W. BAUERSFELD.

STEREO ISOHYPSOGRAPH.

APPLICATION FILED APR. 24, 1914.

**1,151,996.** Patented Aug. 31, 1915.

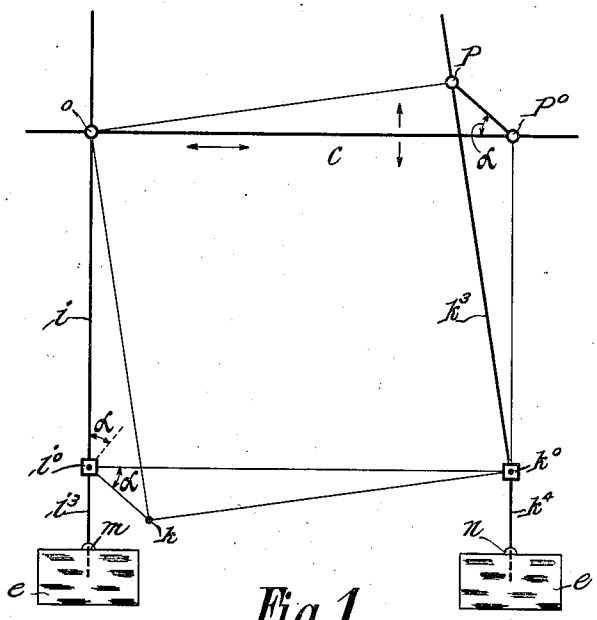
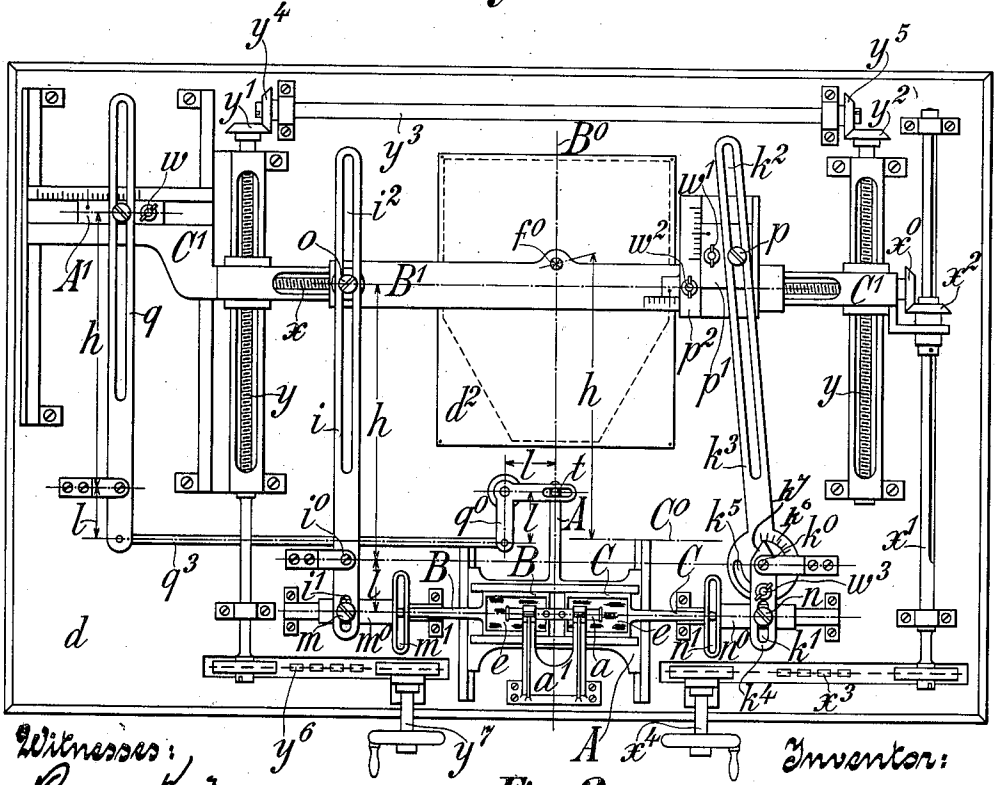


Fig. 1



Witnesses:
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Fig. 2

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# UNITED STATES PATENT OFFICE.

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## STEREO-ISOHYPSOGRAPH.

1,151,996. Specification of Letters Patent. Patented Aug. 31, 1915.

Application filed April 24, 1914. Serial No. 834,080.

*To all whom it may concern:*

Be it known that I, WALTHER BAUERSFELD, a citizen of the German Empire, residing at Jena, Germany, have invented a new and useful Stereo-Isohypsograph, of which the following is a specification.

This invention relates to such copying devices comprising a stereo-comparator system and a drawing device, each of which has a triple cross-slide system, as are set forth in the Patent 1,090,494, and more particularly to the modification, in which the tracer height-slide and the tracer breadth-slide are carried by the tracer depth-slide. With such a device the surface of a spatial object could be copied, if the photograms were taken with identical objectives and the axes of the objectives were parallel to one another and perpendicular to the base-line, in other words, if the photograms lie in one plane.

The subject of the present invention is a device, which is so constructed that it can serve for utilizing photograms, in the taking of which the axes of the objectives were certainly—as was the case so far—parallel to a plane containing the horizontal projection of the base-line (*e. g.*, as is assumed throughout the present application, to a horizontal plane), but had apart from this any inclination to one another. When in the device according to the present invention the comparator breadth-slide carries the two photograms, the movements of the comparator breadth-slide and the comparator depth-slide in the breadth-direction are transmitted each by means of a lever to the cross-slide device of the tracer height-slide, breadth-slide and depth-slide, the two levers being rotatably disposed parallel to a plane, which is determined by the breadth-direction and the depth-direction of the copy-carrier, and the point of application of one of the two levers being displaceable for adjusting the device for a given base-line in the breadth-direction, relatively to that slide of the cross-slide arrangement, which contains the said point.

In order that the device may serve for utilizing photograms, at the taking of which the objective axes were each inclined to the base-line by an angle deviating by the same amount from 90° (were uniformly turned with respect to the base-line), according to the additional invention the said displaceably disposed point of application is disposed in such a manner that it can be displaced relatively to the slide containing it in the depth-direction as well.

The above arrangement may be carried out in an advantageous manner, if the displacement point of application be so disposed as to be movable on an arc having an adjustable radius, the center of the arc lying in each case in that depth-plane, which appertains to the object-point indicated on the copy-carrier by the tool, and having in such case a distance from the breadth-plane containing the other point of application, which is equal to the relative distance of the axes of rotation of the two levers. Another way of carrying out the invention, which is particularly suitable from constructional reasons, results from disposing the displaceable point of application on a cross-slide in such a manner that it can be moved parallel to the breadth-direction and parallel to the depth-direction of the copy-carrier.

When in the device according to the invention the lever having the displaceable point of application is formed as a two-armed lever, and when the said device—a comparator-system of the usual construction being used—is intended to be suitable for the utilization of photograms, during the taking of which the objective axes were each inclined by a different angle to the base-line (were convergent), the said lever is so formed that the two arms are adjustable relatively to one another in the plane of rotation of the lever.

In the annexed drawing, Figure 1 is a diagram of a copying device fitted with the invention and Fig. 2 is a plan view of a constructional example of such a device.

The heavy lines in Fig. 1 show the device, which is in the adjusting condition for a photostereogram *e*, *e*, which has been secured—assuming a simple case—with identical objectives, a horizontal base-line and horizontal objective axes, which meet at a finite distance. For the sake of simplicity the device for measuring heights and the comparator-system are not shown in the diagram. The lightly drawn lines serve for explanation only.

The device comprises two two-armed levers $i$, $i^3$ and $k^3$, $k^4$, which have to transmit the joint and relative displacements of the two photograms in the breadth-direction to a cross-slide device $c$. The levers are to be

supposed as rotatable in the plane of the drawing, the connecting line of their axes of rotation $i^0$ and $k^0$ determining the breadth-direction. $o$ and $p$ are the points of application of the lever-arms $i$ and $k^3$ respectively on the cross-slide arrangement, $m$ and $n$ those of the lever-arms $i^3$ and $k^4$ respectively on the photograms. The lever $i$, $i^3$, the arms of which are to be supposed as being rigidly connected together and in alinement, lies so as to be parallel to the depth-direction. The triangle belonging to the two photograms $e$ and $e$ and formed by the two objective axes and the base-line is represented in the scale of reduction of the copy, and in such a position that the left-hand extremity of the base-line lies in the axis of rotation $i^0$ of the lever $i$, $i^3$, and the left-hand objective axis coincides with the lever-arm $i$. The point $k$ is the right-hand extremity of the base-line and $e$, *i. e.* the point of application of the lever-arm $i$ on the cross-slide arrangement $c$, is the point of intersection of the two objective axes. The angle, by which the left-hand objective axis is inclined to the perpendicular to the base-line, lying in the plane of the drawing, (the turning-angle) is marked $\alpha$. The same angle is then also embraced by the base-line and the breadth-direction. The lever-arm $k^3$ is set in such a manner, that it is parallel to the right-hand objective axis and that its length $k^0\ p$ to the point of application $p$ on the cross-slide device is equal to the length $k\ o$ of the right-hand objective axis from the extremity $k$ of the base-line to the point of intersection $o$ with the left-hand objective axis. In order that this setting—corresponding to the length $i^0\ k$ of the base-line and the angle $\alpha$, which the latter embraces with the breadth-direction—may be effected, the said point of application $p$ is disposed displaceably in the plane of the drawing. For bringing the said point into its correct position, the lever-arm $k^3$ is set parallel to the lever-arm $i$, its point of application $p^0$ on the cross-slide arrangement lying in one and the same depth-plane with the point $o$, and the point of application is displaced, until it occupies the position $p$, in which position the relative distance of $p^0$ and $p$ is equal to the length $i^0\ k$ of the base-line and the connecting lines of $C^0$ with $C^1$ and of $p^0$ with $p$ and of $p^0$ with $o$ embrace the said angle $\alpha$. From this there follows of itself the parallelism of $k^0\ p$ and $k^0$. Since, when copying the body corresponding to the photostereogram $e$, $e$ the relative distance of the points of application $o$ and $p$ on the cross-slide device and the direction of their connecting line $o\ p$ remain unaltered, and since furthermore the position of the points $k$ and $k^0$ is invariable, it follows, that for every position of the cross-slide arrangement the direction and the size of $k^0\ p$ correspond to the direction and the size respectively of $k\ o$. Hence, the disposition of the lever-arms $i$ and $k^3$, indicated in the present case, replaces a disposition, in which the lever-arm $k^3$ from its center of rotation $k^0$ to its point of application $p$ coincides directly with the side $k\ o$ of the triangle $i^0\ k^0$.

In order that a comparator-system of the usual construction may be employed, the arm $k^4$ of the lever $k^3$, $k^4$ must be disposed parallel to the depth-direction, *i. e.*, it must be supposed to be adjustable relatively to the arm $k^3$.

In Fig. 2 let the conditions, under which the photograms were taken, be the same as those forming the basis of the diagram in Fig. 1. In order to be able to copy from photo-stereograms having base-lines of different length and different position relatively to the objective axes, the right-hand double lever is formed in such a manner that its two arms $k^3$ and $k^4$ are adjustable relatively to one another. For this purpose the arm $k^3$ is provided with a circular guide $k^5$, along which the arm $k^4$ may be displaced. A degree-scale $k^6$ marked on the circular guide and an index $k^7$ on the arm $k^4$ permit of the two lever-arms being given any desired relative inclination. A screw $w^3$ serves for clamping the levers together. The stud $p$ for the double lever $k^3$, $k^4$ is fitted to the upper slide $p^1$ of a two-member cross-slide system $p^1$, $p^2$, which is itself fitted to the breadth-slide $B^1$. A screw $w^1$ is provided for clamping the upper slide $p^1$ on the lower one $p^2$, and a screw $w^2$ for clamping the latter on the breadth-slide.

The operation of the device as shown in the drawing is as follows.

The operator having placed the photostereogram $e$, $e$ in the slides B and B C proceeds to set the slides $p^1$ and $p^2$ in such a manner that they are displaced from their zero positions by the amount $i^0\ k \sin \alpha$ and $i^0\ k \cos \alpha$ respectively, $i^0\ k$ being the length of the base-line in the scale of reduction of the copy and $\alpha$ the angle of inclination of the left-hand objective axis relatively to the perpendicular on the base-line lying in the plane of the drawing. Having clamped the said slides by means of the screws $w^1$ and $w^2$, he next gives the arms $k^3$, $k^4$ of the right-hand lever such a relative inclination that the index $k^7$ indicates on the scale $k^6$ the angle contained by the axes of the objectives used when taking the photostereogram, *i. e.* the angle $i^0\ o\ k$ of Fig. 1. The clamping screw $w^3$ is then tightened. The operator thereupon sets the height-slide $A^1$ to the particular line of height desired and tightens the screw $w$. By rotating the two hand-wheels the operator is then enabled to follow, without removing his eyes from the oculars of the microscope, the height-line set for, the pencil at the same time tracing

this line on the sheet of the drawing. On the line being completed, another height is set for by means of the slide $A^1$ and this procedure is repeated until all the height-lines required have been traced.

I claim:

1. In a device for copying from a stereoscopic pair of photograms of an object of three dimensions onto a plane surface the combination of a stereo-comparator comprising three interdependent slides, A, B and C, a drawing device comprising three interdependent slides, $A^1$, $B^1$ and $C^1$, of which $A^1$ and $B^1$ are carried by $C^1$, means comprising two levers for positively coupling the slides of the said stereo-comparator with those of the said drawing device, means for displacing the point of application of one of the two levers in the breadth-direction and in the depth-direction relatively to that slide, which contains the said point, and a system of actuating devices controlling the said stereo-comparator and the said drawing device, the said system being accessible to the operator while he is looking into the stereo-comparator.

2. In a device for copying from a stereoscopic pair of photograms of an object of three dimensions onto a plane surface the combination of a stereo-comparator comprising three interdependent slides, A, B and C, a drawing device comprising three interdependent slides, $A^1$, $B^1$ and $C^1$, of which $A^1$ and $B^1$ are carried by $C^1$, means comprising two levers for positively coupling the slides of the said stereo-comparator with those of the said drawing device, one of which levers is formed as a two-armed lever, the arms of which are adjustable relatively to one another in the plane of rotation of the lever, and has its point of application displaceable in the breadth-direction and in the depth-direction relatively to that slide, which contains the said point, and a system of actuating devices controlling the said stereo-comparator and the said drawing device, the said system being accessible to the operator while he is looking into the stereo-comparator.

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