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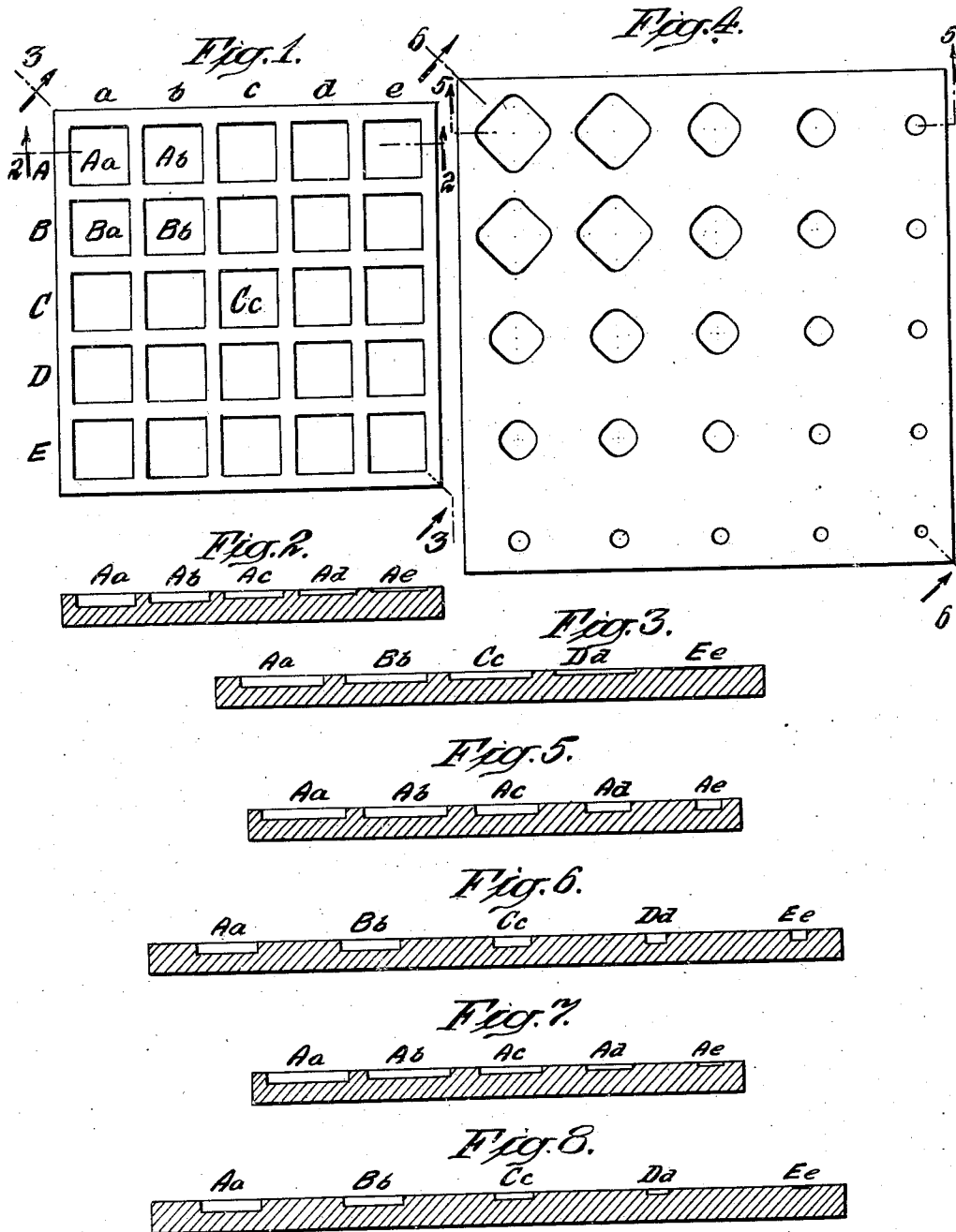
O. R. SCHULTZ ET AL

2,482,638

PHOTOGRAVURE

Filed April 12, 1943

2 Sheets-Sheet 1



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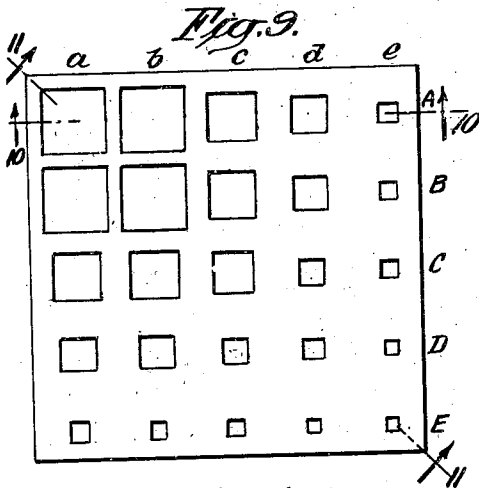
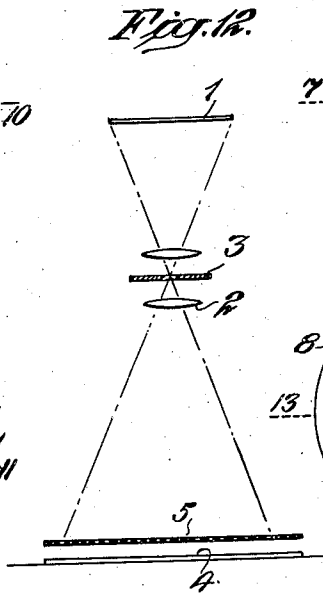
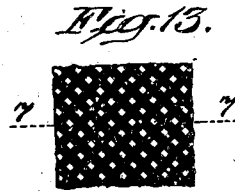
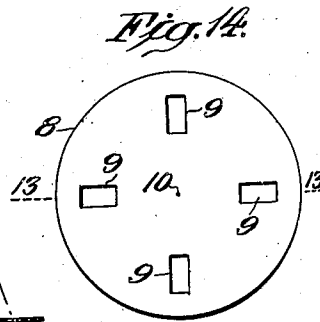
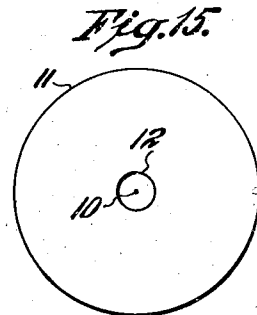
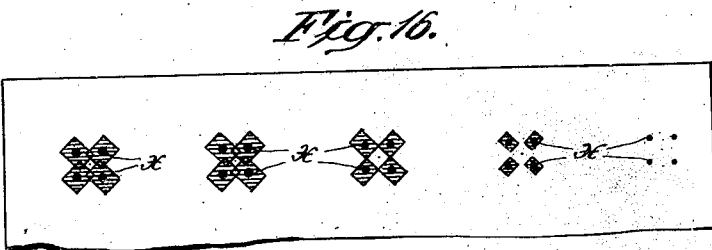
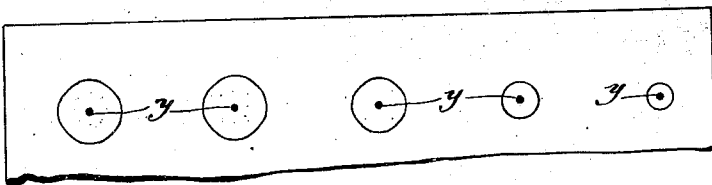
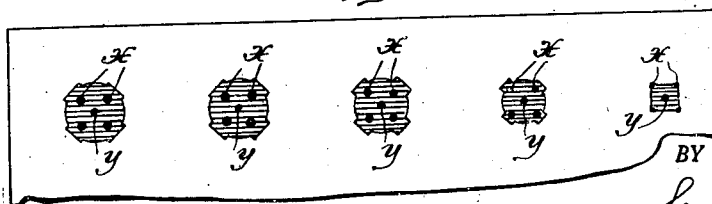
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2,482,638

PHOTOGRAVURE

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This invention relates to photogravure.

It is an object of the invention to produce an improved transparency for use in preparing gravure printing surfaces.

It is a further object of the invention to provide an optical arrangement and method of exposure by means of which such improved transparency is produced.

A still further object of the invention is to provide a method of making intaglio printing surfaces which produces an improved printing surface without increasing the number of steps or quantities of materials beyond those which are necessary in conventional photogravure.

With these general objects and still others which will appear in the following full description in mind, the invention consists in the methods and articles of manufacture which will now first be fully described in connection with the accompanying drawing and then pointed out more particularly in the appended claims.

In the drawing:

Figure 1 is a theoretical schematic plan view of a portion of a conventional intaglio printing surface;

Figures 2 and 3 are sections, respectively, on the lines 2—2 and 3—3 of Figure 1;

Figure 4 is a theoretical schematic plan view of a portion of a reverse half-tone intaglio printing surface;

Figures 5 and 6 are sections, respectively, on the lines 5—5 and 6—6 of Figure 4;

Figures 7 and 8 are sections similar to Figures 5 and 6, respectively, but illustrating a modified form of reverse half-tone printing surface;

Figure 9 is a theoretical schematic plan view of an improved intaglio printing surface;

Figures 10 and 11 are sections, respectively, on the lines 10—10 and 11—11 of Figure 9;

Figure 12 is a schematic view of a camera arrangement suitable for practicing the method of the present invention;

Figure 13 is a schematic view of a portion of a screen suitable for use in practicing the method of the invention;

Figures 14 and 15 are views showing aperture disks or stops suitable for use in practicing the method of the invention; and

Figures 16, 17 and 18 show, respectively, in schematic form, the exposure patterns producible by each of the stops of Figures 14 and 15 and the composite effect of superimposing the same.

Figures 1, 4 and 9 illustrate schematically the ways in which similar patterns of varying tone density may be produced by conventional photo-

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gravure, by reverse half-tone and by the method of the present invention. In each case a pattern of twenty-five cells is shown and the individual cells may conveniently be identified by considering the columns, starting from the left of the figure, as successively lettered *a, b, c, d, and e*, and the rows, starting from the top of the figure, as *A, B, C, D and E*, so that, for example, the center cell in each figure will be identified by the symbol *Cc*, and other cells correspondingly.

In the conventional gravure printing surface, the variation in tone is achieved primarily by varying the depth of the ink cells, thus, as indicated in Figure 2, progressively lighter tones may be produced by employing in the various areas of a picture to be printed progressively shallower ink cells *Aa, Ab, Ac, Ad, and Ae*. To illustrate the characteristics of the surface for printing a full tone the four upper left cells *Aa, Ab, Ba and Bb* are all shown as full depth.

From the standpoint of tone reproduction, the conventional gravure printing surface has a very marked advantage in that tone variation may be obtained by varying the thickness of the ink laid upon the paper, instead of merely varying the area of the inked surface, as in half-tone printing. Further, in the deep tones, most of the surface may carry ink so that it is possible for the ink to flow on the paper so as to produce a solid color, in which the areas in contact with the walls between cells have been covered with ink, as well as those which have come in contact with the ink carrying cells. The proportion of the ink carrying cell area to the total area may be large. For example, the width of the cells (Figure 2) may be four or five times as great as the width of the cell wall between cells, so that about sixty-five or seventy per cent of the surface area carries ink.

Conventional gravure printing is, however, subject to a distinct disadvantage in the printing of light tones due to the fact that in those tones the cells e. g. *Ee* of Figures 1 and 3 must be made so shallow that difficulty, due to action of the doctor and due to drying, may be encountered. As will be understood by those skilled in the art, the conventional gravure printing surface is a polished skin or shell of copper deposited on a cylinder and being only about six one thousandths of an inch thick. A typical cell formation may comprise about 150 lines to the inch, or 22,500 cells to the square inch. In view of these considerations, the maximum permissible depth of etch in the deep tones is limited, and accordingly the depth of etch required to produce sufficiently

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light tones in the highlights may be impractically slight. This defect manifests itself in a number of ways: First, since the highlight cell is very shallow it is possible for drying of the ink to affect the printing very materially and in some cases to obliterate it; secondly, the cell wall being relatively narrow, a certain amount of wear due to abrasion by the doctor will occur and in the case of a very shallow cell the relative decrease in depth thus produced may be such as seriously to affect the printing; thirdly, the effects of variation in the viscosity or other characteristics of the ink and the doctor blade action may be found to interfere with the quality of printing produced by such an extremely shallow cell. It is a primary object of the present invention to produce an intaglio printing surface which retains the advantages of conventional gravure in the deep tones but remedies the defects of conventional gravure in the light tones.

The conventional photogravure process is well understood. Briefly it involves the following steps: First, a negative of the copy to be reproduced is made; second, this negative is photographed without using a screen so as to produce a positive transparency; third, a sensitized resist, typically carbon tissue, is exposed through a gravure screen; fifth, the resist is transferred to the copper cylinder and developed to dissolve away the unexposed areas according to the extent of exposure, those areas which have been subjected to the greatest exposure being rendered more insoluble and those which have been subjected to the least exposure remaining relatively soluble; and sixth, the printing surface is etched through the resist in a bath which consists typically of a series of progressively weaker solutions of ferric chloride. The screen employed, will, of course, be composed of opaque areas corresponding to the ink cells to be produced and of transparent lines, forming a transparent ground which corresponds to the cell walls or unetched surface.

This process may be modified in various ways, to obtain special results where desired. For example, the order of the exposures of the carbon tissue to the screen and to the positive transparency may be inverted. Also, the transparency itself may be screened, and in this case the screen employed will be a negative intaglio screen having relatively transparent areas corresponding to the ink cells to be produced and relatively opaque areas or ground corresponding to the unetched surface or cell walls.

The conventional gravure process, however performed, has very desirable characteristics of simplicity in the number of steps required, economy in materials used, avoidance of registration difficulties and ease of retouching. With regard to the last feature, retouching may normally be done on the positive, but may also be done on the negative. It is an object of the present invention to produce a printing surface of the character indicated above, without sacrificing the major advantages of the conventional photogravure process.

The invention will be more clearly understood by also recalling briefly some of the characteristics of reverse half-tone printing. This process is substantially as old as photogravure itself, and involves the production of a printing surface simulating a half-tone surface, but carrying the ink in depressed areas instead of upon raised areas. Such a surface, having tone variation similar to that of Figures 1, 2 and 3 is shown in Figures

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4, 5 and 6. The largest ink carrying cells being of the same area as those in Figure 1, and an equal minimum thickness of wall between cells being preserved, it will be observed that a much larger area of the printing surface is required to carry the same quantity of ink. For example, where a conventional gravure surface may comprise ink cells occupying about seventy per cent of the total surface in the deep tones, reverse half-tone can have ink cells occupying only about forty per cent of the total surface, which means that the gravure surface is inherently capable of laying seventy-five per cent more ink on the paper in the deep tones than can be done by reverse half-tone. Figures 5 and 6 illustrate the cell formation of a reverse half-tone surface theoretically, all cells being of equal depth. It is, however, apparent that all cells will not be of equal depth as those of larger area will be necessarily of greater depth, due to the action of the etching bath. This effect is noticed even in relief half-tone but is immaterial in that connection for the reason that the raised areas rather than the depressed areas do the printing. Figures 7 and 8 may be taken to illustrate either this effect or the effect of known processes by which explicit provision is made for varying the depth of etch as well as the area of the ink cells. Such proposals are all subject to the common difficulty that while an improvement in reproduction may be obtained in the light tones, this is done at the expense of the deep tones and the characteristic gravure effect is lost. Also, it is not possible, as a practical matter, to control the depth of etch as indicated in Figures 7 and 8 without employing a plurality of transparencies or negatives which require to be superposed in accurate registry. For such reasons, the characteristic simplicity and economy in materials of conventional photogravure are lost, in large measure, and the plurality of negatives or positives which are necessary introduce difficulties in retouching.

According to the present invention a printing surface is produced which has the conventional gravure formation in the deep tones. As indicated in Figures 9, 10 and 11, the deepest tone formation of the printing elements (cells Aa, Ab, Ba, Bb) may be identical with that of a conventional gravure printing surface (Figures 1, 2 and 3). However, in the lighter tones the relative widths of the ink cells and the cell walls are changed so that the cells become progressively smaller and the walls progressively wider. In this way, the amount of ink carried in the lightest areas may be reduced to any desired extent without requiring an impractically shallow ink cell. For example, if the cell Ee of Figure 9 be considered as having a width which is one eighth that of the cell Aa of Figure 9 (or the cell Ee of Figure 1), it will have only one sixty fourth the area and may be made sixty-four times as deep as the cell Ff of Figure 1, if it is to carry the same amount of ink. As will be immediately apparent to those skilled in the art, a printing surface such as that of Figure 9 possesses all the advantages of a conventional gravure surface in the deep tones while remedying its defects in the light tones. This is due to the retention in the deep tones of the characteristic continuous cellular structure of the gravure printing surface as opposed to the checkerboard structure of a reverse half-tone.

The method by which the surface of Figure 9 may be produced may be best described with ref-

erence to the conventional gravure method described above.

The first step involves the production of a similar negative, but the negative should preferably be soft, having a contrast of about 0.7 and sometimes as low as 0.5, as compared with contrasts in excess of 1.0 which are customarily employed in known processes. This in itself indicates the desirable characteristics of the method of the invention, as it may be practiced so as not to lose contrast either at the upper or lower end of the density scale.

The second step involves exposure of the negative 1 in a conventional copying camera such as is now used in conventional process work. The lens of the camera is indicated diagrammatically at 2, the iris diaphragm or other aperture disk at 3, and the positive plate at 4. This plate 4 may be either a plate of one of the "commercial" contrasts used in conventional photogravure or may be of greater or less contrast, as for example a "line" or "process" plate, the control afforded by the process being sufficient to permit use of widely varying emulsions and development procedures. A screen 5 is employed in exposing the positive 4 and will, in effect, be the negative of a conventional gravure screen, having transparent areas corresponding to the ink cells to be produced and opaque areas corresponding to the cell walls to be produced. A cross-line screen may be employed, as usual, so as to produce square ink cells or printing elements. By utilizing suitable optical arrangements, a positive suitable for producing a printing surface having the characteristics of that of Figure 9 may be obtained. The ratio between the opaque lines of the screen and the transparent areas between lines necessarily depends upon or, conversely, if a given screen is to be used, influences, the spacing of the screen from the positive emulsion and the character and size of apertures used. Considerable variation in the ratio is therefore permissible, but a screen in which the opaque lines are equal in width or twenty per cent greater in width than the spaces between lines will be found generally satisfactory. Figure 13 illustrates a portion of such a screen, on an enlarged scale (about fifteen diameters), the "line" of the screen being indicated by the reference number 7. Specific conditions, where referred to for the purpose of illustrating the process more clearly, will be based on the assumption that a screen of such ratio is employed. In a way which will now be more fully described, optical arrangements are utilized by means of which the effective area of the light spot produced upon the emulsion by a given transparent screen element may be either larger, equal to, or smaller than the area of the transparent screen element itself. Moreover, these optical arrangements permit orientating the various light spots similarly to the transparent screen elements so as to produce a true gravure cell arrangement.

The positive 4 is subjected to two exposures, one through an aperture board 8 (Figure 14) having peripheral apertures, preferably rectangular in shape as shown and symmetrically arranged about the lens axis 10, and the other through an aperture board 11 (Figure 15) having a central aperture 12 concentric with the lens axis 10. Referring again to the assumed illustrative condition, a 150 line screen will be placed about $\frac{1}{8}$ inch from the positive emulsion, making the distance of the rulings therefrom about $\frac{1}{8}$ inch, and an exposure of about 15 to 30 seconds may be

given through the stop 8 and about 5 minutes through the stop 11. The stop 8 will be placed in the camera so that a diagonal 13, of the square in which the openings 9 are arranged will be in alignment with the "line" 7, of the screen.

The exposure through aperture 8 will produce light elements corresponding to the transparent elements of the screen having much the appearance of Figure 16, the four apertures 9 projecting rectangular images arranged in a cross and the effective area of these images varying in accordance with the transparency of the negative. As will be understood by those skilled in the art, each rectangular image will be brightest near its center x and will shade off toward its edges, ultimately shading off to a point where there is insufficient light to have any operative effect on the positive emulsion such as will carry through the subsequent processes of exposure of the resist, development of the resist and etching, so as to be apparent in the printing surface. In view of this, the light elements projected on the positive emulsion will have progressively smaller effective diameters as the density of the portions of the negative to which they are exposed increases. In this way, negative areas of progressively increasing density may be made to produce exposure patterns on the positive emulsions having progressively decreasing diameters, and corresponding in order, for example, to the ink cells of different depths which it is desired to produce in the top row of the printing surface shown schematically in Figures 9 and 10. As will be noted, the four brightest points x of the images produced remain in the same position, from picture element to picture element, while their intensities and effective diameters change.

By exposure through stop 11, a pattern of light elements having effective areas such as shown in Figure 17 may be produced, and these elements will automatically be in register with those of Figure 16, as the lens, the negative, the positive and the screen all remain in the same position for this exposure. These elements will, of course, be brightest at their centers y and will shade off toward the edges.

The superposed light elements of Figures 16 and 17 produce composite elements as indicated in Figure 18. Each composite element contains five bright spots arranged approximately as indicated, contributing to the uniformity in density of the dark element produced when the positive plate is developed.

As will be understood, the usual phenomena of spreading of light both by the apertures and screen and in the photographic emulsion itself, will occur, and will largely obliterate the sharpness of the outlines of the composite elements, so that the developed positive will be formed of printing elements, or relatively dense elements, which are substantially square and present the appearance and arrangement of the ink cells of Figure 9, and which are interspersed on a transparent ground having the form of the cell wall structure of the printing surface of Figure 9. By suitably relating the two exposures, the composite elements may also be made to assume the form of a four-sided cuspidal figure, or square with concave sides. This effect may be employed to insure the production of a truly square ink cell, by counteracting the tendency of the etching bath to eat away the cell wall faster toward its center than toward the corners.

The stops 8 and 11 may be simply inserted successively in the lens barrel, in the slot fre-

quently provided adjacent an iris diaphragm for that purpose, or successive exposures through the stops provided for in any other convenient manner. The order of the two exposures is not critical. For example, a stop having both peripheral apertures 9 and a central aperture 12 may be used, part of the exposure being given through all apertures and the remainder through only the central aperture, the peripheral apertures being covered. Theoretically, by exactly proportioning the peripheral apertures and the central aperture, a single exposure through all apertures might be given to produce the desired effect. This, however, would present no advantage and would interfere with obtaining the very desirable control which can be obtained in practicing the present method as more fully gone into below. It should be noted at this point, however, that, where the lens used is provided with an iris diaphragm, the iris diaphragm itself may be used as the aperture 12, it being unnecessary to insert a separate stop 11.

The result of the foregoing procedure is to produce a screened positive transparency in which the various printing elements are arranged in a gravure pattern, but in which the transparent ground forms a rectangular network of lines of varying width, and the printing elements occupying the interstices in this network are of progressively less density as their width decreases.

Inasmuch as a screened positive transparency is produced, the step of exposing the carbon tissue through a separate screen may be eliminated from the conventional gravure process and the carbon tissue is exposed merely through the positive transparency. The optical arrangement of the invention makes it possible to obtain the required areas and depths of cells in the printing surface while maintaining a proper cell wall structure.

The remaining steps of developing the carbon tissue and etching the cylinder are carried out as in conventional photogravure and require no further description.

The primary requisite of a positive transparency for use in practicing the method of the invention is that the area of the relatively opaque elements corresponding to the ink cells to be produced on the printing surface be varied so that the elements corresponding to the lighter areas to be printed will be smaller and those corresponding to the darker areas will be larger. This variation in area should follow with reasonable fidelity the tone variation of the picture to be reproduced. In this connection, however, it should be noted that the areas of the picture elements need not be proportional to the tone density of the picture to be reproduced. In other words, since the ultimate control of tone variation involves also the depth of etch in the various cells a reasonably wide variation in the contrast range of the positive transparency (considering only the area of the elements and assuming them all to be of equal density) is permissible and may in many cases be desirable.

The secondary requisite of a positive transparency to be used in practicing the invention is that there be a difference in density between the picture elements of larger area and those of lesser area. The exact amount of difference is not critical as the depth of cell produced in the printing surface need not and in general will not correspond proportionately or in any other specific way with the photographic density of the

corresponding element of the transparency. This is due to the fact that the depth of etch in the various tones is controlled in the etching process by varying the strength of the successive baths and the length of time to which the printing surface and resist are subjected to the successive baths. Due to this, indistinguishable printing surfaces may be prepared from transparencies having widely different contrasts.

The possibility of control of cell depth or tone contrast in the etching bath which is inherent in the photogravure process makes it possible to pay attention primarily to the area of the printing elements produced in the positive transparency. The variation in density of the printing elements will largely take care of itself. A gradation in density from the larger printing elements to the smaller ones will occur and so long as this is sufficient to make it possible to control the depth of etch, the precise limits of variation are not critical.

The process of the invention, as described above, offers very great possibilities for control. For example, the two exposures may be so inter-related that the lightest areas of the picture (darkest areas of the negative) will produce an effective exposure through the central aperture but not through the peripheral apertures. This permits control of width and depth of the ink cells in the highlights of the picture without appreciably altering the width of the ink cells or cell walls in the deep tones. Alternatively, the effect of the peripheral exposure may be carried up into the highlights, producing a smaller variation in width of the ink cells as compared with the variation in depth.

The exact dimensions and shapes of the apertures used are not critical, and may be varied without varying the effects achieved, where the screen or screen distance are compensatingly varied. The principles controlling the choice of apertures will be best understood by considering the effect of exposure through a single aperture of known type. A great variety of such apertures is known in process work generally and it will suffice to discuss but two of the possibilities.

If it be attempted to produce a positive transparency such as is produced by the present method, using simply a central aperture such as the aperture 12, it will be found that the effective areas of the exposure elements and the effective brightness are inextricably connected so that the one varies with the other. Obviously, density variation of the negative will tend to be multiplied, manifesting itself both in increased area of the printing elements and in increased density. From the standpoint of the transparency, therefore, an extremely low contrast emulsion and development process will be found necessary. This, however, will make it impossible to obtain a sharply defined transparent ground and will result in destroying the cell wall structure. A further difficulty will be encountered due to the center parts of all elements tending to be exposed so close to the limit of exposure of the film that all cells will commence to etch at about the same time in the bath. This effect makes it impossible to etch a gravure printing surface properly, for, as is well known, there must be sufficient difference in the resist thickness of the general masses of deep, middle and light tones to permit control of which set of tones is etched by using different strengths of etching baths.

A single exposure through the peripheral apertures 9 will, on the other hand, result in a positive

in which the printing elements spread and coalesce one into the other before sufficient density is achieved.

With a half-tone screen formation, consisting of a screen and an aperture related thereto so as to produce a half-tone exposure pattern, a gravure pattern cannot of course be obtained. In the second place, the difficulties just mentioned are aggravated, as the diagonals of the printing elements are in alinement and the tendency to break down the transparent ground is aggravated. In such formation, as is well known, when an unsymmetrical aperture pattern is used it must be placed at forty-five degrees to the screen. For example, when an aperture of known type, and consisting of a cross-shaped opening is used, an arm of the cross will be at forty-five degrees to the screen line 7 rather than in alinement with it.

In the present method, on the other hand, a true gravure screen formation is employed, and the difficulties above mentioned do not occur. For example, the aperture 12 may be such that an extremely small and sharp exposure element is projected on the positive emulsion, and exposure may accordingly be prolonged so as to obtain sufficient depth in the highlights without spreading the cells in the deeper tones so as to endanger the cell walls. The apertures 9 are preferably set so as to extend as far out as the lens will permit, their outer ends extending close to or up to the arc of the biggest stop for which the lens is designed, they may also extend inwardly as far as possible without interfering with each other. In this connection, it may be noted that the images of the four apertures 9 may typically overlap slightly where the more transparent areas of the negative are being reproduced. The aperture 12 is preferably of such diameter as to be wholly inside the inner edges of the apertures 9, and the best results will ordinarily be obtained with a small stop, such as about $f:45$ to $f:90$.

As will be clear from the foregoing description, the present process involves no additional steps or materials as compared with conventional photogravure. The step of exposing the carbon tissue through a screen is eliminated and the positive given two exposures instead of one. Retouching, while it must be done upon the negative, can conveniently be done in this way, and the complications involved in retouching where registered transparencies are employed, are avoided.

The essential characteristic of the novel transparency produced is that it is composed of picture elements the denser of which are arranged in a gravure pattern while the less dense elements grow progressively smaller. The picture accordingly will be represented by areas composed of a gravure pattern of picture elements, the deep tones having relatively wide and dense picture elements and narrow transparent ground lines and the lighter areas having relatively narrow and less dense elements separated by wider transparent ground lines. As is apparent, the optical arrangement discussed may be used to produce a pattern in which in the light tones the picture elements are round, and by using central apertures of different shapes, picture elements of different shape may be produced in the lighter tones without disturbing the deep tone gravure formation. Such procedure, while possessing no advantage, may be followed without departing from the invention. In particular, the transparency having the gravure pattern of Figure 9 in the deep tones and a half-tone pattern like that of Figure 4 in

the light tones, or any other desired pattern, may be utilized. Other forms of screen than that described above may be used, but the transparency must have the characteristic gravure formation in its deep tones. Regardless of the shape of the picture elements, they will be arranged in a honeycomb or continuous cellular pattern in the deep tones, in which the polygonal or other shaped elements are arranged with their sides rather than their vertices adjacent.

The present process permits of reproducing material which combines pictorial and type or line subject matter by incorporating all the material in the original negative and a printing surface capable of producing sharp and solid type and line work and also capable of producing delicate gradation even in the highlights is readily obtained. Furthermore, the process is adapted to producing satisfactory monotone and two-color printing, this being impossible with reverse half-tone due to the fact that in reverse half-tone a single cylinder or even two cylinders are incapable of sufficiently covering the paper in the deeper tones.

The essential characteristic of the method of the invention is that a true gravure screen arrangement is employed for the deep tones. In this arrangement, an exposure is given through the peripheral apertures with the diagonals, or greatest diameters of the aperture pattern, in line with the screen, as it is only in this way that a true gravure pattern may be obtained while causing the cell width in the light tones to be less than that in the deep tones. A second exposure to fill the centers of the picture elements is then given, and the specific shape of the picture elements produced by this exposure alone is largely immaterial as it is sufficient localized or concentrated as not to obliterate or disturb the gravure pattern of the deep tones, while the specific pattern produced in the lighter tones is not vital.

In color printing a plurality of separation negatives are employed as usual, a positive transparency being made from each. As the procedure followed is well known, it is unnecessary to describe it in detail, beyond commenting briefly on certain points. As is apparent, some or all of the different transparencies or printing surfaces used for producing the color picture may be prepared according to the present invention and others according to the conventional photogravure method. Screen angles will be varied as in conventional gravure, it being necessary to note only that the aperture boards will also be turned so as to preserve the proper relation to the screen. Additional possibilities of control are opened up, however, as the light tone pattern may be different in the transparencies for the different colors. Also, as will be apparent to those skilled in the art, the double contrast control afforded by the present invention may readily be employed to obtain accurate rendition of very delicate intermediate tints and shades of tints without disturbing the stronger colors and light tints and shades of tints.

What is claimed is:

1. As a new article of manufacture, a picture transparency comprising a substantially uniform ground and picture elements of varying densities, the picture elements which have densities differing most from said ground being arranged in a gravure screen pattern and the picture elements which have densities differing least from said ground having areas decreasing progressively with decreasing density difference

from the ground, each picture element being composite and being defined by a central spot and a plurality of corner spots grouped therearound, the placement and spacing of the spots being the same in the various elements, and each spot comprising a center having a density differing most from the ground and differing progressively less in density from the ground as the distance from the center increases, the said spots of each element overlapping so as to form a single picture element.

2. As a new article of manufacture, a picture transparency comprising a substantially uniform ground and picture elements of varying densities, the said picture elements being arranged in a gravure screen pattern, the areas including elements having densities which differ most from said ground comprising relatively large picture elements separated by relatively narrow ground areas, and the areas including elements having densities closer to that of the ground comprising progressively smaller picture elements and wider ground areas, each picture element being composite and being defined by a central spot and a plurality of corner spots grouped therearound, the placement and spacing of the spots being the same in the various elements, and each spot comprising a center having a density differing most from the ground and differing progressively less in density from the ground as the distance from the center increases, the said spots of each element overlapping so as to form a single picture element.

3. As a new article of manufacture, a picture transparency comprising a substantially uniform ground forming a cross line screen pattern of lines of varying width and defining enclosed picture elements of varying area, the said picture elements having densities progressively further from that of the ground with increasing area, each picture element being composite and being defined by a central spot and a plurality of corner spots grouped therearound, the placement and spacing of the spots being the same in the various elements, and each spot comprising a center having a density differing most from the ground and differing progressively less in density from the ground as the distance from the center increases, the said spots of each element overlapping so as to form a single picture element.

4. As a new article of manufacture, a positive picture transparency comprising a relatively transparent ground and picture elements of varying densities, the denser of said elements being arranged in a gravure screen pattern and the less dense of said elements being of progressively decreasing area with decreasing density, each picture element being composite and being defined by a central spot and a plurality of corner spots grouped therearound, the placement and spacing of the spots being the same in the various elements, and each spot comprising a center of greatest density and decreasing in density as the distance from the center increases, the said spots of each element overlapping so as to form a single picture element.

5. As a new article of manufacture, a positive picture transparency comprising a relatively transparent ground and picture elements of varying densities, the said picture elements being arranged in a gravure screen pattern, the areas including denser elements comprising relatively large picture elements separated by relatively narrow ground areas, and the areas in-

cluding less dense elements comprising progressively smaller picture elements and wider ground areas, each picture element being composite and being defined by a central spot and a plurality of corner spots grouped therearound, the placement and spacing of the spots being the same in the various elements, and each spot comprising a center of greatest density and decreasing in density as the distance from the center increases, the said spots of each element overlapping so as to form a single picture element.

6. As a new article of manufacture, a positive picture transparency comprising a relatively transparent ground forming a cross line screen pattern of lines of varying width and defining interstices of varying area, and picture elements of varying densities occupying said interstices, the said picture elements having densities progressively decreasing with decreasing area, each picture element being composite and being defined by a central spot and a plurality of corner spots grouped therearound, the placement and spacing of the spots being the same in the various elements, and each spot comprising a center of greatest density and decreasing in density as the distance from the center increases, the said spots of each element overlapping so as to form a single picture element.

7. The method of making a transparency for use in preparing printing surfaces which comprises photographing a picture to be reproduced through a screen, part of the exposure of the said picture being given through a stop having a central aperture and part of the exposure of the said picture being given through a stop having peripheral apertures, the said peripheral apertures and screen being so spaced and angularly related as to produce a pattern of exposed elements having their greatest dimensions substantially in alignment with the greatest dimensions of the transparent elements of the screen.

8. The method according to claim 7, in which a cross line screen is employed and the said peripheral apertures comprise four apertures arranged symmetrically about the lens axis.

9. The method according to claim 7, in which the said peripheral apertures are spaced around the lens axis outside the boundary of said central apertures.

10. The method according to claim 7, in which a cross line screen is employed and the said peripheral apertures comprise four apertures arranged symmetrically about the lens axis and spaced around the same outside the boundary of said central aperture.

11. The method of preparing printing surfaces which comprises photographing a picture to be reproduced through a screen, part of the exposure of the said picture being given through a stop having a central aperture and part of the exposure of the said picture being given through a stop having peripheral apertures, the said peripheral apertures and screen being so spaced and angularly related as to produce a pattern of exposed elements having their greatest diameters substantially in alignment with the greatest diameters of the transparent elements of the screen, and the relative exposures through said central aperture and said peripheral apertures being such as to produce a photograph having exposed elements of varying densities, the denser of said elements having a gravure screen formation and the less dense of said elements decreasing in area with decreasing density.

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12. The method according to claim 11, in which a cross line screen is employed and the said peripheral apertures comprise four apertures arranged symmetrically about the lens axis.

13. The method according to claim 11, in which the said peripheral apertures are spaced around the lens axis outside the boundary of said central aperture.

14. The method according to claim 11, in which a cross line screen is employed and the said peripheral apertures comprise four apertures arranged symmetrically about the lens axis and spaced around the same outside the boundary of said central aperture.

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