

DESIGN OF ARC RESISTANCE TESTER

DIPLOMA PROJECT

G.D. VERNEKAR

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BOMBAY

1977

DIPLOMA PROJECT

Submitted in partial fulfillment of the
requirement for the Postgraduation diploma in
Industrial Design

G.D. VERNEKAR

// Guide:- Shri K. Munshi //

K.V. Gopalratnam

APPROVAL SHEET

Diploma project entitled
Design of Arc Resistance Tester
by Shri G.D. Vernekar
is approved for the Postgraduate Diploma in
Industrial Design

Within

K.V. Gopalratnam

K. H. S.

✓ Guide

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ACKNOWLEDGEMENT

My sincere thanks to

- * Shri K. Munshi
- * Shri L.K. Das
- * Shri Chandrasekhar IDEMCO
- * Shri Totla / IDEMCO
- * Shri Govind Rajan IDE

for the kind help they have rendered
during my project work.

G.D. Vernekar

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2. Problem Definition
3. Data Collection
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1.0 Introduction

There are some basic requirements which are to be fulfilled by the dielectricals used in Electrical Technology. For testing associated properties, there exist various types of instruments and methods. Arc resistance test is one of them which is newly brought into practice. To carryout this test, an arc of known current value is struck between two electrodes, resting on the material specimen to be tested. The time duration for which the material can withstand that arc is measured and this duration of arc is inversly proportional to the current rating of the arc. Thus by means of the arc duration measurement the dielectric characteristics of the material can be tested.

It should be considered that while designing the product, it is no longer a piece of equipment but is looked upon as the essential and functional furniture item for industrial environment.

In the design, special emphasis is given on integration of function, appearance, ease and safety.

2.0 Problem Definition

- * Structural: Component and space planning.
- * Functional: Insulation, ventilation, wiring, controls.
- * Ergonomical: Man machine relationship.
- * Maintenance
- * Aesthetical
- * Safety
- * Design specification (Material selection, packaging, processes)
- * Electrode design
- * However more weightage is given for function and ergonomics.



3.0 Data Collection

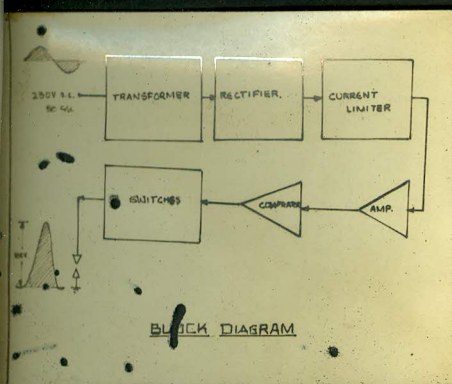
3.1 Literature Survey

Designers specification, American Standards for testing of materials, Books of which the names appear in the bibliography. Human engineering guides, were used for obtaining ergonomical data.

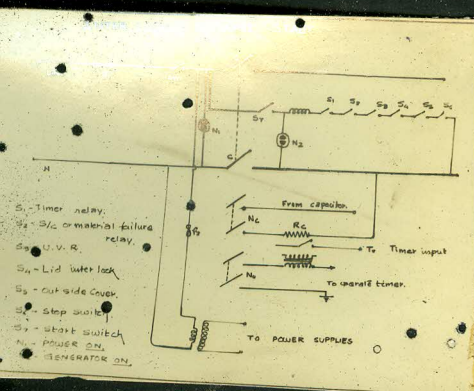
Site Study:- How the equipment works, problems to be solved while design is carried out are noted. Personnel connected with design, maintenance and operation ~~were~~ interviewed. List of concerns is in Appendix.

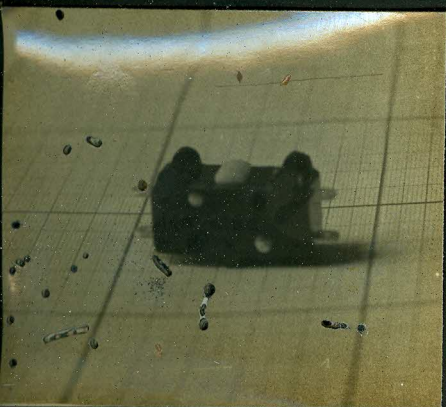
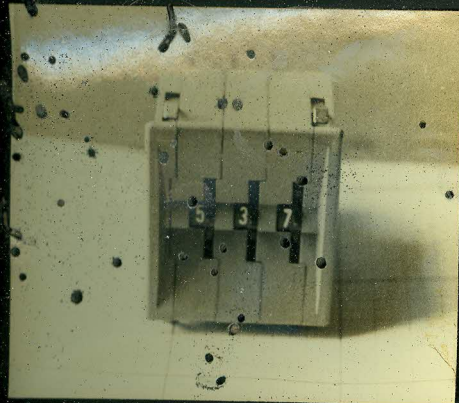
3.1.1 What is an Arc Resistance Test?

A high voltage low current dry arc resistance of solid electrical insulations is a test intended to differentiate in primary fashion among similar materials with respect to their resistance to the action of high voltage low current arc close to the surface of the insulation intending to form a conducting path therein or in causing the material to become conductive due to the localized, thermal and chemical decomposition and erosion.



BLOCK DIAGRAM





3.1.2 Working of Arc Resistance Test

A high voltage low current rectified signal tends to strike an arc between two electrodes separated by a specific distance. The electrodes will be resting on plane surfaced dielectric specimen. The current can be controlled by a current controller switch which is operated for various current setting. A timer is used to cut-off the supply after selected interval.

To carry on the test, a known current valued signal is given to the electrode and the timer is set depending upon the current value. After some time the power trips off due to one of the reasons:

- (i) Timer activation
- (ii) Material failure.

If the tripping off is due to first cause i.e. timer then the material is good, if it is due to the second reason the material is bad. Thus this test shows whether the material is good or bad.

There are various other circuits which control relays for safety purpose.

3.1.3 Types of Failures

- * Organic dielectrics become incandescent
- * Bursting into flames.
- * Tracking: thin wiry line between the electrodes.
- * Carbonization of the surface.

3.1.4 At Failure

At the end of the test i.e. at failure, a conducting path is formed across the dielectrics and arc disappears in the material at the same time noticeable change in sound takes place.

Advantages of this test:

- * Convenient
- * Less time consuming
- * It can be carried out in any atmosphere.

3.1.5 Main Components

Transformer, capacitor, inductor, current limiter switches, various electronic components, printed circuit boards, electrodes and other ventilation devices such as fans etc.

3.2 Functional

In the data collection following points are noted:



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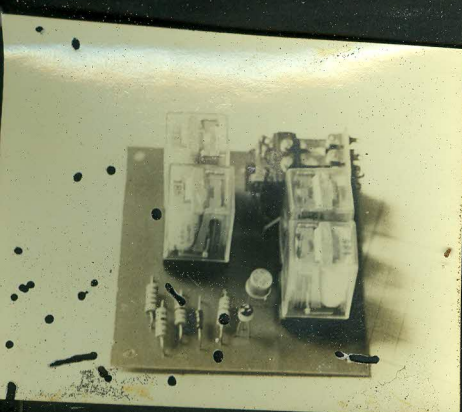
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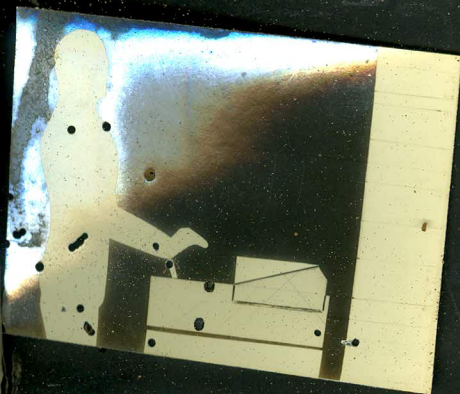
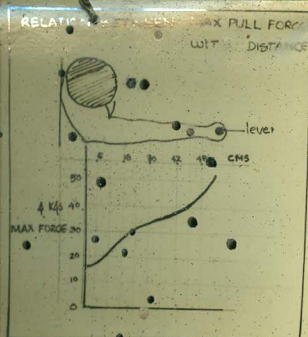
3.1.5 Main Components

Transformer, capacitor, inductor, current limiter switches, various electronic components, printed circuit boards, electrodes and other ventilation devices such as fans etc.

3.2 Functional

In the data collection following points are noted:





* Separation of high voltage (10 KV) and low voltage (15 V)

* Space economy

* Minimum high voltage path length

* Maintenance

* Safety (grounding, shielding)

* Ventilation and cooling

* Placement of microswitches

* Transportation of equipment.

3.3 Ergonomical

* Operator in action

* Operator in maintenance

* Duration of test is about 10-20 min.
standing posture advisable

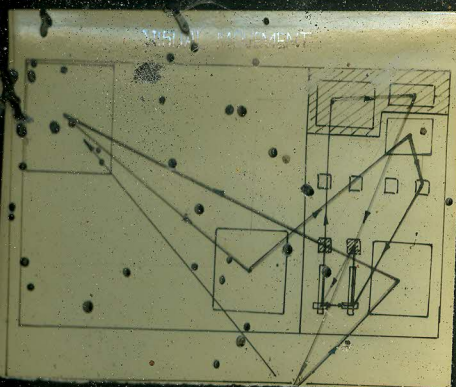
* Electrode placement should be such that easy replacement of specimens and it can be easily viewed.

* Design details regarding control panel and display.

* Anthropometric data.

3.4 Aesthetioal

Environment in which the equipment will be used i.e. electronic laboratories or testing of materials laboratories.



3.5 Users

The user groups is the people with sound knowledge of electrical technology.

3.6 Normal Operation Sequence

*Place the specimen*Adjust the electrodes*
Close electrode lid * Adjust the current
limiter switch * Close its cover * Set
the timer * Put on the main switch* Put
on the high tension line *
Put off the mains to stop.

3.7 Data Regarding Safety

- (1) Proper electrical grounding.
- (2) High Voltage leads protection.
- (3) Prevention of operation of controls when power is on.
- (4) Minimum high tension line length.
- (5) Any of the circuit component should not be ~~readily~~ readily accessible while energized.

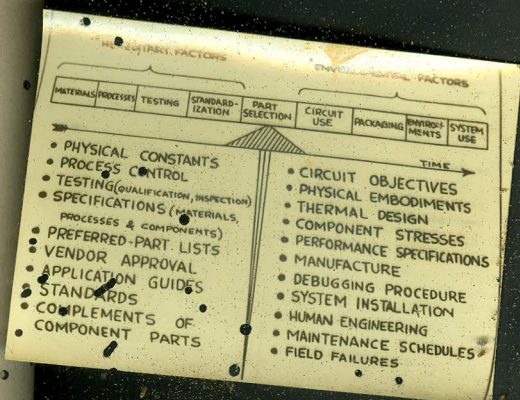
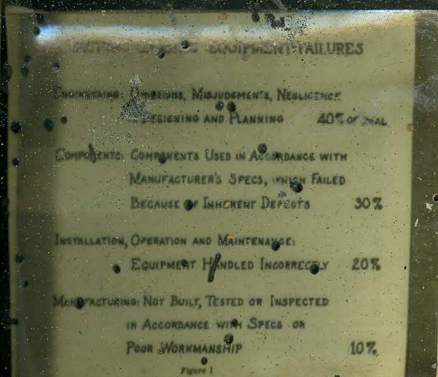
3.8 Cost

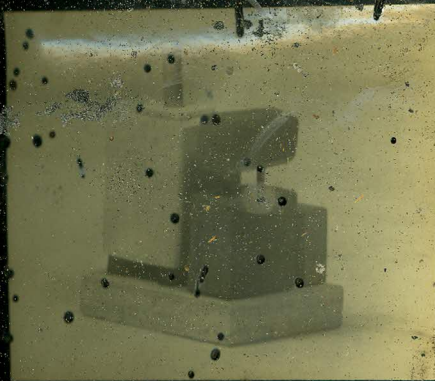
It may go up to 40,000/-

4. Analysis

4.1 Functional

The basic structure of the equipment will be a combinatrix of rectangular elements to differentiate between the different voltage enclosures. The sophisticated and delicate electronic parts are to be kept quite away from the high voltage side. The placement of electrodes should be nearer to the high voltage transformer so that minimization of high tension path can be achieved. The placement of electrode is such that they lie as far as possible from the operator but should be easily viewed and reached. The controls and displays can be mounted on a different surface to distinguish from other surfaces. The current limiter resistors and electrode cavity should be well ventilated to reduce the temperature building up. The location of controls, displays and electrodes etc., should be placed in such a manner that it provides ease of operations. As the production rate is not high, mass production process for manufacture should be avoided. For the maintenance purpose the control circuit enclosure should be easily removable. Also some modifications.





are necessary in the existing product system for better usage.

4.2 Structural

All the main components listed in Data Collection sheet are to be well organised in a frame work with the considerations like, operators convenience, easy maintenance and transportation. The components are to be well supported and fixed so that the equipment becomes portable.

4.3 Ergonomical

What if he has to test several specimens at a time

As the time duration of the single operation is not much the testing can be done by the operator in standing position. The location of various controls and displays should be placed ergonomically.

Sizes and shapes of the knobs will be determined by human factor engineering. *Explains*

4.4. Value Analysis

It is a systematic and analytical technique used to examine all the functions of an existing item, product, system or activity in order to determine if a cost of item can be reduced while maintaining or improving the functional requirements.



Types of values are:

- (1) Use value
- (2) Cost value
- (3) Exchange value
- (4) Esteem value.

Value is the ratio of function to cost.

Use value is the lowest cost required to achieve a given use of service.

Use value is the lowest cost required to achieve desirability.

Cost value is the sum of material-labour and other costs required to produce the item. It also includes cost of distribution.

Exchange value is the market value which enables to exchange. *Need construction*

Thus the use value, exchange and esteem value of the product is obviously very low but cost value is the prominent one whose analysis is not performed due to lack of facilities.

4.5 Formal-Visual Analysis

It is to examine validity and integration of formal elements, visual and psychological functions of colour, shape and product graphics. The natural desire of man while looking at a random pattern

is to create order or to see order, in parts, in relation to the whole. But also, too much order and lack of variety is also unwanted. The form and shape of the products should convey the feelings of its accuracy, sophistication and its function. The product graphics should be effectively situated. Its location, size, colour and shape are of much significance because it projects out the image and identity of the product & manufacturers.

5. Hypothesis

Functional: The equipment should be versatile to test various specimens of different sizes. The unit should be moveable with all the components. Placement of various parts should be functional.

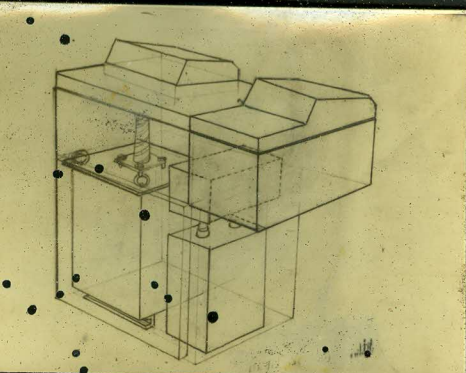
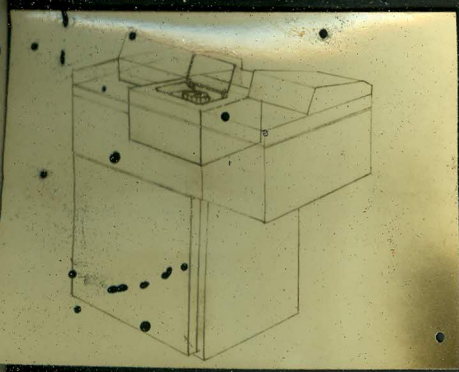
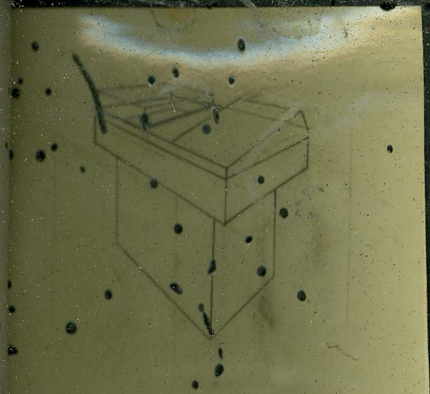
Good ventilation should be provided for necessary cooling of components.

5.1 Structural

The layout of the various components should be such that loss of space is minimum, the accessibility being retained. The overall dimensions are decided by taking into consideration human factors. Material selection should be such that it is structurally strong, light in weight and functional. Fabrication must be easy, quick and less expensive. Separation between high tension and low tension side. Provision for ease of maintenance should be provided.

5.2 Ergonomical and Safety

The equipment should have facilities to stand and perform various operations. The specimen replacement should be easy



and quick. The hight and location of control console should be decided on the basis of anthropometric data. The size shape and counters of the knobs and other controls should be arrived at on the basis of human engineering data. The dial lay out and display placement should be designed in such a way that check reading or quantitative reading is optimum. The placement of components should be such that any of the circuit components are not readily accessable while energized. High tension line length should be minimum. Control elements can not be operated when the power is on.. Good grounding should be provided.

Repeti

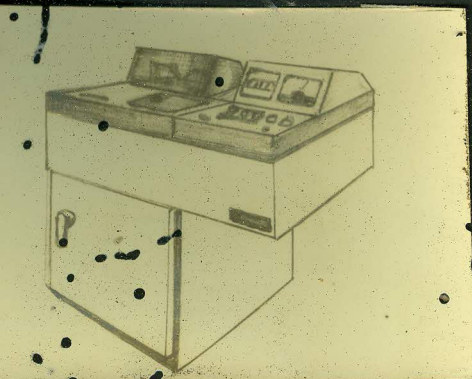
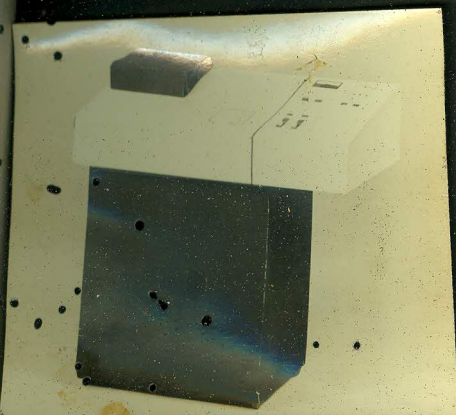
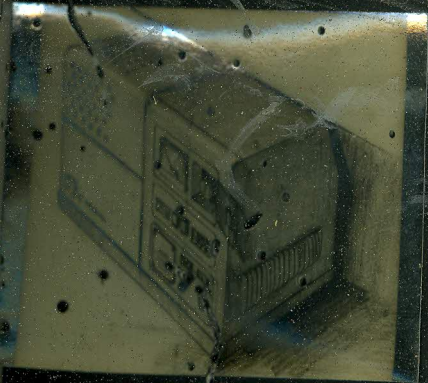
5.3 Formal,

Functional colours should be selected for the different elements. Slected colour should go in harmony with environment where the product will be installed.. Organisation of various elements should be in order, balance and in proportion. There should be economy for planes and forms. Form should be decided

in harmony with the qualities of the material selected. Disturbing elements like screw-heads, weld marks, etc. should be avoided. Product graphics should be effectively located.

6. Concepts

While considering all the above requirements various types of equipment designs are carried out on a rough sketch book. The height of the equipment is first standardized for normal person operating it while standing. Various concepts for locking devices, control panel organisation and modification are found out and most suitable is finalized.



8. Final Solution

* The dimensions of the equipment are decided for operation in the standing posture, the separation of high voltage and low voltage sides as shown in the illustrations.

* The structural details of the equipment are as shown in the drawing. The joining details are also mentioned.

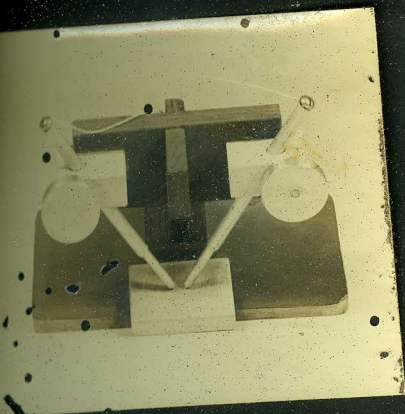
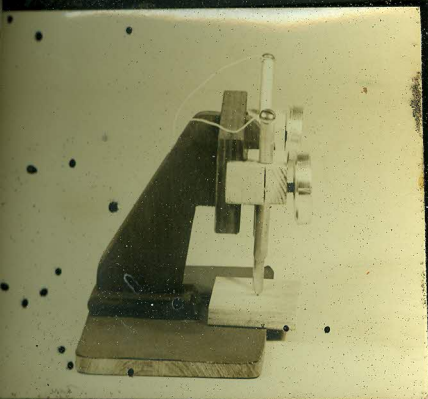
* Casters are provided for the transportation of the equipment.

* Electrode compartment is designed for maximum flexibility. The electrode platform can accommodate specimen of thickness upto 3 cm. thick.

* The electronic circuit control compartment can be opened easily for ease of maintenance.

* Forced cooling is adopted for the cooling of resistor. A fan is used which extracts air from the back side of the equipment. So suitable grill is provided for that.

* Electrodes are also covered with protective grill and it operates a protective microwitch when closed.



* Lever type of switches are made for mains and H.T. switches to facilitate their operation. The knob of current limiter switch is designed for better grip and comfort.

* The dials, graduations, pointer and colour of dial and over all composition of the control panel is arrived at on the basis of ergonomics and perspective psychology. *Explain*

* For ease of maintenance, door is provided at the front.

* The colour scheme of the unit is functional and selected to suit the environment of research laboratories or industries.

* The conventional fuse design is changed and new plug-in-type of fuses are designed for better looks and function.

* The total appearance of the design has been arrived at with the view of imparting order, balance and proportion to the various elements contained in the unit.

VAC ENGINEERING

BELGAUM 590003

REPORT OF ARC RESIST OF MATERIAL

1. Type of the material
2. Name of the material .
3. Condition of fabrication
4. Thickness of the specimen
5. Distance between electrodes
6. Numbers of tests
7. Minimum arc resistance time
8. Special remarks
(burning, softening etc.)

Test Carried by

Date

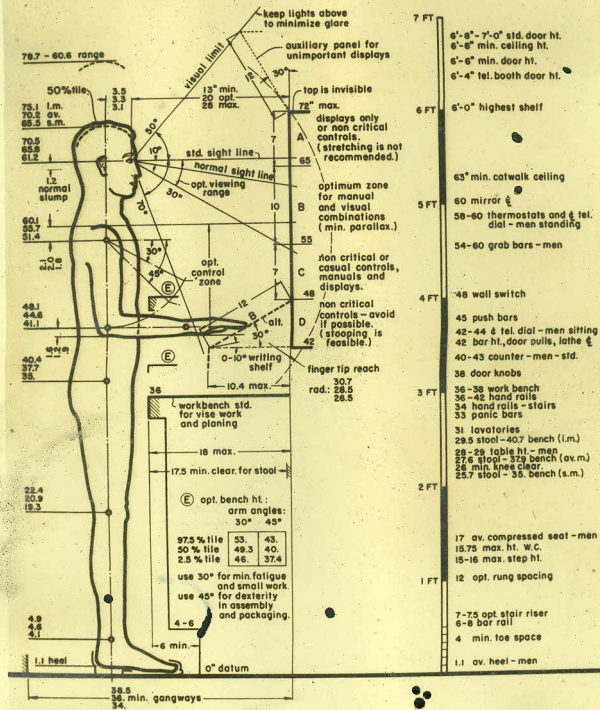
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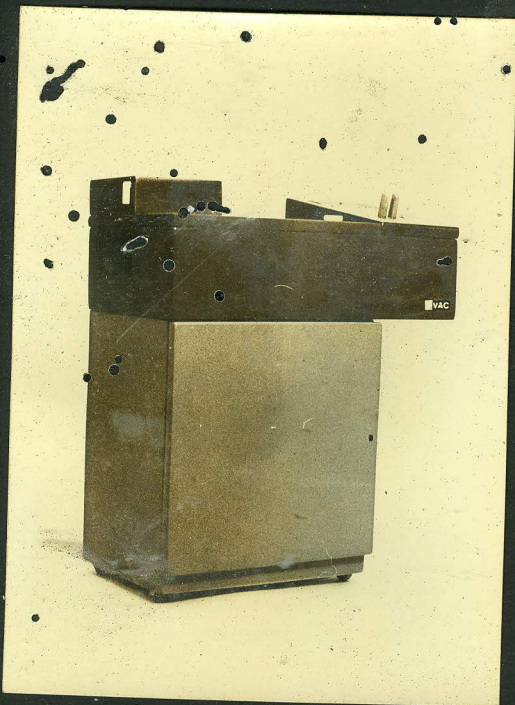
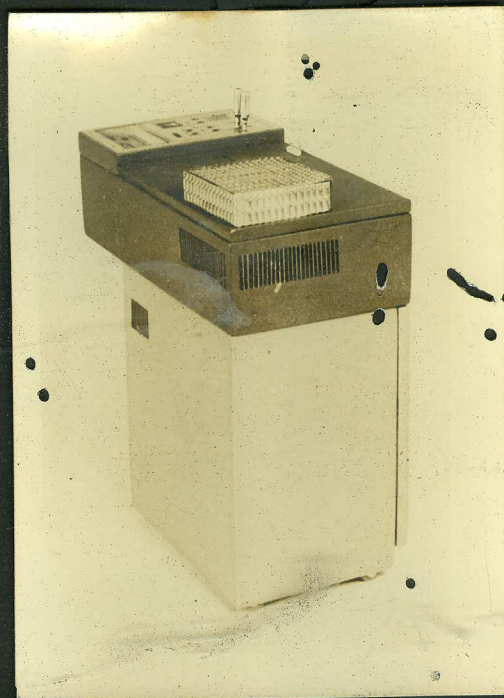
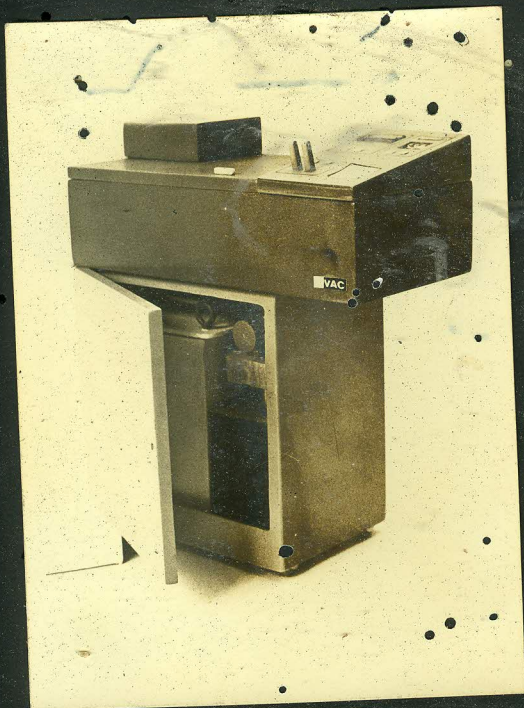
Book

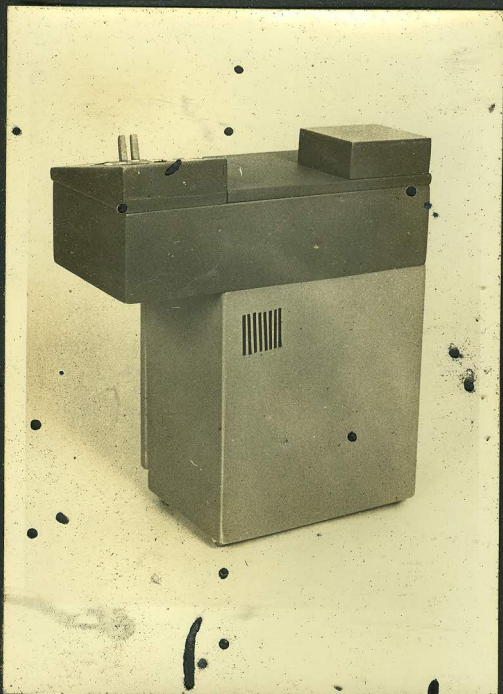
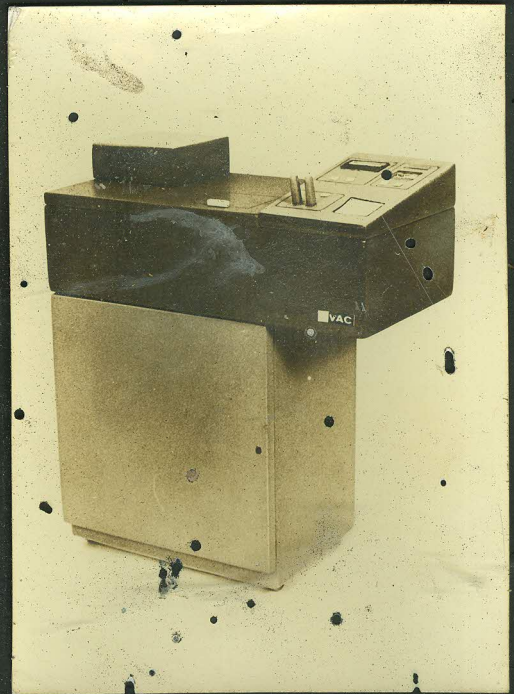
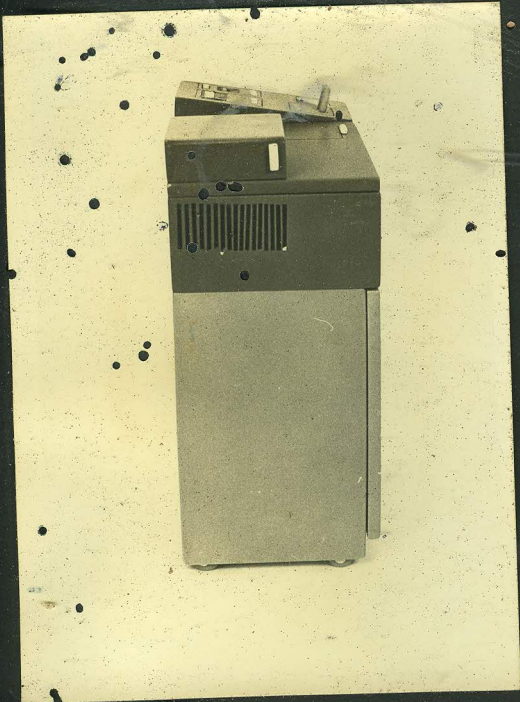
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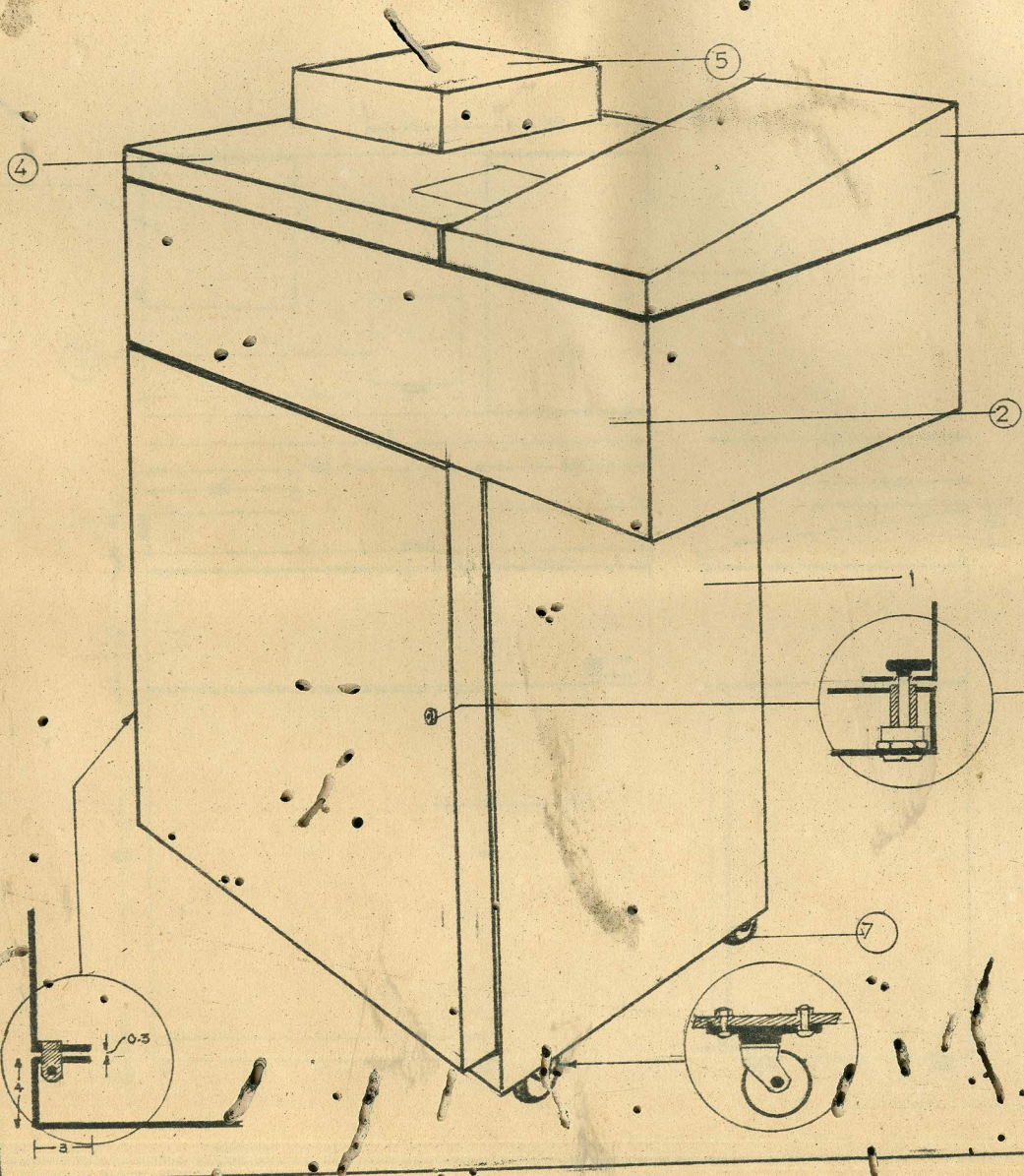
ANTHROPOMETRIC DATA - ADULT MALE STANDING AT CONTROL BOARD









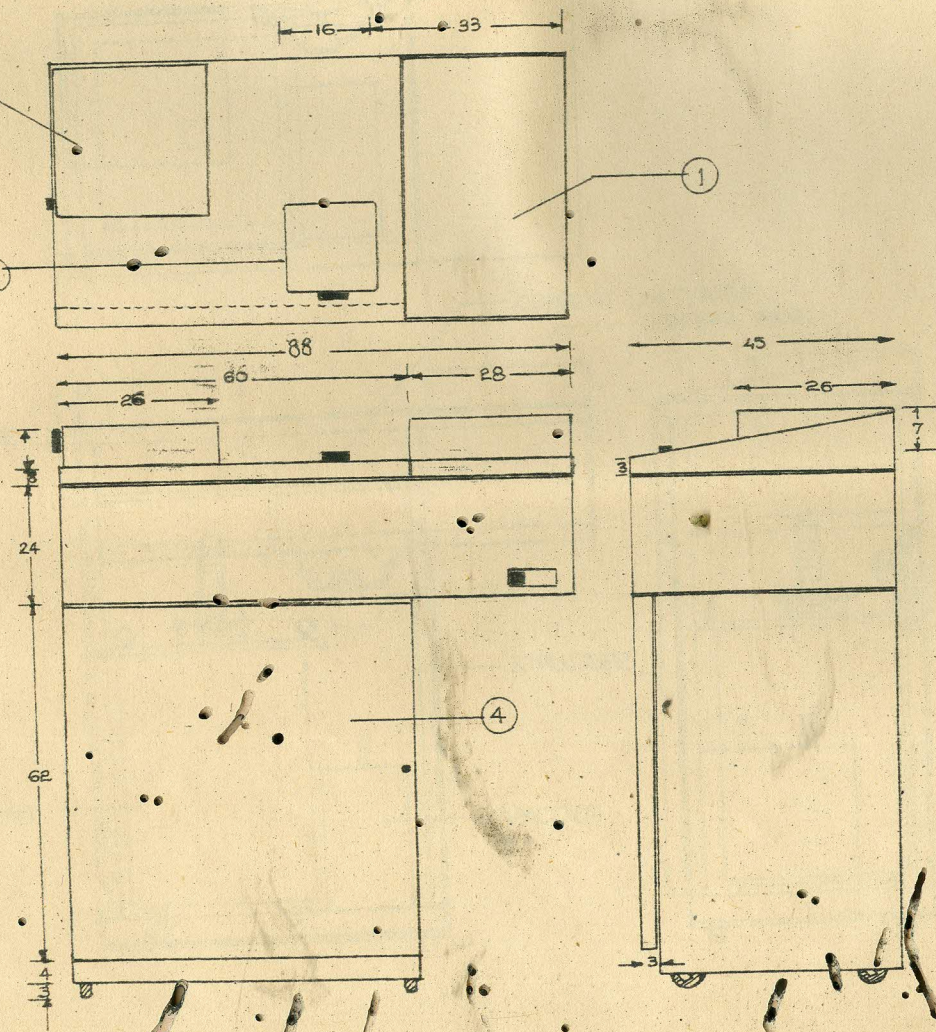


1	SHEET METAL 18 g ²	BENDING & WELDING
2	———— " ————	———— " ————
3	———— " ———— 10 " ————	———— " ————
4	———— " ———— " ————	———— " ————
5	Punched ———— " ————	———— " ————
6	DOOR LOCK	
	CASTERS	

STRUCTURAL DETAILS

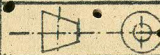
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SCALE	DESIGN OF ARC	7627/57
— ⊕ — ⊕ —	RESISTANCE TESTER	G. D. V.

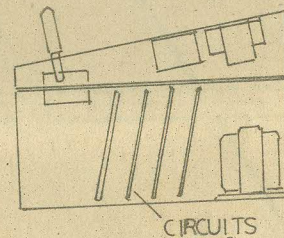
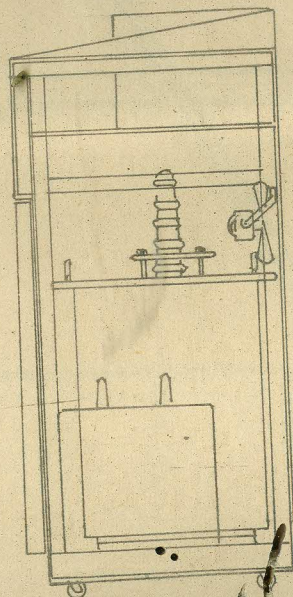
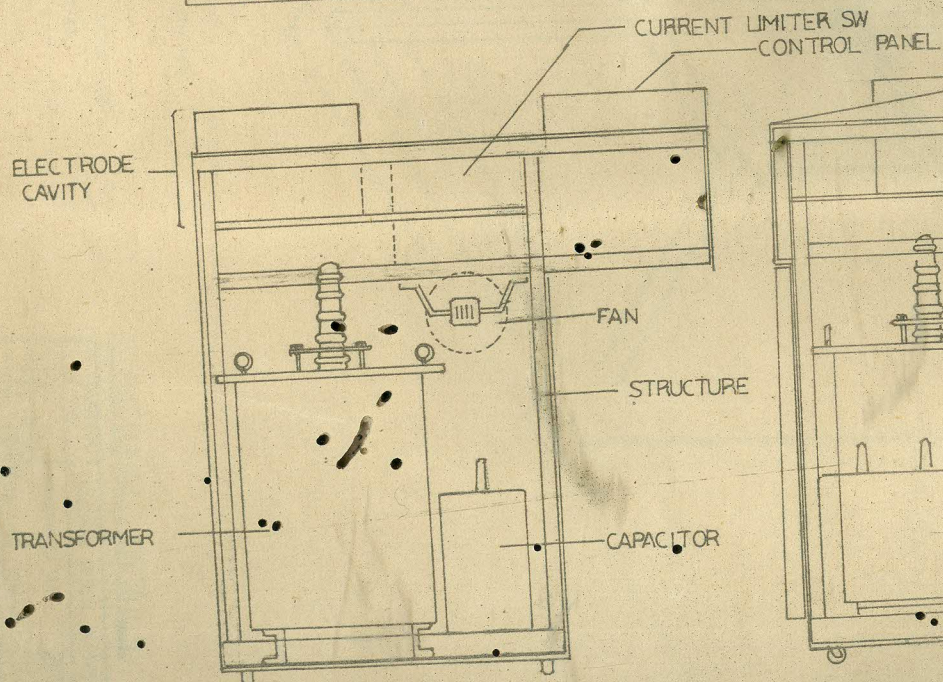
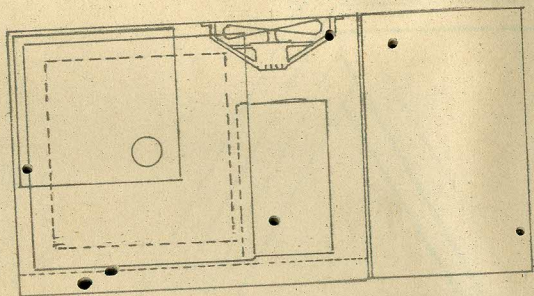
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1	CONTROL PANEL
2	ELECTRODE CAVITY
3	CURRENT LIMITER SW
4	MAIN CABINET

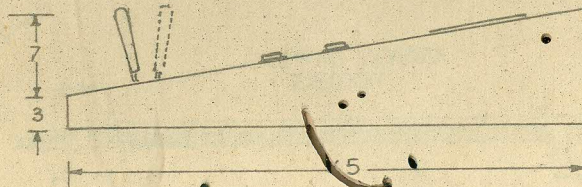
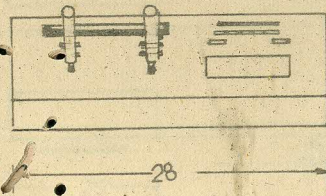
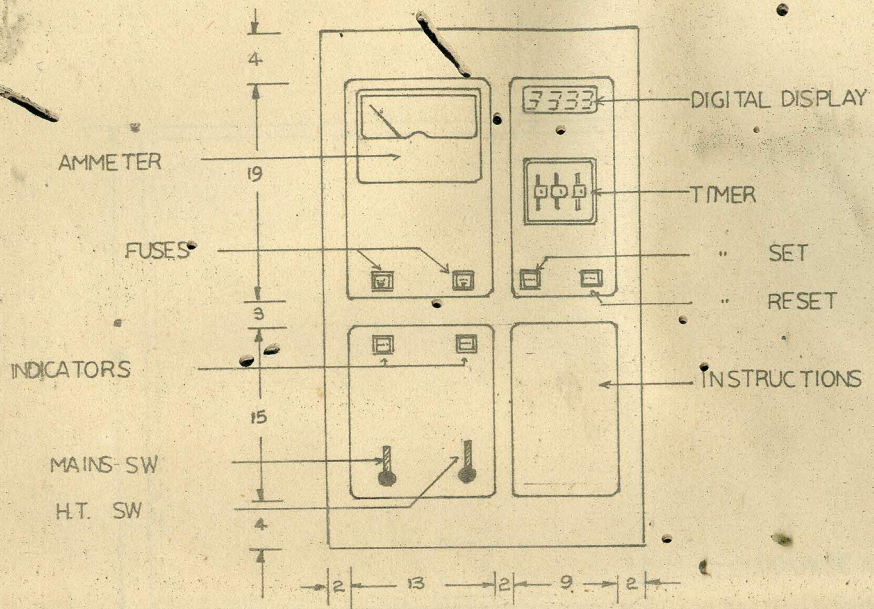
OVERALL DIMENSIONS

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	RESISTANCE TESTER	G.D.V.



COMPONENT PLANNING

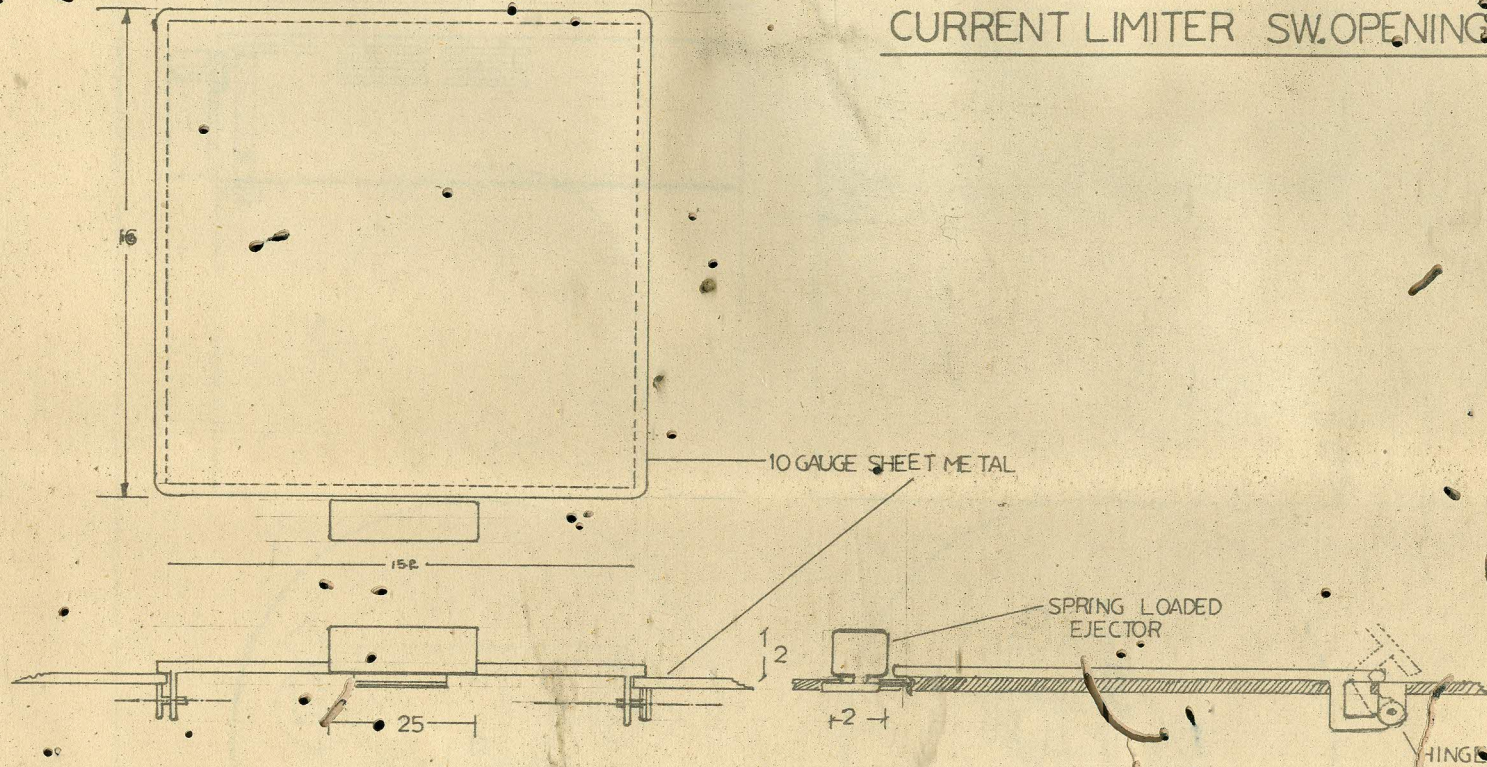
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SCALE	DESIGN OF APC	7627.07	
	RESISTANCE TESTER	G.D.V.	



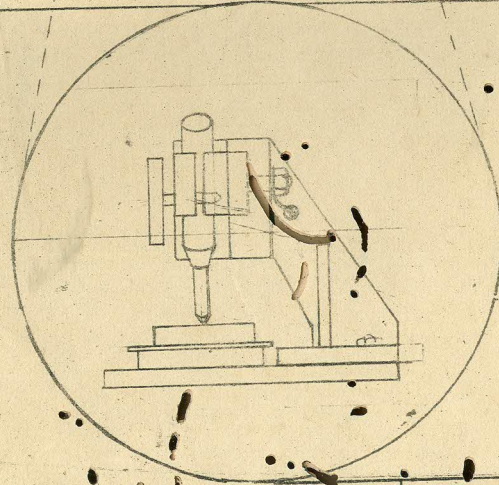
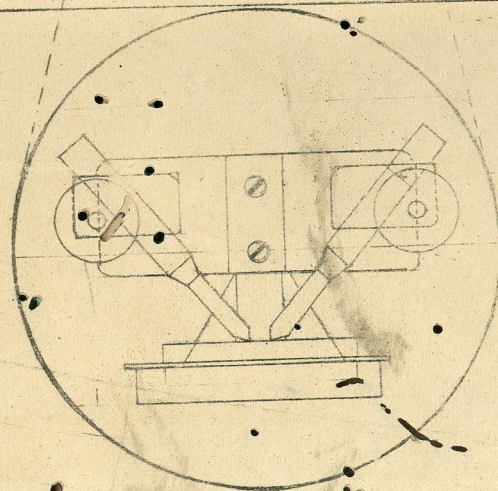
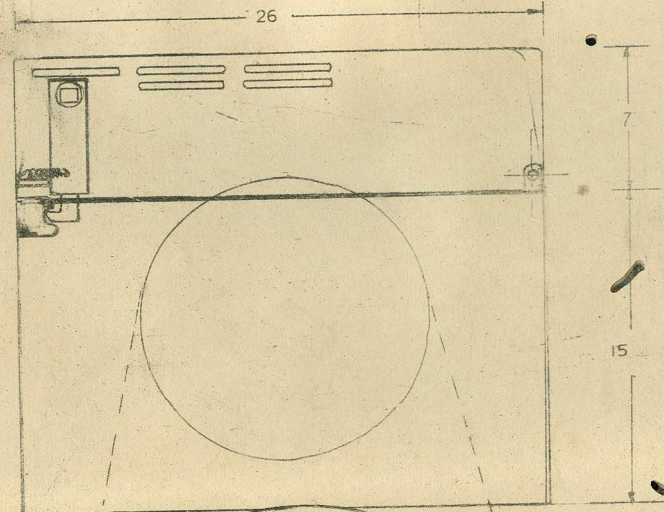
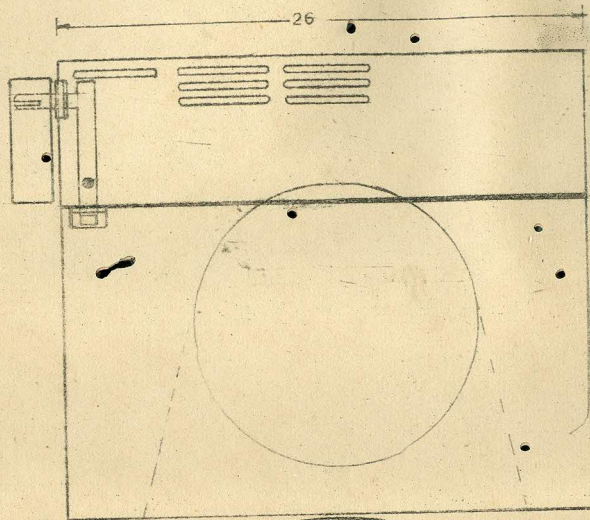
CONTROL PANEL

ALL DIMENSIONS IN CMS.			INDUSTRIAL DESIGN CENTRE
SCALE	DESIGN OF ARC	762707	
	RESISTANCE TESTER	G.D.V.	

CURRENT LIMITER SW. OPENING



ALL DIMENSIONS IN CMS.	INDUSTRIAL DESIGN CENTRE	
SCALE	DESIGN OF APC	762707.
	RESISTANCE TESTER	G.D.V.



ELECTRODES & ITS CAVITY

ALL DIMENSIONS IN CMS		INDUSTRIAL DESIGN CENTRE
SCALE	DESIGN OF ARC	762707
	RESISTANCE TESTER	G.D.V