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ABSTRACT

A method is described for aligning stacks of nuclear emulsions by punching matching sets of holes in them and then using these holes as guides in assembling the stacks, in photographing reference grids on the individual emulsions, and in attaching reference edges to the plates on which the emulsions are mounted.

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INTRODUCTION

One of the problems in using emulsion stacks is the reconstruction of the original exposed volume for making observations and measurements. There are many solutions to this problem, with varying degrees of precision and complexity of equipment.

This report describes a method in use by us, which provides good alignment and permits following tracks with considerable ease throughout the volume, and requires rather simple equipment and preparations.

The method consists briefly of the following steps:

(a) Each emulsion is individually punched with a set of 2 holes and four pin pricks.

(b) The emulsions are next assembled into a stack on two studs which pass through the holes in each emulsion. (The assembled stacks are than exposed.)

(c) After exposure, the stack is disassembled and a grid is printed on the back of each emulsion, again with reference to the punched holes.

(d) After the emulsions are mounted and processed, a metal corner (an "L") is glued onto each glass backing plate, with reference to the four pin pricks punched in Step (a).

A. Punching of the Emulsions

In preparation for the assembly of a stack the emulsions are punched one at a time in a punch press. The punch press, shown in Fig. 1, was adapted for this work from an Atlas press. Each emulsion is placed shiny side down on the press table as shown, so as to be in contact with three guide-posts. When the press lever is pulled down, a felt pad presses uniformly over the emulsion to hold it in place, two punches punch out positioning holes, and then four pins prick the top of the emulsion as shown in the diagram in Fig. 2. The holes punched out are 1/8 inch in diameter. The depth of penetration of the pins can be adjusted by tightening springs on top of each. The pins are adjusted so as to give pin pricks about 100 microns in diameter. Note that extreme care in positioning in the press is not necessary, since the relative positions of holes and pins are always the same.

* Now at the University of Birmingham, Birmingham, England.

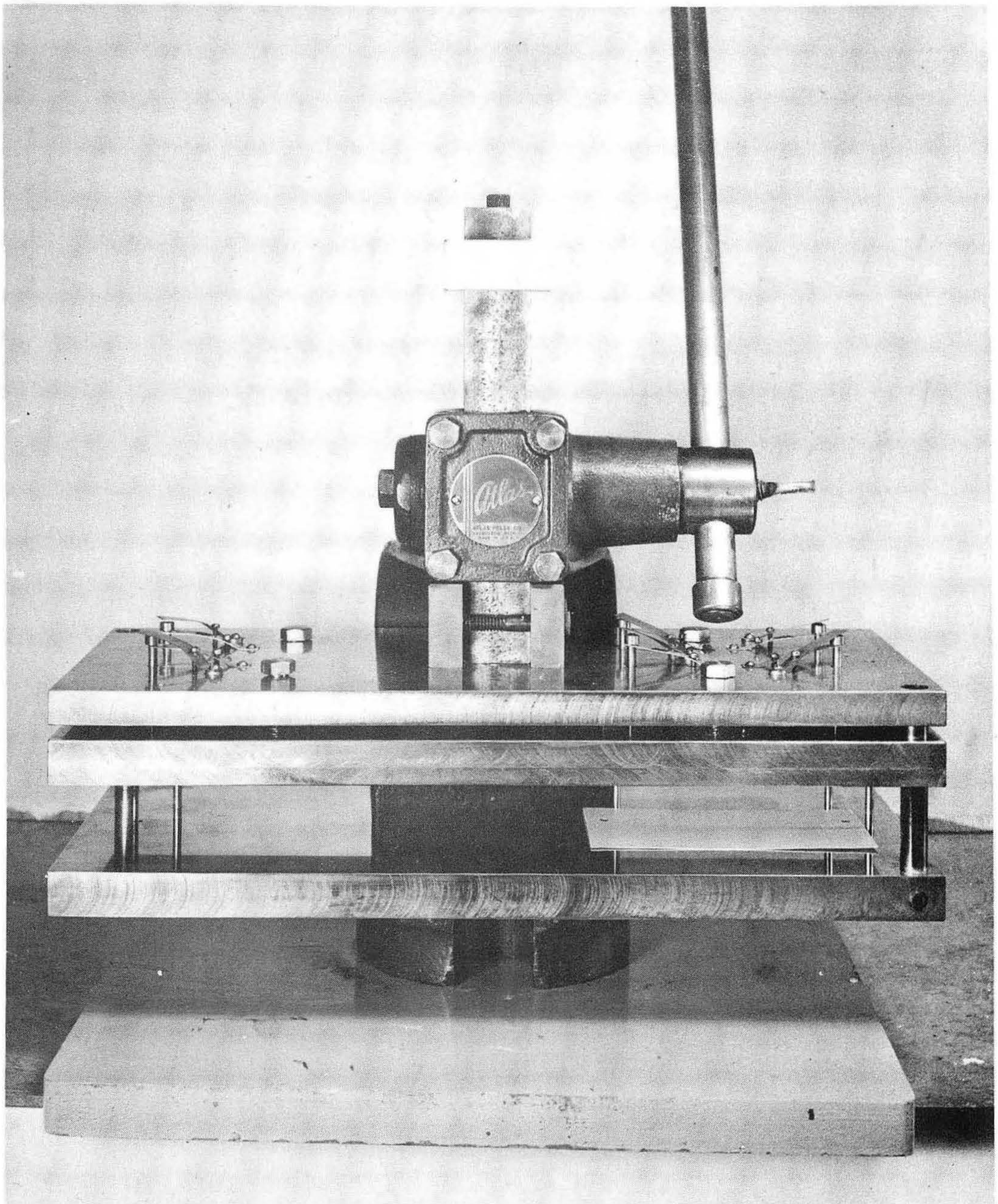

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Fig. 1 Emulsion Punch Press

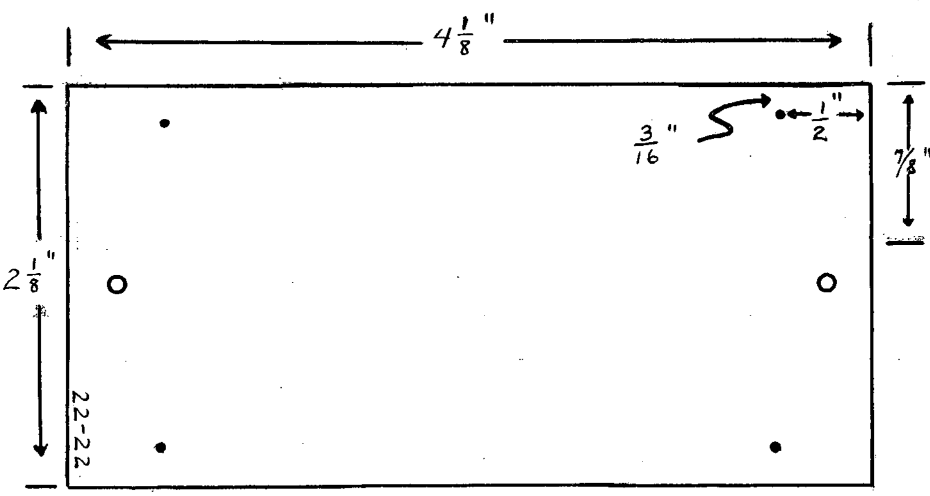

Fig. 2 Example of Punched and Pricked Emulsion

This punching and marking step takes approximately 15 seconds per emulsion.

B. Assembly of the Stack

Each emulsion is numbered and placed in sequence in a stack on a stack-backing plate; when the stack is complete it is topped with another backing plate. The stack-backing plates consist of smooth bakelite, 1/4 inch thick, cut to the same size as the emulsions. Each is provided with holes to match the holes punched into the emulsions. Smooth stainless steel studs, which fit the punch holes snugly, are used to align the emulsions between the backing plates and hold them in place while the stack is firmly taped. The aligning studs are removed and replaced by freely fitting stainless steel bolts, which are used for additional tightening of the stack. The stack is then made lighttight. A stack assembled in this fashion has all the punch holes (and thus also the pin pricks) accurately aligned.

The punch press shown in Fig. 1 can be used for any plate size 4 by 2 inches or larger. For emulsion larger than 11 inches in one dimension, three stud holes and six pin pricks are punched.

C. Printing of Grids

To facilitate re-location of events when different microscopes are used, a matrix grid* is photographed directly onto the bottom of the emulsion (i. e., the side that will be stuck to the glass when it is mounted). For this purpose, the contact printer shown in Fig. 3 was constructed. It consists of a box 32 inches high with a 5-amp microscope bulb (to approximate a point source)

* Similar to the grid discussed by Birge, Kerth, Richman, Stork, and Whetstone, Radiation Laboratory, University of California, Berkeley, California, Report No. UCRL-2690. We are grateful to the Richman group for making the negative of this grid available to us.

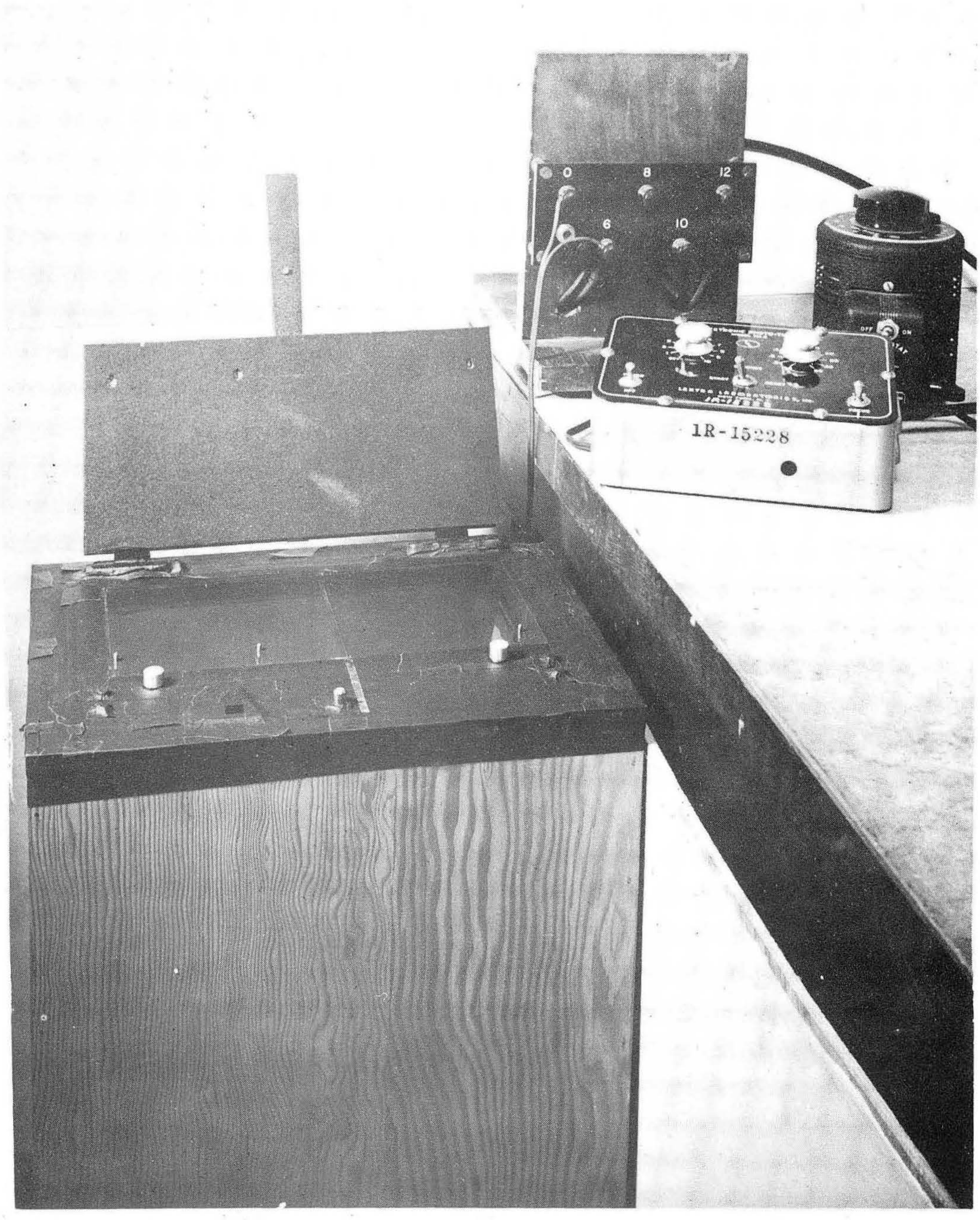

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Fig. 3 Contact Printer for Emulsion Grid at the bottom, and a window at the top on which the negative of the grid is mounted. The exposure time is controlled with a commercial timer. Under these conditions exposure times are of the order of 1 second. Two studs about 1/8 inch high, matching the punch holes in the emulsions, allow us to print the grid in the correct position on each emulsion. The grid used gives lines about 35 microns wide and with numbered intersections 1 mm apart.

This step takes about 15 seconds per emulsion.

D. Mounting of Metal Corners on Plates

After the emulsions have been mounted on glass and developed, and the plates have dried, brass "L's" shown in Fig. 4 are mounted with reference to the four pin pricks on each emulsion. The mounting system, using four 10x microscopes as shown in Fig. 4, was designed for this purpose. Each microscope has two cross hairs in the eye piece. The box has a diffuse light source for each microscope. Initial positioning of the microscopes is accomplished by lining up the cross hairs of each on its respective dot on one plate from the stack being studied. Then each succeeding plate of the same stack is positioned with respect to the dots on this reference plate. For the next stack, slight adjustments may be necessary, to compensate for differences in development of various stacks. If the region of one dot has been distorted because of development difficulties, it will be obvious, and that dot can be neglected in making the alignment. Relative motions, during development, of dots on various plates may also be averaged out in this alignment.

The procedure for mounting the "L's" as follows:

(1) One places a lucite plate holder in the mounting system as shown in Fig. 5, and fastens it down with wing nuts attached to the box, designated by W on Fig. 6.

(2) One then places a plate on the lucite holder. The mounting system is closed and the plate adjusted so that each of the four dots falls at the intersection of the cross hairs in the corresponding microscope. Those bolts on the lucite holder marked 1, 2, and 3 in Fig. 6 are then tightened.

(3) One then puts glue on one side of an "L", and--having opened the mounting system--puts it in position, as shown in Fig. 6, firmly in contact with the three guideposts, G, attached to the box and tightens those bolts on the lucite holder marked 4, 5, and 6 in Fig. 6. The glue used which is suitable for fastening metal to glass, is Epon Adhesive VI manufactured by Shell Chemical Corporation. The compound is mixed with an accelerator (diethylene triamine) just before use, and requires about 12 hours to set.

(4) One then removes the lucite holder from the mounting system while the plate and "L" remain clamped together to the holder. The plate stays in the lucite holder until the glue is dry. (By using a sufficient number of lucite holders, one can mount the entire stack, one plate at a time, and leave them to dry in the holders.) When the plate is removed from the lucite holder the "L" serves as two reference edges for alignment on the microscope.

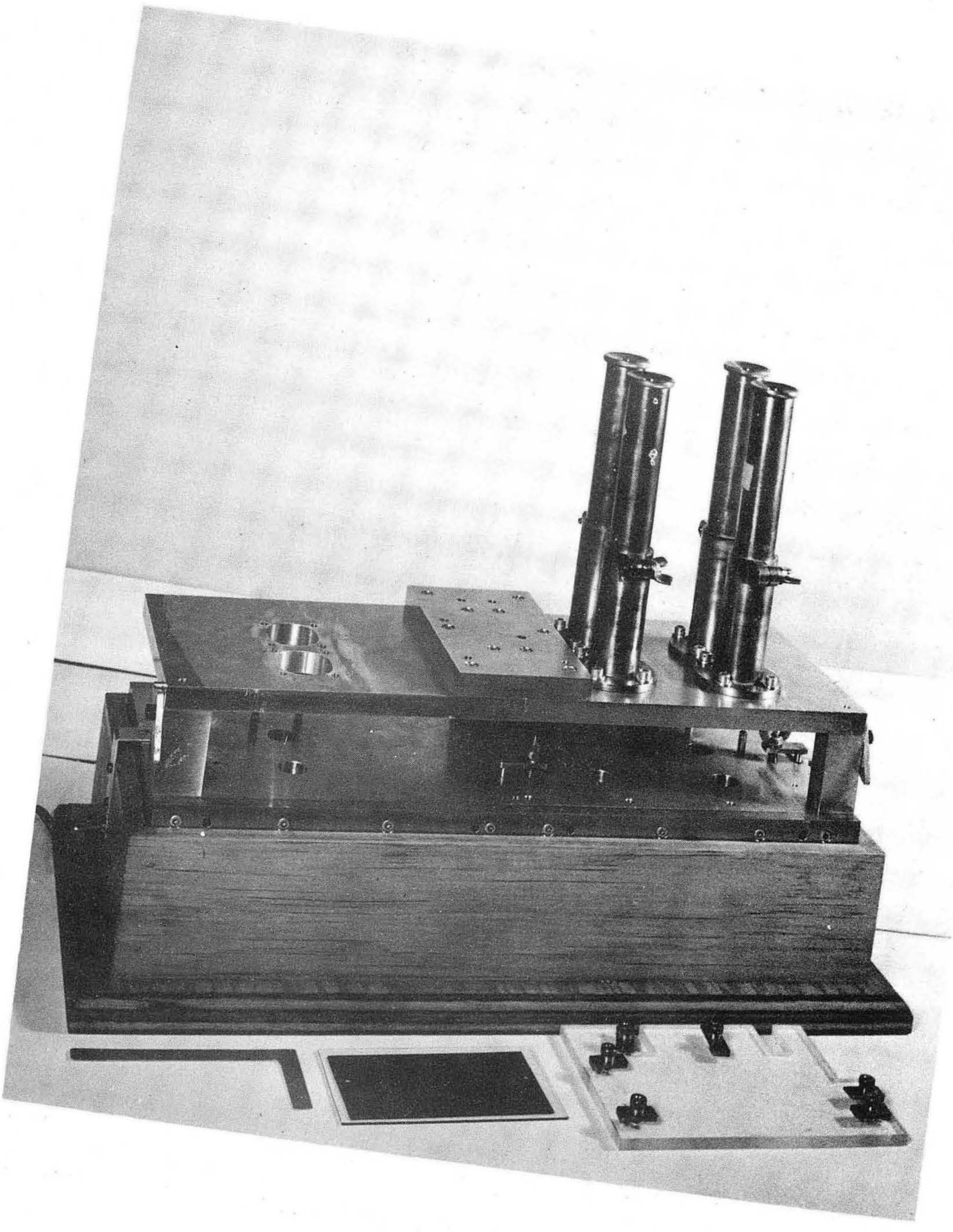

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Fig. 4 Plate-Mounting System

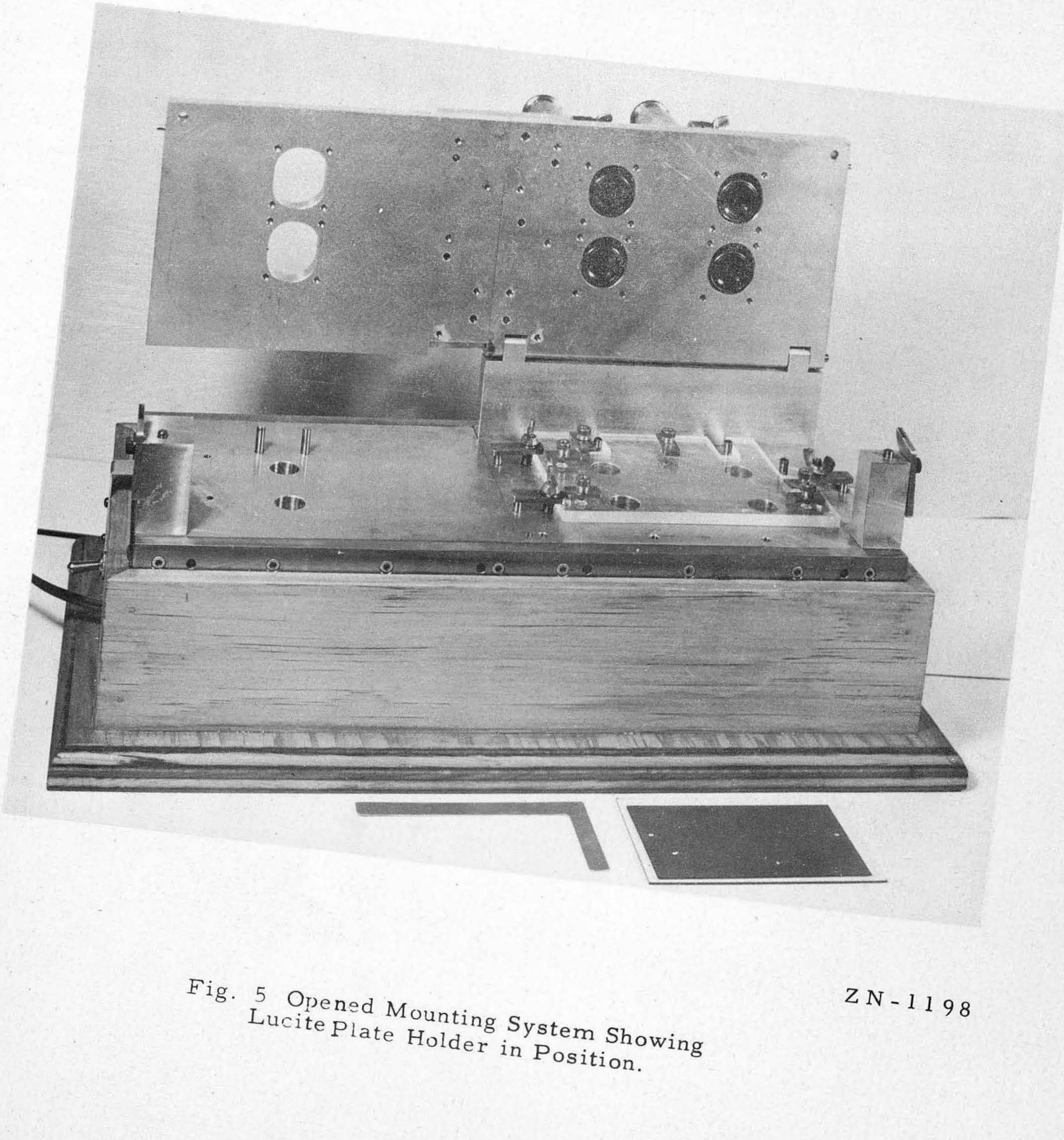

Fig. 5 Opened Mounting System Showing Lucite Plate Holder in Position.

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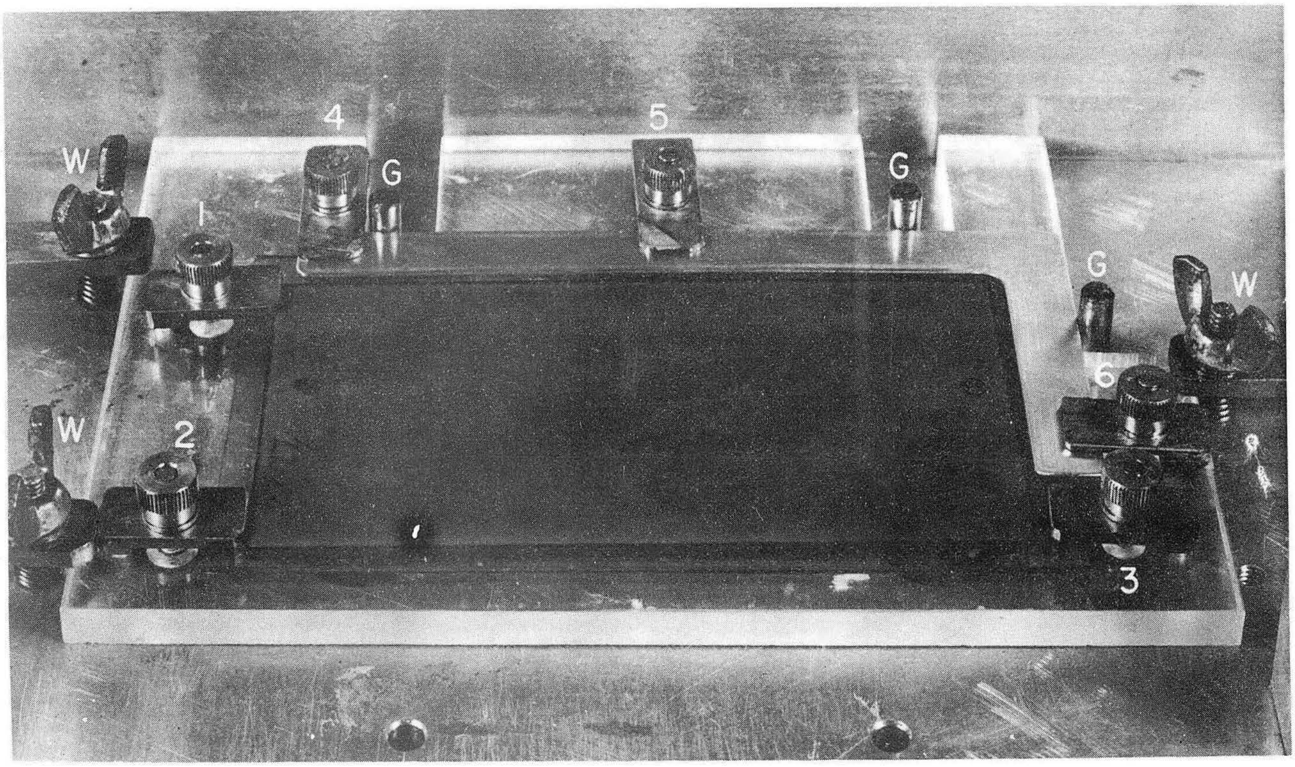

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Fig. 6 Plate in Position with Mounted "L"

E. Conclusion

With reasonable care and experience in mounting the "L's", the relative positioning of adjacent plates can be good to 50 microns or less. Of course, the accuracy may be improved still further by following through heavy tracks under a high-power objective and filing the "L's" appropriately. For most work this has been found unnecessary.

The presence of the grid as a local reference system also helps in the following through of tracks, and is reproducible to within about 20 microns. Actually, either system is sufficient by itself for following through tracks.* We feel, however, that this combination is particularly fast and convenient.

In all of this work we want to express our great appreciation to Mr. William M. Brower, of the Physics Department Shop, for many helpful suggestions and for the final designs and construction of all this equipment. This work was done under the auspices of the U. S. Atomic Energy Commission.

* Dr. Harry H. Heckman and others use a similar grid-printing technique for following tracks.