A SHORT COURSE IN THE TESTING OF ELECTRICAL MACHINERY FOR NON-ELECTRICAL STUDENTS

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88 ILLUSTRATIONS

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PREFACE TO FIRST EDITION

In presenting these brief notes the authors feel that an explanation of their object is necessary. At Columbia University practically all of the engineering students are required to take courses in the electrical laboratories, testing both direct-current and alternating-current machinery. Students in Mining, Mechanical, Metallurgical, Chemical, Civil Engineering, etc., do not have those courses in the theory of electrical machinery, which are really necessary for a proper comprehension of the machines with which they work in the laboratory; it is unreasonable to expect them to consult various text-books to prepare themselves on the theory involved in the tests, and it is with the intention of filling the needs of these men that the notes have been compiled.

Before giving specific directions regarding the test to be performed, a brief analysis of the characteristics of the machine is attempted; in so far as is possible in such a limited space the reasons for the behavior of the machine are given. It is, of course, realized that a complete analysis of the different types of machines is impossible and it is questionable whether a complete analysis would serve the purpose. It has been the intention of the writers to present the subject-matter in such a manner that the student not well versed in electrical theory can get the most out of it in the short time allotted to the electrical courses.

In some of the tests, methods are described which may not be strictly according to the standard practice; if a gain in simplicity and ease of performance is to be obtained by a sacrifice in accuracy of the test of a few tenths of a per cent, it is thought justifiable to use the simpler method of testing.

While the notes are being put into printed form specifically for our use, they may possibly be found of use in other schools where the conditions are similar to those at Columbia.

The authors wish to express their indebtedness to Professor Geo. F. Sever, who first developed the electrical laboratory work for the non-electrical students at Columbia, and whose original schedule of experiments served as a guide in arranging this work; also to Mr. F. L. Mason, who has rendered valuable assistance in the preparation of the book.

J. H. M.
F. W. H.

COLUMBIA UNIVERSITY,
September, 1911.

PREFACE TO THIRD EDITION

IN bringing out the third edition of this manual we have thought it well to expand some of the experiments and to add one on the location of faults in direct-current generators and motors. We have also added many questions which, it is expected, the student will answer in writing his report. The questions have been so selected as to show the main ideas which should have been gained from the work in the laboratory.

J. H. M.
F. W. H.

February 1, 1915.

LIST OF D.C. EXPERIMENTS

1. "Fall of Potential" along a Conductor Carrying Current.
2. Measurement of Armature Circuit and Shunt Field Resistances.
3. The Shunt Generator; Preliminary Work with a Generator. Magnetization Curve; External Characteristic.
4. The Compound Generator; Armature Characteristic of a Shunt Generator; External Characteristic of a Compound Generator; Effect of Operating a Compound Generator at Speeds Higher or Lower than Rated Value.
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6. The Motor Starting Rheostat.
7. Predicted Efficiency of a Shunt Motor by the Stray Power Method.
8. The Series Motor.
9. Current Torque Curves of Different Types of Motors.
10. Parallel Operation of Shunt Generators.
11. Parallel Operation of Compound Generators.
12. Location of Faults in a Direct Current Motor or Generator.

TESTING OF ELECTRICAL MACHINERY

DIRECT CURRENT TESTS

EXPERIMENT I

"Fall of Potential" along a Conductor Carrying Current. (*a*) If an electromotive force is impressed upon a circuit, as for instance a wire, a current of electricity will flow along it. The relation between the current, resistance and difference of potential between any two points on the conductor is given by Ohm's law, which expresses the equality of the impressed force and the reacting force. It is found that the reacting force varies directly with the current and this fact may be expressed by the equation,

$$E = IR$$

from which we obtain,

$$I = E/R, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where I = current flowing in amperes;

E = difference of potential in volts, between the two points considered;

R = resistance of the conductor in ohms, between the two points considered.

It is a fact that all conductors offer more or less resistance to the flow of an electric current and experiment shows that for any particular conductor, the resistance varies directly as its length and inversely as its area of cross-section. This may be expressed in the form of an equation as follows:

$$R = K\frac{l}{a}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$