp-mount—is controlled by another rod run through the middle hole in the frame at *h*, and into the middle hole of the lamp-mount at *z*, being fastened there by filing a notch in the rod, and running a screw down through the wood to grip the notch. The rod should be just long enough to project through the opening *h*, when the lamp-mount is run forward against the piece *a*, so that the full stretch of the track is at the command of the worker. On this block may be mounted a lamp of any type, the center of the light being opposite the middle of the rear condensing lens. This position can be ascertained after the enlarger is complete, as will be described.

The next thing is to place the frame holding the condenser firmly against the piece *a* (Figure 3) with the slot forward, fastening it in this position with two screws run up through the base, as shown in Figure 4*c*. The lantern is now nearly complete.

From a roofer, secure two pieces of tin, 20 x 26 size being convenient. Bend one piece in three sections, the center section being 8⅛ inch wide, and 20 inches long. The strip will then fit down snugly over the frame in the rear and slide forward into the slot around the edge of the condenser-frame, forming the body of the lamp-house. This must be ventilated by means of a light-trap at the top. To make this, cut along a line through the middle of the top section of the tin, starting 2½ inches from one end; make the cut 12 inches long. At each end of this, cut a perpendicular, 1½ inches on each side of the long cut, a total width of 3 inches. Then bend the two pieces up at right angles, along the dotted lines *aa*, *bb*, Figure 5. Then cut two pieces of tin 3 x 3½ inches, bending them across the center at right angles, to make two sections, 3 x 1¾ inches each. Place these at *rr*, as shown in Figure 4, and rivet them in with copper split rivets, which need nothing but a hammer and vise or flatiron to turn. Then form a cover, 12 inches long, 3½ inches wide, and 1½ inches deep, which when inverted will cover the opening cut in the top section. The pieces *rr*, Figure 4, raise the cover ¼ inch above the side pieces of the opening, and the edges of the cover are also ¼ inch above the top of the lamp-house, with ¼ inch space between them and the sides of the opening, giving a ¼ inch ventilating space, 12 inches long, on each side. Before fastening the top in place with a couple of copper rivets *ss*, Figure 4, run a little solder into the cracks of the opening and cover, and then paint with a dull black paint, both the inside of the cover, and the top of the top section around the opening cut in it, so that no light may be reflected out. It is not possible to paint the trap inside after it has been riveted to the top, and if not painted light will escape through it and cause fog.

The lamp-house can now be fastened in place, sliding it under the slot in the condenser-frame, and nailing it at intervals of every 2 inches along the edge of the base, and over the frame in the rear. The strip of tin overhanging in the rear should be bent around the sides of the frame, but cut flush at the top. An 8⅛ square piece of tin should be cut to close the end, sliding in the slot formed by the turned over edge of the tin on the sides. A narrow slit must be cut in the lower edge to allow for the rod projecting through the frame at *h*, Figure 3. This slit should be only the width of the rod, and just high enough to clear the top of the rod, so that no light can leak through the rear of the lamp-house.

This opening in the rear is a necessity, as occasions often arise to make adjustments through the rear of the lamp-house.

A negative-holder must next be made. A 5 x 7 printing frame, built out at the edges so that it will project beyond the sides of the condenser-frame, makes about the most convenient holder. A couple of strips of spring brass placed at the ends will hold the glass in place, the back of the frame being discarded. For film negatives, two 5 x 7 glasses masked to fit the negatives should be used, the mask extending to the edges of the glass so that by no possibility can any light pass through except what goes through the negative. If smaller glass negatives are to be used, kits to fit the 5 x 7 plateholder and accommodate plates of different sizes should be secured.

The forward part of the enlarger we will describe in a general way, as our model is probably different from that which most readers will use. After the holder has been made, place it flush with the front of the condenser-frame, and paste the masks on the glasses so that their centers will be exactly opposite the center of the front condenser-lens. Then build a frame *d*, Figure 4, in front of the holder, so that with the front of the condenser-frame, a slot will be formed in which the holder will slide snugly. It is in the construction of this frame that each reader will need to use his own judgment. The requirements of the frame are simple: construct it so that the camera can be held rigidly in front of the condensers, the lens being centered on the optical center of the condenser. The camera should be placed a few inches forward so that the lens can be placed at distances varying from one and one half times its focal length backwards to its focal length, permitting enlargements of from two diameters up to any limit. If the camera has a long bellows, the back may be fitted flush against the frame *d*. If it has a short bellows, the back should be forward from the frame *d*, a distance equal to about half the focal length of the lens, and the space between the frame and the back of the camera boxed in. The holder described in connection with the window enlarger will be satisfactory for small hand cameras.

Mount the lamp on the lamp-mount, centering it as nearly as possible by inspection. If a gas burner, run a stretch of tubing in through the base as at *t*, Figure 4, allowing enough free play for the lamp to move from end to end of the lamp-house. Similarly with an electric cord.

To get a good air passage, bore several holes through the base, as in Figure 3, and fasten a blackened sheet of tin below them to prevent light leaking out; see Figure 4.

All that remains to do is to give the lamp-house and accessories a coat of dull black paint inside, and finish it on the outside according to taste. Then the lamp can be adjusted. Fasten the Mazda in its socket, or the burner on its upright tube, in the lamp-mount. Place a negative in the holder and focus the image on the easel, which may be built exactly as described for the window enlarger. Pay no attention to the illumination. Remove the negative-holder from the slot. Remove the ground glass from in front of the condenser. The illumination on the easel will be uneven and spotted with colors. Move the lamp forward close to the condensers. The amount of color will increase, leaving only a small spot in the field of illumination that is clear. Raise or lower the lamp, and shift it right or left until this clear spot is in the center of the easel, the easel having been centered opposite the lens. It is quicker to do this than to say how to do it, as one will find when making the adjustment. Once adjusted, move the light backward until the field being enlarged is entirely even. If it does not become so, place the ground glass in place and try again, when the field will even up easily, and the negative may be replaced for work. It is best to shift the light whenever the lens is shifted, the light being readjusted by removing the negative after focusing, so that the field of illumination may be inspected.

It may seem rather difficult to make an enlarger of this type, but with details all in mind, and the work planned, it will turn out to be a very simple problem.

Trays—For enlarging purposes the trays should be large enough to accommodate a full sheet of paper, since sufficient developer must be used to permit rapid, even immersion of the paper just as when developing a plate. Consequently, it is wise to provide trays of several sizes for developing, so that in case the enlargements to be made on any occasion are of medium size only, it will not be necessary to use a much larger tray and so waste developer. Plenty of fixing bath is a necessity, and the tray for this must be roomy enough to allow separation of the enlargements so that fixing will be even and stains prevented. For instance, for 8 x 10 enlargements we would recommend a 16 x 20 fixing tray in case many prints are to be made at once with an apparatus that will produce them rapidly. Trays of this size are too expensive for many amateurs to purchase and can easily be made at home of wood, lined with white oil-cloth.

Arrange the trays from right to left or *vice versa* in the following order: developer, rinsing water, and fixing bath. If the worker is fortunate enough to have a photographic sink, it is a good idea to allow a stream from the tap to run through the rinsing tray continually so that the water will always be clean and cold. Keep all trays perfectly clean and use them for one purpose only. A tray used for miscellaneous purposes does not remain chemically clean, or what is the same thing, photographically clean. Mysterious streaks and spots will occur sometimes if this rule is not observed.

Solutions—One secret of good work lies in using properly compounded solutions and *plenty of them*. We may say that it is impossible to do good work if the latter point is ignored. Besides this, it is not economical. Failure to use plenty of developer of full strength and properly compounded may result in spoiling half the paper used. Similarly, if the fixing bath is old, the prints may tone while fixing or may not be permanent. In more exact figures, it is undoubtedly an economy to lay out fifteen cents in developer and spoil no prints, if a lesser amount of developer will spoil three sheets of, say, 11x14 paper worth thirty cents; the same applies in the use of the fixing bath. As a matter of fact, sclutions made up at home cost very little. Ordinarily twenty ounces of developer can be made up at home at the same cost as eight ounces bought ready prepared. Fixing bath and other solutions can be mixed at home at about the same proportionate cost.

In mixing solutions the first point is to be sure that you have bought the right chemicals. Entirely different salts of various bases, notably of sodium, are sold under confusingly similar names. Sodium *sulphide*, sodium *sulphite* and sodium *sulphate* are commonly used photographic chemicals, but they cannot be used interchangeably, as each has a distinctly different chemical composition and photographic use. Purity is a further consideration in buying chemicals. Always buy chemicals manufactured for photographic purposes only, put up in sealed containers, by a firm whose reliability is unquestioned. Never buy chemicals in bulk. The one exception to this is hypo, which a retailer buys by the barrel and sells in one-, five-, and ten-pound packages to the consumer.

The next thing to consider is a suitable set of scales and weights. A sufficiently accurate set can be secured for $2.50 to $3.00. As most photographic formulas are given in the avoirdupois system, most photographic scales made in this country are supplied with a set of ounce weights and fractions of ounces in the avoirdupois system. Since in this system there are no small weights and the grain is the same as in the apothecary system, the smaller weights, each equivalent to a certain number of grains, are usually supplied in the latter system. In a fairly reliable scale the weights should be secured about as follows:

1, 2, and 5 grains, in aluminum									
½ scruple	equal	to	10	grains	equivalent	to	about	0.66	grams
1 "	"	"	20	"	"	"	"	1.33	"
½ dram	"	"	30	"	"	"	"	2.00	"
1 "	"	"	60	"	"	"	"	4.00	"
2 drams	"	"	120	"	"	"	"	8.00	"
3 "	"	"	180	"	"	"	"	12.00	"
½ ounce Av.,	"	"	220	"	"	"	"	14.15	"
1 ounce Av.,	"	"	440	"	"	"	"	23.30	"
2 ounces Av.,	"	"	880	"	"	"	"	57.6	"

The most useful equivalents are: 15 grains = 1 gram.

30 cc. = 1 fluid ounce Apoth.

Gr. stands for grains; gm. for grams; cc. or ccm. for cubic centimeters. The weight of 1 cc. of distilled water at 4 degrees Centigrade is 1 gram.

The metric system is undoubtedly the simplest and best, but unfortunately it is not much used in this country except for scientific purposes.

Potassium Bromide Solutions—Formulas for most gaslight and bromide paper developers call for a certain number of drops of a saturated or of a ten per cent. solution of potassium bromide. The former is a solution such that the water has dissolved all the chemical it can hold, there remaining some of the undissolved crystals at the bottom of the bath. Solution should be brought about at a temperature of nearly boiling, so that when the temperature is lowered to that of the darkroom there will be no doubt that the solution is saturated; it will be found that approximately 1½ ounces of water is all that is necessary to add to one ounce of potassium bromide to make a saturated solution. A ten per cent. solution is one in which the potassium bromide is present in such concentration that a fluid ounce of the solution will contain one-tenth part of the chemical and nine-tenths part water by weight. It can be mixed with sufficient accuracy by placing an ounce of potassium bromide in a graduate and adding water to make 9 2-3 ounces.

Mixing Developers—The developing solution should be carefully prepared, and the ingredients should be weighed out accurately and dissolved in the order given in the formula. For instance, metol-hydrochinon formulas are generally given in such an order that the metol will be first dissolved, then the sulphite, hydrochinon, and carbonate in the order given, followed by the addition of a certain amount of potassium bromide either in crystal or liquid form. Amidol, on the other hand, needs no carbonate and should not be dissolved until the sodium sulphite has been placed in the solution. Then sufficient bromide is added to prevent fog. Again, glycin is not readily soluble in water, but will dissolve quickly in an alkaline solution. Consequently, it can be added last. In the metol-hydrochinon developer given later, the amount of bromide can be altered to suit the worker. If just sufficient is used to keep the whites of the image clean, the print will develop out rapidly, and the tone will be as nearly blue black as the paper is capable of producing. The addition of bromide increases the contrast of the result, slackens the action of the developer, and produces a print in which the color tends towards brown to a degree depending upon the amount of bromide used. When the amidol formula is employed, it is important that the right amount of bromide for the particular paper used be employed. Use just enough to clear the whites. An excess will cause greenish or brownish blacks that are unpleasant. In general, with this developer, decreasing the water and using a minimum quantity of bromide will be found to produce excellent blue blacks. A weaker solution will yield a purer black which is almost impossible to match with any other developing agent. Metol-hydrochinon is a favorite because it is a clean-working developer and keeps well in solution Amidol produces results which some people prefer, but it should not be mixed in quantities greater than required for immediate use. Suitable formulas for developers and fixing baths will be found on page 66.

Selecting a Negative—Small satisfaction will be derived from enlarging a negative whose optical or chemical quality is poor. Every blemish in the negative will show up in the enlargement in the degree to which the image is enlarged. Not only must the negative be visibly sharp, but enough so that it will still appear sharp when enlarged. The small circle of confusion produced by the modern anastigmat lenses (See *How to Choose and Use a Lens*) makes it possible to produce enlargements that are oftentimes as visibly sharp as the contact prints; consequently, the possessor of an anastigmat lens will have proportionately more negatives that will stand a fair degree of enlargement than he who has but a rectilinear or meniscus-achromatic lens. In addition to the need of optical perfection the chemical quality will need attention. Spots and stains and similar blemishes are tabooed. In contrast the negative should verge on softness and thinness, for it then yields a better enlargement than a contact print on the same grade of paper. As this is true, bromide papers only will yield well-graded prints from snappy negatives, while with medium and thin negatives good results will be secured on soft and medium emulsion gaslight papers. Pyro-developed negatives should be fixed in a bisulphite or acid fixing bath so that stain will be prevented; otherwise the exposure will be exasperatingly prolonged. It pays, partly from the standpoint of time, but more from the standpoint of results, to reduce such negatives as are chosen for enlarging, if they are a bit too contrasty or need a slight treatment to remove fog or stain. It should be remembered, as explained in detail in *How to Make Prints in Colors*, that the color of a toned print depends upon that of the original black and white print, so that the matter of the chemical quality of the negative selected for enlarging bears largely upon the final result if it is to be toned.

Choice of Paper—This is a much more important factor in enlarging than is realized. The wide variety of emulsions and surfaces in which gaslight papers are supplied makes them particularly well suited for all-around enlarging purposes, and consequently the enlarger itself should, wherever possible, be designed to make use of them. Gaslight papers of extra rapid emulsions, now marketed under the general name of special enlarging gaslight papers, can be had for amateur use, but do not give the same snap and brilliance to the print that the slower emulsions produce. Bromide papers are much more rapid than either, and produce even softer prints. Roughly speaking, the special enlarging emulsions are about twenty times as fast as ordinary gaslight emulsions, while the bromide emulsion is about fifty times as fast.

In *Beginners' Troubles* the working of gaslight papers was considered and does not need extensive comment here. The faster emulsions are handled throughout in the same manner, except that the workroom light must be safer. A deep yellow or orange light will suffice for the enlarging gaslight papers, and a deep orange or red light is needed for the bromide papers. Although more susceptible to light fog, the more rapid papers seem less likely to fog during development.

In choosing a surface, the size and subject of the enlargement should be taken into consideration. It does not pay to use a single grade and surface of paper for enlarging, since every subject should receive individual treatment as far as is possible. In consideration of this it is a very good plan to go to the dealer and ask to see his sample book, showing the different surfaces obtainable in the various grades of paper. Consider whether a sepia print will look better than a black and white tone, or whether it will look best if toned as described in *How to Make Prints in Colors.*

A recently introduced medium is bromide fabric, which is coated on a fine mesh cloth, the contrast of the paper being the same as ordinary bromide papers, and the speed being practically the same. This offers possibilities for artistic work, as it may be handled exactly as bromide papers, including toning to different colors, after which it may be waxed or varnished to give a lustrous canvas effect.

Another medium which deserves mention for those who are looking for something out of the ordinary, is Artatone. This is a thin paper tissue coated with a gaslight emulsion. It is handled throughout in the same manner as other rapid gaslight emulsions, although the manufacturer recommends the following developer:

Water	32 ounces
Sulphite of soda (granular)	1 ounce
Citric acid	8 grains
Amidol, dissolve and add	50 grains
Potassium bromide, saturated solution	40 to 50 drops

The soda and citric acid may be made up in the form of a stock solution if desired, but the amidol should not be dissolved until needed, as it does not keep in solution.

As too rapid development is undesirable, a weak or well restrained developer is recommended in case the worker prefers to use his pet formula. When metol is procurable, its use is recommended, a formula being given in the instruction sheet. It is recommended that Artatone be inserted in the developer face down as an aid to uniform development. In the developer, Artatone becomes very limp and may fold over. It is very tough, however, and can be straightened out without danger of tearing. A gentle rocking of the tray will generally suffice to keep the sheet flat, especially if one corner is held during the rocking. Large prints may be folded over, if desired, in changing from tray to tray.

In mounting Artatone, a variety of unusual effects may be secured by placing the print over sheets of tinted paper, which have the effect of tinting the print, as the color of the under sheet can be seen through the thin Artatone print.

The Darkroom Safelight—Before commencing work with the enlarger, the safety of the darkroom light should be tested with the most rapid medium on which the enlargements are to be made. This can be done by placing a strip of the paper on the table, by the side of the developing tray, so that rays from the supposedly safe light are falling upon it. Half the strip should be uncovered, while the other half is exposed to the safe light for about two minutes. At the end of that time the paper should be developed. If the light is not safe, there will be a distinct difference between the two halves of the strip after being left in the developer long enough to develop a print. In such case the light should be weakened or its color deepened, and another test made. This test must be made carefully; a worker merely invites waste and failure by using special enlarging or bromide emulsions under a light that has only been proved safe for use with the slower gaslight papers.

Using a Box Enlarger—Making enlargements with a box enlarger is as simple as making contact prints. In fact, the only difference is that the exposure is longer, and the negative and paper are not in contact. Daylight is usually employed for making the exposure, although when bromide papers are used an illuminator will be satisfactory. If of the fixed-focus type, there are no preliminaries to placing the negative and paper in place and making the exposure. If the focus of the enlarger is variable, it must be focused before the paper is put in the frame. Focusing may be done by pointing the enlarger at a white light in the workroom, which may be lighted especially for the purpose and extinguished before loading the paper into the frame. A single light-source will illumine only a portion of the negative, but this will be enough to secure proper focus. Exposure is made by pointing the enlarger at an illuminator or the sky. A north exposure is usually most even, but on a clear, bright day with no clouds in the sky a bright south exposure is more rapid and entirely satisfactory. It is essential that the light be unobstructed and the sun not included in the pyramid or cone defined by imaginary lines passing from the lens through the corners of the negative to the sky. If these two conditions are not observed, the illumination will not be uniform, and the enlargements will be of correspondingly uneven color.

An entire sheet of paper should not be exposed when making a trial. One sheet of paper should be cut into strips, say an inch wide, and these used to determine the correct exposure. To do this, place a strip of paper across the printing frame in such a manner that it will cover those parts of the image that are likely to be very dark and very light, and which would be the cause of any difficulty that might be met in making contact prints from the negative. In making the exposure, first cover the negative with a sheet of black paper, or something opaque; uncover a quarter of the negative and point the enlarger to the sky. Expose the uncovered strip for about one-third of the time that you think correct. Then uncover another quarter, thus exposing half the negative, and give another exposure of the same length. Repeat this with the remaining two quarters, so that the paper will have received exposure in four sections, the correct exposure being determined by developing the strip. In the case of a bromide enlargement, using a box enlarger equipped with a meniscus lens, about ten seconds will be right for the trial unit of exposure; with special enlarging paper, under similar conditions, two minutes; with ordinary gaslight emulsions, nearly ten minutes.

If the exposure is made by means of an illuminator, the first trial may be made in the same way, but subsequent trials may be much more closely estimated and time saved, as the light furnished will be quite uniform at all times.

Whether exposed by daylight or artificial light, the subsequent handling of the paper is the same as for contact printing.

Working with Projecting Enlargers—Anyone who has seen a magic lantern at work will have no difficulty in sensing the operation of an enlarging device which projects the image upon an easel. In practice, it is simply necessary to place the negative in the holder, upside down, film side nearest the lens, open the lens wide, and move it back and forth until the sharpest possible image has been thrown upon the easel. If the image is larger than desired, the easel is moved nearer the lens, and the lens is moved toward the easel. If the image is too small, the easel is moved away from the lens, and the lens is moved away from the easel. In case condensers are being used, after the desired focus has been obtained, the negative-holder is removed, the light adjusted to secure even illumination, the negative again inserted, and final adjustment of the lens carefully made.

Focusing should always be accomplished with the largest stop in the lens, which may then be stopped down to better the definition if desired. In case condensers are used, the light should be adjusted after the lens has been stopped down, as the illumination depends somewhat on the size of the stop in the lens.

Focus and illumination having been adjusted, the sensitive paper may be placed in position on the easel. To make sure that it occupies the right position, guides of some sort should be placed on the easel. The easiest method is to have the easel adjustable, using some device such as was described in connection with the home-made window-type enlarger, and to use a printing frame to hold the paper. By so doing, focus may be made upon a sheet of plain paper in the frame, which can then be removed from the uprights and loaded easily. If this method is not followed, but the paper is instead pinned upon the easel (rather laborious, we think), heavy cardboard masks should be cut, and thumbtacked over the sensitive paper so that its edges will lie perfectly flat. As an aid to placing the paper in position the enlarger lens may be open, throwing the image upon the easel all the time, but the lens capped with a deep filter so that the paper will not be affected. For gaslight papers, a yellow filter will be safe; for the more rapid papers an orange or red filter must be employed—one being made easily of celluloid or glass at home. Do not focus with this cap on the lens.

Before exposing a whole sheet of paper, use a test strip, as suggested in the procedure for box enlargers. Instead of covering the negative, hold a large sheet of opaque paper in front of the strip on the easel, and uncover it section by section at equal intervals.

Developing the Paper—The development of a large sheet of paper introduces a further problem. In the first place, even with a large tray and plenty of developer, it is quite a knack to immerse the paper quickly and evenly without air bells or bubbles forming on the emulsion. The easiest method is to hold the paper in one hand and lift the nearest edge of the tray with the other, so that the developer runs down into the edge furthest from the worker. Then force the paper to the bottom of the tray and immediately lower it so that developer runs over the paper in one wave; at the same time run the fingers, or a tuft of cotton, over the surface of the paper so that all airbells will be broken up.

Another method of development of large prints is by means of a fairly broad, camel's-hair brush. The paper is pinned upon a board inclined at an angle above the tray, and the developer brushed upon it rapidly, first covering the paper with an up and down stroke and then with a horizontal stroke. By this method it is possible, if desired, to do away with the use of a large tray and to use a minimum quantity of developer, using only a few ounces to make an enlargement or two, which means a decided saving at times when only one or two enlargements are to be made, which by the tray method of development require as much developer as a greater number. A certain amount of control is possible by this method, as it is possible to stop development in certain areas of the paper by swabbing it with water, meanwhile pushing development in other portions by applying more developer.

If the trial exposure has been carefully made, there should be no difficulty in producing a chemically perfect print practically every time, regardless of the method of development. It should be remembered that every paper has a definite developing period relative to a certain developer, and that this period should be known in order that the paper may be developed to the limit of safety, especially if it is to be toned. It is a very common practice to give a trifle too much exposure so as to be on the safe side, and to "jerk" the paper from the developer when the depth is sufficient. This is not productive of prints of good chemical quality, and it will be found that the toned print will not be of the best color, even though the color of the black and white print may be fair. (See *How to Make Prints in Colors.*)

If the development period of the paper is not known, the action of the developer and the color of the print give an indication as to the correctness of the exposure. If the print comes up very rapidly and must be quickly removed because it will otherwise become too dark, it was overexposed, and the color will approach a brownish or greenish black—depending on the excess of exposure. If the image builds up evenly and does not need to be immediately removed from the developer, even after both detail and contrast are about correct—granting the use of the right grade of paper—it received the correct exposure. On the other hand, if the paper must remain in the developer so long that it fogs before detail has been brought out in the highlights, the exposure was too little. This latter case is based on the supposition that the paper is fresh and that the developer has sufficient sulphite and bromide to prevent fog and keep the whites clean under normal conditions. The difference between chemical fog, occurring during development, and light fog, occurring during exposure, may be determined by making an exposure on a masked piece of paper. If the edges of the paper fog during development, it shows that the fault is not with the light, but with the paper or developer. In such case, fresh developer should be made up. If fog then persists, new paper should be tried. If fog still appears, look to the condition of the chemicals used in making up the developer. In developing enlargements we have seldom heard of trouble due to the use of old paper or chemicals, as these are constantly in use in the other branches of developing and printing—and consequently advise as a first step that the light be tested again, if the paper fogs during development.

Fixing—As soon as the paper has been developed it should be rinsed and then placed immediately in the fixing bath, in which it should be moved around occasionally to make sure that the hypo has even access to the emulsion. Never attempt to economize on fixer. An overworked fixing bath is "the source of much evil." An insufficiently fixed print will stain in the course of time, and if it is toned will spot badly. If the print is left in an old bath too long it will tone, especially if the bath be warm. The temperature of the bath should be kept close to sixty degrees Fahrenheit and may be lowered to that point in summer by placing a cup filled with cracked ice in the tray. The prints must be separated if they mat together, and for this purpose it is a good plan to have a print-paddle on hand, so that it may not be necessary to wet the fingers with hypo in order to separate them. The formula furnished by the manufacturer is the best to use for any brand of paper, although any of the prepared acid fixers are efficient. In our own work we have found that an ordinary hypo solution in the proportions of five to one, to each quart of which has been added one or two ounces of liquid sodium bisulphite (or half that quantity of the dry chemical), is a good bath for general use.

Washing—Because of their size, enlargements are not as easy to wash as are contact prints. They have an exasperating habit of matting together in the wash water so that only the top print is washed. Although laborious, the most satisfactory method of washing them is to change them from one tray to another, and back again, by hand, allowing the water to run constantly in the tray into which they are being transferred. These changes should be made at least every five minutes for an hour. The thoroughness with which they are washed, determines the permanence of the black and white prints. If they are to be toned, the presence of hypo may spoil them utterly. For that reason it does no harm to do a little extra washing if the batch of prints is large.

Drying—Because of the difference in the rapidity of drying and the degree of contraction of the two sides of coated paper, prints on large sheets of paper are very likely to curl badly when drying. There are several ways of drying them satisfactorily. The simplest method is to place them face down on cheesecloth stretchers and let them dry thoroughly, after which they may be ironed out flat by pressing with a hot flatiron, placing each one in turn face down on a clean sheet of white paper and placing another sheet of paper over the back so that the iron will not scorch the print. Another method is to secure blotters in large sheets, laying them in a pile, alternating strips of cheesecloth, and placing light weights on top of the pile to hold it flat. A better method is to buy blotter in rolls, run a long strip of cheesecloth between the coils, and laying the prints face down on the cheesecloth, roll them into the blotter. This will dry them with a reverse curl, which will entirely disappear after the print has been removed from the roll and laid out on the table.

Troubles—Aside from incorrect exposure and development there are a number of things that must be avoided when making enlargements. False economy in the use of solutions is responsible for many. Too little developer is likely to cause developer streaks; it may also be the cause of fog—some portion of the print fogging or staining, while another portion, not immersed quickly enough, is given a chance to develop out fully. Too little or old fixing bath spells trouble for the future of the print, although it may not be immediately visible. The temperature of the solutions needs constant watching. From sixty-five degrees to seventy degrees Fahrenheit is the best temperature for developer for most developing papers; the fixing bath should be about sixty degrees Fahrenheit. If this point is not given sufficient attention, weak gray prints from cold developer, stained, blistered prints from warm developer, or mealy, stained, and toned prints from warm fixing bath may be met at any time. A tumbler or cup filled with cracked ice in summer, or with hot water in winter, may be placed in a tray to lower or raise the temperature of the solution; if a larger tray than the one in use can be had, the developing tray can be placed in it, and ice or hot water placed in the outer tray, thus giving considerable surface on which the cooling or warming medium may act. Time alone will tell whether an enlargement will be permanent. Its permanency depends largely on the thoroughness with which it is fixed and washed, and whereas this trouble cannot be foreseen, it can be prevented by using pure chemicals and exercising care and thoroughness in every step of the work. Other troubles are more or less of a mechanical nature and individual in their character.

Dodges—The great advantage in the use of an enlarger of the lantern or projection type lies in the ability of the operator to offset chemical defects in the negative to some extent and produce special effects by working with various devices between the projecting lens and the easel; this is not possible with enlargers of the box type. Shading is the most simple form of this special work and consists merely of holding back light passing through portions of the negative which are too thin, thus allowing the image to be built up by the weaker light rays coming through the too dense portions. If by reason of improper development the negative is thinner at one end than the other, the enlargement can be made even in tone by holding a sheet of cardboard between the lens and easel, so that the light passing through the thinner portion of the negative is blocked out from the easel during a part of the time of exposure. If the line between the thin and dense portions of the negative is abrupt, the cardboard must be handled very carefully so that no line of demarcation will show in the enlargement; during exposure it must be kept in motion evenly across the dividing line so that the thin and dense portions will be sufficiently blended. In the same manner if the corner of the negative is nearly clear because of faulty manipulation, the defect may be rendered unnoticeable in the enlargement by similar use of a sheet of cardboard.

In case the portion which needs holding back is an irregularly shaped spot within the negative, the enlargement can be made even in tone by shading with a piece of pasteboard or black paper impaled on the end of a long hatpin or knitting needle. The black paper should be shaped roughly to the same contour as the portion which is to be held back; an oval, for instance, can be used to prevent a face in the shadow from printing too dark, or a long thin strip can be used to hold back an underexposed tree trunk.

Conversely, if there is a dense spot in the negative which needs longer exposure than the rest of the image, it can be given by projecting a beam of light through a hole properly shaped in a large sheet of cardboard. The cardboard must be sufficiently large to cut out the rest of the image so that only the beam of light projecting the dense portion of the negative will reach the paper.

These methods of dodging require considerable practice, although they are actually very simple. The secret of concealing the mechanical work is to *keep the cardboard in motion all the time*, so that there will be perfect blending between portions of the image which receive different exposures. The greater the lens aperture and the nearer the cardboard is held to the lens, the greater will be the diffusion of light at the easel, and consequently the less apparent the dodging will be. On the other hand, if the work is overdone or the cardboard is held too near the easel and not kept in motion, the blending will be abrupt and will show plainly that mechanical work has been done, and poorly.

Another form of dodging which requires somewhat more skill is known as vignetting. This consists of blocking out a portion of the image with an opaque cardboard or mask. For instance, it frequently happens that it is necessary to select one figure of a group and enlarge it alone as a single portrait. To do this, first cut an opening in a sheet of black paper, making it a trifle larger and of the same shape as the image which is to be enlarged. Fasten the sheet of paper over the negative so that only the roughly selected image can be viewed. Place the negative in the enlarger and project it on the easel. Cut a similarly shaped opening, but larger, in a sheet of cardboard. Hold this at such a distance from the lens that it will barely prevent all light except that of the image from reaching the sensitive paper. When making the exposure, keep the cardboard in motion so that the edges of the image will blend into the background. The cardboard is called a vignetter. If the figure is full length and it is desired to use only the head and bust, the openings in the mask and vignetter can be cut to that shape. Purely as a means of blocking out backgrounds, vignetting should be resorted to only if a single enlargement is desired or if for good reasons the negative cannot be retouched. Otherwise, it is best to outline the image with opaque and cover the rest of the negative with black paper.

In vignetting, if the edge to be blended is a straight line, the vignetter may be used with a straight edge, but if an irregular soft blend is desired, the vignetter should be cut to the approximate shape of the image and the edge of the opening in the vignetter serrated regularly like the teeth of a saw for an even blend, or irregularly if the desired vignette is uneven.

Composite Printing—By blending the images on two different negatives, it is possible to make some very good improvements in many instances. The most common use of composite printing is to introduce clouds into a landscape view in which no clouds are shown in the original negative, or in case the sky portion of the negative is so dense that the clouds cannot be printed through. Oftentimes it is possible to bring out the cloud detail by holding back the foreground by means of the moving cardboard already mentioned, but sometimes this is not possible and it is necessary to print them in.

There are two usual methods of doing this, one in which both exposures are made and the paper then developed, while in the other, one exposure is made and developed before the second is attempted. The former method is the one generally followed, and is outlined in the following paragraph.

A sheet of thin white paper is placed over the landscape negative, and the two are held against a window-pane or placed on the ground glass of a retouching desk. The horizon line is traced on the sheet of white paper, which is then pasted on a sheet of light-weight cardboard; this is cut apart along the line representing the horizon. The two pieces of cardboard are to be used as vignetters when printing in the clouds. The first step is to place the landscape negative in place in the enlarger and ascertain the correct exposure; the cloud negative should then be inserted and the exposure for that also ascertained. The landscape negative is then again inserted and the image sharply focused upon the easel.

The lens should then be stopped way down and capped with a filter so that the image projected upon the easel will not affect the sheet of paper that is next pinned in place. The adjustment is made easy by the image showing on the sheet, and the horizon line may be placed at any desired height. On the edge of the paper where the horizon line of the landscape ends, marks should be placed so that the sky image may be properly registered when the second exposure is made. The exposure should now be made, shading the upper portion of the paper with the cardboard section (cut above the horizon line of the landscape negative), between the lens and the easel. It can be easily adjusted in position and must be kept in motion above and below the horizon line of the image so that the blend at the horizon will be even. The lens is then capped again, the cloud negative inserted and registered by means of the marks already made, and the second exposure made, now using the lower section of the cardboard to block out the lower portion of the paper. This sounds much more difficult than it really is, and the only part of the process that needs any skill is the blending of the two exposures. If the cardboards are not kept in motion for the right distance above and below the horizon when making both exposures, the horizon will not be well blended. It is advisable to make several trials on narrow strips of paper to get the knack of blending the images, after which no difficulty will be experienced. Particular care must be taken when making both exposures to place the cardboard masks at such distance from the lens that the shadow cast by the edge of the mask will coincide with the image of the horizon on the easel. Thus the blending will be uniform. In case the horizon line is too dark because the exposures are not spread enough, it can be reduced by swabbing it with potassium ferricyanide solution, placing the print on an inclined surface with the horizon line running up and down so that the reducer will run on no other parts of the image. A very weak solution should be used so that the action can be stopped easily without danger of going too far or being streaky.

Another method is to develop the paper after having made the first exposure, rinsing it thoroughly in clean cold water, and then placing it again upon the easel so that the second exposure can be made. The contention by workers who use this method is that the cloud image can be more certainly blended with the landscape. However, the sensitiveness of the paper is reduced by rinsing, and a little practice is necessary to enable the worker to allow for this fact.

Combination printing opens up a wide field of work with the projection-enlarger, panoramic pictures, the introduction of images into foreign backgrounds, and similar effects being produced by blending one or more images. It must also be remarked that the user of a 4 x 5 camera, for instance, can produce enlargements of proportions about 4 x 9 when printing from two full size negatives, forming either a panoramic panel or a vertical panel. In the former case the two exposures are made so as to blend the negatives at the edges, both being taken from the same viewpoint, the camera being revolved about the lens. In the second case, one exposure is made so as to include everything slightly above the horizon to within a few feet of the camera, and a second is made to include everything from just below the horizon to as high a point as possible. The images are then blended. Thus it is often possible to secure a good landscape and a beautiful cloud-sky and blend them.

Printing Through Bolting Cloth—There are various ways of securing soft effects when enlarging; one of the most effective is the use of silk bolting cloth. This is a very fine, uniform weave cloth, which can be secured in grades described as fine, medium, and coarse mesh; a great variety of effects can be secured by the use of all three. In practice the cloth is placed between the paper and the lens. Its distance from the paper determines the degree of diffusion. If used in contact with the paper, the effect is that of a print made on a fine-mesh canvas, sharpness of the image being little affected. As a rule the cloth is placed from one-fourth to one inch from the paper, according to the amount of diffusion required. The greater the diffusion the softer the effect, as the blackness of the shadows is considerably broken up, but this also correspondingly lessens the definition. The cloth should lie in a flat plane and should be handled so that there will be no vibration during exposure if the mesh effect is to be preserved. For this reason it is a good idea to stretch it on a light wooden frame which can be fastened at the desired distance in front of the paper. What we consider to be a more satisfactory method is to gum the edges of the cloth to a sheet of glass which will fit the printing frame in the enlarger, or which can be fastened against the easel. The paper can then be placed in contact with the cloth very easily. If slight diffusion is required, the glass may be reversed and printing accomplished through the single thickness. If greater diffusion is needed, another glass may be inserted, or the glass holding the bolting cloth may be fastened a trifle forward of the easel. For those who do not desire to buy the three grades of bolting cloth, the fine-mesh is the best choice, as it can be employed to secure the greatest variety of effects, the amount of diffusion and the mesh effect being controlled by its distance from the paper. In general it may be said that for small prints, or for large prints on smooth paper, the fine-mesh cloth should be used. The medium and coarse meshes are more suitable for rough or semi-rough papers.

Special Methods—When it is required to make a considerable number of enlargements from one negative, it is often time-saving to make an enlarged negative of the desired size, from which the large prints can be made by contact. This can be done in several ways. If the original negative is perfect, a large positive can be made on a slow plate, treating it just as if it were a bromide paper of extreme rapidity. From this a new negative can be made by contact printing with a plate in a printing frame, the final negative being of a contrast and density better than that of the original if alteration is necessary. If the original negative is poor, it is often best to make the largest possible enlargement from it that will preserve good detail. This can be retouched to eliminate blemishes, improve contrast, and sharpen detail where it is poor. A copy can then be made, preferably the size of the final print desired, provided the worker has a sufficiently large camera. If only a small camera is to be had a small copy negative must first be made, from which the enlargement can be produced either by projection or by making an enlarged negative. For workers who are interested in pictorial photography and produce prints in large sizes by the carbon, gum, or similar processes, the ability to make large negatives is a practical necessity. Large transparencies are made in a similar manner, their handling being identical with that of lanternslide plates. In making enlarged negatives or positives, there is practically no difference between the process and that used for making enlargements on bromide papers. The maker's formulas for developer should be employed and the safety of the darkroom light be tested. Dodging, vignetting, and the other special effects here described can be accomplished exactly as when making bromide enlargements.

Soft-Focus Enlargements—An enlargement of a sharp negative or film by an achromatic or anastigmat lens preserves the original texture of the image in proportion to the diameter of magnification; that is to say, a poor negative may have its limit at 8 x 10 or 11 x 14, beyond which detail may be lost. In a perfectly good negative, the magnification can be extended 10,000 times, as witness the motion picture or the old time lantern slide. The only question is the extended distance of the view point, a highly magnified image projected on a screen being unintelligible at close range. The object of enlarging with a semi-achromatic lens is to make an artistic picture from a perfectly sharp record, so that the resulting picture is not an enlarged landscape whose sharpness of outline at a proper viewing distance equals that of the original, but one all of whose lines are softened equally, as in brush work, and which can be viewed on exhibition as a picture and not as a record.

One method, and fairly successful, is to project by an "uncorrected" lens; that is to say, a spectacle lens of meniscus form. The softening is accomplished by the spherical aberration of the lens. By this method the lines are blurred from the center outward, but the axial or central portion is always sharper than the margin, and should the picture contain many straight lines, the result will show barrel distortion, especially noticeable at the edges of the print.

One of the best methods yet recommended for this class of work is the semi-achromatic, in which softening of the lines is accomplished by using a lens semi-corrected for achromatism. By this means the whole of the image is softened by extending the planes along the axis, so the image is no more sharp at the center than over the area. To illustrate: If we take a newspaper half-tone screen, we find it very coarse, about eighty dots to the linear inch; compare this with a high grade process screen of two hundred and fifty dots to the inch, and we find the dots of the latter practically invisible. So it is with the cone of rays (or circle of confusion) in an anastigmat, which is about 1-400th of an inch in diameter, whereas in the semi-achromat it is practically the same as the coarse screen.

The cone of rays or circle of confusion in an anastigmat being so small, necessitates the most accurate focusing, so that in projecting the film for enlargement, one exact point, and one only, is the correct position of the focus. Now, consider the semi-achromat whose cone of rays (in comparison with the fully corrected anastigmat) never reaches a microscopic point, the circle of confusion being at best a point of measurable size. This admits of a latitude of focusing almost bewildering. In an enlargement thrown up by a 10-inch semi-achromatic lens to 11 x 14 size, this latitude of focusing extends along its axis nearly two inches. It is here the judgment of the operator asserts itself, as there are many different qualities obtained by shifting between the inside and outside focus, together with the different stop apertures. The over-lapping of the different color foci admits of numerous and varied effects. The sharp image becomes bathed with soft light, knife-like edges are softened, diffusion is controlled or eliminated at the will of the operator. An enlargement made by this process, from a sharp negative, while producing artistic results, is in no sense as artistic as a soft focus negative enlarged by an anastigmat lens, for the latitude of focus of the semi-achromat gives a separation of the planes and an atmosphere, of which the anastigmat is incapable, and this quality is fully retained if enlarged by the fully corrected lens. As this quality does not exist in the sharp negative, no method can fully introduce it later.

Miscellaneous—There are a great number of small conveniences in operation and apparatus which greatly simplify enlarging and which render the results more satisfactory. These do not adapt themselves well to illustration in these pages. The manufacturer's displays and descriptions should enable the photographer to secure what he needs in the line of equipment. Experience will teach him the little things which make the operation more rapid and convenient. We furnish a few miscellaneous suggestions out of our own experience which could not well be included under other captions.

Whenever it is possible to get away from the conventional order of things and at the same time to produce results which are not grotesque, it is well to do so. Special effects can be produced by various methods using different printing mediums and different styles of mountings. The simplest method of toning is that of producing sepia prints either by the sulphide or hypo-alum process; the manufacturer generally indicates which is most satisfactory with his paper. A great many subjects lend themselves extremely well to sepia effects; in such case the enlargement should best be made on a cream- or buff-colored stock and then toned. When prints are to be toned, they should be a trifle darker than ordinarily made for black and white effects, as described in "Practical Photography, No. 4," *How to Make Prints in Colors*. Sepias are most pleasing when double-mounted on a combination of buff- and chocolate-colored cover paper and mounting board. Other subjects lend themselves to toning in various colors and to mounting on stock of harmonious tints. For instance, some types of marines are most pleasing when toned to a blue color, some landscapes look best in green, fireside effects can be toned red. Whenever toning is attempted, the color selected should harmonize with the spirit of the picture, and the mount itself must not clash in color with that of the print.

Tinted borders can be produced in enlargements just as easily as in contact prints. The duplicate masks are cut in large size and exposure is made to any printing light for the border, just as in contact printing. After the exposure for the border has been made, the final mask is placed in the printing frame or over the paper on the easel, and the image is projected on the paper. As in contact printing, careful registering of mask and paper is necessary.

In conjunction with tinted borders, plate-sinking produces unusually pleasing effects. If one-half inch margin is allowed around a 5 x 7 print made, say, on a

10 x 12 sheet of paper and the 6 x 8 print and margin is plate sunk so that it is about $\frac{1}{32}$ inch lower than the tinted border, the whole sheet then being mounted in a folder, a most effective piece of work is produced. A simple plate-sinking device can be made from a sheet of heavy cardboard cut to the size of the portion which is to be sunk; under the circumstances above, this would be 6 x 8 inches. The print is placed face down on this, the portion to be sunk exactly covering it. The round end of a table knife, a large ball bearing, or something similar, is then pressed down on the back of the print and against the edge of the cardboard rectangle, being run around the latter several times so that the portion of the paper overlapping the rectangle will be pressed into contact with the table. When the print is turned right side up, the portion which covered the rectangle will be lower than the rest of the sheet.

Panel effects are not only pleasing to the eye, but if suitably made up can be used in the home for decoration of corners and odd spaces on the walls which are not large enough to hold framed pictures. Portions of negatives which picture the sun's image reflected in a foreground of water, or a single tall tree with a little patch of cloud in the sky above it, or some similarly proportioned vertical image, will do very well for upright panels; a broad meadow, or mountain range, or long clouds with golden edges stretching out along the horizon will do very well for horizontal panels. Little odds and ends of this sort worked up for decorative purposes add a great deal to the coziness of the home.

Transparencies are sometimes very effective. These can be made on large plates coated with lantern-slide emulsion, or on slow plates which are suitably developed.

The former can be secured from most dealers on special order. They are handled in exactly the same way throughout as bromide paper, except that the strength of the image must be judged by looking through the plate. Special precautions should be taken to see that they are not fogged by unsafe light. Bound against a sheet of ground glass and framed, transparencies may be used for window decoration. They can also be colored if desired.

If the negative is a good one technically, an enlarged negative can be made without the aid of a large camera. By projection, a transparency or positive is made the same size as the desired enlargement. A new negative is made by contact from the enlarged positive, and prints as desired can be made from it by contact.

Although the darkroom light may be considered safe, thousands of dollars' worth of paper is wasted each year because of fog. *Never leave paper lying around loose in the darkroom or anywhere else.* Keep it covered even where the light is known to be safe. Diffusion and reflected light from the image on the easel will fog paper if it is exposed to it too long. It very frequently happens that stray light leaks through projection-apparatus of the lantern type, which can easily fog loose paper. We have known leaks of this latter type to be the cause of fog on paper on the easel, the fog being an absolute mystery to the photographer for a long time.

When making portraits it is frequently advantageous to enlarge through silk bolting cloth, producing soft diffused images and effectively covering up any small blemishes which may exist in the negative. By so doing, retouching the negative becomes unnecessary. Another means of softening portrait images is that of making only a portion of the exposure with the lens stopped down and the image sharply focused. If one-half or one-third the exposure is given with the image sharply focused and a small opening in the lens, and the remainder given with the image thrown slightly out of focus or with a sufficiently large stop to diffuse it, soft effects can be secured.

What stop to use when enlarging is frequently a cause of perplexity. It is advisable to use a combination of light and stop which will require an exposure of say two or three minutes if possible. This does not apply to commercial work where the operator attempts to do practically no mechanical work. By allowing sufficient time for exposure, dodging and vignetting various parts of the negative can be carried out satisfactorily. If the combination of factors makes a very short exposure necessary, handwork of this sort is not possible.

Conclusion—Although the principles which govern the process of enlarging are the same regardless of the type of apparatus used, their application can be so varied that it is impossible in one small volume to give full details of this vitally important and interesting subject. We have endeavored to outline the more common methods of working which have been proved successful up to the present time. Any of the devices that can be purchased for enlarging either by daylight or artificial light will be found thoroughly reliable and efficient within its scope. In making up apparatus at home, the problem can be approached from a great many different angles. Details of various types of apparatus can be changed to meet individual requirements. If the principles explained under the caption "Optical System" and the pages that follow it are thoroughly understood, the apparatus should be practical and efficient within the scope for which it is intended.

If this volume has left any doubts within the reader's mind, we will be glad to clear them up wherever possible, and will be pleased to have you consult the editor of AMERICAN PHOTOGRAPHY about doubtful points. An answer will be sent by mail, and if of sufficient interest will be published in AMERICAN PHOTOGRAPHY. If you are using manufacturer's equipment or material, use the manuals furnished with them. In case of difficulty, consult the maker. If it is a matter of general practice, we will be glad to help. If you are not already a subscriber to AMERICAN PHOTOGRAPHY or other magazines of equal practical value, you should be. They are worth many times the amount spent on them, considering alone the price of material which their perusal will save by helping you to understand and improve your work.

FORMULAE

METOL HYDROCHINON DEVELOPER

For gaslight papers

Water	32 ounces
Metol	15 grains
Sodium Sulphite (dry)	1 ounce
Hydrochinon	60 grains
Sodium Carbonate (dry)	½ ounce
Potassium Bromide	4 grains

For bromide papers

Water	32 ounces
Metol	20 grains
Hydrochinon	90 grains
Sodium Sulphite (dry)	¾ ounce
Sodium Carbonate (dry)	1¼ ounces

When mixed add two drams of 10 % Solution Bromide of Potassium.

AMIDOL DEVELOPER

For gaslight papers

Water, to make	10 ounces
Sodium sulphite (dry)	250 grains
Amidol	50 grains
Potassium bromide	2 grains

For bromide papers

Water, to make	20 ounces
Sodium sulphite (dry)	325 grains
Amidol	50 grains
Potassium bromide	10 grains

SIMPLE FIXING BATH

(Use the formula recommended for the paper in use, in preference to any other.)

Hypo	16 ounces
Water	64 ounces

Dissolve and add

Potassium metabisulphite	1 ounce
Water	16 ounces