H. J. S. Heather

Electrical Engineering for Mechanical and Mining Engineers

Published in 1912, this sought after book contains numerous illustrations, 20 lectures and an index. Lectures were written for the Resident Mechanical Engineers in charge of the machinery on the Gold Mines of the Witwatersrand, South Africa.
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- *Continuous Current Dynamos*
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- *Transformers*
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- *Induction Motors*
- *Effects of running under Abnormal Conditions*

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See pictures below.

"The Electrician" Series.

ELECTRICAL ENGINEERING

FOR

MECHANICAL & MINING ENGINEERS.

BY

H. J. S. HEATHER,

B.A. (Oxon.), M.I.C.E., M.I.E.E., &c.

Electrical Engineering

FOR

Mechanical and Mining Engineers.

BEING

A SERIES OF TWENTY LECTURES PREPARED FOR AND DELIVERED TO THE RESIDENT MECHANICAL ENGINEERS OF THE MINES OF THE WITWATERSRAND, SOUTH AFRICA.

BY

H. J. S. HEATHER, B.A. (Oxon.),

LATE MATHEMATICAL SCHOLAR OF BALLIOL COLLEGE, OXFORD; MEMBER OF THE INSTITUTION OF CIVIL ENGINEERS; MEMBER OF THE INSTITUTION OF ELECTRICAL ENGINEERS; MEMBER OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS; LATE EXTERNAL EXAMINER IN ELECTROTECHNICS TO THE UNIVERSITY OF THE CAPE OF GOOD HOPE AND THE SOUTH AFRICAN SCHOOL OF MINES AND TECHNOLOGY.

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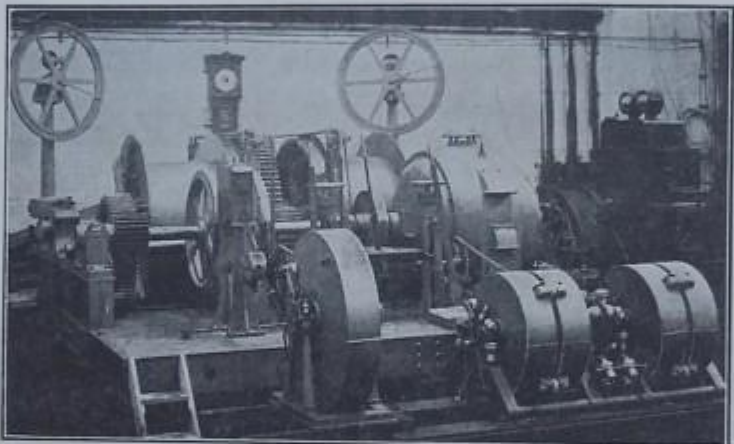

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from a very small suspended mirror is used as a pointer. This has the effect of a very long and sensitive pointer without the objection of large inertia. Owing to this high degree of sensitiveness, they would be difficult to set up in the correct position if the control depended upon the earth's magnetism, and consequently a permanent magnet which can readily be shifted is commonly used as control to get the beam of light into the proper place on the scale.

Of the other controls (e) and (f), gravity and spring, are those generally used for portable and switchboard instruments, in which the galvanometer principle is utilised. The (d) control

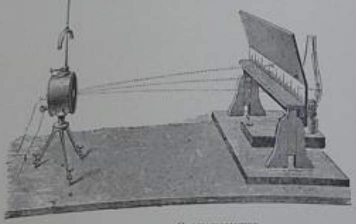

FIG. 41.—REFLECTING GALVANOMETER.

by permanent magnets is also sometimes used in these cases, but its greatest application is for laboratory work.

As regards methods of observation (1) is confined to the laboratory, whilst (2) is that which is almost always used for portable and switchboard instruments.

Voltmeters and Ammeters.

Both voltmeters and ammeters for continuous current work, whenever they are of the electro-magnetic type, are nothing but calibrated galvanometers.

In the case of voltmeters the coil resistance naturally has to

be very high, so as to limit the current flowing to a small amount. If this were not so, when connected across any section of a circuit, they would in themselves consume a large amount of power, which is obviously not desirable. As, moreover, it is the current that passes through the coils that produces the deflection, and it is the volts that we want to read, it is clear that the resistance of the coils is best kept constant in order that we may get a real proportionality between the pressure and the current passing. To keep the resistance constant, whatever the current may be, involves the temperature coefficient being very small. If this is not the case, a correction has to be made.

As these instruments depend upon the action of magnetic fields, it is necessary to take precautions that no external field, due perhaps to the proximity of a dynamo, shall be able to interfere with their accuracy. An iron case is, therefore, often used to act as a magnetic screen, and in order to prevent too rapid oscillations of the pointer some damping arrangement is often employed. The control is generally obtained from the action of gravity or springs, but occasionally from permanent magnets.

For continuous current work, the moving coil, or d'Arsonval, principle is most commonly employed, but for alternating currents an arrangement depending upon the attraction between a coil wound in a solenoidal shape (that is, the ordinary hollow cylinder shape) and a soft iron core is most frequent. This form is, however, liable to the objection that it only gives correct readings when the alternations occur at the frequency for which the instrument is designed. This objection is got over in the usually more expensive dynamometer pattern, using two coils, one fixed and the other movable.

For alternating current voltmeters for high voltages, advantage is often taken of the ease with which alternating pressures can be transformed down from high to low. This gets rid of the danger, both to the instrument itself and to those who have to work with it, of bringing high pressures into the instrument. It also enables a standard form of instrument (that is to say, standard in every respect except that of the scale marked on it) to be used for all voltages. For instance, many manufacturers make all their alternating voltmeter movements uni-

X+A=R+B, the pointer makes an angle of 45 deg. with the last position, and if it is so small that X+A is practically negligible in comparison with R+B, the pointer will lie practically at right angles to its first position.

This is a very elegant practical application of the combination of two magnetic fields into a resultant field, and I would like you to notice that a thorough grasp of the action of the ohmmeter will be of very great assistance to you when we come to deal with polyphase circuits.

QUESTIONS TO BE ANSWERED.

1. How can you best protect apparatus against objectionable magnetic action ?

2. What is the unit current in C.G.S. units, and how is this related to the practical ampere ?

3. Indicate the process by which current affects a magnetic needle.

4. Name some methods of employing this principle in galvanometers.

5. What are the differences in principle and practice between ammeters and voltmeters ?

6. What is the action of the indicating wattmeter ?

7. Do watthour-meters usually employ the same principle ?

8. Give a sketch showing how to connect an ordinary wattmeter in circuit.

9. What is the oscillograph ?

10. Describe the principle of the ohmmeter.

LECTURE VII.

CONTINUOUS CURRENT DYNAMOS.

Rotation of Elementary Loop in a Uniform Magnetic Field—Action of the Simple Commutator—More Detailed Consideration—Magnetisation of Iron—Permeability—Hysteresis—The Magnetic Circuit—Reluctance—Methods of Winding Dynamo Magnets: Series Winding, Shunt Winding and Compound Winding—Characteristics of Series Dynamo—Characteristics of Shunt Dynamo—Characteristics of Compound Dynamo—Questions to be answered.

Rotation of Elementary Loop in a Uniform Magnetic Field.

Suppose we have a steel bar magnet bent up into the shape of a horse-shoe, so that the two ends face one another, as

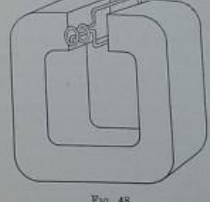

FIG. 48.

shown in Fig. 48. In the space between the two faces is placed a single coil of wire capable of rotating about a centre line parallel to, and midway between, the pole faces. Each end of the coil is brought to a ring, on which bear brushes.