

object to make corrections of the principal distance and the base inserted in the instrument.

With the arrangements above described there was made in 1945 some photography with a Contax at a scale of 2:1 and with the above mentioned bellows-camera at a scale of 1.8:1. Among other things the object was a walnut. In that case, a base of 28.4 mm. and an approximate principal distance of 384 mm. were used. The plotting was accomplished in the Autograph A 5 with an affine transformation of the vertical scale. The walnut was plotted at a scale of 12:1. The pointing accuracy in elevation was found to be 0.02 to 0.03 mm. in the object scale and it was possible to plot contour lines with 0.1 mm. contour

interval. To avoid too many contour lines the plotting was performed with 0.5 mm. contour interval. Before the plotting the grid and the check object were measured. The measurement of the grid showed the stereoscopic deformation of the grid plate. The values are given in Figure 3 and vary between +0.38 mm. and -0.75 mm.

SUMMARY

Through the double exposure of a negative translucent reference grid and the object, it is possible to check the height-deformations all over the model, as well as under the object. As a consequence very simple cameras can be used for taking the photographs.

PHOTOGRAMMETRIC APPLICATION IN DENTISTRY*

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IN CONNECTION with certain investigations at the State Dental Institute, Stockholm, enquiries have been made about the possibilities of recording quantitatively the morphology of the jaws and the teeth by means of photogrammetric methods. The problem involved a "map plotting" of the jaws and the teeth, reproduced in gypsum casts, with a determination of the proportions in three dimensions.

The measurements had to be made with an accuracy of about 0.1 mm.

A special complication was the connection of the "map plottings" of the two jaws; this must be performed very exactly in order to give the correct set of the jaws. From the mathematical viewpoint this implies that both measurements must be referred to the same system of co-ordinates.

Unfortunately, "close-up" photogram-

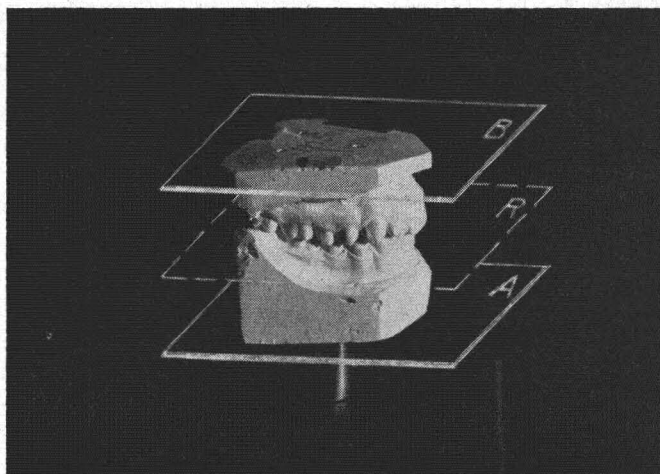


FIG. 1. The zero planes A and B of the two jaws and their reference plane R.

* Abstract from "Fotogrammetriska matmetoders tillampning inom odontologiemi" Svensk Tandlakare-Tidskrift, Stockholm, 1946, No. 1. See also Strenger, F.: "Biting Force in Man" (dissertation), Stockholm, 1949.

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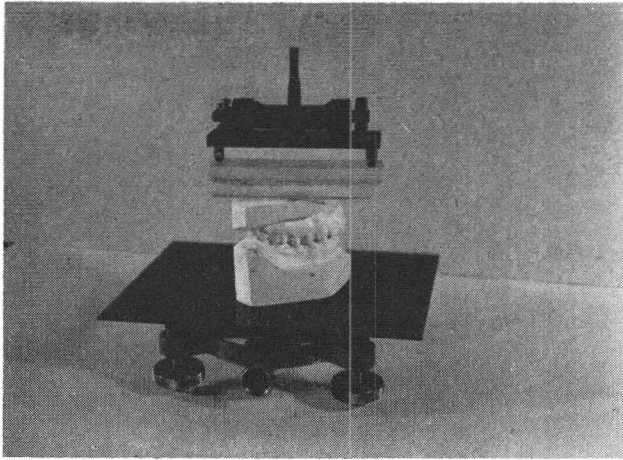


FIG. 2. Levelling of the zero plane *B* of the upper jaw.

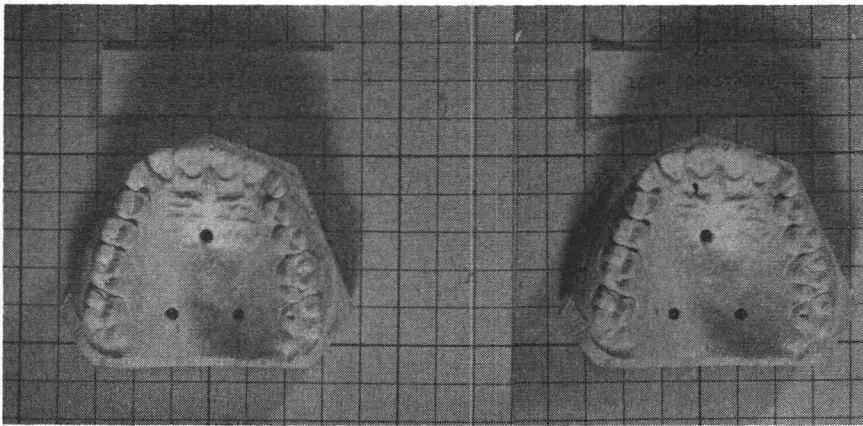


FIG. 3. A pair of stereoscopic pictures of the upper jaw.

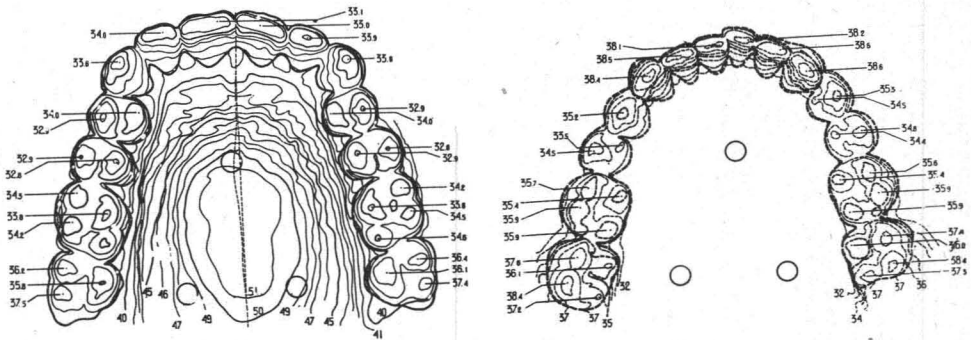


FIG. 4. The contour lines of the two jaws, equidistant 1 mm.

metry is at present subject to a limitation: the minimum range of the usual cameras is about 1 m., which is insufficient for the purpose in hand. Due to lack of a photogrammetric camera, a good amateur camera was taken into use. It was first necessary, however, to study the inner orientation and the lens distortion of this instrument.

In order to connect the results of measurements in height, arrangements were made as shown in Figures 1 and 2. With reference to a plane R , passing through the highest points of the "ones" and the "sevens" of the lower jaw, the two surfaces were prepared in such a manner that they represented two planes A and B , both parallel to R and separated by a distance of " a " mm.

For the connection in plane the casts were provided with vertical holes, bored through the two halves, which were laid together in a precision "Sip" boring machine. See Figure 3.

The stereo-measurement was executed in the "Autograph A 5." A computation of the principal distance for the reconstruction of the inner orientation gave 179.0

mm. A check on the stereo-measurement, however, gave 173.5 mm. as the correct value. The stereo-measurement was made with an equidistance of 1 mm. The characteristic high-points were determined to the tenth part of a millimeter. In order to connect the contour lines of the two jaws, the altitude values of the contours were determined. The results of the measurement are shown in Figure 4. To obtain a direct connection of the contour lines of the two jaws, which implied that one of them had to be represented as a "reflected image," the drawings were made on a transparent material. By laying the drawings together, it is possible immediately to detect the contact points between corresponding teeth, which are situated where contour lines of the same value intersect or touch one another.

This application of "close-up" photogrammetry to odontology has given rise to other questions which, however, belong to the sphere of micro-photogrammetry. As examples may be mentioned the morphology of a single tooth and the structure of the fillings.

METHOD OF MEASURING VOLUME MOVEMENTS OF IMPRESSION, MODEL AND PROSTHETIC BASE MATERIALS IN A PHOTOGRAMMETRIC WAY*

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INTRODUCTION

OUR task has been to work out a method to measure the complicated volume movements, which impression, model and prosthetic base materials undergo during their setting or curing. If possible the volume movements of the prosthesis should be examined even after having been worn by the patient for some time. The discussion about this subject for the last years makes a method eminently real, which is suitable as well by laboratory as by clinical researches.

TESTING ARRANGEMENTS

A. ODONTOLOGICAL ARRANGEMENTS

To make clear the application of the photogrammetric method we have chosen an upper jaw model without teeth, with

ridges in good condition without undercuts and with the palate evenly arched. In order to get rid of the volume movements influencing the measurements, the master-model was made of metal. Control points, which are necessary for the photogrammetric measuring were stamped into the vestibulum of the model. The mouldings, however, were beset with difficulties, mainly due to the stamped marks, which stood out like elevations of the negatives of acrylics or vulcanite. It means that in one case the adjustment of the measuring mark of the stereoinstrument on a control point must be done to the lower surface of the stamped marks; in the other case to the upper one, which appeared like an elevation, as mentioned above. In principle it does not mean anything, but in practice systematic errors can arise. After repeated

* Abstract from "Method of Measuring Volume Movements of Impression, Model and Prosthetic Base Materials in a Photogrammetric Way," *Acta Odontologica Scandinavica* 1951. Vol. 9. Fasc. 2. Stockholm.