housing system for electronic instruments

diploma project

menon s r
industrial design centre

APPROVAL SHEET

Diploma Project entitled

HOUSING SYSTEM FOR ELECTRONIC INSTRUMENTS

by

SASHIDHAR RAVUNNI MENON

is approved for

POSTGRADUATE DIPLOMA

in

INDUSTRIAL DESIGN

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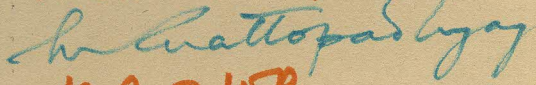
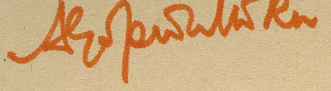
Co-guide . 

Examiners . 

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ACKNOWLEDGEMENTS

My acknowledgements to

Prof. NADKARNI
Shri CHATTOPADHYAY
Industrial Design Centre — for the help that they rendered throughout this work, for the many helpful discussion and for encouragement and interest in this project.

Shri PAL CHOUDHURY
Shri RAJAN
Industrial Design Centre

Shri IRANI
Mech. Engg. Dept.

Shri TULPULE
Shri CHOBAL
Elec. Engg. Dept.

Shri ABYANKAR
Aero. Engg. Dept. — For their help and cooperation.

Shri PRABHAKARAN — for typing this report.

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1. INTRODUCTION

1.1

Electronics has made tremendous advances in the last 25 years. It has helped man land on the moon, communicate over large distances in the fraction of a second, be entertained by radio and television. Behind these visible and glamourous facades of electronics, but unknown to many exist the drab and uninteresting laboratories where the marvels of electronics are born. And the core of these laboratories is the very vast array of electronic instruments that they possess.

1.2

Though very large amounts of money are spent to develop and perfect these instruments electronically, scant attention is paid to their construction. Not much effort for example, has been put to make the fabrication of the instrument housings easier or cheaper. Then again very little attention has been paid to the plight of the instrument repairers who have to dismantle the instruments.

1.2.1

Some of these difficulties have been corrected

to some extent abroad, especially in the United States, England and Germany, by standardization. This has been made possible principally because of the large size of the companies (General Radio, Hewlett Packard, Marconi, Siemens) and thus the resources at their disposal.

1.2.2

In India where by and large the electronics industry is in the small and medium scale sectors the picture is very dismal. Many simply do not have the resources, time, money and personnel - to conduct any worth while research in this direction while the few who are able to do something more often than not ignore this aspect of product development either through a list of misconstrued priorities or by sheer ignorance. A protected market and consumer apathy make things worse.

1.2.3

Also in many foreign countries certain standards have been laid down for electronic instrument housing construction by the government and/or various associations. In India neither the Indian Standards Institution nor any other body has done so and as a result one finds in-

struments made in random sizes and modes of construction. In fact construction of instruments by any one manufacturer vary a great deal amongst themselves not to speak of comparisons with instruments made by other manufactures. This could in part be due to the peculiar conditions in which the electronic industry in India finds itself viz. small firms each trying to maintain its own identity through a multitude of housing sizes and modes of construction.

1.3

Standardization provides the way out of this situation. The advantages of standardization are:

1.3.1

The product (system) becomes just an assembly of prefabricated standard parts (elements).

1.3.2

Large production runs on elements brings down the costs greatly.

1.3.3

Investment on special assembly jigs and tools and on training assembly operatives is trans-

ferred to the new design if both the old and the new designs are based on a common family of standardized elements.

1.3.4

Use of large volumes of standardized elements makes it economic to carry out larger scale life testing and can thus lead to a more reliable system.

1.3.5

Simplification of part inventories and stores.

1.3.6

Ease of repairs by substitution.

1.3.7

One apparent disadvantage is the limitations standardization places on the system designers freedom. This is not so; all that is needed is a little ingenuity on part of the designer.

1.4

Electronic instruments can be broadly catagorized as

Bench type

Rack mounting type

Console mounting type

Portable type.

1.4.1

Each of these catagories has its special requirements and thus special modes of construction. Also each of the catagories is large enough permitting standardization seperately for each.

1.4.2

I have chosen bench type electronic instruments mainly because they are available in plenty for study and analysis. This does not in any way under mine the importance of evolving a set of standards for construction of housing for other catagories of electronic instruments or for that matter a common set of standards for housing of all catagories of electronic instruments.

2. PROBLEM STATEMENT

2.1

To evolve a universal system of housing construction for bench type electronic instruments.

2.2

The emphasis would be on the following points:

2.2.1

The housing should be possible to construct from standard prefabricated parts.

2.2.2

The system should be applicable to all types of and all sizes of bench type electronic instruments and should be based on a common method of construction.

2.2.3

It should be within the reach of (cost wise) and capable of adoption by all electronic instrument manufactures irrespective of their size.

2.2.4

The housing designed should have a clean neat

appearance.

2.2.5

It must fulfill all functions that the present housings perform.

3. WORK DONE

3.1

The project commences with data collection from a literature survey, and from manufacturers, sellers and users of bench type electronic instruments through questionnaires and discussion and from observations made during visits to their premises.

3.2

Next 12 instruments covering a wide spectrum of the available bench type electronic instruments are analysed from a point of view structure, function and form.

3.3

Based on information collected so far a hypothesis of design requirements is drafted.

3.4

Next comes the synthesis where in solution to the problem is arrived at.

3.5

The project culminates in the prototype of a D.C. power supply.

4. DATA COLLECTION

4.0

Data collection consisted of:

4.1

Literature survey of magazines, books, pamplets prepared by electronic instrument industries to advertise their products and advertisements in various newspapers, magazines and journals.

4.1.1

This did not yield very useful information. No books or magazines contained more than a passing reference to electronic instrument housing. All photographs appearing in advertisements or otherwise showed only the exterior. No details were discernable.

4.2

Questionnaires given to manufacturers, sellers and users and visits to the premises of some electronic instrument factories for observations and discussions. (Most of them sell the instruments they manufacture themselves and also use a number of electronic instruments thus providing a combination of manufacturer, seller and user at one point).

4.2.1

The questionnaires did yield useful information though many questions were either not answered at all or were not upto the point. Also the same questionnaire given to different people yielded different answers resulting in more opinions beings obtained than facts. All this goes to show how little attention has been paid to electronic instrument housing in these quarters.

4.2.2

However some of the useful information got this way is listed below:

4.2.2.1

Manufacturer:

4.2.2.1.1

Electronic instruments are made by batch production with total annual output varying between 200 and 1000 pieces.

4.2.2.1.2

Between 1 and 4 series are produced with 5 to 25 different ranges in each series.

4.2.2.1.3

The sizes of instruments vary greatly with dimensions (width height and depth) varying from 10 to ~~15~~ cms.

4.2.2.1.4

The housing are designed by the instrument manufactures though some of them get them fabricated outside.

4.2.2.1.5

Those of them who fabricate their own housings had the following equipment at the premises:

Hand presses
Power press brakes
Shearing machine
Grinder
Drilling machine
Spot welding machine
Spray painting equipment
Oven.

4.2.2.1.6

Housing design started only after electronic design is complete in all respects.

4.2.2.1.7

Sometimes alterations are made after making the prototype mainly due to heat dissipation problems or last minute changes in circuit or components.

4.2.2.1.8

Common materials used are mild steel and aluminium sheets and angles.

4.2.2.1.9

Some common troubles during fabrication are alignment of parts or screw holes. This is mostly the case where parts are made or holes drilled by hand.

4.2.2.1.10

Spot welding is preferred as this given a better appearance.

4.2.2.1.11

Not much information was forth coming on tooling costs though some estimated it as being between Rs.10,000 and Rs.50,000.

4.2.2.1.12

The cost of housing varied between 2 and 10% of the instrument cost.

4.2.2.1.13

Most thought that the major short coming of their instrument housings was 'looks', especially finish.

4.2.2.1.14

Some wanted to change housing designs frequently to facilitate change in models.

4.2.2.1.15

No standards were being followed not was the existence of any standards regarding instrument housing construction known.

4.2.2.1.16

The instruments are sent to the seller or various places distribution complete in all respects.

4.2.2.1.17

Storage after manufacture in shelves or stacked on floor.

4.2.2.1.18

Instruments are packed in corrugated cardboard cartons and in some cases transported in wooden crates.

4.2.2.1.19

Some changes they would have liked to make they are unable to because of the non availability of certain processes like brazing and spot welding of aluminium.

4.2.2.1.20

Operational elements like knobs meters etc are generally purchased ready made from the market and used.

4.2.2.2

Seller:

4.2.2.2.1

Some of things a customer generally looks for in a instrument apart from its technical performance are size and ease in handling and maintenance.

4.2.2.2.2

They would like to get instruments fully assembled from the manufacturer.

4.2.2.2.3

Some common complaints they get from customers are that the paint goes off and the structure is sometimes weak.

4.2.2.2.4

A customer cares more for finish than for shape.

4.2.2.3

User:

4.2.2.3.1

Instruments difficult to dismantle in that the chassis do not slide out easily from the housing cover or there are too many screws to be opened before the housing can be taken apart.

4.2.2.3.2

Some screws have improper access.

4.2.2.3.3

Sometimes it is not very clear the first time as to how to dismantle an instrument.

4.2.2.3.4

Ordinary screws which can opened by the simple screw driver are preferred. (Philips screws not preferred because of special pointed screw driver needed).

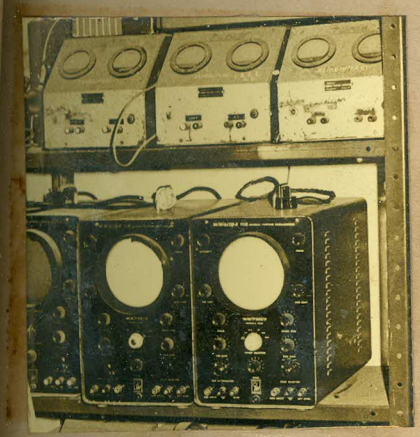
4.3

Visits to the various laboratories of the

Department of Electrical Engineering, I.I.T. Bombay.

4.3.1

This proved to be a vertable mine of useful information. Here the instruments were dismantled and examined in detail. A very wide range of instruments both Indian and foreign were available and various modes of housing construction by them were studied.

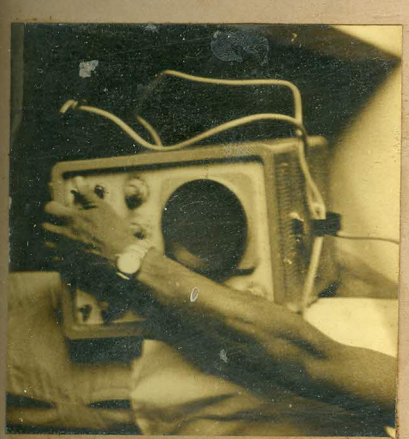


4.3.2

Also the way the instruments were stored carried dismantled and reassembled were noted.

4.3.2.1

ONE IMPORTANT OBSERVATION MADE WAS THAT THOUGH ALL INSTRUMENTS WERE PROVIDED WITH HANDLES, THESE WERE NEVER USED IN CARRYING THEM.



4.3.2.1.1

On close observation and on questioning this was found to be due to two reasons.

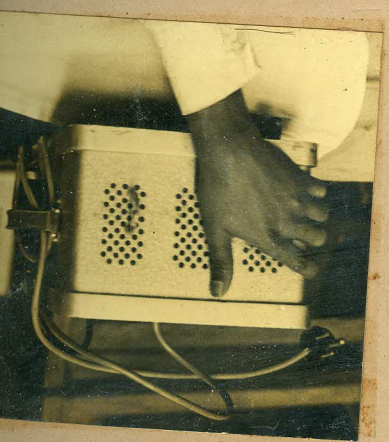
4.3.2.1.1.1

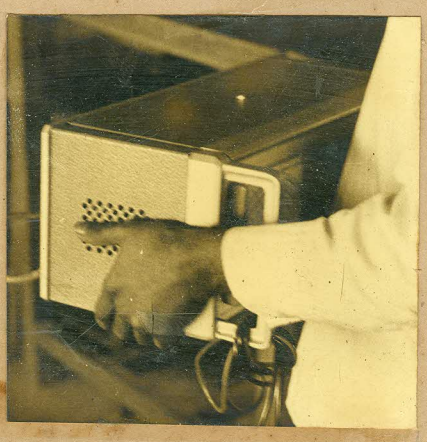
Firstly in some cases especially the heavier instruments the handles were not only located in such a way as to make them very uncomfor-

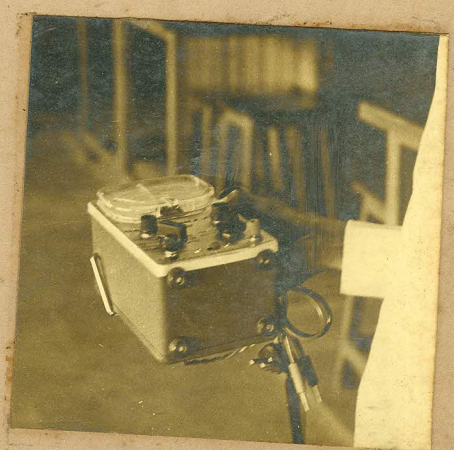
table to use but also were mechanically not strong enough to bear the load.

4.3.2.1.1.2

The second and the more important reason is a psychological one. Instruments are both costly and delicate. As a result there is a tendency not to lift the instrument by the handle which not only look flimsy but also due to their being a seperate identity not integrated with the rest of the instrument, the presence of a joint between the handle and the rest of the instrument which could easily fail is brought out strongly to the person carrying the instrument. Also as most instrument housings are painted in a dark colour, the instruments appear heavy strengthening still more the tendency to carry it securely cradled in the arms.







5. ANALYSIS

5.1

Bench type electronic instrument come in a wide variety and in a number of ranges. For purposes of this project 3 types of bench type electronic instruments were chosen - power supplies, vacuum tube voltmeters and cathode ray oscilloscopes - and in each type 4 instruments of different make were analysed The instruments chosen can be said to cover the whole spectrum of bench type electronic instruments available in this country.

5.2

The instruments analysed are:

5.2.1

Power supplies:

APLAB	T.P.S.U.	LVP 6/6
APLAB	V.T.S.P.S.	HVF/6
RADART		608 A
BELTRONICS	T.P.S.	50 V/2A

5.2.2

VTVMs:

SANWA CONY	VTVM	
SIMPSON	VTVM	321-I
PHILIPS		GM 6009
APLAB	AC Milli Voltmeter	FM 2

5.2.3

CROS:

PHILIPS	AC Oscilloscope	GM 601
ECIL	DC Oscilloscope	OS 763 A
TEKTRONICS	Scope Mobile	585 A
RUSSIAN	Double Beam Oscilloscope	C1 - 18

5.3

The analysis covers the structural, functional and formal aspects of the 12 instruments. First a general analysis of these instruments covering their common features is made (Section 5.4) and then a detailed structural and formal (pertaining to finish and colour) analysis of features in which these instruments distinctly differ from one another is made.

5.4

General Analysis

5.4.1

Structural:

5.4.1.1

All housing studied were made of sheet metal. Plastics are not used because of their inferior mechanical strength. The housings are subjected to frequent jolts, impacts etc. in a laboratory while moving them from storage

racks to the experiment table or back or from one place in the laboratory to another. Also sheet metal used is mild steel. Its nearest rival, aluminium, is not used because of inferior mechanical strength, difficulty in welding, poor thread strength, etc.

5.4.1.2

All housings used screws in varying numbers for jointing. In some cases (the CROS) one end is pushed into a groove and the other end was securely screwed. Screws were found suitable as they easily opened if the cabinet is to be taken apart for maintenance etc. and because they are easily accessable from outside. Moreover they are readily and cheaply available.

5.4.1.3

The process used for housing construction is mainly presswork - blanking, piercing, bending and forming. In most cases screw holes were threaded onto the thin angular sections. In some other cases a nut was struck on to the back of the metal sheet. A common difficulty found in this regard is the failure of screw threads and difficulty in aligning the holes.

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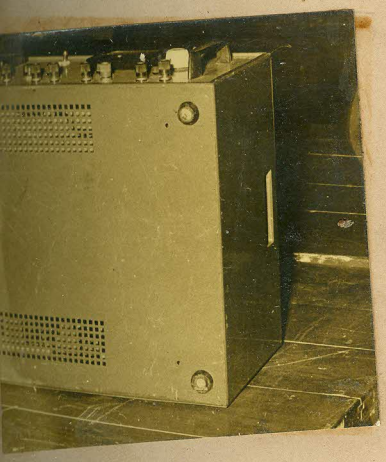
5.4.1.4

The ventilation holes/grooves are punched into the sheet metal as and where required. These are either circular holes (grouped in rectangular patterns), square or rectangular holes (also grouped in rectangular patterns), grooves or lancing.



5.4.1.5

The instruments rest on circular rubber feet screwed on to the bottom in case of smaller instruments like the power supplies and V.T.V.M.s and on two parallel metal square rectangular sections on either side at the bottom running the whole length of the instrument from the front to the back in case of heavier instruments like the CRO.

5.4.1.6

The handles of the instrument are clearly seen in the figures.

5.4.2

Functional

5.4.2.1

One function of the housing is to protect the operator. In the normal course of using the

instrument the operator moves his hands often to make various adjustments. The housing protects him from touching any live part in the instrument.

5.4.2.2

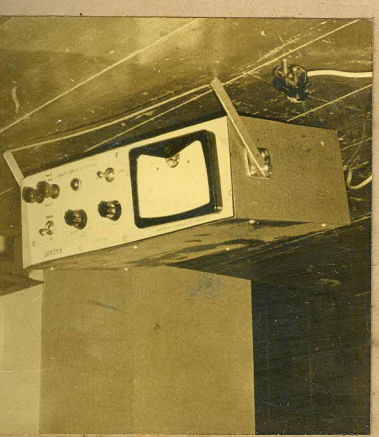
The housing protects the circuit (its components and soldered joints etc) from damage by impact with external bodies.

5.4.2.3

The housing protects the circuit from dust.

5.4.2.4

Also since an electronic instrument circuit is one in which the working (like current flowing through or the voltage across a component) cannot be seen by the operator, it is better to shield it in that the operator does not have to see the unnecessary parts. The operator is solely concerned with the controls and indicating devices.

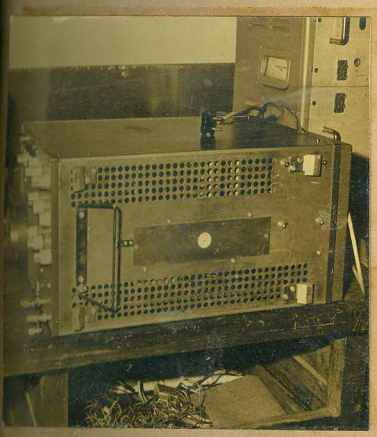


5.4.2.5

Also a simple rectangular housing ensures easier handling and storage.

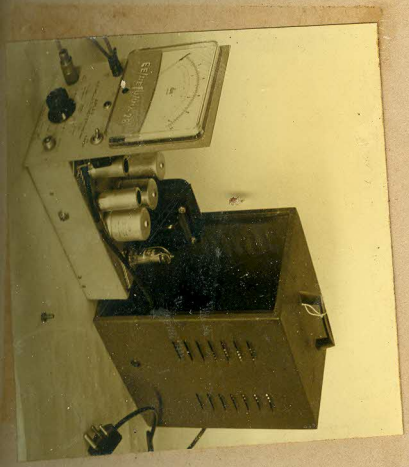
5.4.2.6

In some instruments the handle or foldable

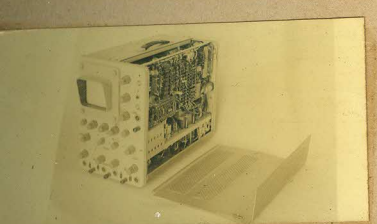


sections at the bottom were used to tilt the instrument so that the front panel becomes normal to the line of sight of the operator. This is found to be unnecessary. The instruments can be operated without any strain to the operator when the front panel is vertical.

5.4.2.7



In the smaller instruments like power supplies and V.T.V.M.s there is tendency to build the instrument in two parts - the cover which forms the back, top, sides and bottom and the front panel along with the chassis attached to it which can be pulled out after unscrewing a screw or two at the back. This way the dismantling is easier (only two screws to be opened). In this case one particular difficulty is that while pulling out the instrument from the cover, the chassis or other parts got stuck inside the cover. In larger instruments like the CRO since moving the instrument is difficult the cover comes off in parts. The side along with ½ the top forms one unit. On taking of the two sides, thus the top is also uncovered. In case any component at the bottom has to be reached, the bottom can be unscrewed.



5.4.2.8

In almost all cases the front panel had a smooth glossy finish while the rest of sides had a textured finish (hammer tone, crackle finish, wrinkle finish rexene finish) in dark colour. The reason is as follows: The instrument operator is solely concerned with the operational elements which are located on the front panel. The lighter colour of the front panel being brighter draws the operators attention. Secondly most of the graphics come on the front panel along with the operational elements. Thus the smooth finish. Also the front panel being lighter easily dirties and would have been difficult to clean had it been finished in a rough textured finish.

5.4.3

Formal

5.4.3.1

An electronic instrument will have a complex grouping of components like resisters, inductors, capacilors, transformers, etc. of various sizes and shapes. Often in trying to economize on space these are cluttered together in what appears to be a very haphazard manner. The housing encloses these in a

simple box like structure which is both uncomplicated and simple to the eye.

5.4.3.2

As mentioned in section 5.4.2.8, in all housings the front panel was smooth and glossy (barring one) and finished in a light colour while the rest of the sides had a rough textured finish in a dark colour.

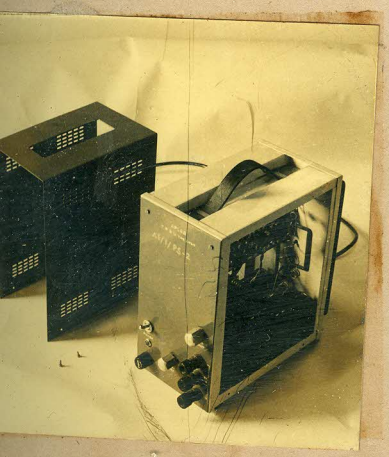
5.4.3.3

Two many screws showing on the housing marred a simple look and also unnecessarily attracted attention.

5.5

A detailed instrument by instrument analysis of those aspects which differ distinctly (structural and formal as far as it pertains to colour and finish) is given.

5.5.1



APLAB T.P.S.III. Type LVP 6/6

5.5.1.1

Cover

Material : M.S. sheet metal

Process : Blanking, Punching , Bending.

Finish : Dark grey hammertone on outside and smooth on inside.

5.5.1.2

Front, back, bottom and top

Material : Aluminium sheet, M.S. sheet
Process : Shearing, Piercing, Bending, Threading, Welding, Spot welding
Finish : Dark grey, glossy on front, rest white smooth.

5.5.2

APLAB Vacuum tube stabilized power supply type HVF 6

5.5.2.1

Cover : Top, Sides, Back, Bottom.
Material : M.S. sheet metal, Perforated sheet.
Process : Blanking, Punching, Bending, Spot welding.
Finish : Dark grey hammertone finish top, Sides, Back, Bottom and inside smooth dark grey.

5.5.2.1.1

Name plate
Material : Aluminium sheet

Process : Punching

Finish : Screen printing

Screwed on as well adhesive used.

5.5.2.1.2

Rubber feet as usual.

5.5.2.2

Front panel + Chassis

Material : Aluminium sheet, M.S. sheet and angle

Process : Blanking, piercing, bending, welding, spot welding, threading.

Finish : Front panel white paint. Graphics engraved and paint filled in. Angles and M.S. chassis parts painted in same dark grey.

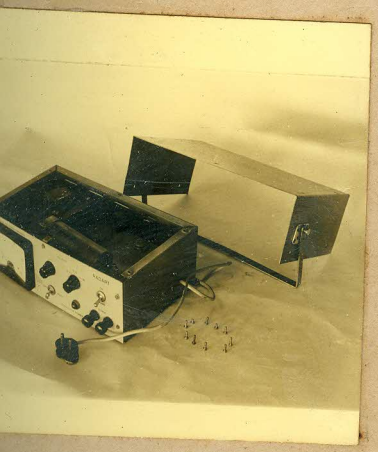
5.5.2.2.1

Handle

Material : M.S. round rod

Process : Bending

Finish : Chromium plating.



5.5.3

Outer casing : Top, sides, handle

Material : M.S. sheet metal

Process : Blanking, piercing, bending threading.

Finish : Brown hammertone, chromium plating.

5.5.3.2

Bottom plate

Material : M.S. sheet

Process : Blanking, piercing, punching, threading.

Finish : Cadmium plating.

5.5.3.2.1

Rubber feet as before.

5.5.3.3

Front panel + sides + back + chassis.

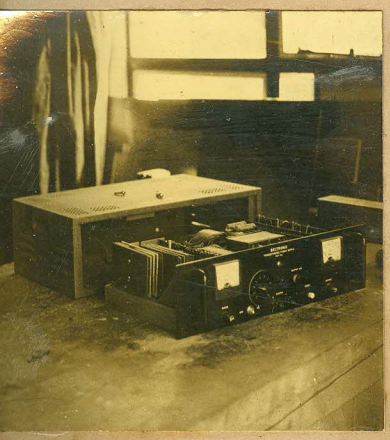
Material : Aluminium sheet, M.S. sheet, M.S. eyelets (for threading)

Process : Blanking, bending, piercing punching, lancing, threading.

Finish : Light bluish grey smooth finish. Brown hammertone outside. Dark bluish smooth paint (inside) cadmium plating.

5.5.4

BELTRONICS transistorized power supply unit 50 V, 2A.



5.5.4.1

Cover : Top, bottom, sides, back.

Material : M.S. sheet

Process : Shearing, blanking, piercing, punching, lancing, drawing, spot welding, bending riveting, welding.

Finish : Dark grey hammertone on all sides except bottom outside. Inside and bottom smooth dark grey.

5.5.4.1.1

Name plate attached as in section 5.5.2.1.1.

5.5.4.2

Front panel (including chassis)

Material : M.S. sheet and plate, aluminium sheet.

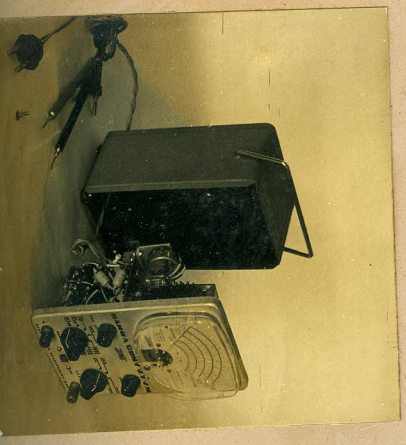
Process : Blanking, bending, piercing, welding, threading, riveting.

Chassis attached to front plate by lower front components.

Finish : Front panel black letters engraved. M.S. brackets grey.

5.5.4.2.1

Handles screwed on.



5.5.5

SANWA CONY VTVM

5.5.5.1

Cover

Material : M.S. sheet metal

Process : Blanking, bending, piercing, deep drawing, threading, spot welding.

Finish : Dark grey hammertone finish on outside. Smooth grey (same) on inside.

5.5.5.1.1

Handle

Material : M.S. (round) rod

Process : Cutting, bending.

Finish : Chromium plating.

5.5.5.1.2

Rubber feet

Material : Rubber, steel screws

Process : Moulding, screwing.

5.5.5.2

Front panel

Material : Aluminium sheet

Process : Blanking, piercing, deep drawing

Finish : Light green anodizing smooth dull. Graphics screen printed in black and red.

5.5.5.2.1

Chassis

Material : Mild steel sheet

Process : Blanking, piercing, bending, threading.

Finish : Cadmium plating.

The chassis is fixed on to the front panel by the two potentiometers zero and ohm adjusters.

5.5.6

SIMPSON VTVM Model 321-I

5.5.6.1

Top

Material : M.S. sheet metal

Process : Blanking, piercing, bending.

Finish : Blue rexene finish on outside. Blue smooth finish on inside.

5.5.6.2

Bottom : From one sheet metal piece + 4 small roughly square sheet metal pieces + 4 rubber feet (moulded)

screwed on the bottom plate. At the point of screwing an additional small square plate is put to increase thread length.

Material : M.S. sheet metal

Process : Blanking, punching, bending, threading.

Finish : Blue smooth glossy paint.

5.5.6.3

Back plate

Material : M.S. sheet metal

Process : Blanking, piercing

Finish : Blue rexene finish on outside. Blue smooth glossy on inside.

5.5.6.3.1

Name plate

Material : Aluminium sheet (thin)

Process : Punching

Finish : Screen printed

The name plate is stuck to the back plate using adhesive.

5.5.6.3.2

Rubber washer

Material : Rubber

Process : Moulding

It is just pressed into a hole punched in the back plate to provide the power cable outlet.

5.5.6.4

Main body consisting of front panel, sides, frames for attaching the back, bottom and top plates. Chassis and component bearing members and section.

Material : Aluminium (casting), M.S. sheet metal, Aluminium square section rods.

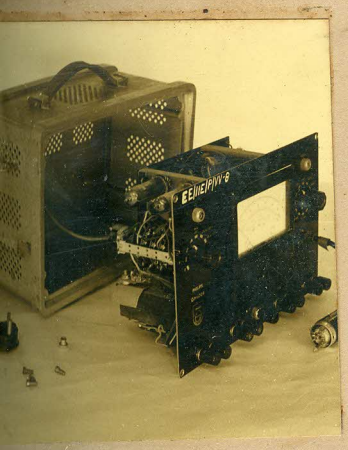
Process : Gravity casting and finishing to give smooth finish, blanking, piercing, bending, threading, screwing, drilling.

Finish : Smooth light grey paint on front panel and aluminium frames. Screen printing (in black and red on front pa panel). Blue rexene finish outside. Blue smooth glossy on inside of sides. Plating.

5.5.7

PHILIPS VTVM GM 6009

5.5.7.1



5.5.7.1

Back panel (of two sheet metal plates)

Material : M.S. sheet metal

Process : Blanking, piercing, threading.

Finish : Silverish grey hammertone.

5.5.7.1.2

Name plate (reveted to back plate)

Material : Aluminium sheet

Process : Punching

Finish : Screen printing

5.5.7.2

Main casing : Sides + top + bottom

Material : Aluminium, M.S. sheet metal, M.S. rod (round)

Process : Gravity casting, machining to get good finish, blanking, piercing, bending, drilling, threading, riveting.

Finish : Grey hammertone on sheet metal. Grey smooth on casting.

5.5.7.2.1

Handle

Material : Leather, sheet metal

Process : Cutting and stitching leather, blanking, punching, bending.

Finish : Chromium plating.

5.5.7.3

Front panel (including chassis)

Material : Aluminium sheet, M.S. sheet and rod.

Process : Blanking, punching, bending, threading

Finishing : Cadmium plating of M.S. sheet parts.

Chassis screwed on to front panel which consists of a thin aluminium sheet placed on a mild steel sheet.

5.5.8

APLAB AC Millivoltmeter type FM 2

5.5.8.1

Casing : Top, bottom, sides, back

Material : M.S. sheet metal, perforated sheet

Process : Blanking, punching, bending, lancing, spot welding shearing

Finish : Dark grey hammertone on top sides back on outside and smooth on inside. Bottom

dark grey smooth both outside and inside.

5.5.8.1.2

Handle

Material : Brass/Aluminium

Process : Cast + machining or die cast.

Finish : Dark grey smooth finish.

5.5.8.1.3

Rubber feet

5.5.8.2

Front panel (including chassis which is screwed on to front panel by two components - the range selector + output).

Material : Aluminium sheet metal, aluminium square rod.

Process : Shearing, punching, bending, welding + machining, threading.

Finish : Smooth light bluish grey on front panel letters engraved and paint filled in.

5.5.9

PHILIPS CRO GM 601

5.5.9.1

Side panel

Material : M.S. sheet metal

Process : Blanking, bending, piercing, (eyelet) riveting spot welding (of nuts)

Finish : Silverish grey hammertone.

5.5.9.2

Top panel

Material : M.S. sheet metal, M.S. plate (to support handle)

Process : Blanking, bending, piercing, eyelet reveting, spot welding.

Finish : Silverish grey hammertone.

5.5.9.3

Back plate

Material : M.S. sheet

Process : Blanking, punching

Finish : Grey glossy outside. Black inside smooth

Alluminium name plates (two) reveted to back plate.

5.5.9.4

Bottom plate

Material : M.S. sheet

Process : shearing, piercing, punching, bending, riveting

Finish : Cadmium plating

5.5.9.5

Front panel + chassis + angles + back frame)

Material : Aluminium casting, M.S. sheet and M.S. angle, aluminium sheet and square rod, phosphor bronze.

Process : Blanking, piercing, bending, drilling, threading, spot welding.

Finish : Front panel silverish. M.S. sheet parts cadmium plated.

5.5.10

ECIL 0$763 A Oscilloscope

5.5.10.1

Side panel + half top

Material : Aluminium sheet metal

Process : Blanking, bending, piercing, + progressive

Finish : Dark grey glossy outside. Inside no paint.

5.5.10.2

Bottom same as above

5.5.10.3

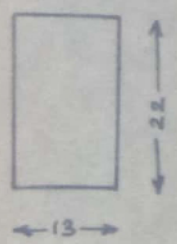
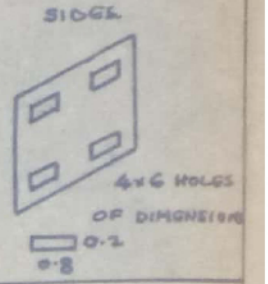
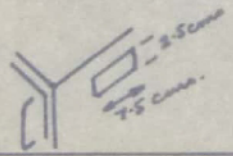
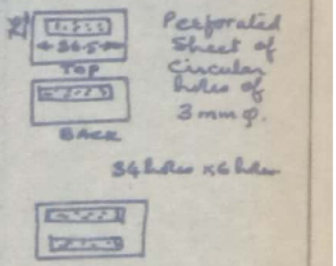
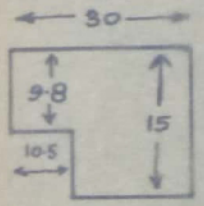
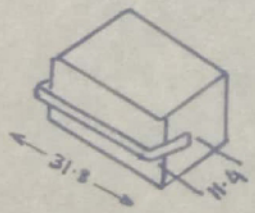
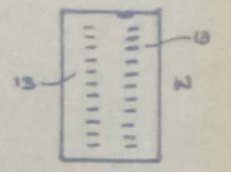
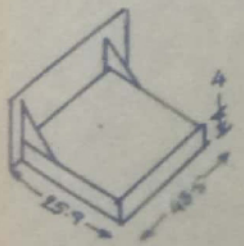
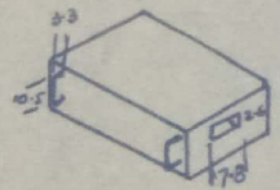
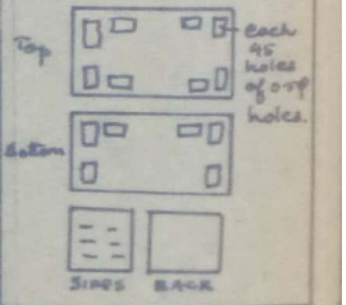
Front + back + chassis

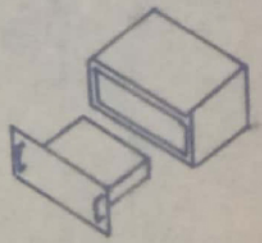
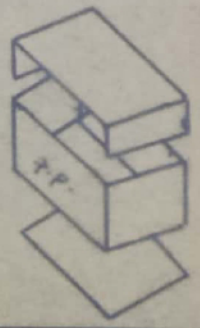
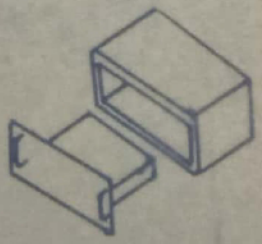
Material	:	Aluminium sheet and angle M.S. sheet
Process	:	Blanking, bending, piercing, punching, welding
Finish	:	Bottom outside dark grey glossy. Front panel silverish smooth glossy. M.S. angle cadmium plate.

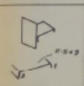
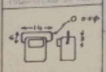
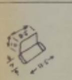
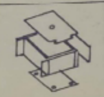
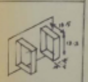
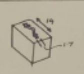
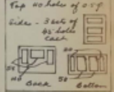
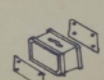
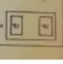
5.5.10.4

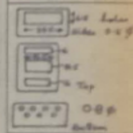
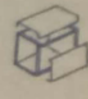
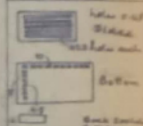
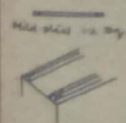
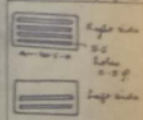
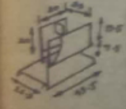
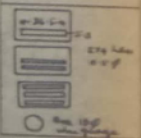
Front panel held to main body (front plate) by components.

PRODUCT NAME/TYPE	PHOTOGRAPH	OVERALL DIMENSIONS (in cms) W X H X D
APLAB T.P.S.U. TYPE LVP 6/6 6V, 6A		13 x 24 x 22
APLAB Vacuum Tube Stabilized Power Supply. Type HV P/6 600 V 200 mA		50 x 24.5 x 32.8
RADART (Eastern Electronics) Type 608 A 30 V 0.6 A		31 x 10.5 x 21
BELTRONICS Transistorized Power Supply 50 V 2 A		51.5 x 15.5 x 28.2

CHASSIS DIMENSIONS (in cms)	OPERATIONAL ELEMENTS (DIMENSIONS IN CMS.)	NUMBER OF TRANFORMERS, SIZES & LOCATIONS (Dim. in cms.)	HANDLE SIZE AND LOCATION (Dimensions in cms)	VENTILATION HOLES/GROOVES
	Knob 2 1.5Ø / 1.5 Knob 2 2.5Ø / 1.8 Binding posts 2 1.2Ø / 1.6 Switch 1 1.3 x 0.6 Ind.meter 1 11 x 8.5 x 1.5 8 All on front panel	One 5 x 6 x 5 Centre of chassis	Leather handle at top. 	SIDES 
	Knob 2 2.0Ø / 1.5 Knob 2 3.3Ø / 2.1 Binding posts 5 1.5Ø / 2.5 Ind. lamp 1 1.2Ø meter 1 12 x 10 x 1.5 11 All on front panel	One 5 x 6 x 6.3 Left hand side centre	4cm 16cm 2 in front of chrome plated tied circular section 	
	Knob 2 2.3Ø / 2.4 Binding post 8 1.5Ø / 3 Meter 1 12 x 12 x 1.5 Zero adj. 1 1.5Ø / 3 Ohm adj. 2 1.5Ø / 0.8 Voltage control 1 1.2Ø Wire probe outlet 1 1.5Ø 16 All on front panel	One 7.5 x 7 x 7.5 Bottom left hand side of chassis		3·7×0·9 cm grooves on bottom panel. 
	Knob 1 3.7Ø / 2.4 Toggle switch 1 1.6Ø / 1.5 Ind. lamp 1 1.2Ø Meter 1 13.7 x 10.7 x 1.6 Binding posts 1 1.3Ø / 2.2 Input terminal 1 1.5Ø / 1 Output terminal 1 1.5Ø / 1 7 All on front panel	One 8 x 8 x 7 Back left hand side of chassis		

DIMENSIONS FIXED BY (in descending order of importance)	TYPE OF ASSEMBLY	FEET	FINISH
Here the the length and depth fixed by transformer condensors and front panel operational elements. Height could be reduced but perhaps is provided for fixing a meter if the user so chooses.		 Rubb er Fee t	Top sides grey hammertone. Front grey glossy. Back and bottom white (off white) glossy
Length fixed by two transformers and tubes mounted on metal sheets. For this length the height is fixed to accommodate all components on the front panel. The depth could be reduced by about 25% but is perhaps kept to keep a reasonable proportion.		Rubber Feet	Top sides back grey hammertone bottom grey glossy Front white glossy
Size decided by etched wiring board, transformer and a big condensor. The operational elements on the front panel appears slightly crowded. Four operational elements are at the back as a result.		Rubber Feet	Top sides back brown hammertone Bottom cadmium plated M.S. Front bluish grey glossy finish.
In the instruments the space is fully utilised The components are jam packed. Length height and depth fixed by transformers, etched wiring board, power transformer and heat sink.		Rubber Feet	Light military green wrinkle finish top sides and back. Light military green glossy finish on bottom. Front panel black glossy.

[illegible]DUCT [illegible]ND/TYPE	PHOTOGRAPH	OVERALL DIMENSIONS (in cms) W x H x D	CHASSIS DIMENSIONS (in cms)	OPERATIONAL ELEMENTS (Dimensions in cms.)	NUMBER OF TRANSFORMERS, SIZES AND LOCATIONS (Dimensions in cms.)	HANDLE SIZE AND LOCATION (Dimensions in cms)	VENTILATION HOLES/GROOVES	DIMENSIONS FIXED BY (in decending order or importance)	TYPE OF ASSEMBLY	FEET	FINISH
[illegible] CONT [illegible]		12 x 19 x 9.5		Fuse 1 1.6φ / 1.5 Ind. lamp 1 1.2φ Switch 1 1.2φ / 1.7 Voltage adj. 1 1.6φ / 2.1 Current adj. 1 1.6φ / 2.9 Binding posts 2 1.7φ / 2.5 All on front panel	One 11 x 8 x 8 Centre bottom plate		No ventilation holes or grooves.	Space fully occupied. Selectors which decides depth. Selectors which, valves and transformer decide length and width.		Rubber feet	Bluish green hammertone finish for top sides and back and bottom. Front light green glossy anodized finish.
SIMPSON VTVM [illegible]-1		41 x 15 x 16.7		Ammeter 1 6.1 x 5.3 x 1 Voltmeter 1 6.1 x 6.2 x 1 Toggles switch 3 1.7φ / 1.7 Knobs 4 2.3φ / 2.3 Binding posts [illegible] 1.3φ / [illegible] Socket 1 [illegible] / 1.6 Ind. lamp 1 1.2φ All on front panel	Two 11 x 10 x 11.5 located at two sides at the back of chassis		58 holes of 0.5φ in centre of two sides. Back - two sets of 58 holes on either side Bottom 110 holes.	Front panel size decided by operational elements. A lot of space seems to be lying unoccupied. Depth could be reduced by about 2 cm.		Rubber feet	Top sides and bottom blue rexine finish. Front aluminium. Silver grey anodized. Lettering also photo anodized.
PHILIPS VTVM GM 6009		[illegible] x 21.8 x 15.4		[illegible] All on front panel [illegible]	One 8 x 6 x 7.5 at left front side back on chassis		Top 40 holes of 0.5φ Side - 3 sets of 45 holes each 			Rubber feet	Top sides back and bottom. Silver grey hammertone. Front black anodized along with letters.
APLAB AC Milli Voltmeter Type [illegible]		17 x 24.5 x 26		Meter [illegible] 5.3 x 5.3 x 1 Fuse [illegible] Toggle switch 1 [illegible] Binding posts [illegible] Ind. lamp 1 [illegible] Output adj. 1 [illegible] Reset 1 [illegible] All on front panel	Three [illegible] x 11.6 x 9.5 6.5 x 8 x [illegible] 6 x 6.5 x 9.5 All on [illegible] back [illegible]		14 louvings of 0.4 x 4.3 on either sides 8.5 x 14 perforated (circular holes) at back. Bottom 0.4 square holes 	Dimensions (height) could be reduced by about 2 cms. Height is mainly governed by meter and components under the chassis. Length and depth decided by tube and components under the chassis.		Rubber feet	Back top bottom sides black wrinkle finish. Front light bluish grey glossy finish. Letters engraved on front panel.

PRODUCT MAKE/TYPE	PHOTOGRAPH	OVERALL DIMENSIONS (in cms) W X H X D	CHASSIS DIMENSIONS (in cms)	OPERATIONAL ELEMENTS (Dimensions in cms.)	NUMBER OF TRANSFORMERS, SIZES & LOCATIONS (Dia. in cms.)	HANDLE SIZE AND LOCATION (Dimensions in cms)	VENTILATION HOLES/GROOVES	DIMENSIONS FIXED BY (in descending order of importance)	TYPE OF ASSEMBLY	FEET	FINISH
PHILIPS AF Oscilloscope GM [illegible]		25.3 x 28.5 x 38		Knobs 6 1.3Ø / 2 Knobs 1 0.9Ø / 2 Knobs 4 2.5Ø / 3 Connector 1 1.5Ø / 3.5 Binding posts 2 1.3Ø / 2.5 Sockets 5 1.2Ø Switch 1 2.4 x 1 x 0.2 Screen 1 11.5 x 11.5 x 3.5 21 all on front panel Fuse 1 [illegible] Socket 1 1.5Ø / 1.2 [illegible] socket 1 4.5 x 2.5	One 12 x 9.5 x 10 Back left hand side Supported on angles			Space is more or less fully utilised. Since sides, top can be opened all components can be reached.			Top sides grey (silverish) hammertone. Back grey glossy. Front light silverish grey glossy. Sliding front and back grey (same as base) bottom [illegible] cadmium plated.
[illegible] RF Oscilloscope Type [illegible]		35 x 41 x 59.5		Knob 8 3.5Ø / 2.5 Knob 6 2.2Ø / 1.8 Toggle switch 1 1.7Ø / 1.7 Ind. lamp 1 2.2Ø / 1.8 Screen 1 15 x 15 x 1.7 Screw adj. 2 1.3Ø Connection 4 1.6Ø / 1.1 Switches 2 1.3 x 0.7 x 1.5 25 all on front panel Fuse 1 1.3Ø on back panel	One 15 x 15 x 10.5 On the back right hand side of main chassis (more transformers not an important unit in a determining view).			A lot of vacant space is there. Size seems to have been fixed by considerations of [illegible] of repair and good accessibility of components as also ventilation. (a fan is used)			Top sides back and bottom dark grey glossy. Front light silverish grey smooth.
TEKTRONIX Scope Mobile Type [illegible] (scope) Type [illegible] mobile		32 x 40.5 x 54.2		Screen 1 15.3 x 15.3 x 3.7 Binding posts 3 1.3Ø / 2.3 Toggle switch 1 1.7Ø / 1.7 Ind. lamp 1 2.2Ø Ind. lamp 1 1.4Ø Metal binding posts 1 1.9Ø / 2.3 Knob 6 3.5Ø Knob 4 2.2Ø Knob [illegible] Connector [illegible] Switch [illegible] / 1 Preset [illegible] Metal binding post [illegible] / 1.1	-						Bluish casing finish (same as [illegible]) Top sides and back. Front silverish grey smooth.
[illegible] Oscilloscope Type [illegible]		[illegible]		Screen 1 15.3 x 15.3 x 5.7 Toggle switch 2 1.7Ø / 1.7 Ind. lamp 2 0.9Ø Knob 1 1.3Ø / 0.7 Knob 12 2.4Ø / 1.2 Binding posts 3 1.9Ø / 2.1 Socket 4 1.3Ø / 2.4 Adj. 3 2.2Ø Switch 2 1.3Ø Knob 4 0.7 x 2 x 0.5 Push button 1 2.5Ø / 1.9 37 all on front panel	One 10 x 16.5 x 10 Right hand side middle back The transformer has very little effect on the overall size			The volume is necessary to house the circuit. Hardly any space is unutilised. If the space were to be reduced further, accessibility and ventilation problems would arise. Fan exhaust used. Front panel size decided to house operational elements.			Top sides back bottom light blue hammertone. Front off white (light greenish) glossy.

6. HYPOTHESIS

6.1

Evolve a set of standard dimension and at the same time maintain flexibility so that the bench type electronic instrument housings of various dimensions (width, height and depth) can be constructed.

6.2

The instrument housing must be constructed from cheap mass produceable prefabricated standard parts. These prefabricated standard parts should be such that there is no or only a minimum of processing and operations (like shearing, press work, spot welding etc.) at the instrument manufacturers place. Also they should be such that they can be assembled at the instrument manufacturer place easily and quickly with least amount of training.

6.3

The colour, finish ventilation holes or groves should be left to the instrument manufacturer's choice.

6.4

No handles are required.

6.5

No means of tilting the instrument to make the front panel normal to the line of sight of the operator is required.

6.6

The housing should be such that the instrument can be dismantled (for repairs maintenance) by anyone quickly and easily and with some commonly available laboratory device like a screw driver.

6.7

The prefabricated parts should be easy to package and transport.

6.8

The instrument housing should be simple to look at and must have aesthetic appeal.

7. SYNTHESIS

7.1

First of all a set of standard dimensions was arrived at. It was found after studying the 12 instruments that the most convenient dimensions for bench type electronic instruments are numbers which are multiples of 5. The minimum dimension needed is 5 and the maximum 60. Any particular dimension is rounded off to the smallest feasable multiple of 5. For example the depth of an instrument 21.5 cms at present could be rounded off to 20 cms. If however this is not possible either due to internal component placing or heat dissipation problems, it is rounded off to 25 cms. Of course a few cubic centimetres of additional unwanted space may be added this way but that is the price to be paid for standardizing dimensions and the benefits that accrue from it. See next two pages.

7.2

Next an attempt was made to find out the shapes most suitable for housings in the context of standardization. The dimensions and layout of components were noted and various possible shapes were tried out for all the

No.	Dimensions in ascending order	Standard dimension
1	09.50	10
2	10.50	10
3	12.00	15
4	13.00	15
5	15.00	15
6	15.40	15
7	15.50	15
8	16.70	15
9	17.00	20
10	19.00	20
11	21.00	20
12	21.30	20
13	21.80	20
14	22.00	25
15	24.00	25
16	24.00	25
17	24.50	25
18	24.50	25
19	25.50	25
20	28.20	30
21	28.50	30
22	31.00	30
23	31.00	30
24	32.00	35
25	32.80	35
26	33.00	35
27	35.50	35
28	38.00	40
29	40.50	40
30	41.00	40
31	41.00	40
32	50.00	50
33	50.20	50
34	51.50	50
35	54.20	55
36	59.50	60

Type	No	Make	Dimension		Standard Dimension
	1	Aplab	W	13.00	15
			H	24.00	25
			D	22.00	25
	2	Aplab	W	50.00	50
			H	24.50	25
			D	32.80	35
	3	Radart	W	31.00	30
			H	10.50	10
			D	21.00	20
	4	Beltronics	W	51.50	50
			H	15.50	15
			D	28.20	30
	5	Sanwa	W	12.00	15
			H	19.00	20
			D	9.50	10
	6	Simpson	W	41.00	40
			H	15.00	15
			D	16.70	15
	7	Philips	W	31.00	30
			H	21.80	20
			D	15.40	15
	8	Aplab	W	17.00	20
			H	24.50	25
			D	24.00	25
	9	Philips	W	21.30	20
			H	28.50	30
			D	38.00	40
	10	ECIL	W	33.00	35
			H	41.00	40
			D	59.50	60
	11	Textronics	W	32.00	35
			H	40.50	40
			D	54.20	55
	12	Russian	W	25.50	25
			H	35.50	35
			D	50.20	50

12 instruments while trying tomake the instruments compact and to get the same shapes or parts of them repeated over the whole range of instruments. This resulted in an array of shapes which were totally different for each instrument with no prospects of standardization. Also an attempt was made to see if any shape other than the present rectangular shape could be used commonly for all instruments. It was found that the present rectangular shape is the best and most suitable as different manufacturers use different circuits different components and different layouts.

7.3

Next it was tried to build the housing from a set of common elements, the emphasis being on extensibility based on repeated use of the same element. This attempt proved to be abortive in that it resulted in complex elements and also very time consuming and difficult processes of assembly. The advantages of standardization would be more than off set by slow and costly assembly processes.

7.4

Also the use of other unconventional materials like rexene, cloth, nets etc was investigated and was found unsuitable.

8. DESIGN DECISION

8.1

The new design is a simple rectangular shape of dimension (taking X as the standard dimensions of multiples of 5 i.e. X = 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60 cms)

Overall width = X cms

Overall height = X + 1.5 cms

Overall depth = X + 0.75 cms

Front panel width = (X - 1.5) cms

Front panel height = X cms

8.2

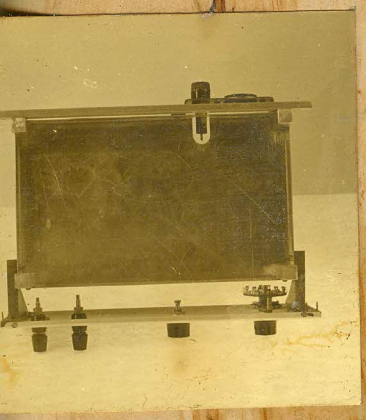
The instrument housing can be divided into three main parts:

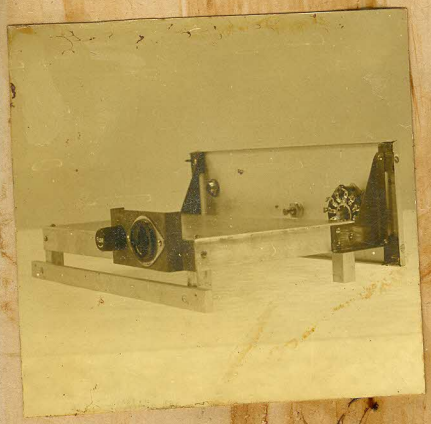
8.2.1

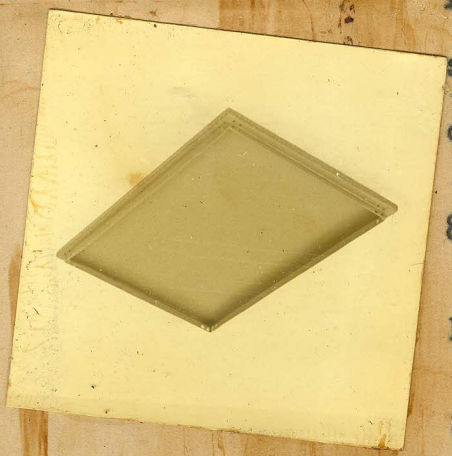
The upper cover: This consists of 4 standard panels screwed on together from the inside to form the top, back and two sides of the housing. Screws (8 in all) are the self threading type. Ventilation holes are punched as per requirements. The upper cover has no screws visible from the outside.

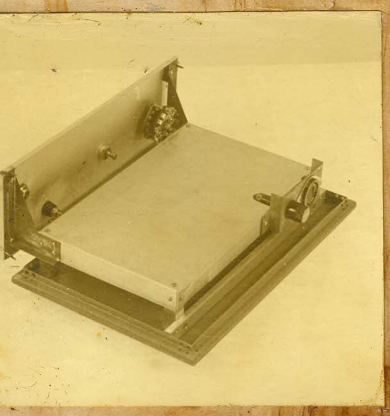
8.2.2

The front plate: The front plate is attached









rigidly to the chassis. At the four corners are corner pieces on which are 3 pins each. The corner pieces are screwed on to the front panel (which as inward folds on all four edges) from the top sides and bottom. The front panel is attached to the chassis in such a way that its lower edge is 1.5 cms high level when the chassis is placed on a level surface. Front panel can be got punched from the element manufacturer if ordered in large quantities or drilled at instrument manufacturer's place. No screws are seen on the front panel when the housing is assembled.

8.2.3

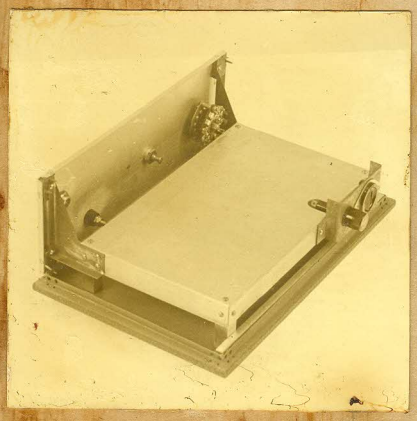
The bottom panel: The bottom panel is a simple standard panel with 4 PVC feet stuck on at the bottom.

8.3

Procedure for assembly:

8.3.1

Place chassis on bottom plate and slide it back wards so that pins on the bottom end pieces of the front plate (attacked to chassis) slide into the corresponding holes in the bottom panel and the back of the



chassis touches the folded back portion of the bottom panel and the threaded holes of the former align with the corresponding holes in the latter. This requires no special effort on part of the operator as the chassis legs just fit the bottom panel.

8.3.2

Next the upper cover is brought into position and slid forward so that the pins on the corner pieces of the front panel slide into the corresponding holes in the upper cover and the holes in the bar at the lower bottom of the top cover align with the already aligned holes in the chassis and bottom panel. The housing is screwed up by two screws which pass through the bar of the upper cover, bottom panel into the threaded hole in the back of the chassis.

8.4

For dismantling reverse the procedure.

8.5

Element manufacture:

8.5.1

The panels can be mass produced on a press

(One of the bending operations requires a goose neck punch.) The corners are welded after folding. A minor amoutn of finishing is required to smoothen out the corners.

8.5.2

The front panel is again made on a press.

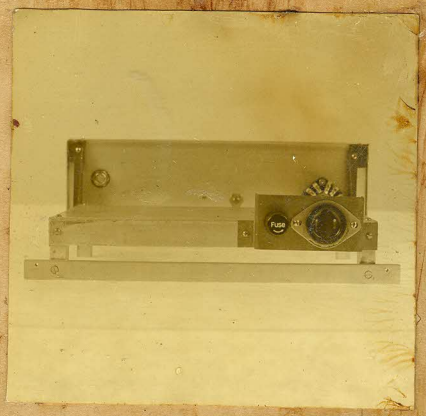
8.5.3

The end pieces are made of mild steel, the pins being screwed on into threaded holes.

8.5.4

The bar can be either extruded or die cast.

8.5.5



The chassis is fabricated at the electronic instrument manufacturers place according to his requirements. (The only constraint is that the two threaded holes at the back should be correctly spaced.

8.5.6

The feet are in PVC and are injection moulded.

8.6

Economics of the design

8.6.1

Since the design lays no constraints on the housing material or thickness and because no precise costs of existing housings was available during data collection, only a relative comparison of the costs can be made.

8.6.2

Assuming that the same material is being used we can take the material costs to be the same. (Actually this is not so. Since the element manufacturer who makes the panels will be buying the material in bulk he would in all probability be getting it cheaper also. But let us give the benefit of the doubt to the existing housings).

8.6.3

But the process costs of the element manufacturer, who makes in very large quantities (to be supplied to various instrument makers) will be much lower.

8.6.4

Also assembling the new housing is much simpler and quicker than for the existing housings and thus much cheaper.

8.6.5

Then there are the other advantages mentioned in Section 1.3.

8.6.6

The dictates of common sense tell us that the new design is much more economical.

8.7

Advantages

8.7.1

All construction from prefabricated standard parts.

8.7.2

Interchangability of panels giving great flexibility.

8.7.3

Flexibility in chassis design.

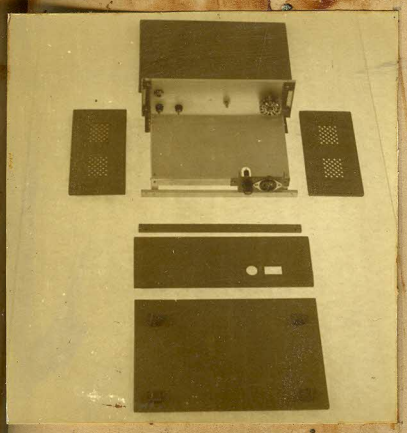
8.7.4

No screws visible on housing except the two at the back bottom inset.

8.7.5

Only two screws to be unscrewed to dismantle the instrument making dismantling and assembl-

ing very easy and quick (less than a minute's time each).

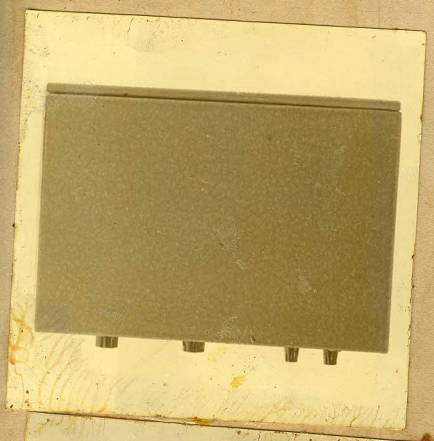


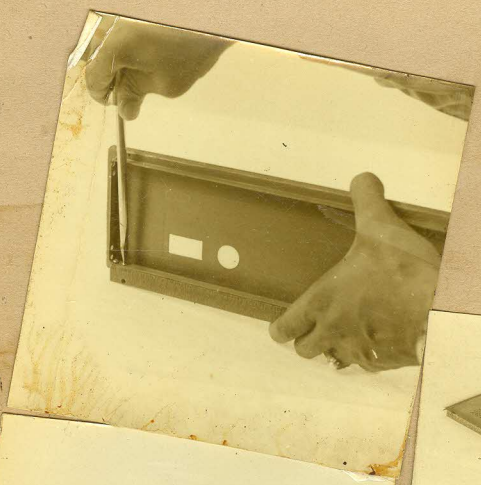
8.7.6

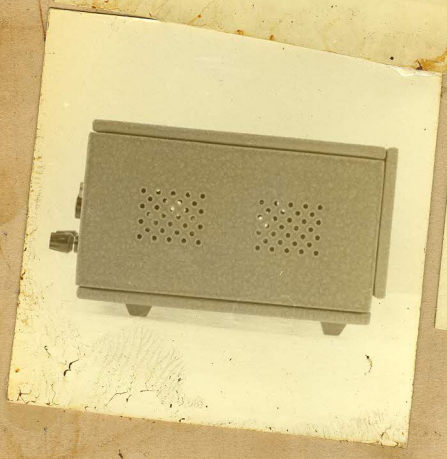
Possibility of use of many materials like mild steel, aluminium and even plastics.

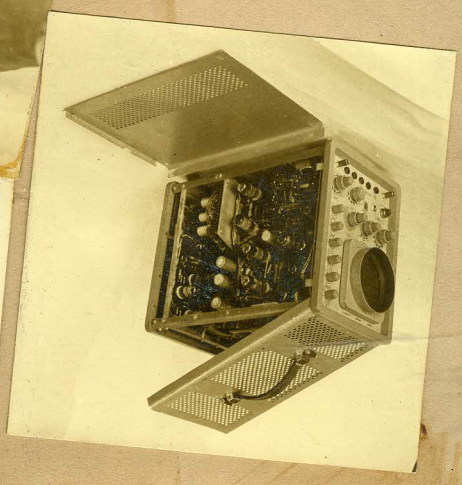
8.7.7

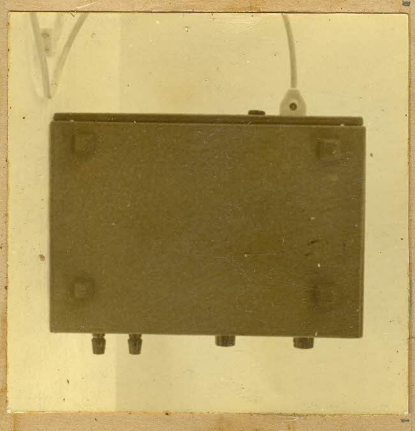
Very cheap.

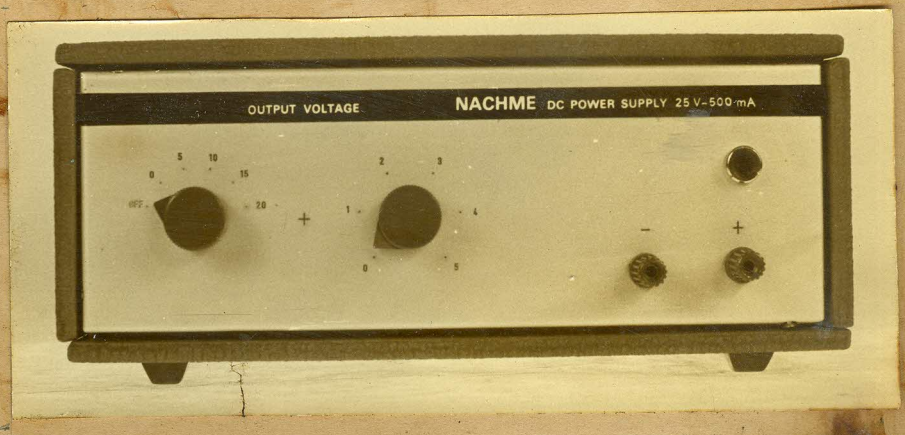


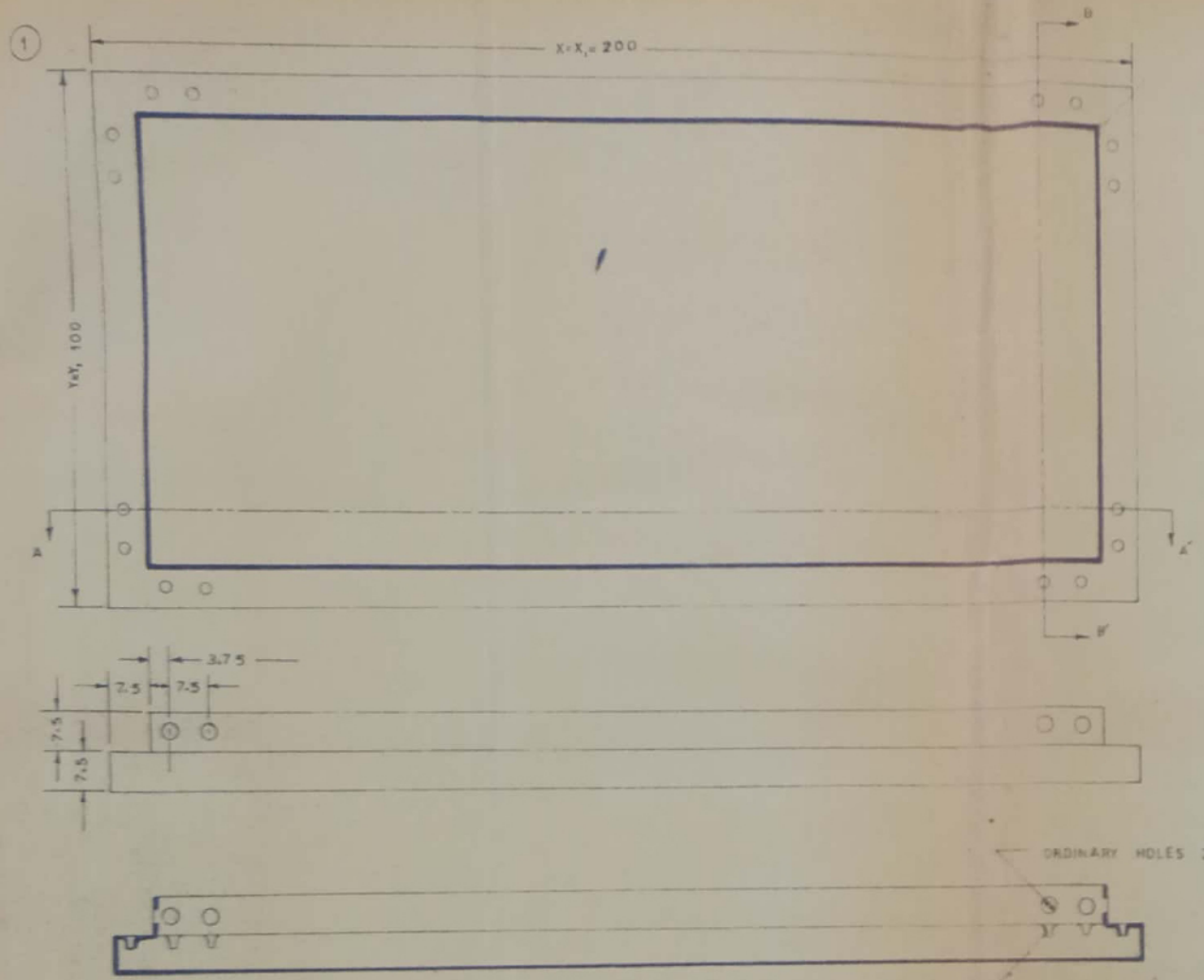




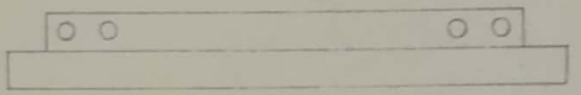




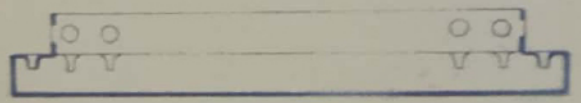




SIDES	2 NOS.	X_1=200	Y_1 = 100
TOP	1 NO.	X_2=300	Y_2 = 200
BOTTOM	1 NO.	X_3=300	Y_3 = 200
BACK	1 NO.	X_4=300	Y_4 = 100



SECTION A A'



SECTION B B'

1	PANEL	MILD STEEL 22 SWG	5
PART NO	DESIGNATION	MATERIAL	PIECES

DIPLOMA PROJECT

ELECTRONIC INSTRUMENT HOUSING

S. R. MENON

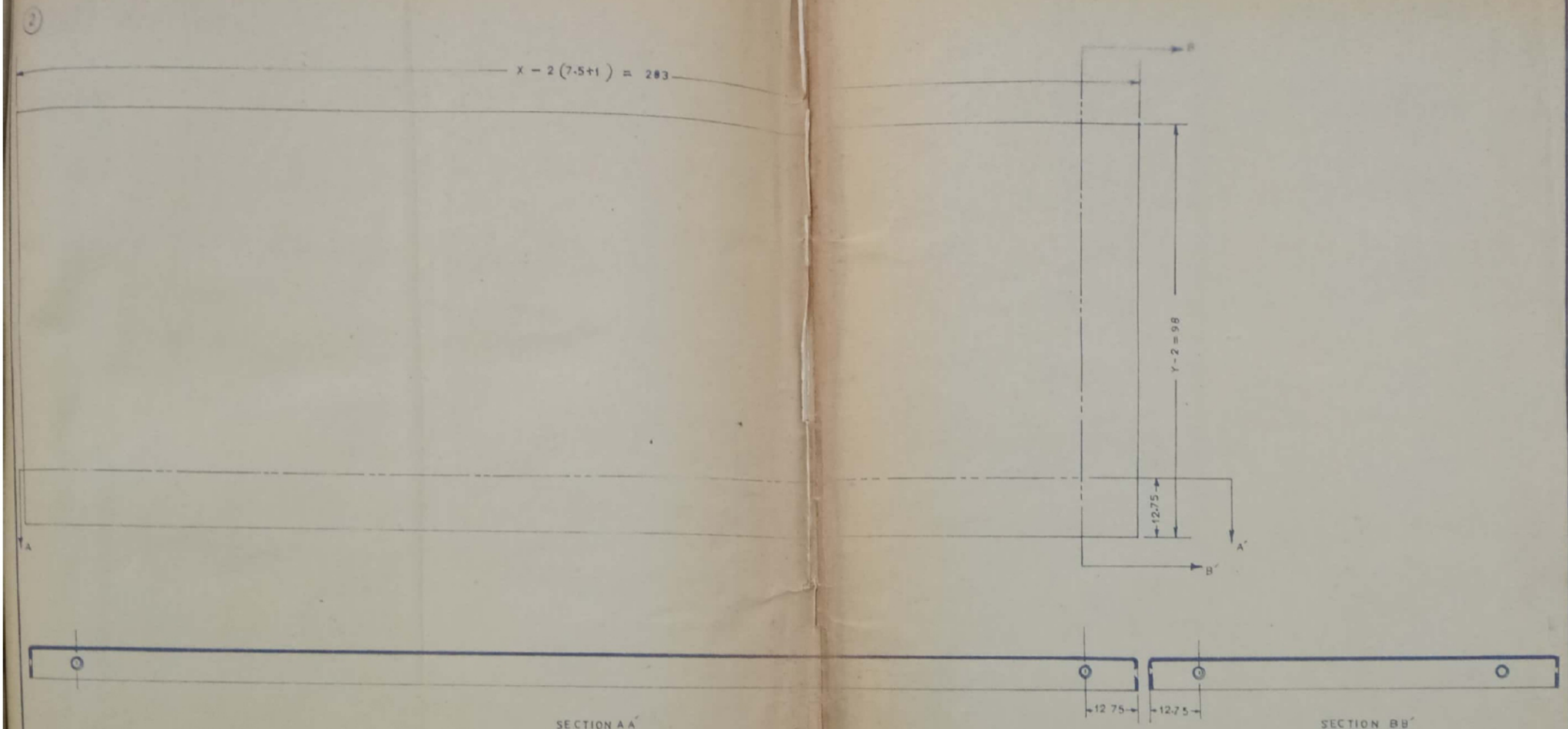
ROLL NO S-972 | 70-71 BATCH

FULL SCALE

DIMENSIONS IN MM

INDUSTRIAL DESIGN CENTRE, I. I. T. BOMBAY

(2)



SECTION A A'

SECTION B B'

2.	FRONT PANEL	ALUMUNIUM 16 SWG	1
PART NO.	DESIGNATION	MATERIAL	PIECES

DIPLOMA PROJECT

ELECTRONIC INSTRUMENT HOUSING

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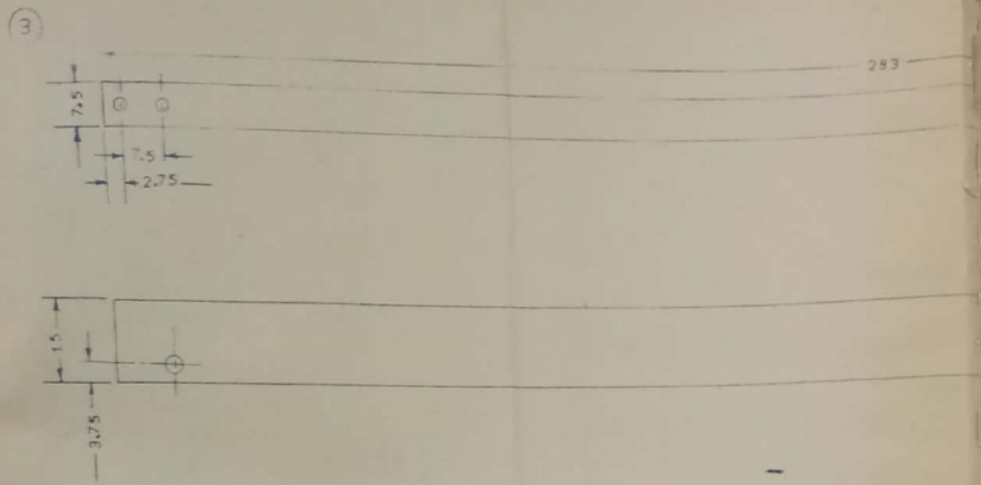
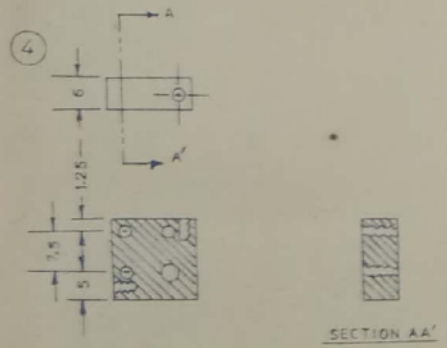
FULL SCALE

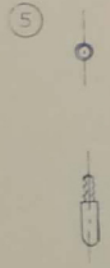
DIMENSIONS IN MM

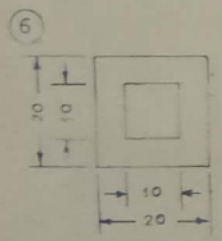
INDUSTRIAL DESIGN CENTRE, I.I.T. BOMBAY

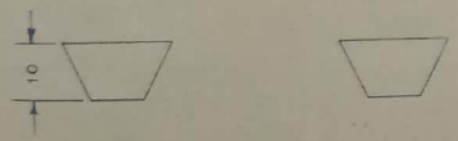


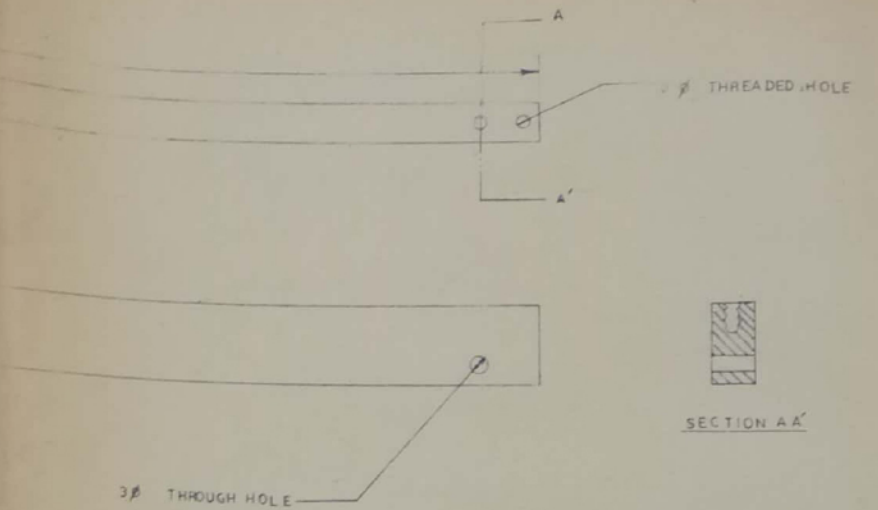


SECTION AA'









SECTION AA'

PART NO.	DESIGNATION	MATERIAL	PIECES
6	FEET	PVC	4
5	PINS	BRASS	12
4	CORNER PIECES	MILD STEEL	4
3	BAR	MILD STEEL	1

DIPLOMA PROJECT

ELECTRONIC INSTRUMENT HOUSING

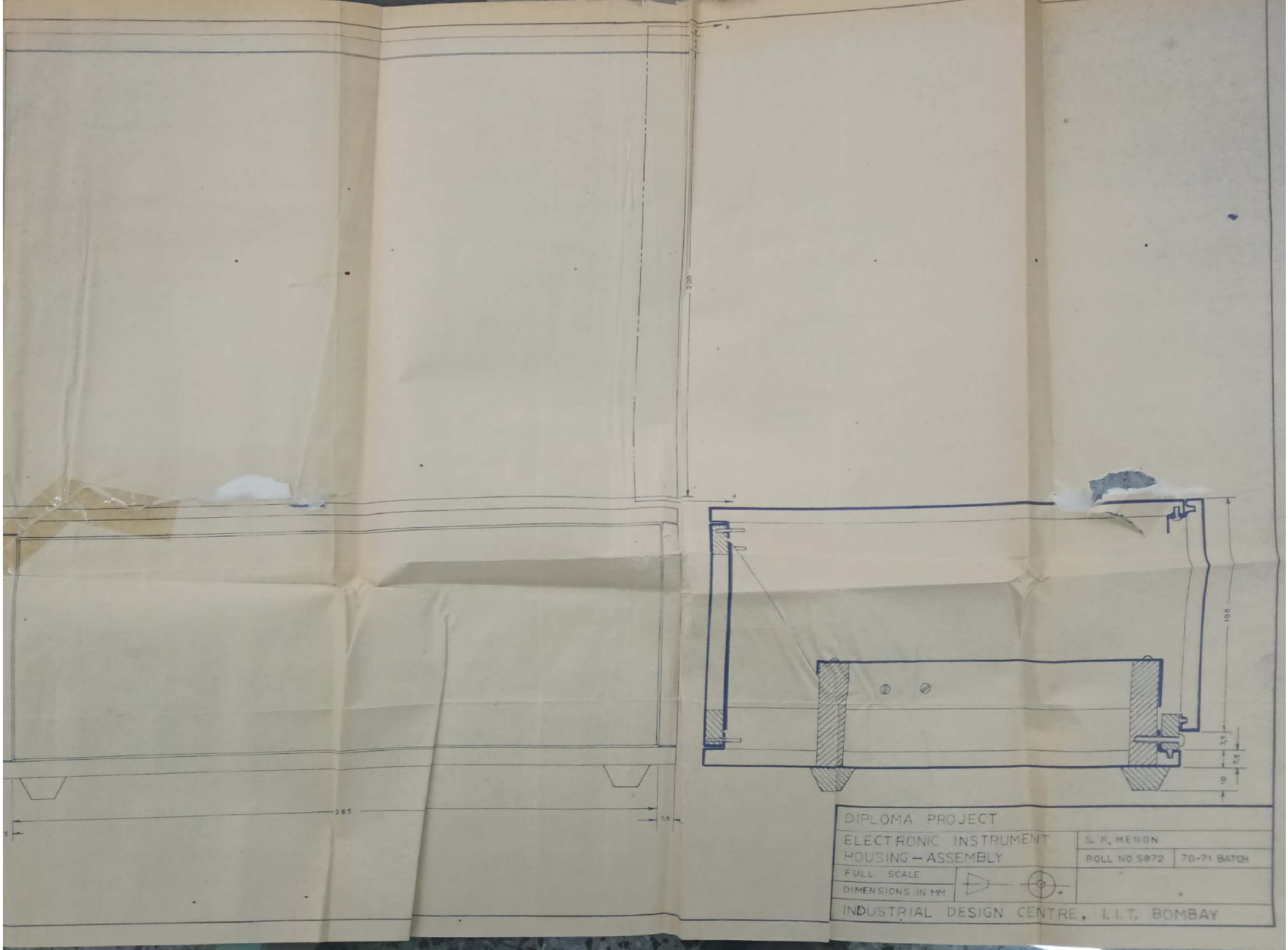
S. R. MENON

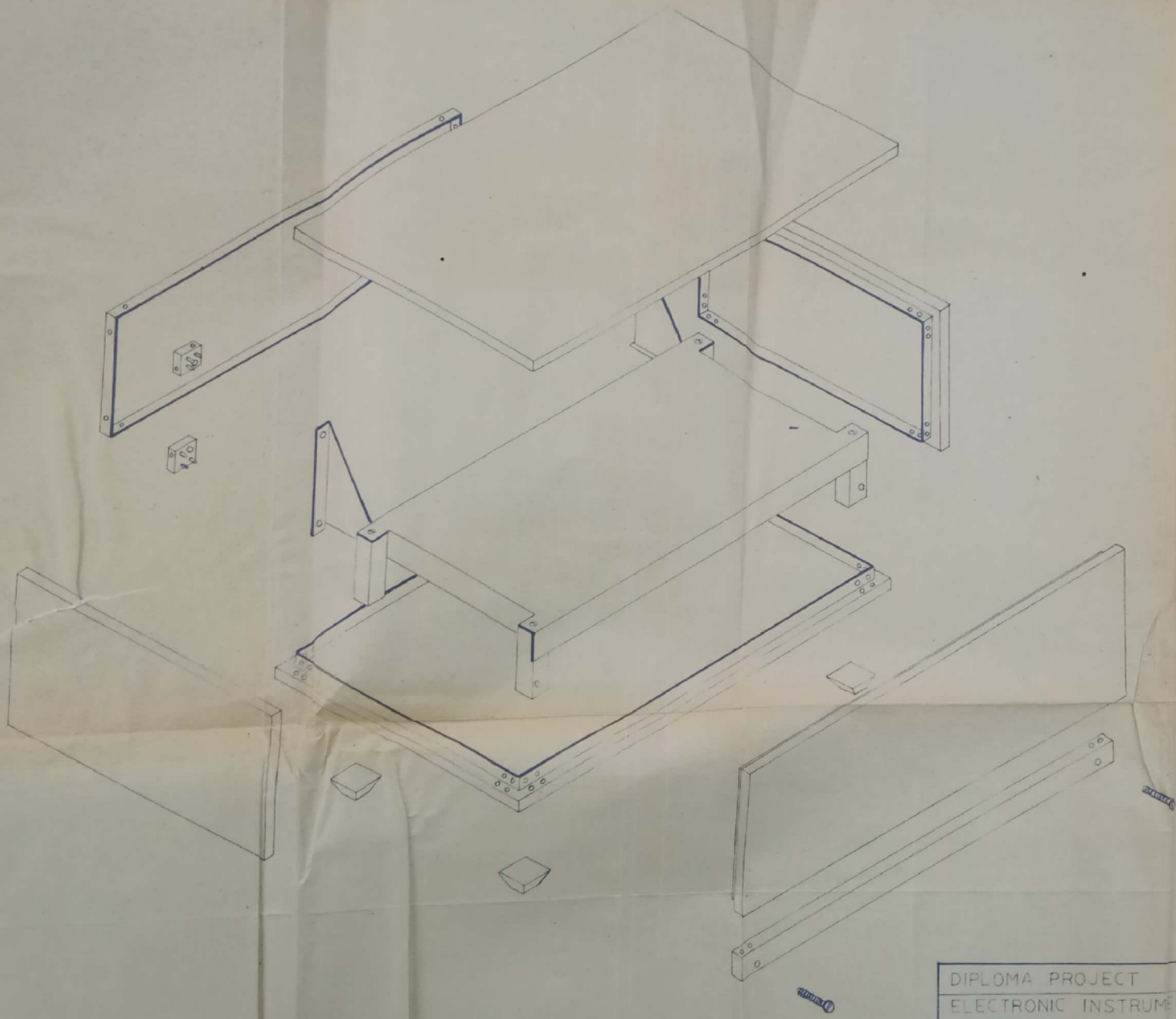
ROLL NO. S-972 | 70-71 BATCH

FULL SCALE

DIMENSIONS IN MM

INDUSTRIAL DESIGN CENTRE, I. I. T. BOMBAY





DIPLOMA PROJECT

ELECTRONIC INSTRUMENT HOUSING — EXPLODED VIEW

S. R. MENON

ROLL NO. S-972 | 70-71 BATCH

SCALE 1:4

DIMENSIONS IN MM

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