DESIGN AND FABRICATION OF PNEUMATIC WALKING ROBOT

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ABSTRACT

This report is based on the study about final year project, design and fabrication of pneumatic walking robot. The objective is to design a four legs robot using pneumatic actuator and fabricate the robot structure .In this project, the use of programming logical control software as robot legs motion controller and using pneumatic actuator to move the legs robot. This project need a study about an existing robot in order to produce a moving four legs robot, that only use four actuators because an existing four legs robot use many actuators. Normally eight actuators are use in designing a moving four legs robot. By creative thinking, four legs robot can be design for only four actuators. The method used is divided into two chapters.

The first method is by using the *SolidWork* software to design the robot's legs and body. The second method is verify the way of robot's motion tests by making a ladder diagram program with the Programming Logical Control (PLC) software. Lastly, a four legs robot's model is produced. The problems encountered were discussed.

ABSTRAK

Laporan ini adalah hasil daripada kajian dalam menyiapkan projek tahun akhir, merekabentuk dan penghasilan robot berjalan yang menggunakan pneumatik silinder. Objektif untuk projek ini ialah merekabentuk robot empat kaki yang menggunakan pneumatik silinder dan membikin badan robot. Dalam projek ini penggunaan perisian *"Programming Logical Control"(PLC)* sebagai pengawal gerakan kaki *robot* dan menggunakan silinder untuk menggerakkan kaki robot.Projek ini memerlukan penyelidikan tentang robot yang sedia ada untuk menghasilkan robot empat kaki yang boleh bergerak hanya menggunakan empat pneumatik silinder kerana kebanyakan robot empat kaki yang sedia ada menggunakan lapan silinder. Projek ini memerlukan pemikiran yang kreatif untuk mereka bentuk kaki robot supaya ia hanya dapat menggunakan empat penggerak sahaja.. Kaedah yang digunakan dalam menyiapkan projek ini terbahagi kepada dua **bahagian.Pertama ialah mereka bentuk kaki dan badan robot** dengan menggunakan perisian *SolidWork*. Kedua ialah menjalankan percubaan cara robot berjalan dengan membuat program ladder diagram menggunakan perisian "Programming Logical Control" **(PLC). Akhir sekali, model robot empat kaki** dihasilkan. Masalah-masalah yang dihadapi semasa menjalankan projek ini dibincangkan.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

The final year project title is design and fabrication of pneumatic walking robot. The project involves analysis about how four legs moving or walking carry body with stable. The field of robotic is very interesting to anyone curious about how organisms (including people) interact with the "real world". A true robot kit allows to get a closer understanding of how human animals senses work, and how memory (programming) can be used for specific tasks. Some do both and others only one of these things, but either is sufficient to separate a real robotic kit from a toy.

A real robot can move along a programmed path .It is also reacting with its environment using sensors. A real robot can also do a combination of the above tasks. For example, roaming robot could be programmed to wander about a room and change its course if a sensor hits an object, and to the right if the left sensors does.

In the robotic community ,there are two basic robotic architectures; analytical approaches (Donner,1987) and biologically inspired approaches (Brooks,1986b).the

merging of these two types of architectures generates a third group of approaches-hybrid approaches that integrate the characteristics of both analytical and biologically inspired architectures (Nicolescu and Mataric, 2002).The analytical approaches generally required a mathematical model of the system and are relatively less computationally intensive.

Mataric 2002 stated that this type of approach employs general and bottom-up philosophies that support a certain degree of freedom from interpretation and computations. It can also tolerate a certain extend of false sensor information. Bekey (2000) stated that robotic control mechanisms could get more inspiration from the biological world as it exhibits greater reliability and efficiency despite the complexity of the world itself.

Robot can be categorized into two group based on their method of locomotion; wheeled robot and legged robots. Legged robots have received increasing interest as they have some advantages that are less easily achieved by wheeled robots, such as navigating in an uneven terrain. Legged robots can further be sub-classified into three major groups;

i. Biped robots that have two legs (the bipedal walking robot of Collins and Ruina, 2005).

ii. Quadruped robots that have four legs (BISAM by Iig and Berns, 1998).

iii. Insectoid robots that have more than four legs (Boadicea by Binnard, 1998).

1.2 Project Objective

1.2.1 General Project Objectives

Diploma final year project objective is to practice the knowledge and skill of the student that have been gathered before in solving problem using academic research, to born an engineer that have enough knowledge and skill. This project also important to train and increase the student capability to get know, research, data gathering, analysis making and then solve a problem by research or scientific research.

The project also will educate the student in communication like in a presentation and educate them to defend their research in the presentation. The project also will generate students that have capability to make a good research report in thesis form or technical writing. This project also can produce and train student to capable of doing work with minimal supervisory and more independent in searching, detailing and expanding the experiences and knowledge.

1.2.2 Specific Project Objectives

I. To design four legs walking robot using pneumatic system

II. To fabricate the robot structure

1.3 Scope of project

The scope of this project is restricted to four legs robot to move the robot body. A pneumatic actuator is used to move each of robot legs. The pneumatic actuator will be controlled by the Programming Logical Control to move the robot legs. This project also involves fabrication and assembly the robotic component.

1.4 Project Planning

According to the Gantt chart from figure 1.1, the project briefing started followed by collecting literature review. These include search for a project title and gathering raw data via internet, book and other source. The planning process is from week 1 until a week 7.

After that, this project was continued with design and measurement process at a week 3 and 4. This is started with sketching 3 types of pneumatic walking robot and then identifies the best design from analysis. Next, design the pneumatic walking robot that was chosen using solid work software with actual dimension.

Then the material that will use must be suitable and ease to get. The specification when choosing a material is includes strength, durability and light. This is important for fabrication process.

The fabrication was started after finish a cutting material. This process consist fabrications to part that have been designed by follow the dimension using various type of manufacturing process. The manufacturing process is determined from a literature review.

When the fabrication was finish the robot must be test using Programming Logical Control (PLC) for get to know the robot can move required or not. The ladder diagram must be draw for using programming logical control.

Evaluation stage has been implemented after fabrication stage. The evaluation is by considering the strength, durability, safety, and workability of the robot. During the evaluation, if problem occur such as malfunction, modification will be done.

Next task is the final report writing and final presentation preparation. The report is guided by UMP Thesis writing guided and also the guidance of my supervisor. Due to all problems had when doing the project the management has agreed to extend the time to submit the report and the presentation. All the task is scheduled to take about fourteen weeks overall.

1.5 Summary

This chapter has been discussed generally about project background, problem statement, question which has been formulate from the problems, objective of the project and scope of the project in order to achieve the objective as mentioned.

1.6 Gantt chart

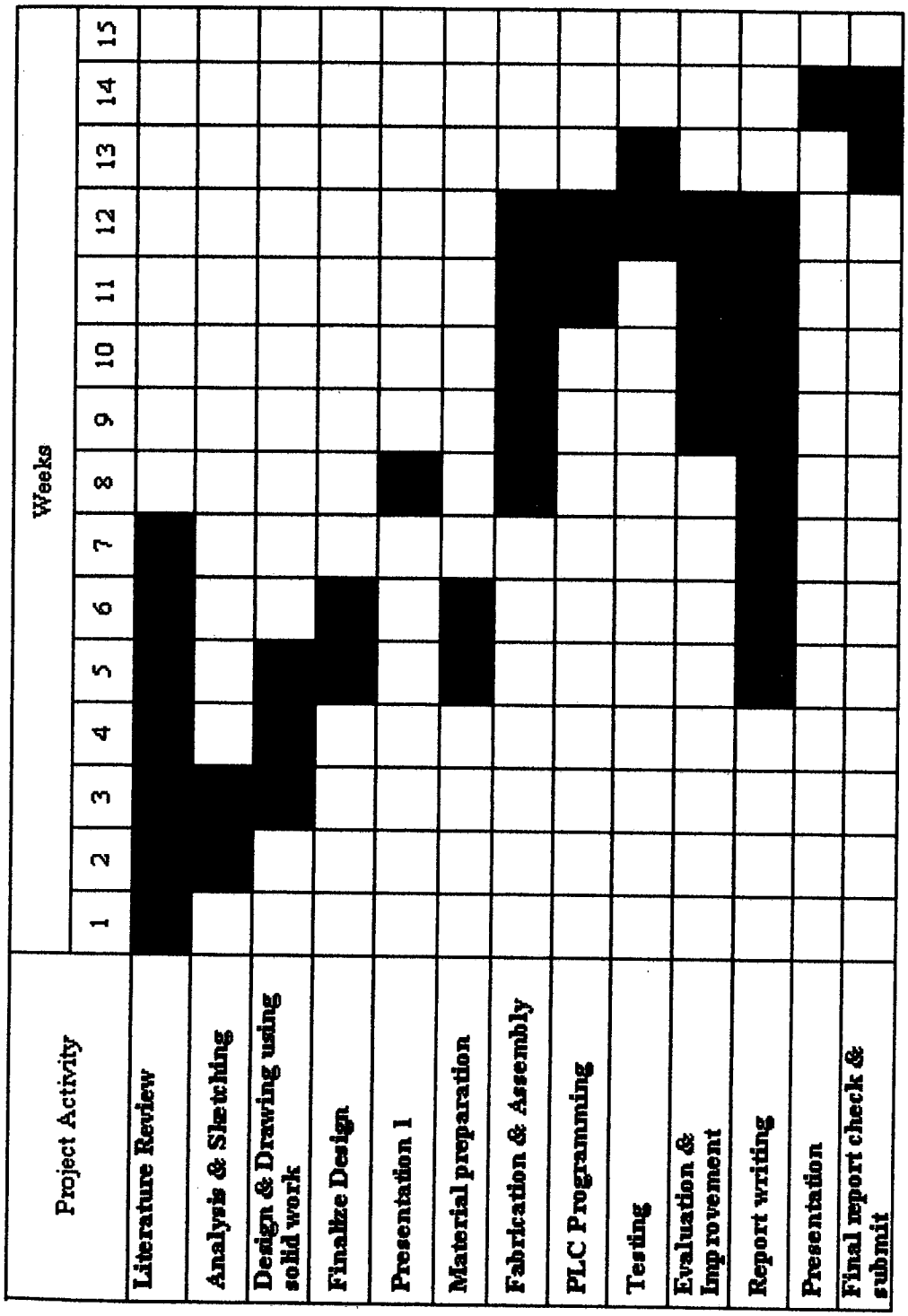

Figure1.1: Gantt chart

CHAPTER 2

LITERATUR REVIEW

2.1 Introduction

The word 'robot' came into English language in 1923 from the translation of a 1921 Czech play R.U.R (Rossum's Universiti Robot) by Karel Capek (Capek 1975).It is derived from the Czech word 'robota' meaning slave labour.The 'robot' in the play are designed to replace human worker and are depicted as very efficient and indistinguishable from human except for their lack of emotion.Robotic is set to become a revolution in the way we live. The next 20 years will see a boom in robotics. Each type of design has their advantages and disadvantages. Nowadays, there are different types of walking robot design such as;

i. Two leg robot

ii. Four leg robot

iii. Eight leg robot

iv. Using pneumatic actuator

v. -Using hydraulic actuator

vi. -Using electric motor

2.2 Technical Review

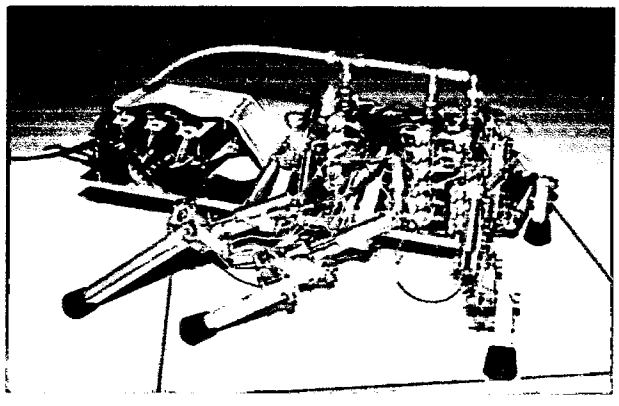

Figure 2.1: Six legs robot

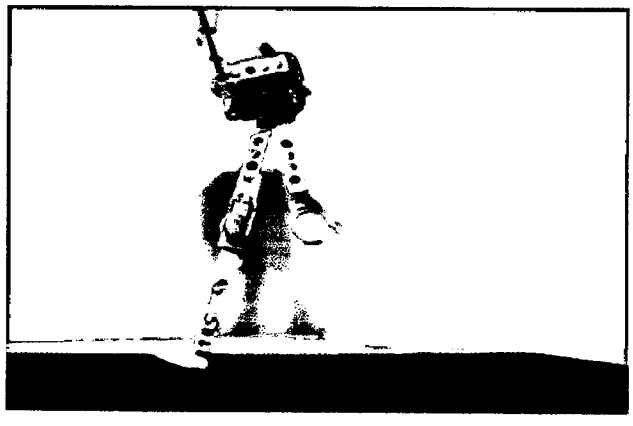

Figure 2.2: Two legs robot

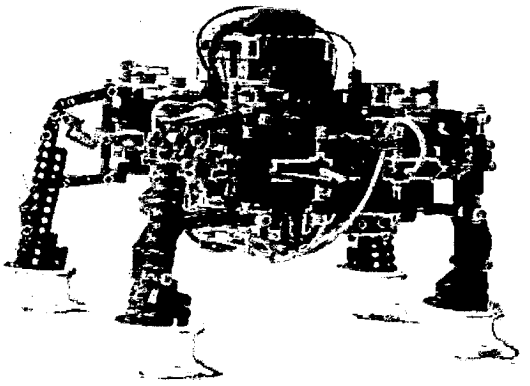

Figure 2.3: Four legs robot

Genghis, the six legged walking robot

As mentioned previously, Genghis was a legged robot in which Brooks (1989) implemented the idea of SA to enable the robot walk. Genghis is a six legged robot, build to walk on uneven terrain.

Each leg of Genghis was manipulated by two motors. The first one was used to move a leg in a forward or backward motion, while the second one was used to move a leg in an up or down motion. This resulted in each leg having two degrees of freedom (DOF), Referred to as "Forward-Backward" and "Up-Down". A picture of Genghis is shown in figure 1.4. Genghis has a wide base and low centre of gravity. This is to be contrasted with the experimental robot employed in this thesis which had four legs, a narrow base, high centre of gravity and multi-jointed legs, each with 3 degrees of freedom (i.e. "ankle"," knee" and "hip" joints).

Only static balance was implemented in Genghis, which is to be contrasted with the experimental robot that deals with both static and dynamic balance. Behaviors of Genghis were composed of; stand up, simple walk, force balancing, leg lifting, whiskers, pitch stabilization, prowling, and steered prowling.

Behaviors stand up has the lowest priority, which means that this behavior will be activated if no other behavior is triggered. Behaviors simple walk enable the robot to carry out a "tri-pod" type walking, i.e. front and back legs of one side and the middle leg of the other side being on the ground to support the robot while the rest of other legs are off ground and moving forward.

Behavior force balancing and pitch stabilization will be active when the robot needs to move its leg over an obstruction. Behavior whiskers, prowling and steered prowling were used to deal with obstacles and path following. Overall, interaction of this behavior generated emergent behavior of an insect-like motion.

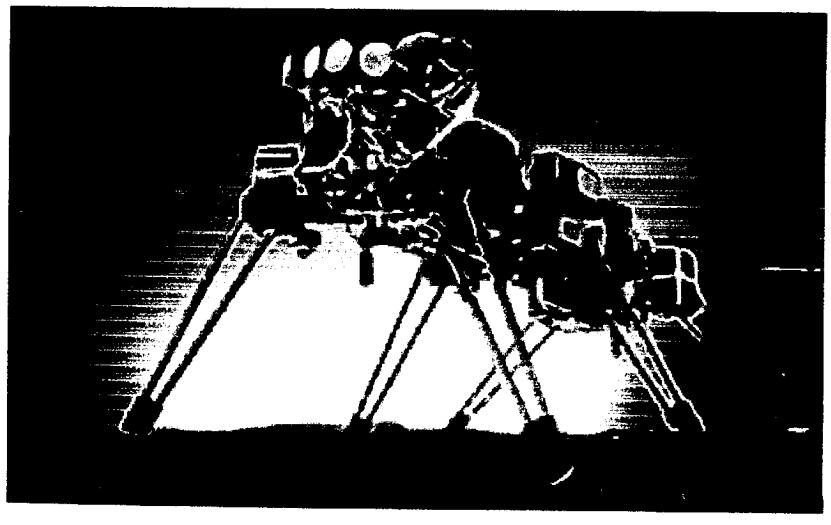

Figure 2.4: Genghis (brooks, 1989)

2.3 Basic Part

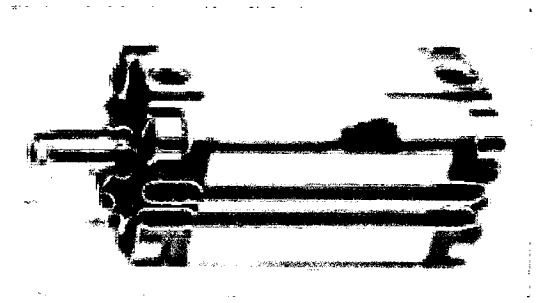

Figure 2.5: Pneumatic actuator

2.3.1 Pneumatic actuator

Pneumatic actuators are powered by compressed air. They offer rapid point-to-point linear positioning and have a high load-carrying capacity relative to their size; they are also cheap, mechanically simple and easy to maintain.

Pneumatic actuators generally operate at air supply pressures of at least 6 bars. The air released into the atmosphere at the exhaust still has a relatively high pressure - but there is no practical way to recycle it.

2.3.2 Tubing or Hose

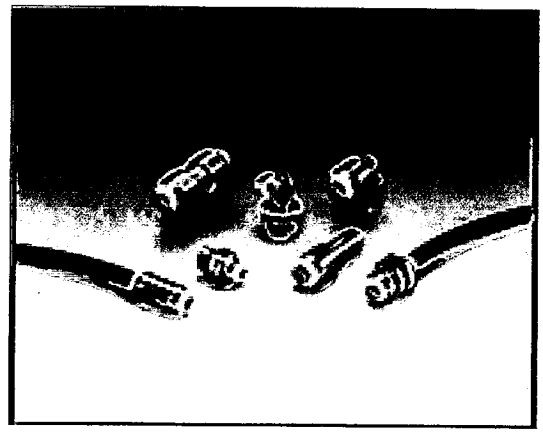

Figure 2.6: Hose

Function of tube to join air from supply to actuator. The working pressure is up to 25 bars, and working temperature is -25 to +100 Celsius. This tube has much diameter size.

2.3.3 Air filter

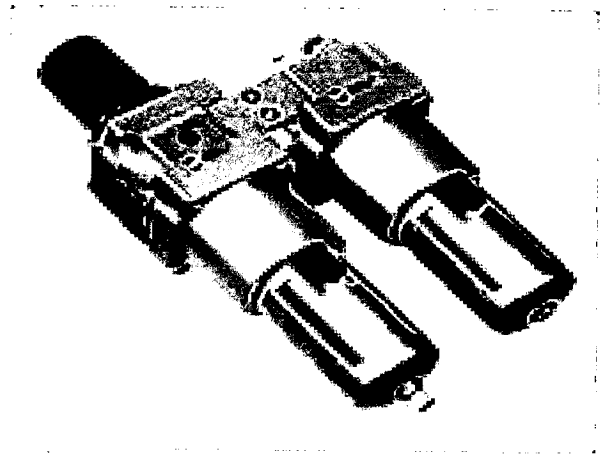

Figure 2.7: Air filter

Function of air filter to separate air from stain during air supply to actuator .Its normally using between tube and valve for guard the valve from stain.

2.3.3 Valve

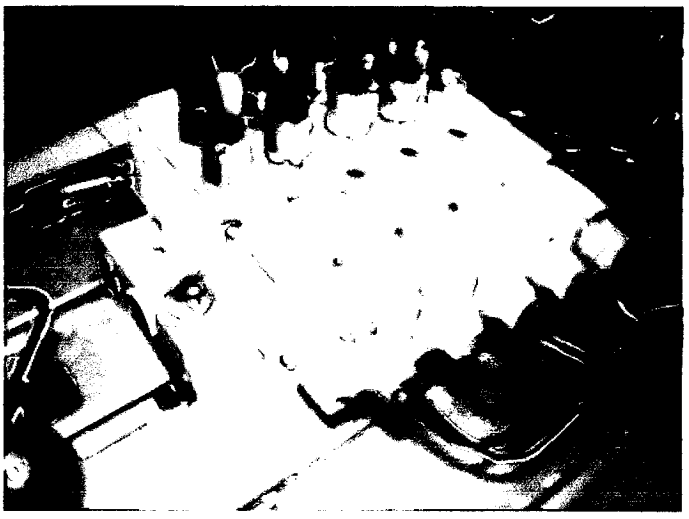

Figure 2.8: Valve

Function of valves is to control the pressure or flow rate of pressure media. It will categories five type such as Directional control valves, Non-return valves ,Flow control valves, Pressure control valves, Shut-off valves

2.3.4 Programming logical controller (PLC)

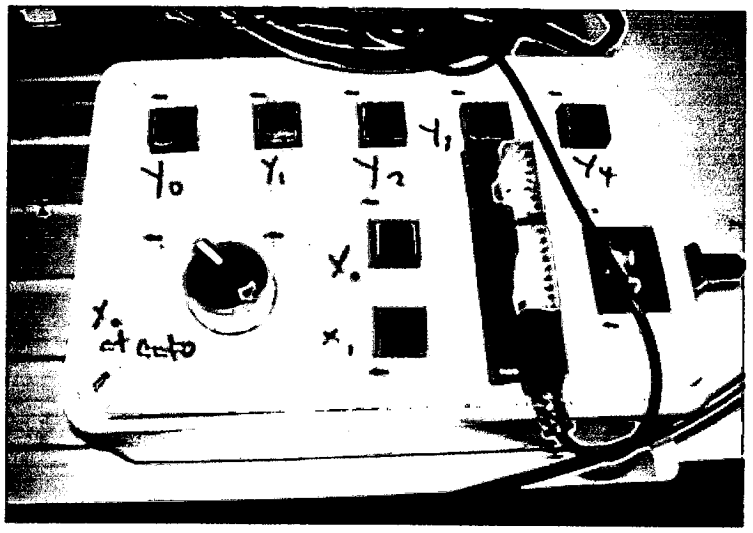

Figure 2.9: Programming logical control

NEMA, the National Electrical Manufacturers Association, defines a programmable logic controller (PLC) as:

The programmable controller is a digitally operating electronic apparatus which uses a programmable memory for the internal storage of instructions for implementing specific functions, such as logic, sequencing, timing, counting and arithmetic, to control through digital or analog input/output, various types of machines or process.

Programmable Logic Controllers, programmable controllers, or PLC is solid-state devices used to control a machine or process. The advent of the PLC began in the 1960's and 1970's to replace traditional "hard-wired" controls, and has since become the predominant choice for industrial controls.

2.4 About Process

2.4.1 Turret Punch Machine

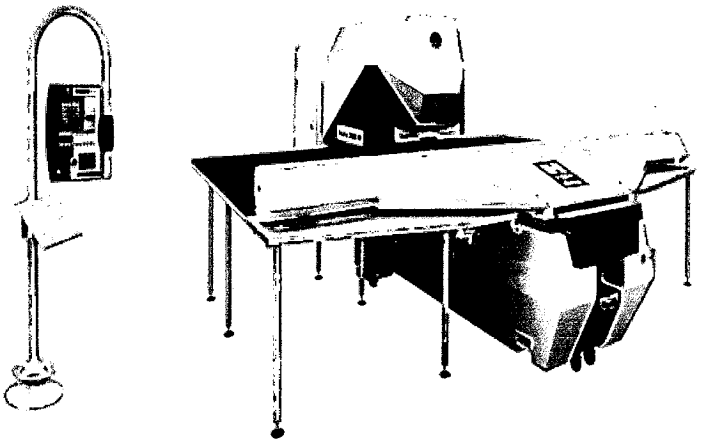

Figure 2.10: Turret punch machine

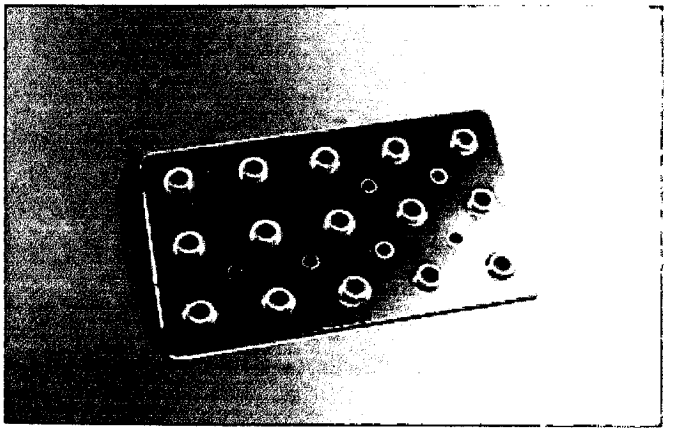

Figure2.11: Example product