A Design of the Electrical Laboratory

for

R. E. Olds Hall of Engineering

A Thesis Submitted to

The Faculty of

MICHIGAN AGRICULTURAL COLLEGE

By

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Preface.

In this Thesis the author has endeavored to compile from various sources a set of experiments for both direct and alternating current laboratory work, to list the apparatus required, to lay out the floor plan and distributing system of the laboratory, and to design the test-stands and the switchboards.

In preparing the following set of experiments no attempt was made to go into detail, or to prescribe how the experiment should be conducted. This was left to the discretion of the instructor in charge, who can outline the experiment to suit the existing conditions. However, free use has been made of laboratory text-books, and such trade publications as made possible the compilation of a set of experiments that will acquaint the student with the characteristics of the different kinds of electrical apparatus. From the same sources a list was made of the apparatus necessary to perform each experiment; and the text-books in which a discussion of the experiment may be found were noted for future reference.

In laying out the floor plan and distributing system, illustrations of the electrical laboratories at other institutions and of the one recently destroyed here were referred to freely. The future development of the laboratory was considered in planning the arrangement of the apparatus, so that any change or rearrangement necessary may be easily made without detracting

from the appearance of the laboratory.

In the design of the test-stands, machines saved from the recent fire were measured and manufacturers' bulletins and leaflets have been consulted for the dimensions of the apparatus likely to be used upon them. The faults of the piers used in the former laboratory were considered and an attempt was made to overcome these defects in the design of portable and rigid stands.

In the design of the switchboards reference was made to illustrations of switchboards at other institutions, to the one recently destroyed here and to switchboards in power plants. A wide range and a great flexibility of transmission of current from the power house or current generated in the laboratory was the object in view.

Contents.

Part 1.

A List of Experiments for both Direct and Alternating Current Laboratory Work.

This list is arranged to follow as near as possible the theoretical work taken up in a class room, and at the same time the arrangement is such that the same apparatus is required for the first and for the second five experiments. The experiments towards the end of the list are more for demonstrating to the whole class some special feature or some application of electrical machinery as may from time to time be studied in the class room. The apparatus required for each experiment is listed in order to give the student an idea what he is to work with.

Reference is given to the books in which the student may find a discussion of the experiment by the authors; also where the instructor may find material for outlining the method of procedure of the experiment, and where he may find questions that he may present to the student so as to call attention to some characteristics of the machine that may not be shown experimently.

In performing five experiments at one time twenty to twenty-five students may be in the class. The apparatus required for one laboratory periodis the summation of the apparatus required for five experiments.

List of Experiments for Direct Current Laboratory.

1 A Study of the Switchboard.

2 A Study of the connections and Operation of a Motor Starting Box, and Resistance Measurements of the Various Circuits of a Dynamo Electric Machine.

3 No-Load Characteristics of a Shunt Motor.

4 Load-Speed Characteristics of a Shunt and a Compound Wound Motor.

5 No-Load Characteristics of a Shunt Generator.

6 Brake Test of a Shunt Motor.

7 Distribution of the Magnetic Flux in the Air Gap of a Dynamo Electric Machine.

8 Load-Voltage Characteristics of a Shunt and a Compound Wound Generator.

9 Characteristics of a Series Dynamo Electric Machine.

10 Efficiency of D.C. Machines by Direct and Indirect Methods.

11 A Study of the Three-Wire System.

12 Operation of Shunt and Compound Generators in Parallel.

13 Opposition Method of Testing Two Similar Machines.

14 A Study of the Automatic Battery Booster.

Experiment 1.

A Study of the Switchboard.

The object of this experiment is to study the wiring of the switchboard and its connections to the principal electrical apparatus.

Apparatus:

Switchboard.

Experiment 2.

A Study of the Connections and Operations of a Motor Starting Box, and Resistance Measurements of the Various Circuits of a Dynamo Electric Machine.

The object of this experiment is to study the construction of the most common starting boxes, and the principles of motor starting. Also to measure the resistances of the various circuits of a dynamo electric machine.

Apparatus:

Shunt or Compound Wound Motor.

Starting Boxes.

Ammeter.

Voltmeter.

Reference:

Franklin & Esty, p. 112-116.

Karapetoff, Vol.I, Art. 390-396.

Clewell, p. 26-30.

Experiment 3.

No-Load Characteristics of a Shunt Motor.

The object of this experiment is to study the factors by which the speed of a Shunt Motor may be adjusted or controlled, also to obtain data for the construction of the performance curves of a Shunt Motor operating at no-load.

Apparatus:

- Shunt Motor.
- Starting Box.
- Two Rheostats.
- Ammeter.
- Voltmeter.
- Water Barrel or Lamp Bank.
- Tachometer.

Reference:

- Franklin & Esty, p. 97-99, 101-105.
- Karapetoff, Vol.I, Art. 249-252.
- Clewell, p. 54-58.
- Bedell, p. 27-35.
- Wilson, p. 21-23, 29.

Experiment 4.

Load-Speed Characteristics as of a Shunt and a Compound Wound Motor.

The object of this experiment is to determine the variations of speed with load for the same motor connected up in three ways:- Shunt, Cumulative and Differential.

Apparatus:

Compound Wound Motor.

Shunt Generator.

Starting Box.

Two Rheostats.

Booster-Set.

Water Barrel or Lamp Bank.

Two Ammeters.

Voltmeter.

Tachometer.

Reference:

Franklin & Esty, p.97-99,116-117,123.

Karapetoff, Vol.I, Art.257-261.

Bedell, p.27-38.

Wilson, p. 21-23, 26-27.

Experiment 5.

No-Load Characteristics of a Shunt Generator.

The object of this experiment is to study the factors by which the voltage of a Shunt Generator may be adlusted or controlled. Also to obtain data for the construction of the performance curves of a Shunt Generator when operating at no load.

Apparatus:

- Shunt Generator.
- Shunt Motor.
- Starting Box.
- Rheostat.
- Ammeter.
- Voltmeter.
- Tachometer.

Reference:

- Franklin & Esty, Chap. 4 & 5.
- Karapetoff Vol.I, Art. 223.
- Clewell, p. 33-45.
- Bedell, Exp. 1-B.
- Wilson, p. 9-14.

Experiment 6.

Brake Test of a Shunt Motor.

The object of this experiment is to obtain data by means of a brake test for constructing the performance curves of a Shunt Motor.

Apparatus:

- Shunt Motor.
- Starting Box.
- Rheostat.
- Two Ammeters.
- Voltmeter.
- Tachometer.
- Prony Brake.
- Scales.

Reference:

Karapetoff, Vol.I, Art. 255.

Experiment 7.

Distribution of the Magnetic Flux in the Air Gap of a Dynamo Electric Machine.

The object of this experiment is to determine the Distribution of the Magnetic Flux in the air gap of an electric machine when the armature is running free and when it is loaded.

Apparatus:

Shunt Generator with Template.

Shunt Motor.

Starting Box.

Voltmeter with Pencil Leads.

Lamp Bank.

Rheostat.

Ammeter.

Reference:

Karapetoff, Vol.I, Art. 135-136.

Wilson, Exp. 17.

Caldwell, D-27.

Experiment 8.

Load-Voltage Characteristics of a Shunt and a Compound Wound Generator.

The object of this experiment is to study the factors by which the voltage of a Shunt and a Compound Wound Generator may be adjusted or controlled. Also to obtain data for the construction of the performance curves of the Generators when operating under load.

Apparatus:

Compound Wound Generator,
Variable Speed Motor.
Variable Speed Starting Box.
Two Rheostats.
Two Ammeters.
Voltmeter.
Tachometer.
Water Barrel.

Reference:

Franklin & Esty, p.397-408.
Karapetoff, Vol. I, Art. 221-230.
Bedell, p. 13-26.
Wilson, p. 9-12, 14-19.

Experiment 9.

Characteristics of a Series Dynamo Electric Machine.

The object of this experiment is to study the Series Dynamo and to obtain data for the construction of the performance curves of the machine when operating as a generator and when operating as a motor.

Apparatus:

- Shunt-Series Set.
- Starting Box.
- Rheostat.
- Water Barrel or Lamp Bank.
- Two Ammeters.
- Two Voltmeters.
- Tachometer.

Reference:

- Franklin & Esty, p.78,86,118-123,386-397, p.410-412.
- Karapetoff, Vol.I, Art.249-252.
- Bedell, p.1-9, 39-40.
- Wilson, p.24-36.

Experiment 10.

Efficiency of D.C. Machines by Direct and by Indirect Methods.

The object of this experiment is to determine the efficiency of D.C. Machines by measuring the losses, and by measuring the input and output of the machine.

Apparatus:

- D.C. Motor-Generator Set.
- Starting Box.
- Two Rheostats.
- Three Ammeters.
- Two Voltmeters.
- Water Barrel or Lamp Bank.
- Tachometer.

Reference:

- Franklin & Esty, p. 129-132.
- Karapetoff, Vol.I, Art. 272-277.
- Bedell, Exp. 2-B.
- Wilson, Exp. 12.

Experiment 11.

A Study of the Three-Wire System.

The object of this experiment is to determine the voltage and the current relations in a Three-Wire System.

Apparatus:

Rotary Converter with three balancing coils, or a Balancer Set.

Starting Box.

Rheostat.

Three Ammeters.

Two Voltmeters.

Water Barrel or Lamp Bank.

Reference:

Franklin & Esty, p. 112-113.

Karapetoff, Vol.I, Art. 240-243.

Wilson, Exp. 20.

Experiment 12.

Operation of Shunt and Compound Generators in Parallel.

The object of this experiment is to study the action of two Generators when supplying currect to a common load circuit.

Apparatus:

Two Shunt or Compound Generator Sets.

Two Starting Boxes.

Two Rheostats.

Three Ammeters.

Three Voltmeters.

Water Barrel or Lamp Bank.

Reference:

Franklin & Esty, Art. 86-87.

Karapetoff, Vol.I.,Art. 233-239.

Clewell, p. 70-78.

Wilson, p. 19-21.

Experiment 13.

Opposition Method of Testing Two Similar Machines.

The object of this experiment is to determine the efficiency, regulation, and temperature rise of D.C. Machines by the opposition or pumping back method.

Apparatus:

Motor-Generator Set.

Booster Set.

Three Rheostats.

Two Voltmeters.

Three Ammeters.

Tachometer.

Reference:

Karapetoff, Vol.I, Art. 294-306.

Electrical World, Vol.68, p. 1160.

Experiment 14.

A Study of the Automatic Battery Booster.

The object of this experiment is to study the factors by which the current demand of a fluctuating load is automatically supplied by means of a Battery Booster Set.

Apparatus:

- Generator Set.
- Booster Set.
- Storage Battery.
- Three Ammeters.
- Two Voltmeters.
- Two Rheostats.
- Water Barrel or Lamp Bank.

Reference:

- Franklin & Esty, p. 258-261.
- Karapetoff, Vol.I, Art. 382-384.
- Standard Handbook, Sec. 20, 154-156.

List of Experiments for Alternating Current Laboratory.

1 A Study of Impedance.

2 A Study of Inductance and Capacity in Series.

3 Power Measurement in A.C. Circuits.

4 Voltage Regulation of an A.C. Generator.

5 Efficiency and Regulation of a Constant Potential Transformer from its Losses.

6 Voltage Relations Resulting from Various Transformer Connections.

7 Brake Test of an Induction Motor.

8 Excitation and Impedance Tests on a Three-Phase Induction Motor.

9 Influence of the Excitation of a Synchronous Motor on the Power Factor.

10 A Study of the Single-Phase Commutator Motor.

11 Operation of a Constant Current Regulator.

12 A Study of the Rotary Converter.

13 A Study of an Assynchronous Generator.

14 Operation of Alternators in Parallel.

15 A Study of the Wave Form of Alternating Current.

Experiment 1.

A Study of Impedance.

The object of this experiment is to study the fundamental relations between currents and voltages in alternating circuits containing Resistance and Inductance.

Apparatus:

- Rotary Converter.
- Starting Box.
- Rheostat.
- Inductance Coil with Movable Iron Core.
- Lamp Bank.
- A.C. Ammeter.
- A.C. Voltmeter.
- D.C. Ammeter.
- D.C. Voltmeter.
- Tachometer.

Reference:

- Sheldon & Mason, Chap. 4.
- Karapetoff, Vol. I, Art. 96-108.
- Bedell, p. 111-120.
- Wilson, p. 55-59.

Experiment 3.

Power Measurements in A.C. Circuits.

The object of this experiment is to become familiar with the various methods of measuring power in A.C. Circuits.

Apparatus:

Alternator Set.

Starting Box.

Two Rheostats.

Three Wattmeters.

A.C. Voltmeter.

A.C. Ammeter.

Portable Lamp Banks.

Reference:

Sheldon & Mason, p. 107-113.

Karapetoff, Vol.II, Art. 525-532.

Standard Handbook, Sec. 3, 170-178.

Bedell, p. 226-239.

Experiment 4.

Voltage Regulation of an A.C. Generator.

The object of this experiment is to obtain data for the construction of the saturation curve and the short circuit curve, and for calculation of the voltage regulation of an A.C. Generator by the E.M.F. and by the M.M.F. methods.

Apparatus:

- Alternator Set.
- Starting Box.
- Two Rheostats.
- Three Current Transformers.
- Two A.C. Ammeters.
- A.C. Voltmeter.
- D.C. Ammeter.
- D.C. Voltmeter.
- Tachometer.

Reference:

- Sheldon & Mason, p. 116-124.
- Karapetoff, Vol.II, Art. 572-578.
- Bedell, p. 73-100.
- Wilson, p. 62-65.

Experiment 5.

Efficiency and Regulation of a Constant Potential Transformer from its Losses.

The object of this experiment is to determine the losses of a Constant Potential Transformer from which the efficiency and regulation may be calculated.

Apparatus:

Rotary Converter.
Starting Box.
Rheostat.
Transformers to be Tested.
Two Wattmeters.
Voltage Regulator.
A.C. Ammeter.
A.C. Voltmeter.
D.C. Ammeter.
D.C. Voltmeter.
Tachometer.

Reference:

Sheldon & Mason, Art. 64-65, 67.
Karapetoff, Vol.I, Art. 315-316,
Vol.II, Art. 498-502.
Bedell, p. 93-95.
Wilson, p. 150-175.

Experiment 6.

Voltage Relations Resulting from Various Transformer Connections.

The object of this experiment is to study the various transformer connections and the relation of the voltages produced.

Apparatus:

Motor-Generator Set.

Starting Box.

Two Rheostats.

Bank of 1 to 1 Transformers.

Two A.C. Voltmeters.

Portable Lamp Banks.

Reference:

Sheldon & Mason, Art. 69.

Karapetoff, Vol.II, Art. 539-549.

Standard Handbook,Sec. 6, 132-161.

Wilson, p. 102-108.

Experiment 7.

Brake Test of an Induction Motor.

The object of this experiment is to obtain data by means of a brake test for constructing the performance curves of an Induction Motor.

Apparatus:

- Alternator Set.
- Starting Box.
- Two Rheostats.
- Three Phase Induction Motor.
- Two Voltage Transformers.
- Two Current Transformers.
- Two Wattmeters.
- Two A.C. Ammeters.
- Two A.C. Voltmeters.
- Two Tachometers.
- Prony Brake.
- Scales.

Reference:

- Sheldon & Mason, Art. 75-77.
- Karapetoff, Vol.I, Art. 332-336,342-353.
- Wilson, p. 80-83.

Experiment 8.

Excitation and Impedance Tests on a Three-Phase Induction Motor.

The object of this experiment is to obtain data for constructing the circle diagram of a Three-Phase Induction Motor.

Apparatus:

- Alternator Set.
- Starting Box.
- Two Rheostats.
- Three-Phase Induction Motor.
- Two Current Transformers.
- Two Wattmeters.
- Two A.C. Ammeters.
- A.C. Voltmeter.
- D. C. Ammeter.
- D.C. Voltmeter.
- Tachometer.

Reference:

- Sheldon & Mason, Art. 84-85.
- Karapetoff, Vol.II, Art. 601-614.

Experiment 9.

Influence of the Excitation of a Synchronous Motor on the Power Factor.

The object of this experiment is to study the influence of the excitation of a Synchronous Motor on the power factor, and to obtain data for the construction of the V-curves.

Apparatus:

Rotary Converter.
A.C. Motor-Generator Set.
Two Starting Boxes.
Three Rheostats.
Two Wattmeters.
Two Current Transformers.
Two A.C. Ammeters.
Two A.C. Voltmeters.
Two D.C. Ammeters.
D.C. Voltmeter.
Tachometer.
Water Barrel or Lamp Bank.

Reference:

Sheldon & Mason, Art. 84-85.
Karapetoff, Vol.II, Art. 551-553.
Wilson, p. 72-75.

Experiment 10.

A Study of the Single-Phase Commutator Motor.

The object of this experiment is to study the construction and wiring of a Single-Phase Commutator Motor and its starting box, also to obtain data from which to plot the performance curves.

Apparatus:

- Single-Phase Alternator Set.
- Single-Phase Commutator Motor, with Starting Box.
- Two Rheostats.
- Wattmeter.
- A.C. Ammeter.
- A.C. Voltmeter.
- D.C. Ammeter.
- D.C. Voltmeter.
- Tachometer.
- Prony Brake.
- Scales.

Reference:

- Sheldon & Mason, Art. 98.
- Manufacturer's Instruction Bulletin.
- Caldwell, AM-23.
- Wilson, p. 91-92.

Experiment 11.

Operation of a Constant Current Regulator.

The object of this experiment is to study the operation of a Constant Current Regulator and its uses.

Apparatus:

- Rotary Converter.
- Starting Box.
- Rheostat.
- Constant Current Regulator.
- Two Wattmeters.
- Two A.C. Ammeters.
- Two A.C. Voltmeters.
- Water Barrel or Lamp Bank.

Reference:

- Sheldon & Mason, Art. 72.
- Karapetoff, Vol.I, Art. 213-214.
- Wilson, p. 114-115.

Experiment 12.

A Study of the Rotary Converter.

The object of this experiment is to study the various methods of starting and operating the Rotary Converter, and to obtain data for the construction of the performance curves.

Apparatus:

Rotary Converter.

Starting Box.

Rheostat.

Two Wattmeters.

Two A.C. Ammeters.

A.C. Voltmeter.

D.C. Ammeter.

D.C. Voltmeter.

Tachometer.

Lamp Bank.

Reference:

Sheldon & Mason, p. 105-112.

Karapetoff, Vol.II, Art. 585-595.

Caldwell, Cv-19.

Wilson, p. 76-79.

Experiment 13.

A Study of an Assynchronous Generator.

The object of this experiment is to study the behavior of an Induction Motor when run above synchronism.

Apparatus:

Rotary Converter.

D.C.-Induction Motor Set.

Two Starting Boxes.

Two Rheostats.

Two Wattmeters.

Three A.C. Ammeters.

A. C. Voltmeter.

Portable Lamp Banks.

Tachometer.

Reference:

Franklin & Esty, p. 271.

Wilson, p. 89-91.

Caldwell, A.C.-83.

Experiment 14.

Operation of Alternators in Parallel.

The object of this experiment is to study the methods of connecting two Alternators in parallel, to determine the division of the load between them, and the effect of unequal field excitation.

Apparatus:

Two A.C. Generator Sets.
Two Starting Boxes.
Four Rheostats.
Four Wattmeters.
Three A.C. Ammeters.
Two A.C. Voltmeters.
Water Barrel or Lamp Bank.
Synchronism Indicator.

Reference:

Karapetoff, Vol.I, Art. 327-231.
Caldwell, A-33.
Wilson, p. 69-72.
I.C.S. Hand-Book, p. 261-268.

Experiment 15.

A Study of the Wave Form of Alternating Current.

The object of this experiment is to study the form of the E.M.F. and the current waves of alternating current, and to determine the effects of different types of load on the wave form.

Apparatus:

Oscillograph.
Alternator or Rotary Converter.
Induction Motor.
Inductance Coil.
Transformers.
Condensers.
Two A.C. Ammeters.
Voltmeter.
Starting Box.
Rheostats.
Lamp Banks.

Reference:

Karapetoff, Vol.II, Art. 646-655.
Caldwell, CF-13.
Wilson, p. 122-125.

Part 2.

Apparatus Required for the First 5 Experiments in D.C.Work.

4 Shunt Dynamos.

1 Compound Dynamo.

1 Booster Set.

6 Starting Boxes.

6 Rheostats.

8 Ammeters.

6 Voltmeters.

2 Water Barrels or Lamp Banks.

5 Tachometers.

Apparatus Required for the Second 5 Experiments.

4 Shunt Dynamos.

1 Compound Dynamo.

1 Shunt Series Set.

1 Booster Set.

1 Rotary Converter.

1 Balancer Set.

8 Starting Boxes.

8 Rheostats.

10 Ammeters.

9 Voltmeters.

2 Water Barrels or Lamp Banks.

4 Tachometers.

Apparatus Required for any of the 2 Remaining Experiments.

6 Shunt Dynamos.

1 Booster Set.

5 Starting Boxes.

6 Rheostats.

6 Ammeters.

5 Voltmeters.

2 Water Barrels or Lamp Banks.

2 Tachometers.

Apparatus Required for the First 5 Experiments in A.C. Work.

2 Rotary Converters.

3 Motor-Generator Sets.

5 Starting Boxes.

8 Rheostats.

5 A.C. Ammeters.

5 A.C. Voltmeters.

4 D.C. Ammeters.

4 D.C. Voltmeters.

4 Tachometers.

1 Set Portable Lamp Banks.

1 Inductance Coil with Movable Core.

1 Bank of Condensers.

3 Current Transformers.

Apparatus Required for the Second 5 Experiments.in A.C. Work.

1 Rotary Converter.

2 Motor-Generator Sets.

3 Starting Boxes.

5 Rheostats.

1 Single-Phase Motor-Generator Set.

1 Single-Phase Commutator Motor.

1 Three-Phase Induction Motor.

4 Current Transformers.

2 Voltage Transformers.

5 Wattmeters.

5 A.C. Ammeters.

6 A.C. Voltmeters.

4 D.C. Ammeters.

4 D.C. Voltmeters.

1 Voltage Regulator.

5 Tachometers.

1 Water Barrel or Lamp Bank.

1 Bank of 1 to 1 Transformers.

1 Prony Brake.

1 Pair Scales.

Apparatus Required for any 2 other Experiments.in A.C. Work.

2 Motor-Generator Sets.

2 Rotary Converters.

4 Starting Boxes.

6 Rheostats.

6 Wattmeters.

6 A.C. Ammeters.

4 A.C. Voltmeters.

2 Tachometers.

2 Water Barrels.

2 Lamp Banks.

Part 3.

A List of Machines Saved from the Fire.

Rotary Converters.

Make & No.	H.P..	Volts.	Amps.	R.P.M.	L	W	H
Ws-17587	5	220	19	1200	38	22	10½
W-1 Type S	3	220	13	1800	28	16	8½

D.C. Dynamos.

W-38204	5	125	30	1000	36	21	16
W-209038	2.5	125	15	1800	27	16	7½
W-34655	2	125	12	12000	27	16	7½
W-2 Type S	6	220	25.5	1465	27	18	9½
N-26985	1	220	4.5	400	29	15	7
S-692	1	110	6.8	1230-2020	24	10	5½
W-304096	13Kw	250	52	700	36	34	16
W-304093	10Kw	250	40	750	36	34	16

Induction Motors. 60 Cycle.

G-183030	5	220	13.4	1200	22	15	7½
G-71406	2	220	5	1800	20	18	7½
G-56006	1	220	2.5	1800	17	14	6½
G-2647741	1	110-220	10.4-5.2	1710	20	13	6½

Bases for

S-692					21	9	4 1/8
G183030					21	16	3
G-56006					16	14	4½
G-2647741					17	14	2½

W-Westinghouse, G-General Electric, N-Northern, S-Stow.

Part 4.

A Layout of the Floor Plan and Distributing System of the Laboratory.

The layout, shown on Drawing No.I, is for the two western rooms in the basement of the R.E. Olds Hall of Engineering. The apparatus, test-stands and switchboard are shown arranged in a logical order. The large and fixed machines are arranged along the walls in such a manner that they are well lighted and are accessible for experimental purposes. The test stands are in the center of the rooms where they can be arranged around their respective conduit to suit the conditions of the experiment. Suitable tables having electrical connections with the switchboards are placed near the windows where experiments requiring small apparatus may be performed. A balcony is provided at one end of the A.C. room for the storage battery and all the stationary transformers.

The distributing system is through conduits in the floor and along the walls. The wires to machines on test stands are laid in floor conduits. At a convenient point a tap is made into which a branch may be inserted and lead to the control board of the pair of test-stands. The conduits along the walls contain the wires leading to the fixed machines, to the tables and to other rooms in the building where electrical power may be used for demonstrating or experimenting purposes.

Part 5.

A Design of a Test-Stand with a 5 H.P. Motor-Generator Set upon it.

The test-stands are designed for generator-sets up to 7½ horse power capacity. The legs and cross beams are of 2½x2½x5/16 angles, while the braces and control board frames are of 1x1x3/16 angles. The tops of the stands are of 2 inch hardwood planks. These are of two lengths, 80 and 66 inches long, a width of 27 inches, and 26 inches from the floor.

The control board has a starting box to be used for either machines, two field rheostats, two armature switches with fuses, and a connection panel containing all the leads from the machines and the connections from the switchboard. Connections of the machines are made on the panel by means of short copper wires held between two copper washers by an iron wingnut, The wingnuts facilitate the making of connections and eliminate the use of screw-drivers or pliers. On the control boards of test-stands in the A.C. room, three pole switches with fuses are used for three-phase work.

A design of a test-stand with a 5 H.P. motor-generator set upon it is shown on Drawing No.II.

Part 6.

A Design of the Switchboards for the Laboratory.

Since the laboratory is to be in two separate rooms it is necessary to design a switchboard for each room. The switchboard is the terminal of the leads from all the machines in the room, also for above and adjacent rooms where electric power may be used. The two switchboards are connected so that power generated in the one room may be transferred to the other for distribution. Panels may be added to each switchboard as necessity requires, or they may all be assembled into one unit without interferring with one another or leaving a dead panel. All plug holes on the switchboard are properly labelled.

On the D.C. switchboard are circuit breakers for opening the power house or the storage battery circuit whenever an overload occurs on them. A two pole double throw switch for connecting the storage battery for 62 or for 125 volts is on the panel. D. C. instruments for measuring the current and the voltage of main circuits are also on the switchboard.

On the A.C. switchboard synchronizing switches and a synchronism indicator are provided for operating two or three altinators in parallel. Instruments for measuring the currect and the voltage of the power generated in the room are at the top of one of the panels. A three pole double throw switch for connecting three single-phase currents from one altinator into delta or into star connections.

and a two pole double throw switch to give 110 or 135 volts three-phase A.C. from a transformer are on one of the panels.

The following power is available at the switch-boards;

220 volts D.C. from Power House.
110 " " " 220 and Neutral.
125 " " " Storage Battery.
62 " " " " "
220 " A.C. Three-Phase from Laboratory.
135 " " " " " "
110 " " " " " "
220 " " Single-Phase " "
110 " " " " " "

A design of the switchboards for the laboratory is shown on Drawing No. III.

Pocket has:
Blueprint 1, 2, 3
&
Plans