

SPECIFICATION

Stereophotographic process for producing works of sculpture

- 5 This invention relates to a process for producing replicas of originals (e.g. an object of sculpture) based on stereoscopic photography. 5

One known type of stereophotographic process for producing such replicas is as follows:-

- A number of projectors and cameras are arranged alternately in a circle concentrically around and facing towards an original to be copied. Each of the projectors is fitted with a screen having a number of parallel vertical lines or stripes as indicated in Figure 2. The projectors can thus project the striped patterns of the screens onto the original, which is then photographed simultaneously with the cameras. For convenience, the procedure up to this point is called a "photographing step". 10

- Next, the original is replaced by a mass of modelling material and, at the same time, the cameras are replaced with the same number of additional projectors, which are installed at the corresponding locations. The additional projectors are loaded with the positives of the pictures taken by the respective cameras, whilst the original projectors remain fitted with the screens. Either the pictures alone or the pictures and the screens are projected on the modelling material surface. Each picture represents the pattern of parallel stripes of the screen projected from the same point against the original and photographed, in the preceding photographing step, as deformed according to the surface configurations of the original. Thus, for example, if the original is a spherical body and screens of the pattern as shown in Figure 2 are projected on it from both sides of a camera, the parallel stripes of the two screens will be photographed as deformed to the curves indicated in Figure 4. Now if either two such pictures or one such screen and one such picture are projected on the surface of the modelling material by the same projectors, said surface will look black striped. The operator or sculpture can then model the material, building up or cutting it away until the black stripes projected separately meet and coincide on the material surface, indicating that the material has become a replica of the original. For convenience, the procedure after the "photographing step" is called the "modelling step". This is a conventional process for producing statuary based on stereoscopic photography. 15

- With such a process it is necessary for the sculptor to check every stripe on the modelling material to make certain that the stripe patterns on the finished model are in perfect coincidence, even in the edge portions. This adds greatly to the modelling time. In addition, unmatched stripes can frequently be overlooked because of the complexity and indistinctness of the overlapping patterns, and the model thus obtained stereo photographically is sometimes not an exact replica of the original. 20

- An object of the present invention is to improve such a process so that the modelling time can be shortened and the model obtained a very fine replica of the original. 25

- According to the invention, a stereo-photographic process for producing replicas of originals of the type comprising locating a number of cameras and projectors in a circle around the original so as to face the latter, fitting a screen having a number of parallel stripes in each projector, taking original pictures of said original with said cameras simultaneously while projecting the striped screens onto the original, replacing said cameras with additional projectors at positions corresponding to respective cameras, replacing the original with a mass of modelling material, projecting the original pictures, or the original pictures and screens, fitted in said projectors onto said mass of material, and modelling the surface of said material until the stripes of the respective sources of the projected original pictures, or of the projected original pictures and screens, are in complete coincidence on the material surface, is characterized in that selected pairs of the projectors are fitted with original pictures, or with an original picture and a screen, as appropriate for their particular locations, so as to coincide, when projected on the material surface, one original picture or the screen being a positive and the other being a negative, in that the projectors are switched on in the selected pairs to project stripes s''' which are a combination of the co-inciding stripes s' and s'' of said positive and said negative respectively and which produce fringe areas of unusual brightness or darkness along the edges of said stripes s''' where said stripes s' and s'' do not completely coincide, and in that the surface of said material is modelled to produce a replica of the original by eliminating all the fringe areas of unusual brightness and darkness so that, when lit by the projectors, said surface is of uniform brightness. 30

- Other objects and advantages will become more apparent from the following description of one embodiment of a process in accordance with the invention taken in conjunction with the accompanying drawings in which:-

- Figure 1 is a plan view of one arrangement of the process for stereo photographically taking pictures of an original, 35

Figure 2 is a front view of a typical projector screen;

Figure 3 is a plan view of a spherical body representing an original onto which beams of light through a plurality of screens are projected;

- Figure 4 is a front view of the spherical body of Figure 3; 40

Figure 5 is a plan view of another arrangement of the process for modelling replica of the original,

Figure 6 is a diagrammatic view of a mass of modelling material onto which a stripe s_n'' of a negative picture $F_n'' + 2$ and a stripe s_n' of a positive picture F_n' are projected forming a coincident stripe s_n''' ;

- Figure 7 is a diagrammatic view of a mass modelling material onto which a stripe S_n' of a positive screen S_n' and a stripe s_n'' of a negative picture F_n'' are projected forming a coincident stripe s_n''' ; 45

Figure 8 is a diagrammatic view of a mass modelling material onto which a stripe s'_n of a positive picture F'_n and a stripe s''_n of a negative screen S''_n are projected, forming a coincident stripe s''_n ;

Figure 9 is a diagrammatic view of a stripe s''_n having fringe areas marked W in white and B in black along both its sides as indications incomplete coincidence of the two stripes projected onto the material surface;

Figure 10 is a diagrammatic view of a completely coincident stripe s''_n on the material surface; and

Figure 11 is a photographic representation of a figure with stripes as represented in Figure 9, projected thereon.

The process according to the invention comprises two steps of (1) taking pictures of an original (photographing step) and (2) making a replica of the original based on a stereophotographic projected image of the original (modelling step), as will be described in detail below.

(1) Photographing Step

This step will be explained with reference to Figures 1 to 4 of the accompanying drawings. Firstly, around an original O (a ball is shown here instead of a sculpted figure for the sake of simplicity), a number of cameras $C_1, C_2, C_3 \dots C_n$ and a number of projectors $P_1, P_2, P_3 \dots$ which latter are equipped, respectively, with screens $S_1, S_2, S_3 \dots S_n$, each having parallel vertical lines or stripes $s_1, s_2, s_3 \dots s_n$ as shown in Figure 2, are arranged in a circle at suitable locations, the cameras and projectors being directed to face the original O at the centre. Now, if the projectors $P_1, P_2, P_3 \dots$ throw beams of light through their screens $S_1, S_2, S_3 \dots$ onto the work O, the parallel stripes of their respective screens will appear on the ball surface, as represented in plan view by Figure 3 and in front view by Figure 4. The original O with such projected patterns on its spherical surface is photographed by the cameras $C_1, C_2, C_3 \dots C_n$.

The pictures taken with the cameras $C_1, C_2, C_3 \dots C_n$ are herein called $F_1, F_2, F_3 \dots F_n$, respectively. Also, positives of the screens $S_1, S_2, S_3 \dots S_n$ designated $S'_1, S'_2, S'_3 \dots S'_n$, negatives of the screens, $S''_1, S''_2, S''_3 \dots S''_n$, and positives $F'_1, F'_2, F'_3 \dots F'_n$ and negatives $F''_1, F''_2, F''_3 \dots F''_n$ of the pictures $F_1, F_2, F_3 \dots F_n$ are prepared. In the embodiment being described the screens $S_1, S_2, S_3 \dots S_n$ correspond to the positives and are substantially the same as $S'_1, S'_2, S'_3 \dots S'_n$. The designation by the symbols is merely by way of simplicity and illustration.

(2) Modelling step

This step will be explained with reference to Figures 5 to 11.

The screens $S_1, S_2, S_3 \dots S_n$ used in the photographing step and the positives or negatives of the photographs $F_1, F_2, F_3 \dots F_n$ are fitted, respectively in the projectors $P_1, P_2, P_3 \dots$ and in additional projectors $P'_1, P'_2, P'_3 \dots P'_n$ which replace the cameras $C_1, C_2, C_3 \dots C_n$. These projectors are made ready to project beams of light through their respective positive or negative onto a mass of modelling material O' and so as to be switched on and off individually. The projectors P_1, P_2, P_3 and the additional projectors $P'_1, P'_2, P'_3 \dots P'_n$ are installed at points generally coincident with the positions of the respective projectors P_1, P_2, P_3 and the respective cameras $C_1, C_2, C_3 \dots C_n$ occupied during the photographing step. In this case, there is a free choice of positive or negative for the screens and pictures. To be more exact, there are alternatives of S'_1 or S''_1 , S'_2 or S''_2 , S'_3 or S''_3 and F'_1 or F''_1 , F'_2 or F''_2 , F'_3 or $F''_3 \dots$ which may be replaced with each other as desired.

Following the preparation as above described, the projectors are switched on or off in such a manner that, of the two or more projectors which throw overlapping pictures or screens on the surface of the modelling material O', each adjacent pair of projectors or every other or every third projectors are switched on, while the rest are all switched off. Also, where either the picture or screen in a projector is a positive, a negative is used for the other. In this way the corresponding stripes from the same sources of the pictures or screens are projected on the mass of modelling material, and therefore the sculptor models the material by building up or cutting away the surface until the stripes coincide completely. Figure 6 shows a stripe (curve) s'_n of a negative picture F''_{n+2} and a stripe (curve) s'_n of a positive picture F'_n being projected on a mass of modelling material so that the two stripes are matched, forming a coincident stripe s''_n on the material surface. Figure 7 shows a stripe (curve) s'_n of a negative picture F''_n and a stripe (straight) s'_n of a positive screen S'_3 projected and matched by similar modelling, thus forming a single stripe s''_n which is completely coincident on the material. Figure 8 shows a stripe s''_n similarly obtained on a mass of modelling material by projecting a stripe (straight) s'_n of a negative screen S''_n and a stripe (curve) s'_n of a positive picture F'_n and by modelling the material until the two stripes coincide completely.

In the afore-described modelling step, as can be seen from Figure 9 (and also from Figure 11), the coincident stripe s''_n will have fringe areas of unusual brightness or darkness along its edges. For example, where white light sources are used, the areas shown white (W) or black (B).

These fringe areas indicate that the stripes s'_n and s'_n are not in complete coincidence. The portions of the material represented by the white areas (W) and the black areas (B) must be built up or cut away as appropriate until the stripes s'_n and s'_n coincide exactly as indicated in Figure 10. Then, the stripe s''_n is uniform, with its edges free of the fringe areas (W) or (B). The stripe s''_n is now as bright as the portions of the material surface along its edges. Extension of such a condition from stripe to stripe will produce a growing region of uniform brightness (for example a uniform gray region).

In this modelling step, modelling to obtain a coincidence of all the stripes $s'_1, s'_2, s'_3 \dots s'_n$ in the manner described will effectively remove the stripe patterns from the material surface so that said surface, when lit by the projectors is of a uniform brightness. A replica based on stereo-photography and which is practically an exact replica of the original O can thus be obtained.

For the present process it is not essential that all positive and negative pictures and screens be used in the modelling step. Therefore, all of the positive and negative pictures are not necessarily made in the

photographing step; it is merely necessary to prepare most of the pictures in positive and negative form.

CLAIMS

- 5 1. A stereo-photographic process for producing a replica of an original of the type comprising locating a number of cameras and projectors in a circle around the original so as to face the latter, fitting a screen having a number of parallel stripes in each projector, taking original pictures of said original with said cameras simultaneously while projecting the striped screens onto the original, replacing said cameras with additional projectors at positions corresponding to respective cameras, replacing the original with a mass of
10 modelling material, projecting the original pictures, or the original pictures and screens, fitted in said projectors onto said mass of material, and modelling the surface of said material until the stripes of the respective sources of the projected original pictures, or of the projected original pictures and screens, are in complete coincidence on the material surface, characterised in that selected pairs of the projectors are fitted with original pictures, or with an original picture and a screen, as appropriate for their particular locations, so
15 as to coincide, when projected on the material surface, one original picture or the screen being a positive and the other being a negative, in that the projectors are switched on in the selected pairs to project stripes s'' which are a combination of the co-inciding stripes s' and s'' of said positive and said negative respectively and which produce fringe areas of unusual brightness or darkness along the edges of said stripes s'' where said stripes s' and s'' do not completely coincide, and in that the surface of said material is modelled to
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2. A process according to Claim 1, wherein a white light source is used for the projectors and said fringe areas of unusual brightness or darkness appearing along the edges of said stripes s'' where the stripes s' and s'' do not completely coincide are white or black.
- 25 3. A stereo-photographic process for producing replicas of original works substantially as hereinbefore described with reference to the accompanying drawings. 25

(16)



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- 25 3. A stereo-photographic process for producing replicas of original works substantially as hereinbefore described with reference to the accompanying drawings.