

[54] **DEVICE FOR MAKING A PAIR OF STEREO-MAPS**

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[51] Int. Cl. .... G03b 21/00

[58] Field of Search ..... 353/5, 6, 7, 10; 33/20 R,  
33/20 D

[56] **References Cited**

**UNITED STATES PATENTS**

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& Scinto

[57]

**ABSTRACT**

A device for and a method of making a pair of stereo-maps from a series of sections obtained by sectioning an object at various levels. The device comprises support means having a first recording sheet fixed thereon, a second recording sheet placed over the first sheet and duplicating means interposed between the two sheets. A manually operable slider is mounted on the work bench to slide the second recording sheet in the direction X. An optical system is provided for projecting one of the series of sections vertically on the second recording sheet so that projected image may be traced on the second recording sheet. The manually operable slider is adapted to slide the second recording sheet in the direction X to effect a parallax corresponding to the perspective of a new section to be traced on the second recording sheet. The device may further include third and fourth recording sheets disposed on the support means, a manually operable slider for sliding the third and fourth sheets in the direction Y, a deviator coupled to the latter slider to deviate the fourth recording sheet in the direction X, and duplicating means interposed between the third and fourth recording sheets.

**7 Claims, 11 Drawing Figures**

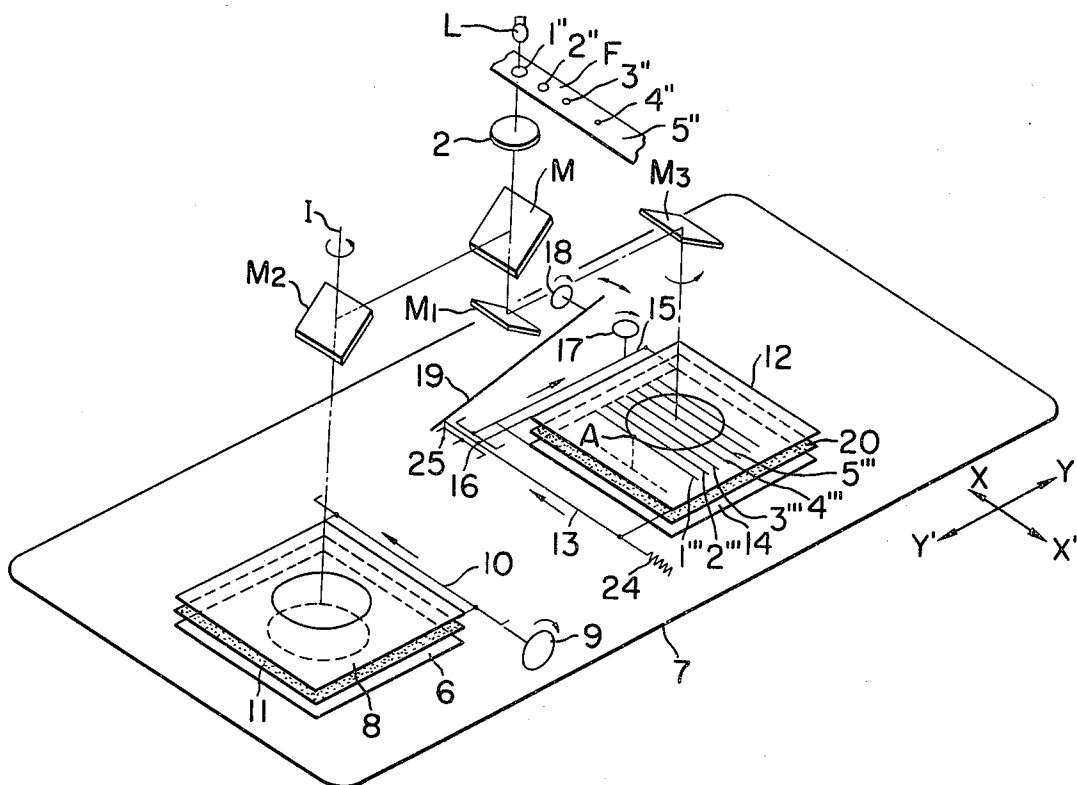




FIG. 2a

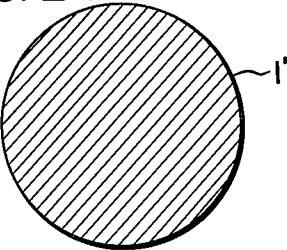


FIG. 2b

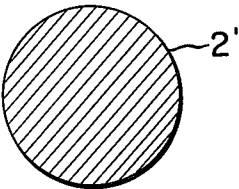


FIG. 2c

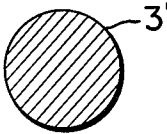


FIG. 2d

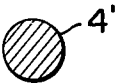


FIG. 2e



FIG. 2f

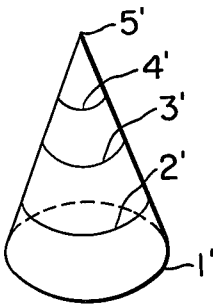


FIG. 3a

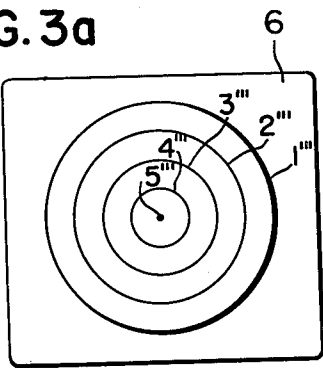


FIG. 3b

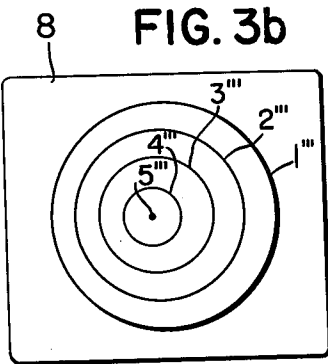
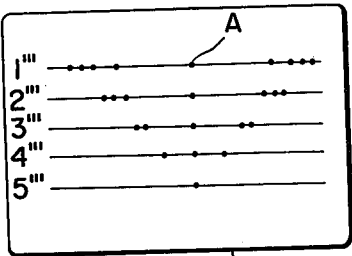
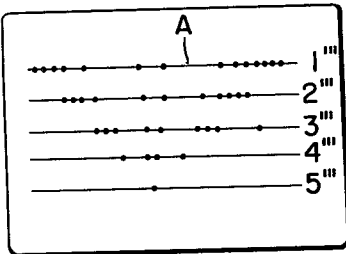


FIG. 4a



14

FIG. 4b



12

## DEVICE FOR MAKING A PAIR OF STEREO-MAPS

### BACKGROUND OF THE INVENTION

#### 1. Field of the Invention

This invention is related to the science of stereoscopy, and more particularly, to a device for making a pair of stereo-maps which enables the image of an object to be stereoscopically observed.

#### 2. Description of the Prior Art

It is known to photograph an object from two points at suitable distances therefrom and thereby make a pair of stereo-photos which enables a three-dimensional image of the object to be perceived.

With such prior technique, however, the pair of stereo-photos has only allowed three-dimensional perception of the exterior configuration of an object and not of the interior of the object.

### SUMMARY OF THE INVENTION

We have conceived a method and apparatus by which we are able to overcome the above-described problem and to make a pair of stereo-maps which not only enables the exterior of an object to be observed stereoscopically, but also enables the perspective of the interior of the object to be observed in stereo-vision.

By our method and apparatus, we are able to make a pair of stereo-maps which enables a three-dimensional image of an object to be observed in any desired horizontal direction.

We are further able to make both a stereo-map which enables a three-dimensional image of an object to be observed in the vertical direction thereof, and a stereo-map which independently enables a three-dimensional image of the object to be observed in the horizontal direction thereof.

One particular field of application of the present invention is found in the area of medicine wherein, for example, the device can make a pair of stereo-maps which not only enables the external configuration of human viscera to be observed stereoscopically from a number of fragments of such viscera, but also enables the perspective of the interior of such viscera to be observed in stereo-vision.

By means of the present invention, it is also possible to make a pair of stereo-maps which enables observation of three-dimensional images of the viscera as viewed in any desired direction.

There has thus been outlined rather broadly the more important features of the invention in order that the detailed description thereof that follows may be better understood, and in order that the present contribution to the art may be better appreciated. There are, of course, additional features of the invention that will be described hereinafter and which will form the subject of the claims appended hereto. Those skilled in the art will appreciate that the conception upon which this disclosure is based may readily be utilized as a basis for the designing of other structures for carrying out the several purposes of the invention. It is important, therefore, that the claims be regarded as including such equivalent construction as do not depart from the spirit and scope of the invention.

### BRIEF DESCRIPTION OF THE DRAWINGS

A specific embodiment of the invention has been chosen for purposes of illustration and description, and is shown in the accompanying drawings, forming a part of the specification wherein:

FIG. 1 is a schematic perspective view of the device according to an embodiment of the present invention and illustrating the principle of the invention;

FIGS. 2(a), 2(b), 2(c), 2(d), 2(e) and 2(f) show a cone as an object and a series of sections taken at various levels thereof;

FIGS. 3(a) and 3(b) show a pair of stereo-maps made of a series of contour lines as the cone of FIG. 2(f) is viewed vertically thereof; and

FIGS. 4(a) and 4(b) show a pair of stereo-maps made of a series of contour points as the cone of FIG. 2(f) is viewed horizontally thereof.

### DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 1, a film F carries thereon photographic images 1'', 2'', 3'', 4'' and 5'' which correspond to cross-sections 1', 2', 3', 4' and 5' of a cone, as shown in FIGS. 2(a) to 2(e). A light source L is provided at one side of the film F to illuminate same and a lens 2 is provided at the other side of the film to project therethrough the photographic images carried on the film F. A half-mirror M is provided below the projection lens 2 to split into two directions an image formed through the projection lens 2. Mirrors M<sub>1</sub>, M<sub>2</sub> and M<sub>3</sub> are arranged so that the image formed through the projection lens 2 may be separately directed to recording sheets 8 and 12. The mirror M<sub>2</sub> is rotatable about a vertical axis I so as to adjust the positions of the aforesaid sectional images. The mirror M<sub>3</sub> is also rotatably mounted for a reason which will later be described.

A first recording sheet 6 is fixed on a work bench 7. A slider 10 holds a second recording sheet 8 and is slidable in the direction X—X' upon rotation of a knob 9. A sheet of carbon paper 11 is interposed between the first recording sheet 6 and the second recording sheet 8. A slider 15 holds a third recording sheet 14 and is slidable in the direction Y—Y' upon rotation of a knob 17. A deviator 13 holds a fourth recording sheet 12 and is slidable in the direction X—X'. The deviator 13 is secured to the slider 15 at right angles thereto by means of guide sheath 23, and is movable with the slider 15 in the direction Y—Y'. A guide rule 19, for guiding the deviator 13, is swingable about a point 25 in a plane parallel to the horizontal plane of the bench 7 upon rotation of a knob 18, and the deviator 13 is biased toward the guide rule 19 by a spring 24. Automatic deviation of the deviator 13 in the direction X—X' may be effected due to the contact of one end thereof with the guide rule 19, and the amount of the deviation of the deviator 13 may be adjusted by swinging the guide rule 19 in the horizontal plane.

The fourth recording sheet 12 is formed with a plurality of straight lines 1''', 2''', 3''', 4''' and 5''' extending in the direction X—X' and corresponding to the levels 1', 2', 3', 4' and 5' of the aforesaid sections through the cone. A sheet of carbon paper 20 is interposed between and in intimate contact with the third recording sheet 14 and the fourth recording sheet 12; and the first and second recording sheets 6 and 8 are

in intimate contact with the carbon paper 11 therebetween.

Description will now be made of the operating procedures through which the sections of the cone, as shown in FIGS. 2(a) to 2(f) are made into a pair of stereo-

maps which enables a vertical perspective of the exterior and interior of the cone to be perceived in stereo-vision as shown in FIGS. 3(a) and 3(b) stereo-maps will have lines of

First, the film F is moved until the sectional image 1'' photographed thereon is alined with the optical axis of the projection lens 2. Thereby, the sectional image 1'' is projected on the second recording sheet 8 via half-mirror M and mirror M<sub>2</sub>. The scale of the knob 9 is then read, whereafter the projected sectional image 1'' is exactly traced on the second recording sheet 8. As a result, the projected sectional image 1'', so-traced, is duplicated on the first recording sheet 6 with the aid of the carbon paper interposed between the first and second recording sheets 6 and 8. Thus, the contour lines 1''', as indicated in FIGS. 3(a) and 3(b), have been depicted.

Subsequently, the film F is moved until the sectional image 2'' photographed thereon is coincident with the optical axis of the projection lens 2, whereafter the sectional image 2'' is projected on the second recording sheet 8. Then, in order to give a parallax corresponding to the height from the section 1' to the section 2' shown in FIG. 2(f), the knob 9 is rotated so that the second recording sheet 8 is deviated in the direction X-X' by an amount corresponding to the aforesaid height, from the position where the projected sectional image 1'' has been traced on the second recording sheet 8. It is the second recording sheet 8 alone that is deviated in the direction X-X', because the first recording sheet 6 is fixed to the bench 7. As a result, a parallax corresponding to the height from the section 1' to the section 2' has been effected.

In this position, the projected sectional image 2'' on the second recording sheet 8 is traced on that sheet. Thus, the projected sectional image 2'' on the second sheet 8 is duplicated on the first recording sheet 6. In this way, the contour lines 2''', as indicated in FIGS. 3(a) and 3(b) have been depicted.

Thus, a proper amount of parallax should be given whenever a new section is to be traced. By repeating the described procedures, the sectional images 2'' to 5'' may all be traced on the second and first sheets, thereby to provide a pair of stereo-maps as shown in FIG. 3.

By observing such pair of stereo-maps through a stereoscope, the exterior of the cone may be stereoscopically perceived as if the cone were actually seen from above it, and the interior perspective of the cone may be perceived in stereo-vision as if the cone were transparent.

For example, it is assumed that an object (not shown) is present in the section 2' shown in FIG. 2(b) and that an object (not shown) is also present in the section 3' shown in FIG. 2(c). If these objects, and the respective sections are traced together on the second recording sheet, the resultant pair of stereo-maps will have lines of such objects added to the pair of stereo-maps as shown in FIGS. 3(a) and 3(b). By observing such stereo-maps through a stereoscope, the images of the two objects present in the interior of the cone may be perceived in stereo-vision.

Description will now be made of the operating procedures through which the sections of the cone, as shown in FIGS. 2(a) to 2(e), are made into a pair of stereo-maps which enables a horizontal perspective of the exterior and interior of the cone to be perceived in stereo-vision as shown in FIGS. 4(a) and 4(b).

First, the film F is moved until the sectional image 1'' photographed thereon is alined with the optical axis of the projection lens 2. As a result, the sectional image 1'' is projected on the fourth recording sheet 12 via half-mirror M and mirrors M<sub>1</sub> and M<sub>3</sub>.

The knob 17 is then rotated to move the fourth recording sheet 12 so that the projected sectional image 1'' is tangent to the line 1''' on the fourth recording sheet which corresponds to the section 1' of the cone, whereafter the tangential point is plotted on the fourth recording sheet 12. At the same time, the tangential point is duplicated on the third sheet 14 with the aid of the carbon paper 20 interposed between the recording sheets 12 and 14. This point is the point A indicated in FIGS. 1 and 4(a) and 4(b).

Subsequently, the knob 17 is rotated to displace the fourth recording sheet 12 in the direction Y by any desired amount, whereupon the point of intersection between the projected sectional image 1'' and the aforesaid line 1''' is again plotted on the fourth recording sheet 12. Thereupon, the knob 17 is further rotated to displace the recording sheets 14 and 12 together in the direction y by an equal amount, and the fourth recording sheet 12 alone is also displaced in the direction X with the aid of the guide member 19. As a result, the fourth recording sheet 12 is deviated in the direction x with respect to the third recording sheet 14. A parallax is given by such deviation. This amount of deviation is determined by the inclination of the guide member 19 in the horizontal plane. The inclination of the guide member 19 is adjusted so as to give a parallax corresponding to the horizontal depth of the point at which the point of intersection between each projected sectional image 1''-5'' and each corresponding lines 1'''-5''' on the recording sheet 12 is plotted on the sheet 12.

Subsequently, as the knob 17 is further rotated to displace the fourth recording sheet 12 in the direction Y', the successive points of intersection between the projected sectional image 1'' and the line 1''' are plotted on the line 1''' on the sheet 12.

By the described procedures, a contour line representing the sectional image 1'' has been developed on the straight line 1''' as shown in FIGS. 4(a) and 4(b).

By repeating the same procedures, contour lines representing the sectional images 2'' to 5'' may be plotted on the straight lines 2''' to 5''' on the recording sheet 12, respectively, as shown in FIGS. 4(a) and 4(b). Thus, a pair of stereo-maps may be completed as shown in FIGS. 4(a) and 4(b).

By observing such pair of stereo-maps through a stereoscope, the exterior of the cone may be stereoscopically perceived as if it were actually viewed horizontally and a perspective of the interior of the cone may be perceived in stereo-vision as if it were transparent. Since the mirror M<sub>3</sub> is rotatably mounted, the stereo-maps of the object, as viewed in any desired horizontal direction, can be perceived.

We believe that the construction and operation of our novel apparatus and the practice of our novel method will now be understood, and that the advan-

tages thereof will be fully appreciated by those persons skilled in the art.

We claim:

1. A device for graphically reconstructing a series of sections, each of which is obtained by sectioning an object at various levels thereof, in the form of paired stereo-maps for observation with a stereoscope, comprising:

- a support means (7);
- a first recording sheet (6) fixed on said support means;
- a second recording sheet (8) placed over said first sheet;
- an optical system for projecting one of said series of sections on the second sheet so that the projected image of said one section may be traced on said second recording sheet, said optical system including a projection lens and reflection means, the latter being adjustable to adjust the position of each projected sectional image relatively to said second recording sheet; and
- duplicating means (11) interposed between said first and second recording sheets to duplicate said traced image onto said first sheet;
- said manually operable slider sliding said second recording sheet in said one direction to give a parallax in accordance with the perspective of a new section to be traced on said second recording sheet.

2. A device for graphically reconstructing a series of sections, each of which is obtained by sectioning an object at various levels thereof, in the form of paired stereo-maps for observation with a stereoscope, comprising:

- support means (7);
- a first recording sheet (14) disposed on said support means;
- a second recording sheet (12) placed over said first recording sheet;
- an optical system for projecting one of said series of sections to form an image on said second recording sheet;
- a manually operable slider (15, 17) mounted on said support means to slide said first and second recording sheets in one direction;
- said second recording sheet being provided with a plurality of straight lines thereon, each of which corresponds to each of the various levels of the sectioned object and is at right angles to said direction;
- a deviator (13, 16, 24, 19, 18) coupled to said slider to deviate said second recording sheet (12) in a second direction when said first and second recording sheets are slid in said one direction by said slider; and
- duplicating means (20) interposed between said first and second recording sheets.

3. A device as defined in claim 2, wherein said duplicating means is a sheet of carbon paper.

4. A device as defined in claim 2, wherein said optical system includes a projection lens and reflection means, the latter being adjustable to adjust the position of each projected sectional image relatively to said second recording sheet.

5. A device for graphically reconstructing a series of sections, each of which is obtained by sectioning an object at various levels thereof, in the form of paired

stereo-maps for observation with a stereoscope, comprising:

- support means (7);
- a first recording sheet (6) fixed on said support means;
- a second recording sheet (8) placed over said first sheet;
- a manually operable slider (10, 9) mounted on said support means to slide said second recording sheet in one direction;
- an optical system for projecting one of said series of sections on the second sheet so that the projected image of said one section may be traced on said second recording sheet;
- duplicating means (11) interposed between said first and second recording sheets to duplicate said traced image onto said first sheet;
- said manually operable slider sliding said second recording sheet in said one direction to give a parallax in accordance with the perspective of a new section to be traced on said second recording sheet;
- a third recording sheet (14) disposed on said support means;
- a fourth recording sheet (12) placed over said third recording sheet;
- a second optical system for projecting one of said series of sections to form an image on said second recording sheet;
- a manually operable slider (15, 17) mounted on said support means to slide said third and fourth recording sheets in one direction;
- said fourth recording sheet being provided with a plurality of straight lines thereon, each of which corresponds to each of the various levels of the sectioned object and is at right angles to said direction;
- a deviator (13, 16, 24, 19, 18) coupled to said slider to deviate said fourth recording sheet (12) in a second direction when said third and fourth recording sheets are slid in said one direction by said slider; and
- duplicating means (20) interposed between said third and fourth recording sheets.

6. A device for graphically reconstructing a series of sections, each of which is obtained by sectioning an object at various levels thereof, in the form of paired stereo-maps for observation with a stereoscope, comprising:

- a support means (7) for supporting first and second recording sheets with duplicating means therebetween;
- a manually operable slider (10, 9) mounted on said support means to slide the second recording sheet in one direction; and
- an optical system for projecting one of said series of sections on the second sheet so that the projected image of said one section may be traced on the second recording sheets, said optical system including a projection lens and reflection means, the latter being adjustable to adjust the position of each projected sectional image relatively to said second recording sheet;
- said manually operable slider adapted to slide the second recording sheet in said one direction to give a parallax in accordance with the perspective of a new section to be traced on the second recording sheet.

7. A device for graphically reconstructing a series of sections, each of which is obtained by sectioning an object at various levels thereof, in the form of paired stereo-maps for observation with a stereoscope, comprising:

support means (7) for supporting first and second recording sheets with duplicating means therebetween;

an optical system for projecting one of said series of sections to form an image on the second recording

sheet;

a manually operable slider (15, 17) mounted on said support means adapted to slide the first and second recording sheets in one direction; and

5 a deviator (13, 16, 24, 19, 18) coupled to said slider and adapted to deviate the second recording sheet (12) in a second direction when the first and second recording sheets are slid in said one direction by said slider.

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UNITED STATES PATENT OFFICE  
CERTIFICATE OF CORRECTION

Patent No. 3,884,564 Dated May 20, 1975

Inventor(s) MUNESATO YAMADA et al.

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 3, line 8, change "3(bstereo maps will" to  
-- 4(b). --  
line 9, delete "have lines of".

Column 4, line 29, change "y" to -- Y --;  
line 32, change "x" to -- X --.

Signed and Sealed this

sixteenth Day of September 1975

[SEAL]

Attest:

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Commissioner of Patents and Trademarks