A CASE STUDY FOR AUTOMATIC ASSEMBLY: IBM 3178 LOGIC UNIT

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ABSTRACT

A Case Study For Automatic Assembly:
IBM 3178 Logic Unit

An IBM 7565 Manufacturing System with two finger gripper was used to assemble an IBM 3178 Logic Unit. This attempt resulted in some design modifications for automated assembly. The importance of snap fits for automated assembly was observed and snap fits were implemented on some parts. Elimination of flexible wiring from the keylock enabled assembly of all the parts with the robot.

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1. INTRODUCTION

To automate production, design engineers need to know the capability of the automation systems being used. To this end, a series of robotic assembly case studies has been set up at the Robotic Applications Lab of The University Of Michigan Mechanical Engineering Department. The goal is to investigate and derive design rules and suggestions for automated assembly through analysis of case study assemblies.

The IBM 3178 Logic Unit is well taken as a case study and consists of the following parts. See figure one.

1. Bottom Plastic Cover
2. Power Supply
3. Logic Planar Card
4. Keylock
5. Top Plastic Cover

Parts are assumed to be fed to specific locations on the robot table and rigid fixtures are used to keep their orientation. In the next section we will investigate in detail how each part behaved and what had to be done assemble them, thereby exposing the limitations of the robot.

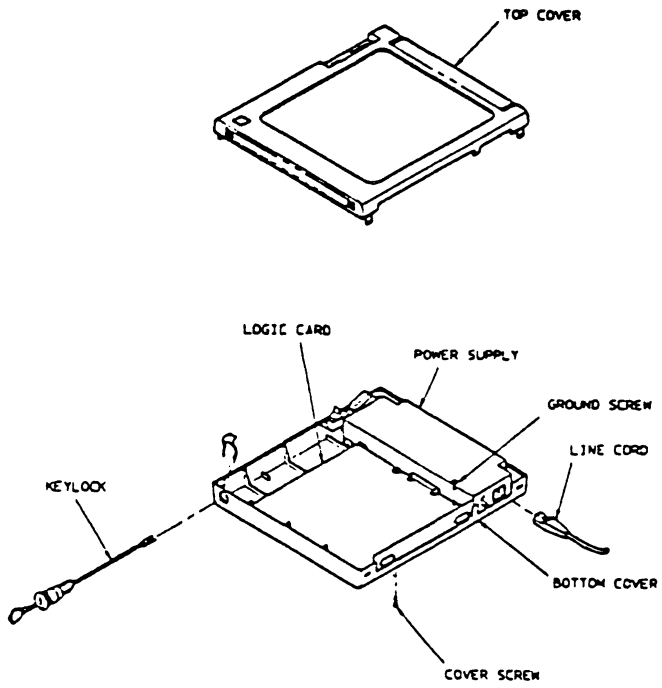


Figure 1. IBM 3178 Logic Unit Parts

2. DESCRIPTION AND FLOW OF ASSEMBLY

2.1 Bottom Plastic Cover

This part served as a base part and the rest of the components were picked up by the robot and assembled onto it. It was placed manually on a rigid fixture. Therefore handling of it by the robot was not required.

2.2 Power Supply

The rectangular shape of the power supply created no handling difficulties for the robot. It had to be gripped near the center of mass, so that it would not rotate. Fastening of this part was achieved by four snap type joints already present. It was tilted about 30 degrees to the horizontal and then two of the snap fits on one side were inserted without snapping. Then the part was dropped on the other two snap joints, and pushed down by the robot till snapping was performed. See figure two for the assembly process of this part.

2.3 Logic Planar Card

Again, this part was picked by the robot from a fixed point on the worktable and transferred and oriented such that it could be inserted into the power supply. Because of its small thickness and relatively large side dimensions which forced gripping far from the center of the card, the part vibrated excessively during the gross motion between feeding point and insertion. The vibration was minimized by moving the part very slowly. Since full horizontal orientation of this part was not possible, (i.e. because of physical limitations like the width of the gripper.) insertion of the card contacts into the power supply was performed at the smallest possible angle to the horizontal contact receptacle. This suggested having either the card contact or power supply receptacle on a pivot as a design improvement. After this insertion was done, the part was dropped to its final location and secured manually to the power supply with a ground screw. This screwing operation is done by a special purpose machine in industry. See figure three for the assembly of this part.

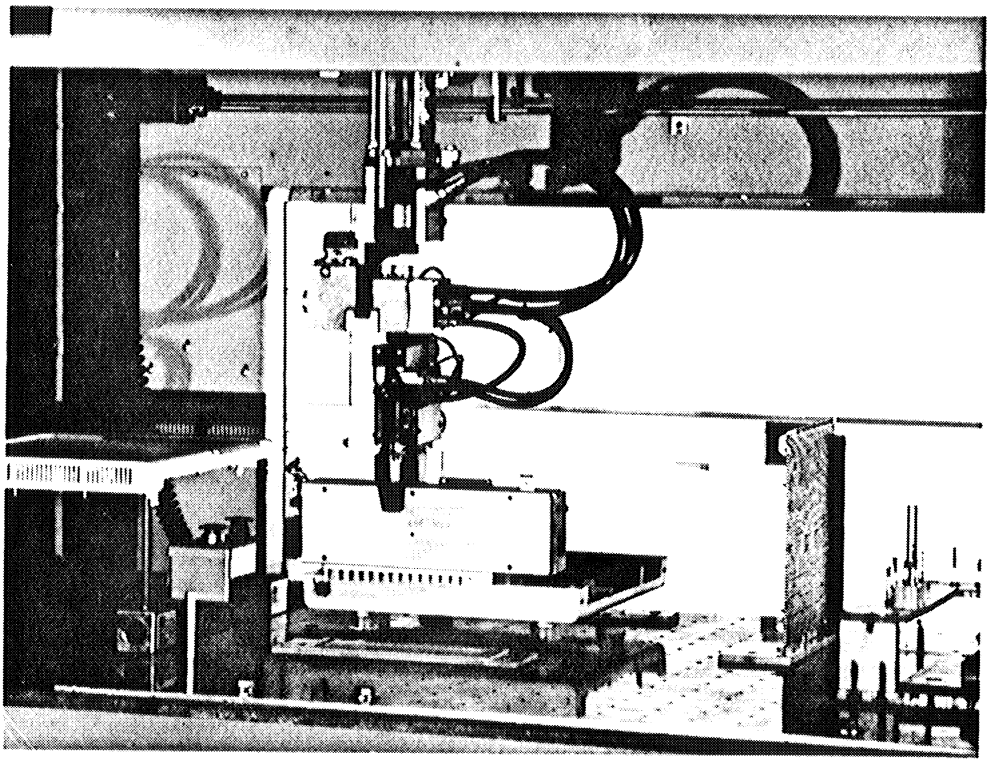


Figure 2.a. Power Supply Is Being Picked Up By RS2 Robot

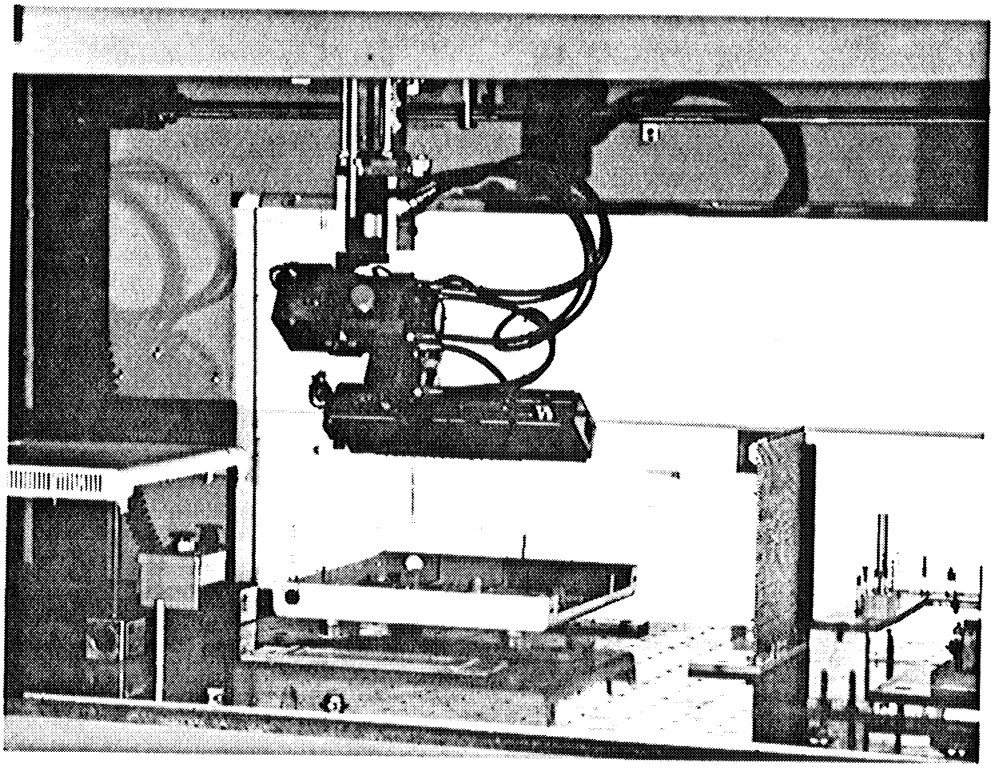


Figure 2.b. Orientation Of Power Supply

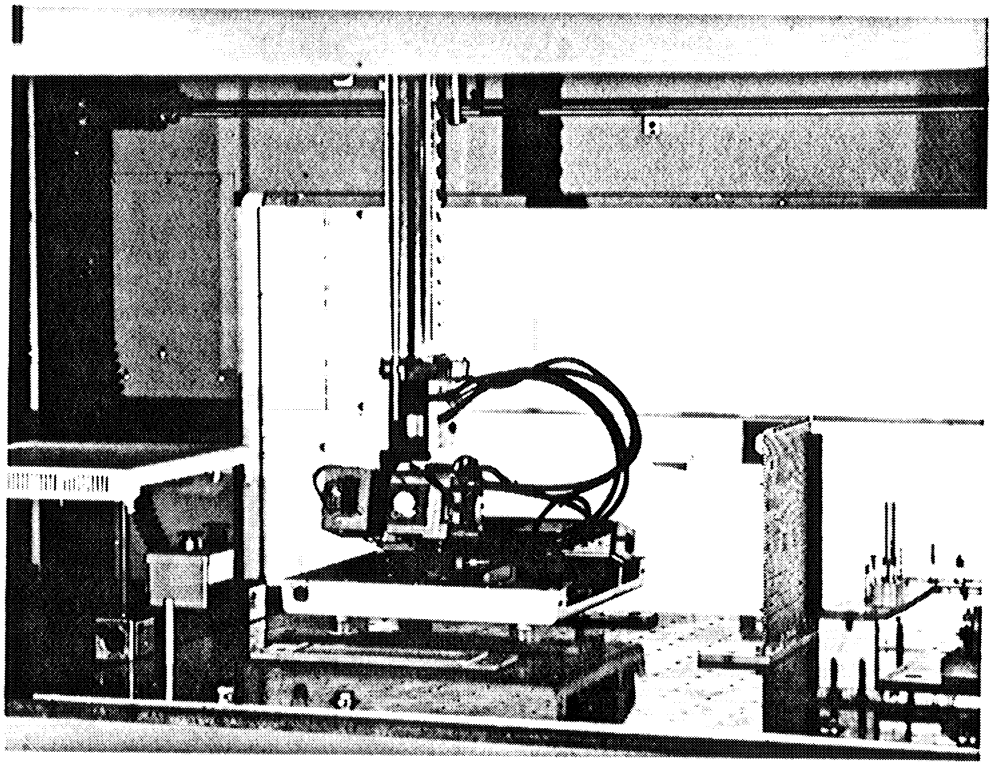


Figure 2.c. Power Supply Is Dropped On Two Of Four Snap Type Joints

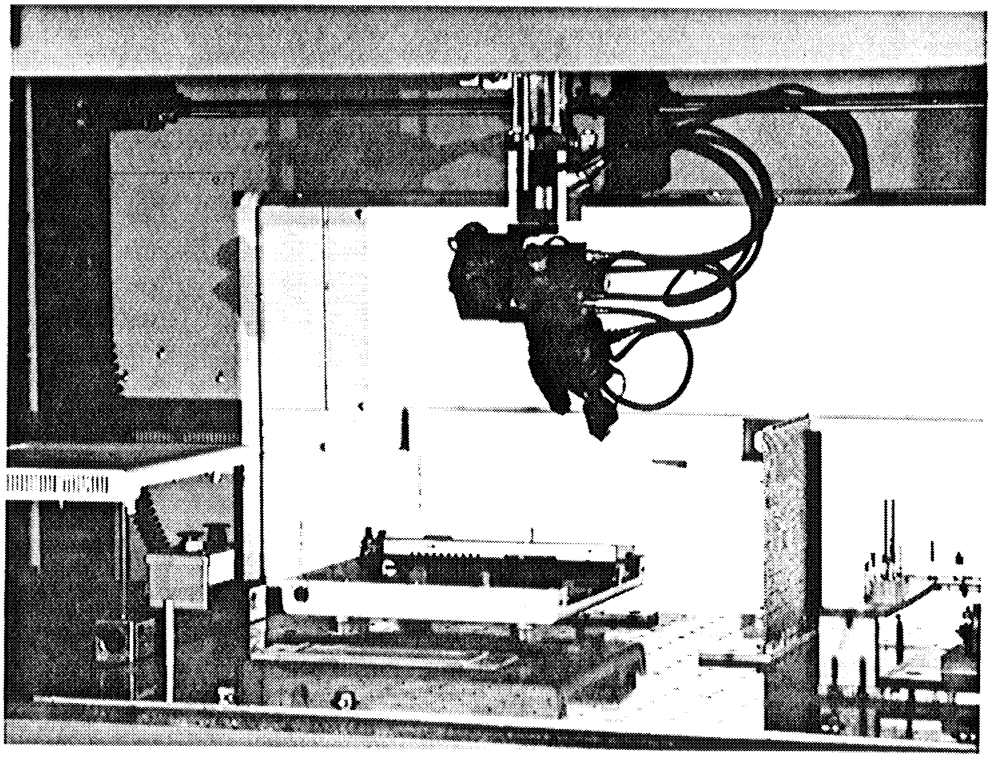


Figure 2.d. Arm Prepares Itself To Snap The Power Supply

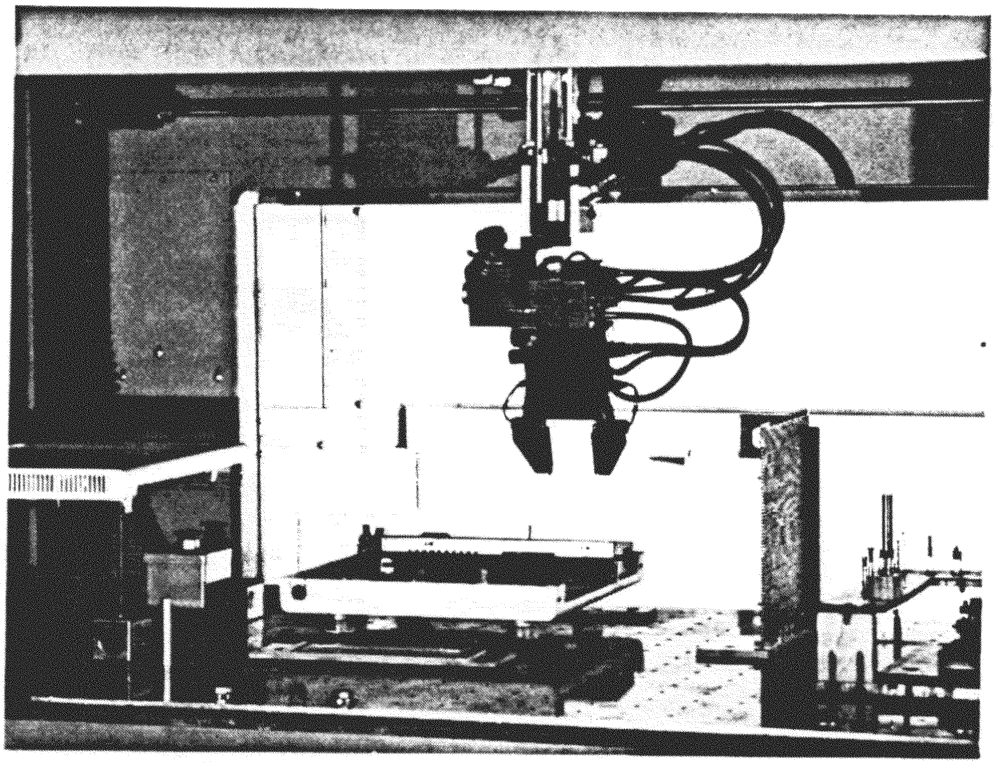


Figure 2.e. Arm Is Being Lowered

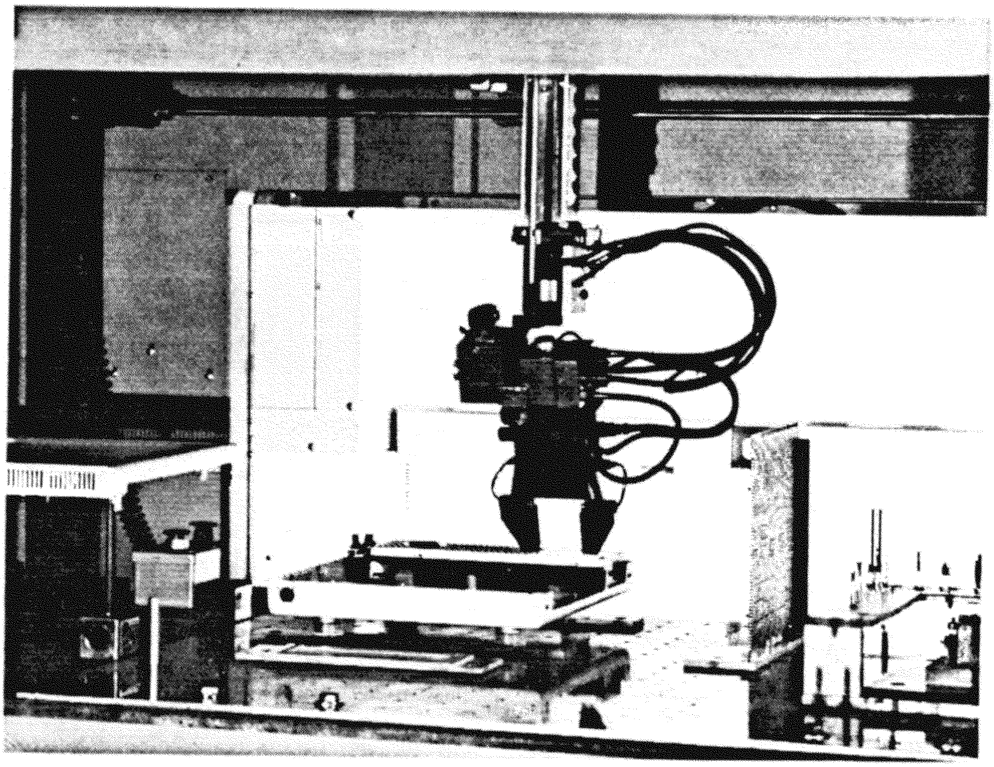


Figure 2.f. Final Snapping Is Performed

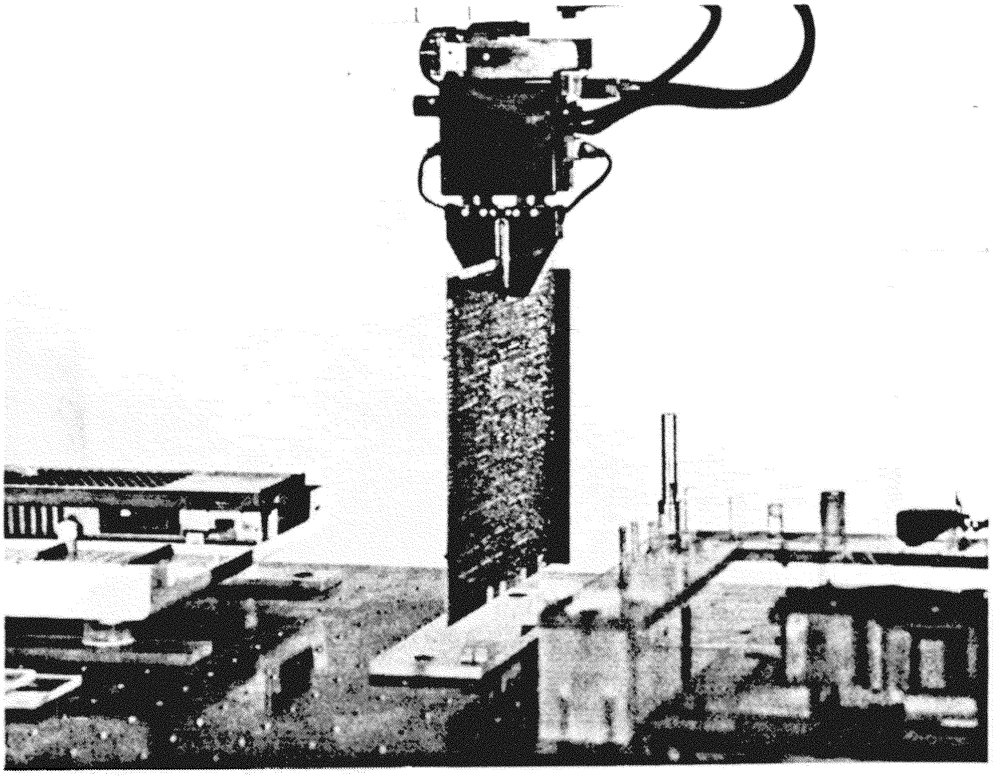


Figure 3.a. Logic Planar Card Is Picked Up From Its Fixed Position

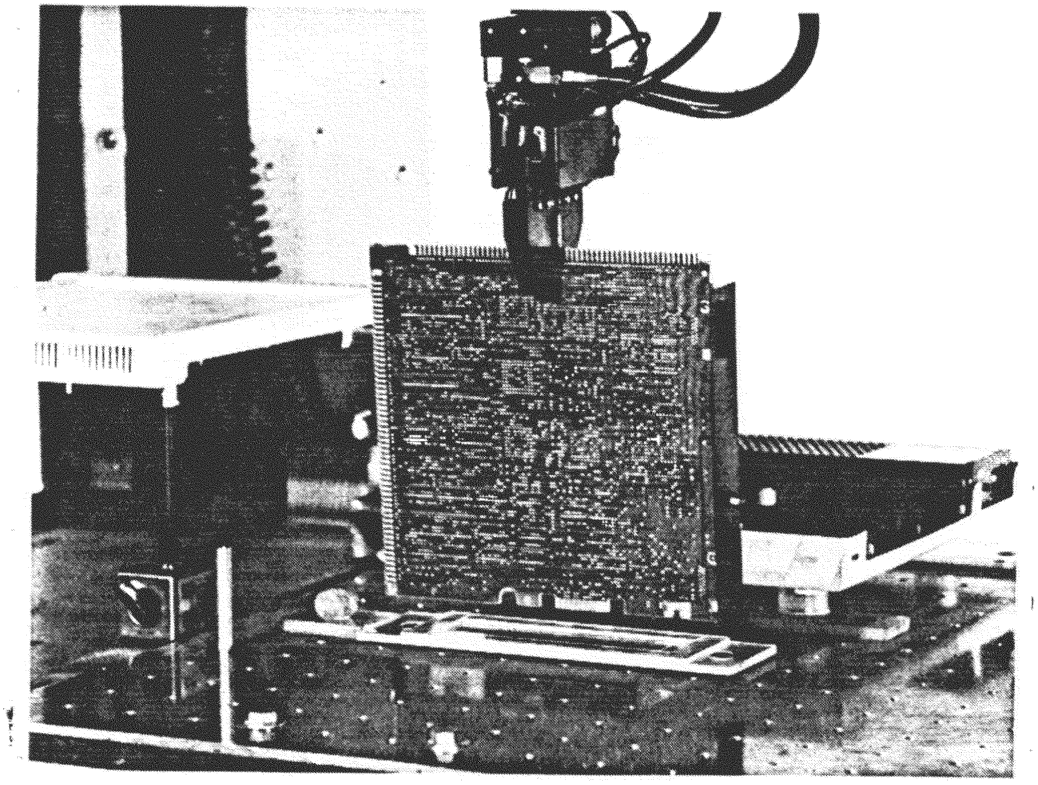


Figure 3.b. It Is Carried To The Assembly Location

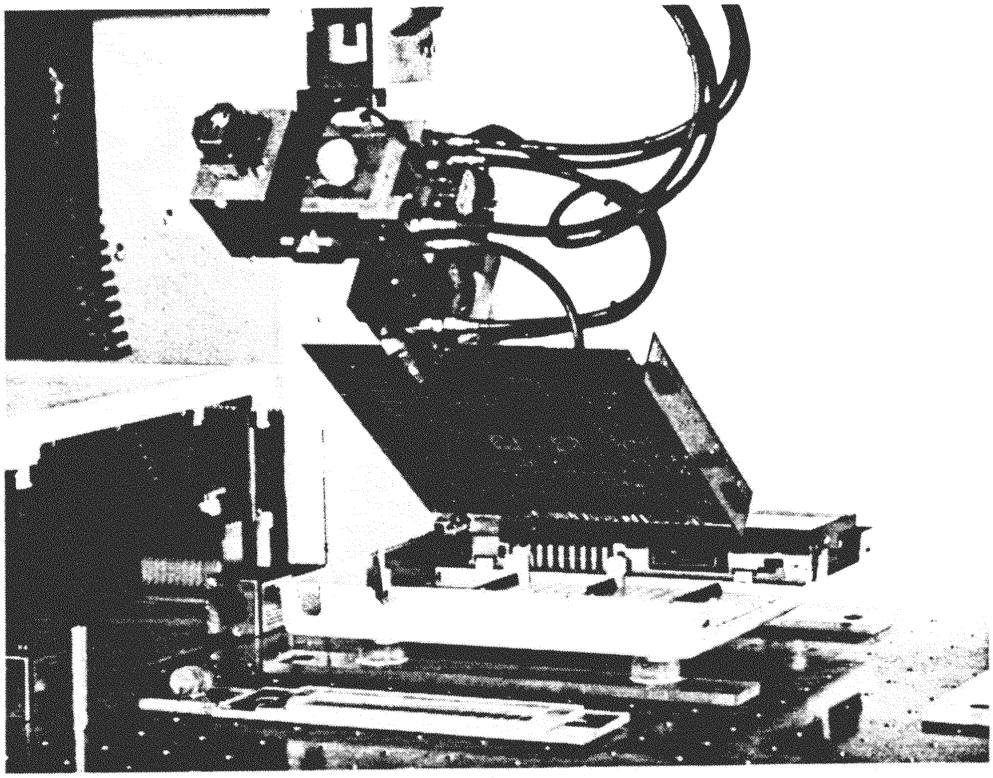


Figure 3.c. It Is Being Tilted

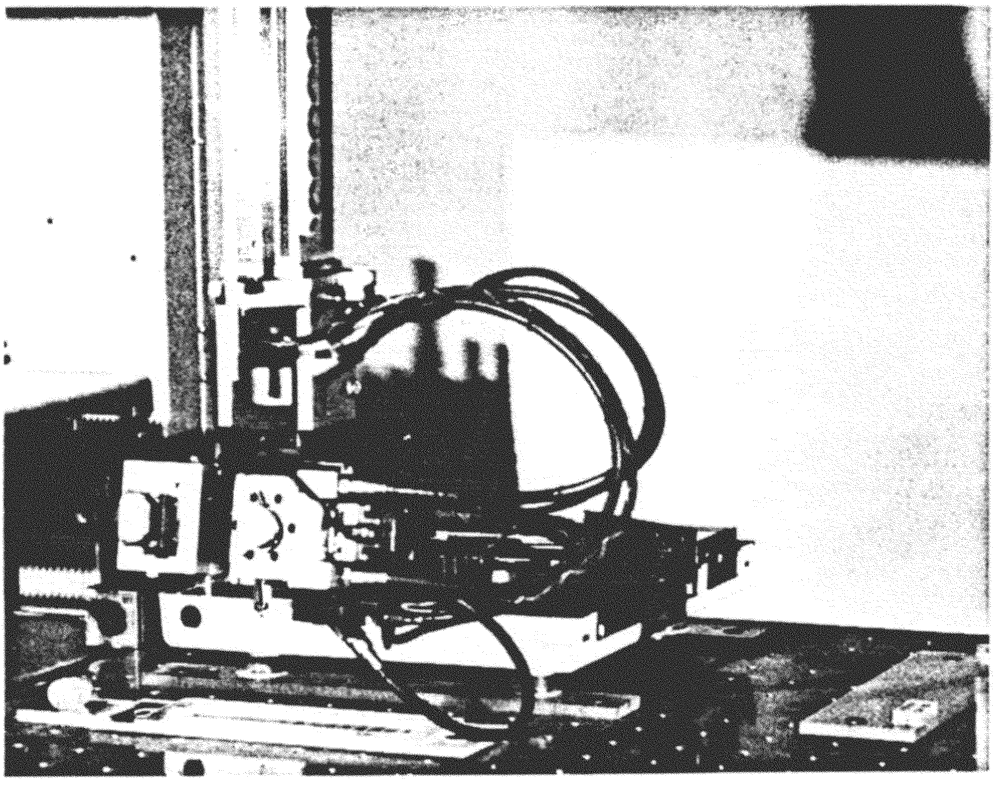


Figure 3.d. Insertion Of Planar Card To The Power Supply Is Performed

2.4 Keylock

As it was observed in previous experiments [1] , any part with flexible wiring should be modified for automated assembly. A model keylock with no functioning capability was built to demonstrate one of the many likely design solutions. Small modifications were also made on the top and bottom plastic covers to accomodate the changes in the keylock. See figure four for the new design and the assembly procedure of the keylock. The modified keylock was picked up by the robot from a fixed location and was inserted to the contact located on the logic planar card, and into a semi circular relief cut at the side edge of bottom plastic cover.

2.5 Top Plastic Cover

Finally, insertion of the top plastic cover completed the assembly. Since this part did not offer the proper contact area for the gripper type that we used, special care was necessary in handling. It was located about 10" above the worktable to allow enough space for the gripper to pick it up. First the gripper closed until contacts between the bottom finger and the thin vertical wall and the top finger and upper surface were achieved. At this moment the robot kept moving upward and closing the gripper simultaneously, resulting in contact between the inner surface of the cover and the bottom finger. As expected, at this stage the cover is at an angle of approximately 20 degrees to the horizontal. Once it is secured between the fingers it is transferred to its location obove the rest of the assembly. Due to its tilted nature when lowered, one side made earlier contact with bottom plastic cover before the other side. Then the part was dropped and pressed down for a snap fit. See figure five for assembly of the top plastic cover. A second screw which would fasten the top plastic cover to the bottom plastic cover, was replaced by a snap mechanism, which was inserted at the same time of assembly as the top plastic cover. See figure six for this snap mechanism.

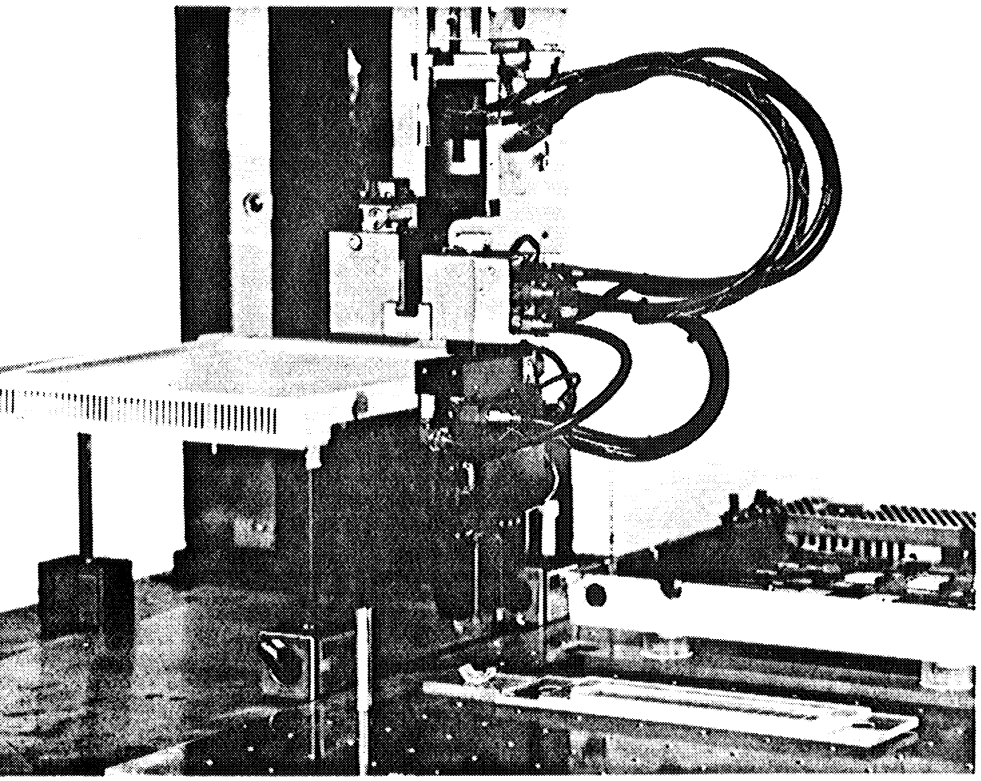
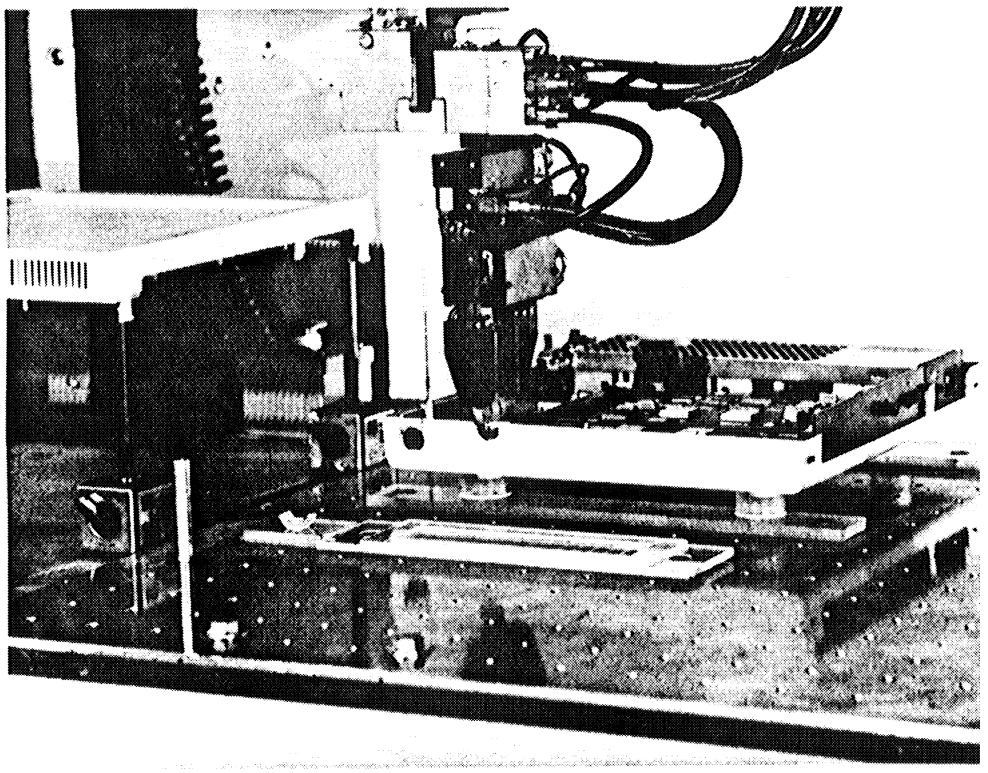


Figure 4.a,b. Modified Keylock Being Picked Up And Inserted



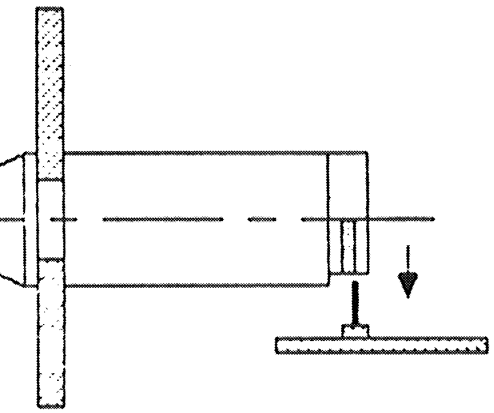


Figure 4.c. Modified Keylock With No Wiring

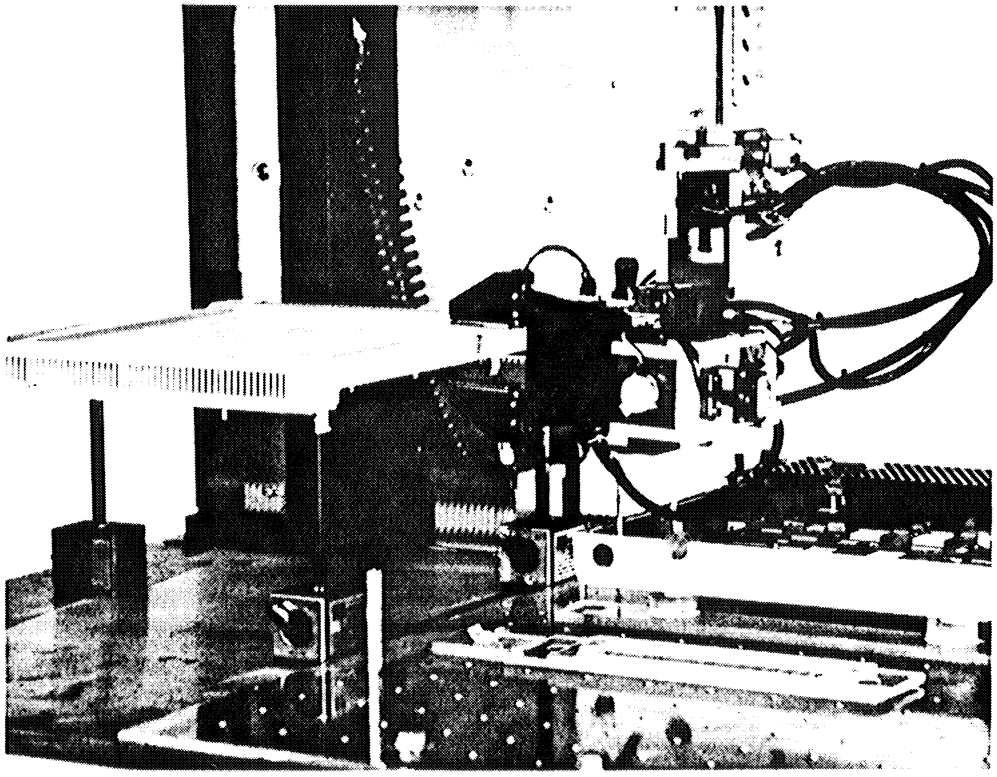


Figure 5.a. Top Plastic Cover Is Being Picked Up

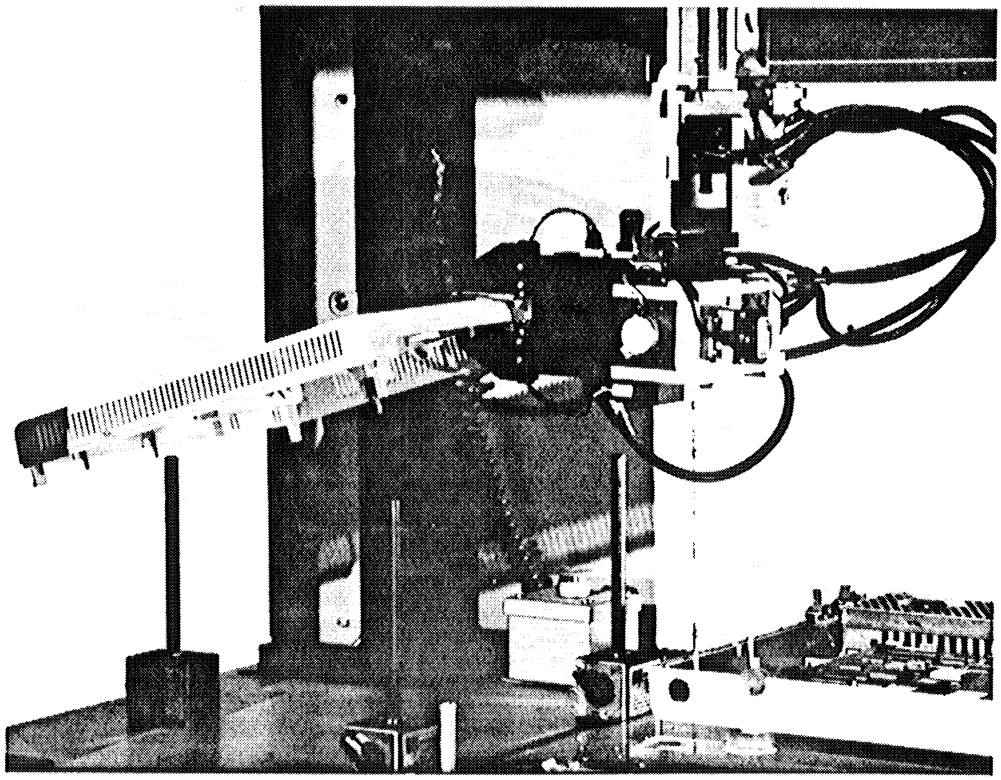


Figure 5.b. Arm Is Moving Up Till Bottom Surface Touches The Gripper

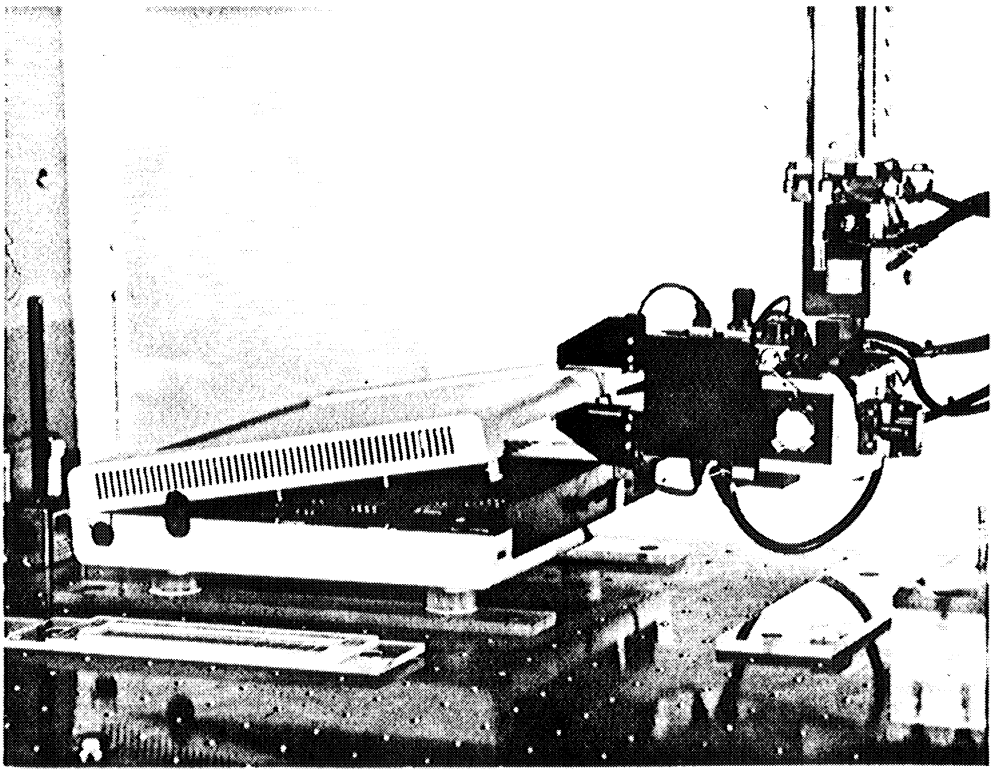


Figure 5.c. Part Is Carried To The Top Of Rest Of The Assembly

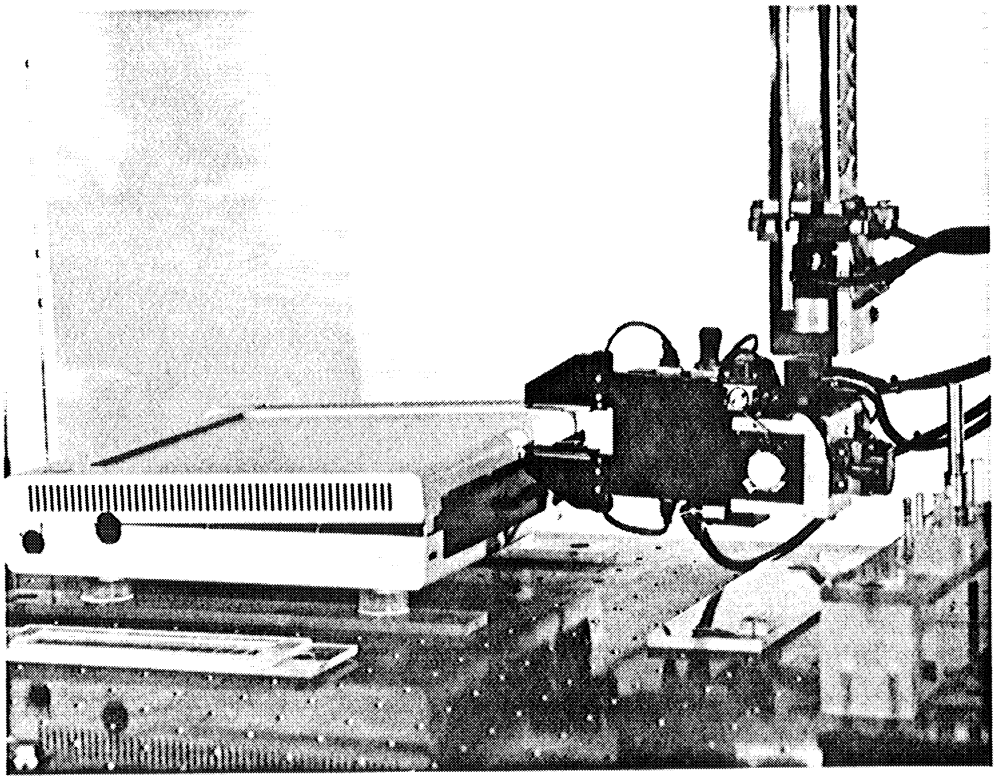


Figure 5.d. It Is Dropped On To The Assembly

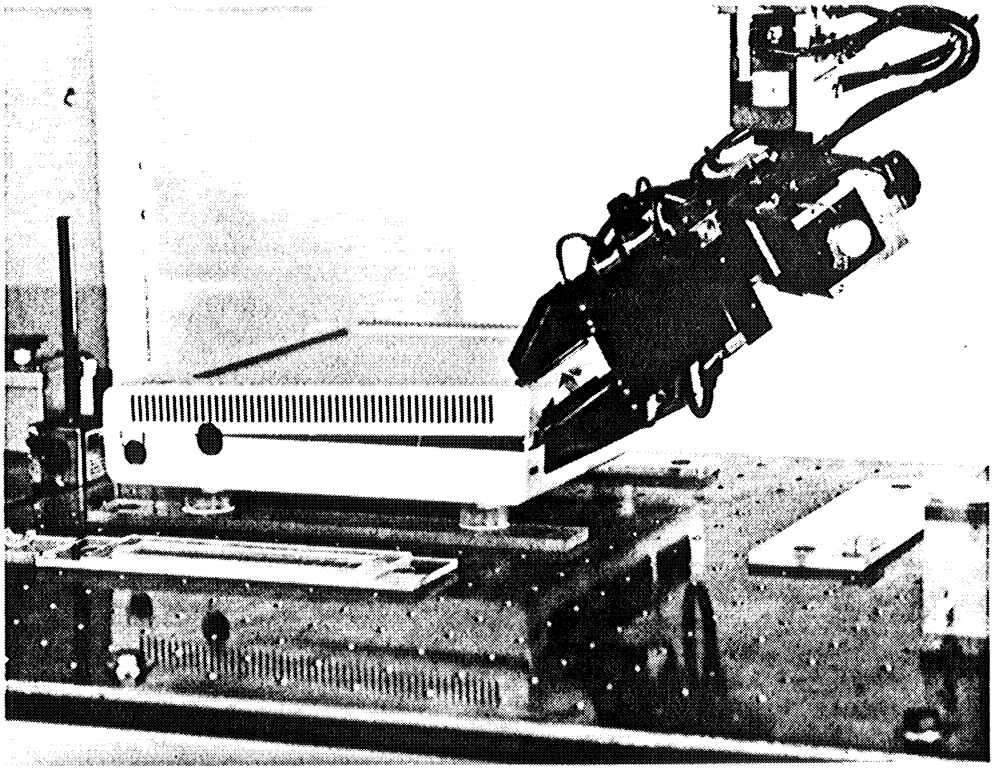


Figure 5.e. Snap Mechanisms Are Being Pushed In

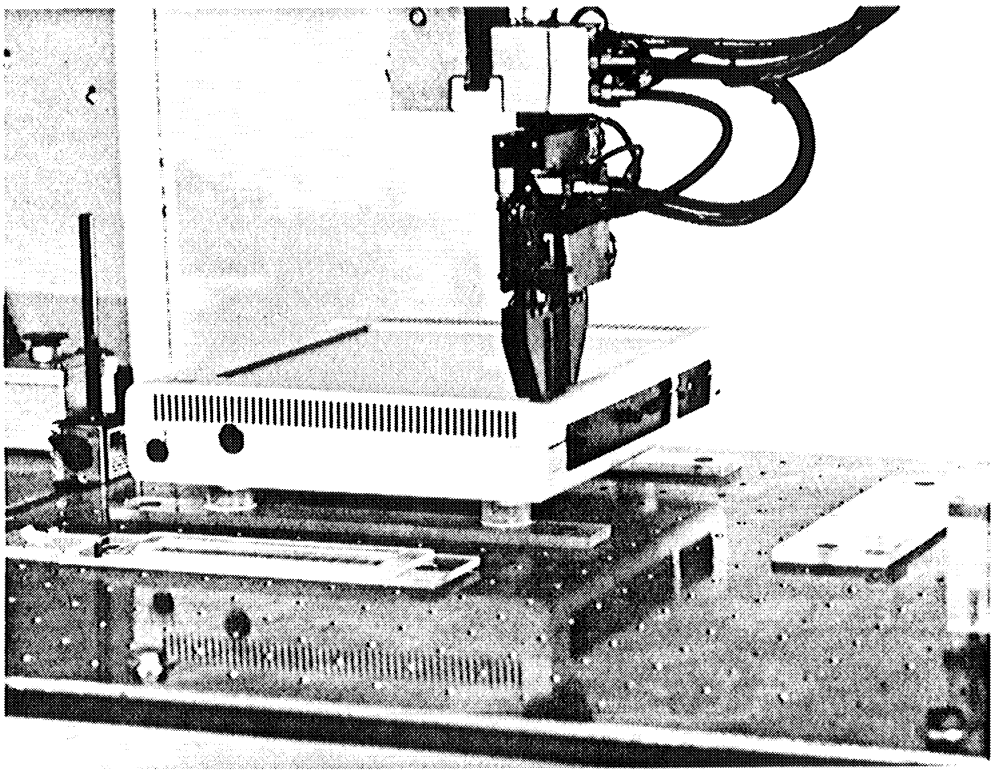


Figure 5.f. Snapping Is Being Performed

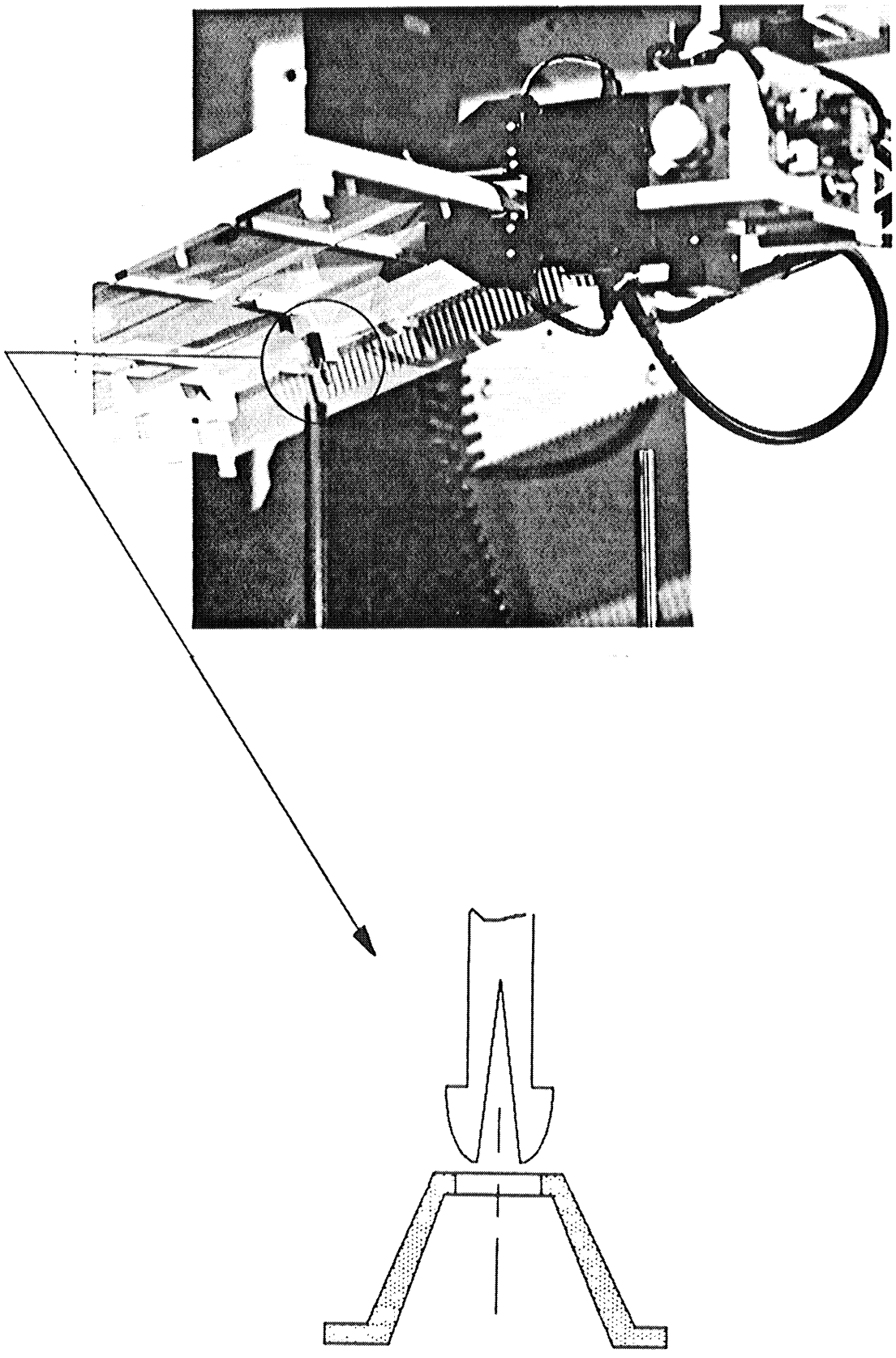


Figure 6. Snap Mechanism Which Substituted The Screw Is Used To Fasten The The Top And Bottom Plastic Covers

3. CONCLUSIONS

Even though the IBM 3178 Logic Unit had only five parts, it revealed some more design rules for automated assembly. These can be summarized as follows.

3.1 Snap Fit

There are no specific rules to use snap fits. Rather, when and how to use them is left to the imagination of the design engineers. They should be used whenever possible especially to eliminate screw fastenings.

3.2 Pivoted Contacts

Some horizontal insertions are not possible because of physical limitations. One solution is to replace these with vertical ones. Another solution is to allow enough flexibility for these contacts by means of either rubber mounted or pivoted joints.

3.3 Thin Plates

Transportation of relatively thin plates can slow down the assembly process significantly because of vibration. It may be necessary that edges are made thicker to resist the excessive vibration when the robot is in motion.

3.4 Elimination Of Wiring

As observed in previous experiments, flexible wirings create loss of orientation and should be eliminated from the assembly when possible.

REFERENCES

[1] Isikbay, N., A Case Study For Robotic Assembly: Dualjet Carburetor Subassembly, Report No. UM-MEAM-85-33, Univ. of Michigan, Ann Arbor, Aug. 1985.