Feb. 19, 1935. V. C. ERNST 1,991,888

LENTICULAR FULL TONE REPRODUCING SCREEN

Filed Nov. 11, 1932

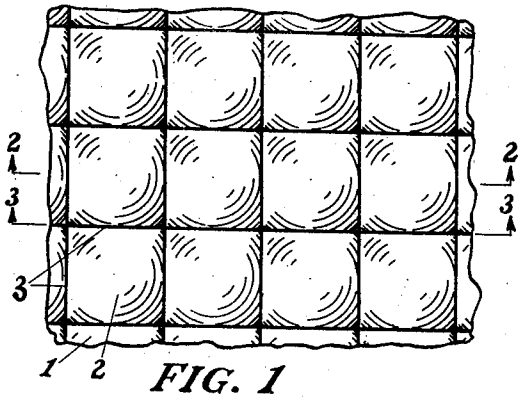


FIG. 1

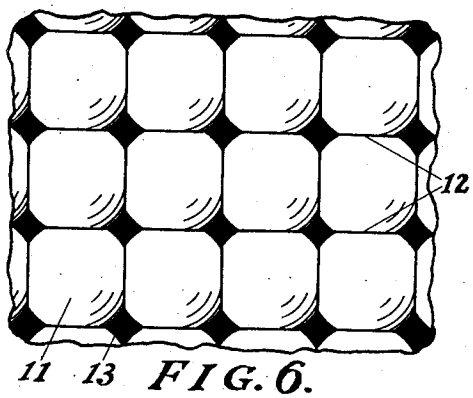


FIG. 6.

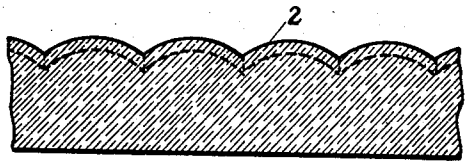


FIG. 2

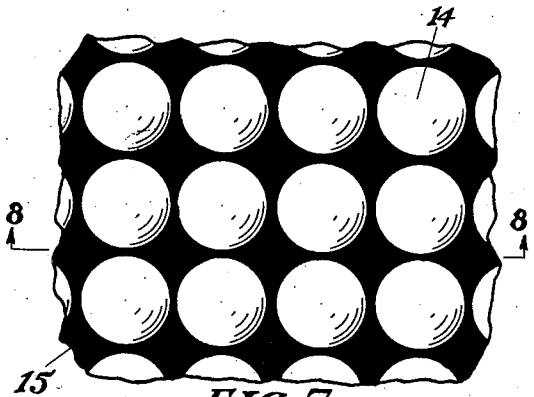


FIG. 7

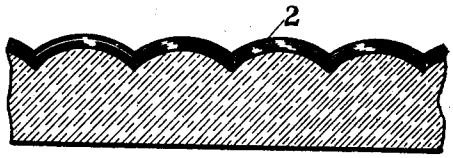


FIG. 3.

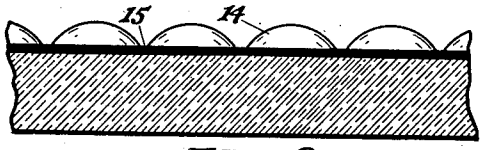


FIG. 8

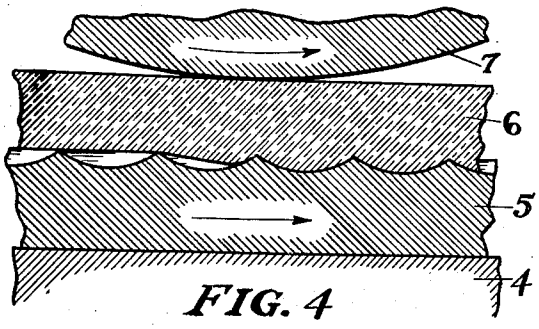


FIG. 4

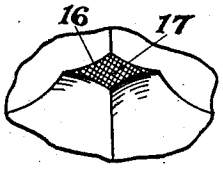


FIG. 9.

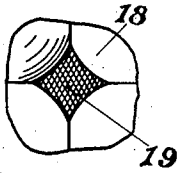


FIG. 10.

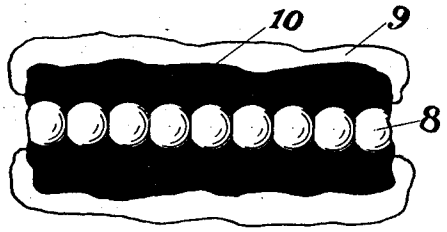


FIG. 5

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UNITED STATES PATENT OFFICE

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LENTICULAR FULL TONE REPRODUCING SCREEN

Victor C. Ernst, Cleveland, Ohio, assignor to The Full Tone Process Company, Cleveland, Ohio

Application November 11, 1932, Serial No. 642,237

5 Claims. (Cl. 95—81)

My invention pertains to a lenticular full-tone-reproducing screen which constitutes a modification of the subject matter of my patent for a lensic screen issued November 15, 1932, No. 1,887,872 and the use of which may involve the process shown, described and claimed in my Patent No. 1,849,036 of March 8, 1932. In part the showing hereof constitutes subject matter divided out of the application for the later issued patent above identified.

The art of half tone production derived its name from the attainment of an intermediate, middle or half tone between the two extremes of black and white and while an improvement was still far short of exact tonal reproduction, because the mutation as between areas of white, grey and black or as between high, middle and shadow tones remained very abrupt. Moreover, human manipulation is required when employing a prismatic or ruled screen in order to obtain the desired dot formation and since the half tone process involved use of the screen in a camera it was required to control results by different exposures, varying diaphragm openings and different time intervals of exposure depending upon the size of diaphragm opening. It was in truth a highly technical and expensive art while retaining insurmountable imperfections.

My invention achieves full tone production in the sense of a faithful reproduction of all the tonal gradations of a continuous tone negative. Its application permits of attainment of high, middle and low high lights, high, middle or low intermediary tones and high, middle or low shadow tones or even higher multiples of all three. Attainment of its superior results is independent of special camera accessories or camera adjustments as for instance of the diaphragm opening or adjustment of a screen within the camera. Pithily, it is optically automatic, accurately to reproduce by dot formation control through the lensic screen.

Besides realization of the general objects set forth in my identified patent and patent application, my present invention improves by perfecting the plate etching procedure more easily yet more reliably to insure sharp edge definitions. The lenticular screen itself is formed with over twelve thousand lenses to the square inch, but instead of having only separated portions of the lenses truncated to provide symmetrically arranged bordering edges which coincide with similar truncation edges of a plurality of surrounding lenses to leave flat-bottomed transparent areas between groups of three or more lenses which have their centers on a circle, I bring such groups of lens centers still closer together until complete lens edge truncation occurs or until all flat or unrefractive areas are eliminated. That permits closer lens centers or more lenses of given size to the square inch without loss of indispensable optical performance because the retained convex (spherical as exemplified) surfaces are less affected by aberration.

As an operative equivalent for the new design of screen just explained, I may supply opacity to the intervening flat areas of my earlier employed partial lens-truncation form of screen and likewise to appositioned portions of the lenses by partially filling the depressions therebetween with an opaque coating. That is accomplished by coating the entire screen with a suitable black media and then rubbing off the raised centers of the lenses by polishing application of a flat surface in contact therewith. Much of the spherical aberration would be similarly eliminated because the effect would be the same as curtailing the diaphragm opening of a camera lens. To a negligibly lesser extent the desired modification of my earlier screens (first as in my patent and second as in my allowed application) could be achieved by knurling the raised islands between the lens-forming depressions in my forming die so as to make adequately translucent only the flat areas of the screen.

Adverting to the drawing:

Figure 1 is a top plan view greatly magnified, of a small portion of a lensic screen showing a plurality of plano-spherical lenticular elements each in quadrilateral merging relationship with eight surrounding lenses.

Figure 2 is a section on line 2—2 of Figure 1.

Figure 3 is a section on line 3—3 of Figure 1.

Figure 4 illustrates a manner of fabrication of the lensic screen as by compression of the material of which it is composed between a die and a roller.

Figure 5 is a plan view of a modified form of screen supplied with an opaque coating according to the principle shown, described and claimed by my copending application Serial No. 488,849.

Figure 6 is a view corresponding to Figure 1 of a modification wherein individual lenses though of slightly smaller size have the centers of adjacent pairs spaced apart about the same distance as the centers of pairs of adjacent lenses in Figure 1 and wherein the intervening space between groups of four lenses are supplied with an opaque coating.

Figure 7 is a view corresponding to Figure 6, illustrating a further modification with com-

paratively larger opaque lens-interjacent areas.

Figure 8 is a section on line 8—8 of Figure 7 to reveal the depth of the opaque medium.

Figure 9 is a perspective view of one of a multitude of prominences on forming die showing the flat upper surface of the prominence knurled whereby to impress a complementarily roughened surface to function as the equivalent of the opaque areas between individual lenses.

Figure 10 is a view corresponding to Figure 9 showing one of the lens-interjacent areas as formed by the die prominences shown in Figure 9.

The integral lensic screen 1 will be composed of some transparent material with adequate optical properties and has embossed thereon a multitude of spherically surfaced lenses 2. As actually produced and in successful commercial use, in the form shown in Figure 6 excepting for the opaque coating, there are twelve thousand one hundred lenses 2 to the square inch. In order to bring the lens centers closer together each lens is fashioned with four quadrilateral determinant edge truncations each of which coincides with a similar edge truncation of an adjacent lens. The design of Figure 1 besides permitting the presence of more lenses of given size to the square inch achieves the advantage of elimination of lens-bordering areas where more aberration is expectable. In other words, the same beneficial result is realized as when employing a diaphragm opening of less diameter than the diameter of a lens in a camera. Actually, the lens centers in Figure 1 are brought close enough to each other, with consideration of the chosen spherical curvature, to cause the four truncation planes of each lens to define a square and to completely eliminate any intervening flat areas on that side of the lensic screen from which the lenses project. The truncation plane determining lines are designated by the numeral 3.

In Figure 4 is shown a suitable base 4 on which rests a die 5 fashioned above with appropriately formed cavities in which the plastic lensic screen material 6 is to be roll-compressed with the aid of a roller 7. It is mentioned that such lensic screen production would not subject to any restriction in size because composed of flexible material.

The single row of microscopic lenses 8 is in Figure 5 shown to be embossed upon a strip of transparent material 9 and to be enclosed by an opaque coating 10 because it has been discovered that such a novel product achieves an astounding improvement when inserted in the optical trail of sound heads employed for the recordation of sound tracks on film and for the reproduction of sound from sound track records. Such a single row of eleven lenses 8 comprehending in length about five-sixteenths of an inch has been successfully made and advantageously used and sold.

Figure 6 discloses lenticular elements 11 each of which is partially defined by four symmetrically arranged truncation planes which are determined by the lines 12 whereby to leave flat lens-surrounded areas 13, which according to this invention are supplied with an opaque coating to preclude the passage of parallel rays or to delimit the emergence of light through the lensic screen to refracted rays.

Figures 7 and 8 pertain to a modification in which the bordering circles of the lenses 14 are not truncated and consequently in which the interjacent flat areas are proportionately larger. Figure 8 is purposed to reveal a depth of opaque coating 15 in excess of what would be required for merely preventing the passage of light rays through the flat areas of the screen. By supplying the opaque coating 15 to an appreciable depth it necessarily rises to restrict the diameter of transparency of the lenses and thereby fulfills the equivalent function of restricting refraction of the light rays to a central smaller circular area which the law of optics establishes to be most effective. In manufacturing a screen such as is shown in Figures 7 and 8 the entire upper surface is covered with an opaque coating and thereafter the desired central circles of the lenses are again made transparent by a gentle abrasive application to the collection of lenses.

While Figure 9 illustrates only one die prominence 16, it is to be understood that thousands will be employed in predetermined spaced relation, the number necessarily varying according to the size or area of lensic screen to be produced and used. The upper substantially flat surface of each prominence 16 is knurled as indicated by the numeral 17 so that when it is applied to the lensic material 18 it fashions a lens-interjacent depression the bottom 19 of which is similarly knurled and hence adapted to preclude the passage of undesirable parallel rays in a manner equivalent to the opaque areas 13 in Figure 6.

It is to be realized that the scope of my invention comprehends many equivalent methods and constructions. The showing of the drawing and the particular description are merely specific exemplifications of a plurality of mechanical embodiments and arrangements.

By my earlier reference to my Patent No. 1,887,872, I meant to have it understood that the common photographic printing procedures will be practiced with the unique aid of my lensic screen. Ordinarily, a photographic continuous-tone negative of the object or picture which it is desired to reproduce is first obtained. For simplicity and convenience the sensitized emulsion may be deposited on the flat side of the lensic screen preparatory to recordation and preservation thereby of the desired picture. If a negative has been previously made, it is placed in contactual relationship to one side of the lensic screen. During so-called contact printing the light rays are projected toward the metal plate and intercepted by the lensic screen to be multiple-refracted thereby through the negative to the plate. In projection printing (enlarging or reducing) the light rays are first directed through the photographic negative and then through the lensic screen to the light sensitized surface. The use of my lensic screen permits of achieving full tone reproduction of all variations of light and shade independent of the cumbersome and expensive wet process and with a realization of the advantageous fidelity which photography has over human artistry which however skilled is subject to the uncertainty of every human equation.

I claim:

1. An optical element of the character described comprising a row of microscopic spherically surfaced lenses truncated on opposite sides crosswise of said row and opacity means between appositioned arcuate areas of pairs of lenses.

2. A screen of the character described comprising a multitude of rows of microscopic lenses each truncated on opposite sides both lengthwise and crosswise of said rows and opacity means between groups of said lenses and extending around each.

3. A lenticular screen integrally formed with a

multitude of microscopic lenses each of polygonal shape and defined by edge truncations of which truncation planes of adjacent pairs of lenses coincide whereby to increase the effective refracting surfaces per unit of area while minimizing spherical aberration and an opaque coating enveloping said lenses and extending above the tops of said truncation planes.

4. A lenticular screen integrally formed with a multitude of definitely arranged microscopic plano-spherical lenses of equal size and having centers of adjacent pairs of lenses closer than double their own radius yet with said centers far enough apart to leave lens-enclosed flat areas, and an opaque coating on said intervening areas and on portions of the lenses defining said areas.

5. A lenticular screen integrally fashioned with a multitude of lenses to the square inch, said lenses being of plano-spherical form and circularly arranged in predetermined groups about a corresponding number of points, each of said lenses being fashioned with a predetermined number of equispaced truncated edges which are defined by plane geometric figures, the latter being alike and each defined by curved and straight lines coinciding in pairs with corresponding lines of an adjacent lens, said lenses being of such size and with their centers so spaced as to provide flat bottomed intervening recesses defined by convex lens surfaces of a surrounding group of lenses, and an opaque coating on said intervening flat areas of said recesses and also on lower marginal areas of the convex lens surfaces.

VICTOR C. ERNST.