CHAPTER III

EXPERIMENTAL PROCEDURE

3.1 Preparation of Bi Thin Films and Electrical Contacts

The desired sample shape is a rectangular film of dimensions 0.5×2 cm^2. For electrical leads, silver paste was painted in the clean slab of microscope slide as shown in Fig.4. The slide was then

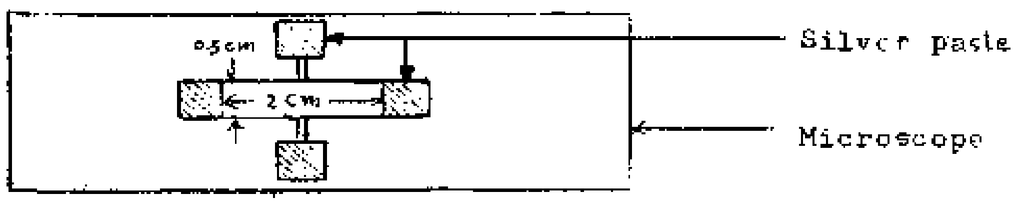

Fig.4 Positions of Silver Paste Contacts.

heated in an oven to 500 °c for 10 minutes. Then it was wrapped in a sheet of aluminum foil with a rectangular opening slightly larger than the desired sample area. The slide was then placed on an aluminum stand with an opening slightly smaller than the slide. The opening is about 17.5 cm directly above a molybdenum boat. The boat contained tiny chunks of Bi chipped from a big lump of pure Bi metal.

The Bi was evaporated onto the microscope slide by passing 1.0 amp. of a.c. through the molybdenum boat. The Bi film of the desired size and shape just touches the silver paste connections.

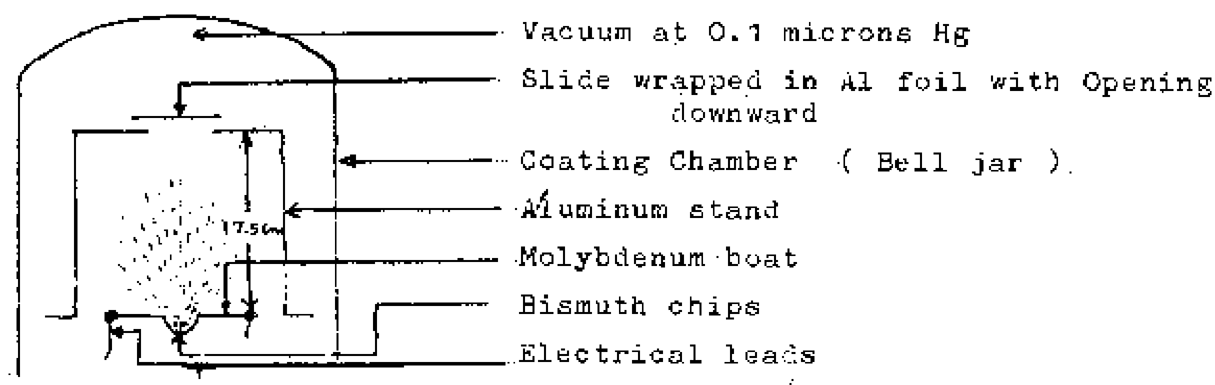

Fig.5 Coating Chamber.

A pair of electrical wires were attached to the drop of epoxy mixed with ground dried colloidal silver (prepared in the lab) deposited on the silver paste connections.

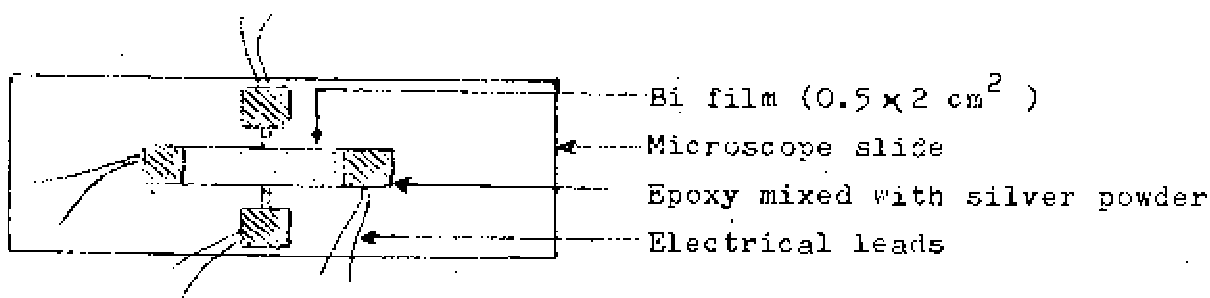

Fig.6 Finished Bi Film with Electrical Leads.

Bi films of five different values of thickness were prepared by placing different amount of Bi chips in the molybdenum boat for each coating.

3.2 Measurement of Film Thickness

The thickness of the prepared Bi film was measured by the multiple beam interferometry technique. The method made use of the optical interference fringes of equal air gap thickness. It was assumed that the microscope slide on which the Bi film was deposited was an optically flat surface. Another piece of optically flat slide was partially coated with silver by evaporation and then cut into small strips. One of these silvered strips was placed with the silvered face downward to cover the edge of the Bi film.

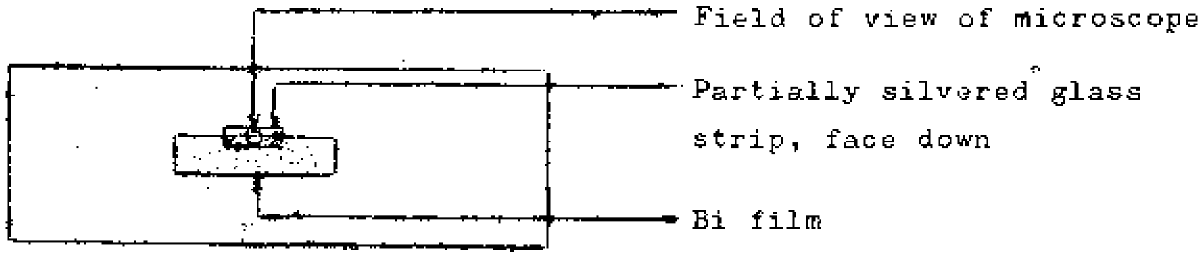

Fig.7 Setup for Measurement of Film Thickness.

These formed an interferometer and was illuminated with a beam of parallel monochromatic light from a sodium arc at normal incidence.

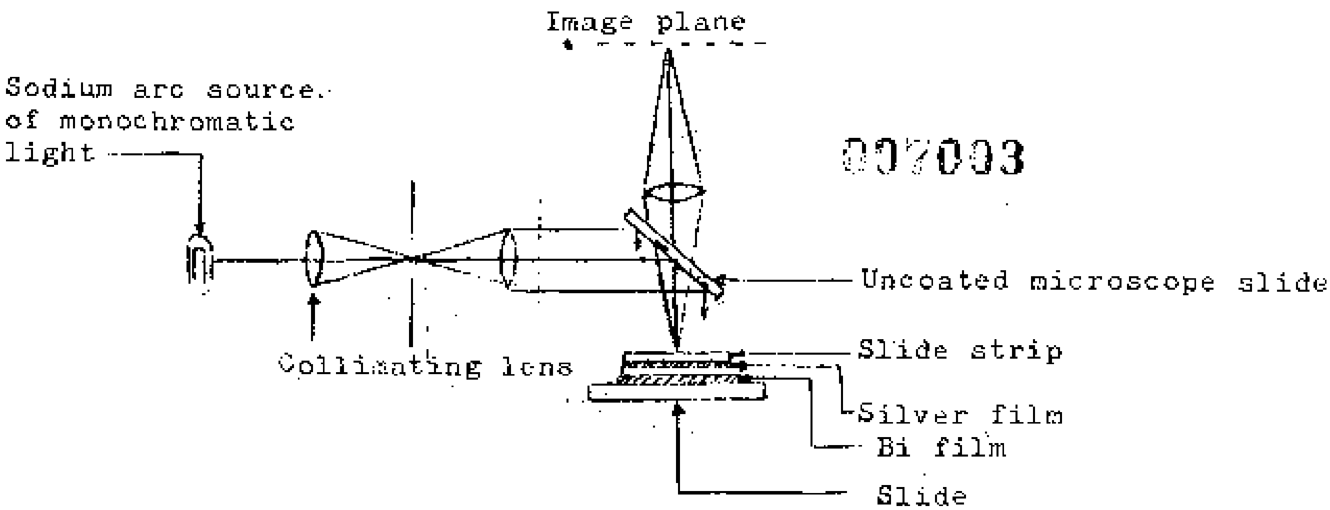

Fig.8 Multiple Beam Interferometry Technique.

A low power microscope was used to view the dark interference fringes in the vertical direction, the field of view of the microscope being the center of the silvered glass strip above the edge of the Bi film.

By tilting one end of the silvered glass to form a wedge shape air gap, dark interference fringes will appear to trace out points of equal air gap thickness. By adjusting the relative positions of the two glass plates, the fringes were made to run in straight lines perpendicular to the steps of the Bi film edge. The fringes show a displacement as they pass over the step edge.

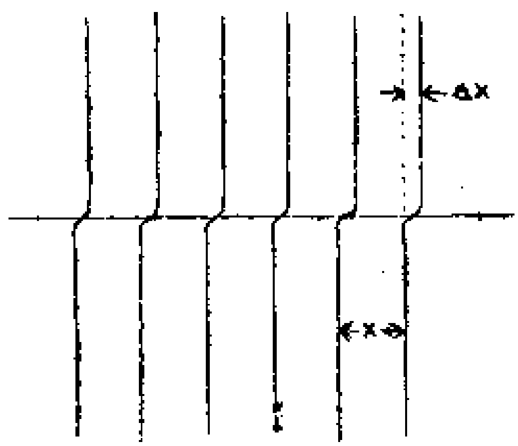

Fig.9 Interference Fringes.

The displacement of the fringes was measured in terms of fraction of a fringe width; $\frac{\Delta x}{x}$, by using the cross hair of the microscope eye-piece.

The difference in the air gap spacing for two adjacent fringes is $\lambda/2$ and the film thickness was obtained as $\frac{\lambda}{2} \cdot \frac{\Delta x}{x}$.

3.3 Measurement of Hall Coefficient and Conductivity

The Bi film was mounted in a vertical plane parallel to the pole pieces of an electromagnet. For convenience in mounting, the microscope slide carrying the film was attached to a piece of thin plastic plate with six binding posts attached for electrical connections. The connections and their labels are as shown in Fig.10.

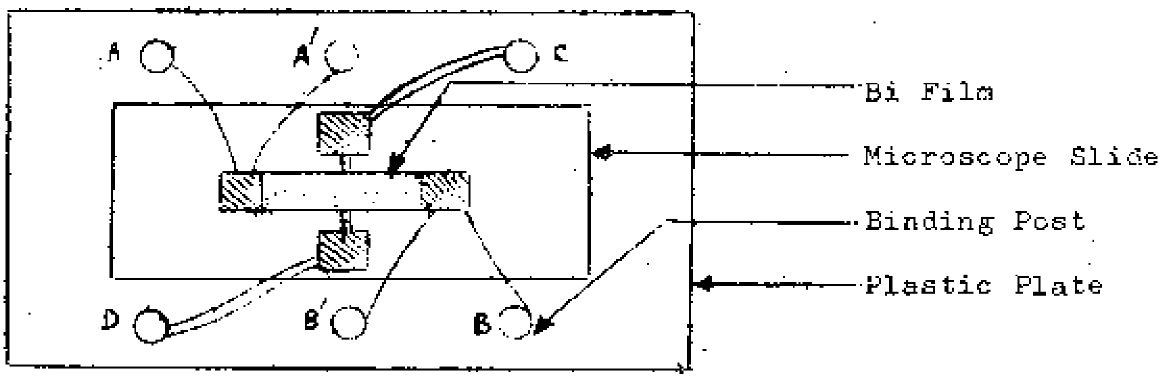

Fig.10 Film on the Microscope Slide Attached to the Plastic Plate for Mounting in the Magnetic Field

The experimental apparatus consists of a battery to supply the d.c. through the film, a rheostat to vary the current and an milliammeter to measure it. A reversing key was used to change the direction of current flow through the Bi film. A d.c. potentiometer capable of microvolt reading, was used to measure the Hall voltage, V_H, between poles C,D and to measure the voltage across the film, A,B in conductivity measurement. The connections and arrangement of the apparatus are as shown in Fig.11.

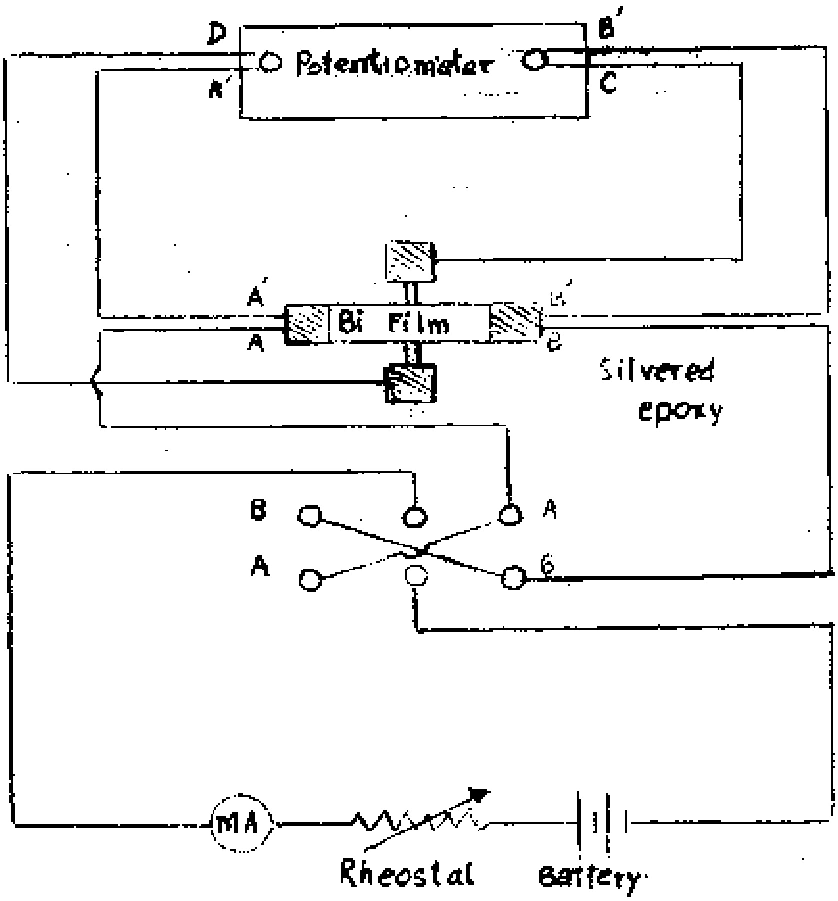

Fig.11 General Setup of the Experiment.

To correct for errors introduced by galvanomagnetic and thermomagnetic effects and the error due to the fact that C and D are not exactly at the same equipotential, each measurement of Hall voltage was repeated four times under different conditions. With the magnetic field pointing in one direction and the d.c. flowing through the film in one direction, the voltage across CD was read on the potentiometer. The d.c. was reversed by use of the reversing key and again the voltage across CD was read. The direction of the magnetic field was then reversed by reversing the direct current through the electromagnet, and two readings of V_H were taken for the two directions of d.c. through the film. The average of these four readings will give the correct Hall voltage, as explained in the Theory. The minute voltage due to the Ettingshausen effect, V_E, was neglected.

Five Bi films of different thickness were prepared. For each film, the Hall voltage V_H was measured and plotted against magnetic field strength, with different d.c. passing through the film. All measurements were made at room temperature. The Hall voltage were also plotted against the value of d.c. flowing through the film.

To obtain the value of the electrical conductivity of the various films, the voltage across the film was measured, using the leads A',B', while passing the d.c. through the Bi film. The value of the d.c. was varied four times for each film.

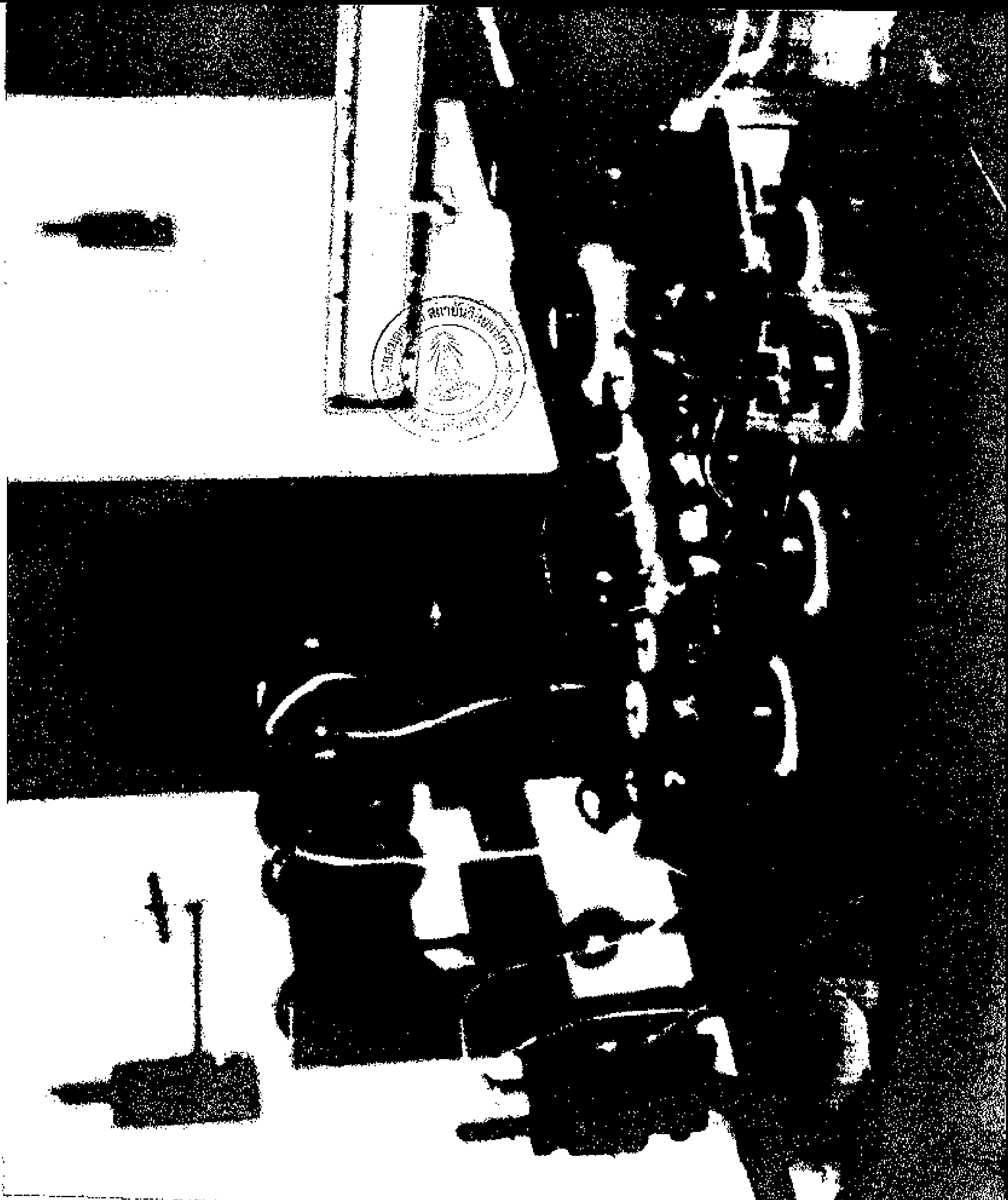

Fig. 12 Photograph of the Apparatus.