THE CONSTRUCTION OF AN ELECTRIC DYNAMOMETER

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INTRODUCTION

The construction of the instrument here described was selected as a suitable thesis, first, because it afforded an opportunity for the combined application of the manual arts learned during the first two years of the college course and the scientific knowledge acquired during the last two years; and second, because of its usefulness in the laboratory experimental work.

The basic design of the instrument is that used in the construdtion of a laboratory instrument designed and built by Dean H.V. Carpenter and Mr. H. J. Dana of the Engineering Experimental Staff of the State College of Washington. Much valuable assistance was received from Engineering Bulletin no. 15 from that college. This bulletin, which contains a clear description of the instrument, was prepared by the men named above.

I also wish to take this opportunity to express my appreciation to Mr. F. W. Sullinger of the Engineering College for his valuable assistance in the way of furnishing tools and materials which otherwise would have been quite difficult to collect in the time available for the work.

CHAPTER I.

PURPOSE

The purpose of this thesis is the construction of a stationary laboratory instrument for use in measuring small amounts of power, and in checking and calibrating portable instruments, especially of the Alternating Current class. It may, by changing the outside connections, be used to measure difference of potential or currents, but its chief use is as a wattmeter.

There are several advantages in this type of instrument, the main ones being as follows:

I. Freedom from pivots which might become worn or injured by shock.

II. Freedom from springs.

III. Less torque required on the moving element, permitting less current and more resistance in the circuit of the moving element. This reduces the inductance of the circuit.

IV. Removal of the limitations of the scale which may be used.

V. Simple construction and therefore lessened cost.

CHAPTER II.

DETAILS OF CONSTRUCTION

The instrument is designed as a stationary instrument. This does not mean, however, that it is too large or for any other reason cannot be moved, but that it is not to be considered as one of the portable type. This is due to the fact that the instrument requires accurate leveling and adjustment of the telescope.

It is designed on the general principle of the wall-type dynamometer, the underlying principle of which is that when a current is passed through two coils suspended in perpendicular planes, there will be a tendency for the coils to rotate. If one coil is fixed, the other will rotate through an angle which depends upon the current flowing.

In the design all dimensions and wire sizes were arbitrarily selected as the instrument was built primarily for experimental purposes and to be calibrated after completion.

The details of construction are taken up separately in the remainder of this chapter.

THE CASE

The case was constructed of three-quarter inch seasoned cherry and is approximately nineteen and three-quarter inches high, three and one-half inches wide, and two inches deep inside dimensions. The joints were butted, glued, and held by wooden dowel pins.

The front is of one-quarter inch plate glass and slides in grooves from the top. The joints between the glass and wood are made air-tight with felt strips to prevent the effects of air currents.

The case is fastened with dowel pins to a rectangular base of the same material. The use of wooden dowel pins eliminates the possibility of eddy currents and stray fields which might be caused by the use of metal screws or bolts. There is, however, a limited number of screws used in the construction of some of the other parts, but their use is restricted to parts well out of the fields of the coils.

THE MOVING ELEMENT

The coils (A-A') of the moving element are composed of one hundred tuns each of no. 33 Single Silk covered enameled magnet wire. There are two of these coils, approximately ellipsoidal in shape and three-quarters by one-half inch inside dimensions. These are mounted on a mica strip, in the same plane, and with their major axes coinciding with the axis about which the element is to rotate. The centers of these coils are one and seven-eights inches apart and half way between these is mounted in the same plane a one-half inch round mirror (B).

The coils are so connected that the circuit forms a figure eight and the loose ends are soldered to small copper hooks. These hooks are rigidly fastened to the upper end of the mica strip.

The support for the moving element was made as follows, a block (C) $1\frac{1}{2}$"X $3\frac{1}{2}$" X $\frac{3}{4}$" was cut from the three-quarter inch cherry. Through this block two holes were drilled with their centers one-quarter inch apart. These holes are of such size that one-eigth inch rods will slide freely in them. The rods, made of brass are one and three-quarter inches long and pointed on the lower ends. Holes were drilled and springs inserted perpendicular to these rods to prevent any movement except vertically.

These rods are adjustable vertically by means of strips of spring brass (D-D') bent in U-shape and fastened to the lower side of the block. The strips are moved by thumb screws (E-E') with fixed nuts on each side of the strips.

Electrical connection is made between the tops of these rods and binding parts on top of the case by insulated copper wire soldered at both ends. On the lower ends of these rods are soldered copper hooks similar to those on the upper end of the mica strip.

The block is fastened to the back of the case with its large face parallel to the base.

The suspension is of the bifilar type, made of gilt strips, 0.0005 " thick by 0.015 " wide, spaced one-quarter inch apart. These strips are ten inches long and have loops soldered in each end. By means of these loops the suspension strips are fastened to the rods and to the mica strip. These suspension strips also form a part of the moving element circuit.

The lower end of the mica sheet is enlarged and dips into a small cup of oil, thus acting as a damping vane.

Outside resistance is used in the moving element circuit, calculated on the basis of approximately thirty thousand ohms when connected to 110 volt line.

THE STATIONARY COILS

The stationary coils are four in number and consist of twelve turns each of no.14 Single Cotton covered enameled wire. These are wound on wooden blocks (F-F') which fit in holes in the sides of the case and are held by brass bolts and wing nuts. These blocks are concave on the inner ends and are of such size that they fit closely to the moving coils.

The two coils on one side are continuous but wound in opposite directions. Winding these and the moving coils in this manner eliminates the effects of stray fields. The coils are connected to binding posts on the outside of the case.

These coils are replacable by others which may be constructed of different capacity.

THE SCALE AND OPTICAL SYSTEM

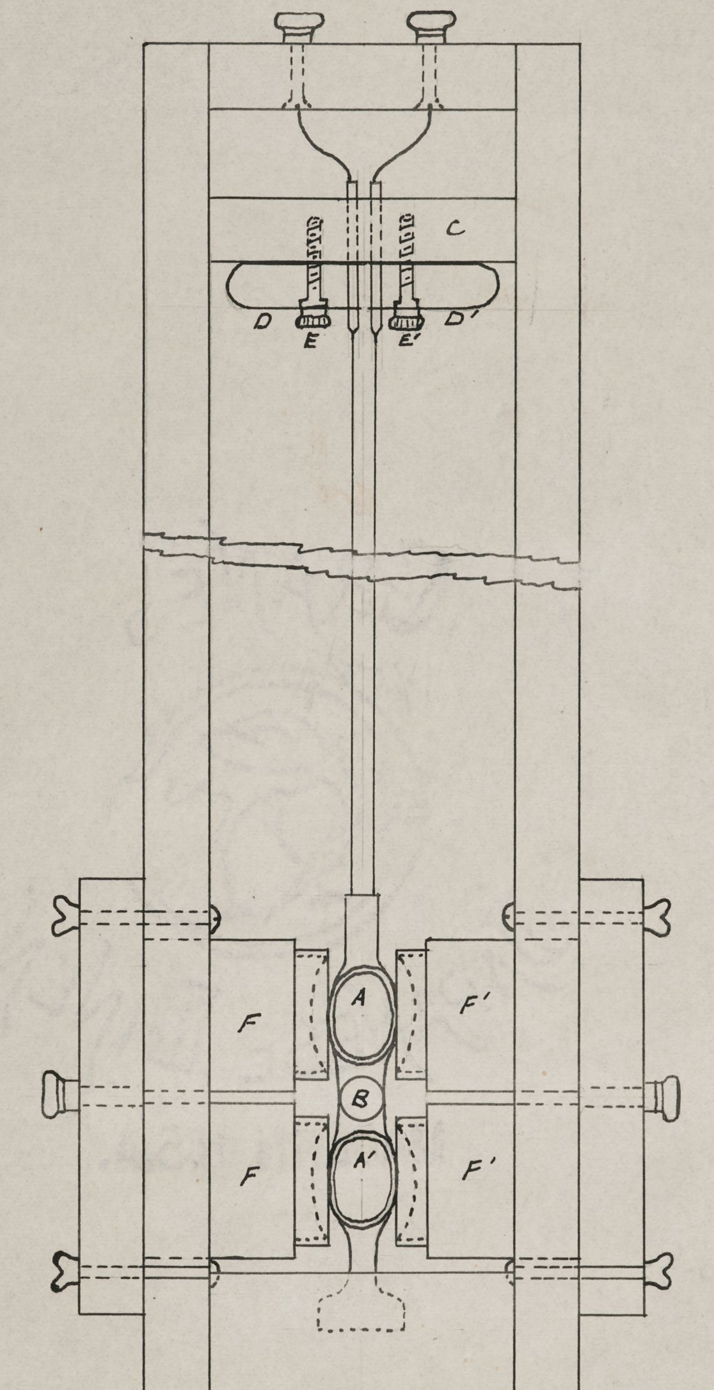
The scale is an ordinary centimeter scale with inverted figures.

The optical system consists of a hair-line telescope mounted on the tripod with the scale. The telescope is focused on the image of the scale as reflected by the mirror (B).

The instrument is to be calibrated and a curve drawn shaving the corresponding values for different scale readings.

The usefulness and convenience of the instrument may be increased by the installation of leveling screws on the base and the construction of other sets of stationary coils.

These things done, we have a very permanent and serviceable instrument which will not be affected by moisture or other climatic conditions and which, when calibrated throughout its range, may be used for many purposes.



Scale - 1/2" = 1"

APPROVAL

The foregoing thesis is hereby approved as a creditable study of an engineering subject, carried out and presented in a manner sufficiently satisfactory to warrant its acceptance as a prerequisite to the degree for which it has been submitted. It is to be understood that by this approval the undersigned does not necessarily endorse or approve any statement made, opinions expressed, or conclusions drawn therein, but approves the thesis only for the purpose for which it is submitted.

Name________________________

Title________________________