A strong magnet is used and it is provided with an adjustable shunt so that the intensity of the field in the air gap can easily be varied over a considerable range.

With the period adjusted to 10 seconds and the field strength adjusted so as to make the external critical resistance 20 ohms the sensitivity is approximately 20 mm. per micro-volt, with the scale at a distance of 1 meter.

As compared with the most sensitive "low resistance" galvanometers on the market, taking the mean of the operating constants of three instruments of different designs, we have, approximately—external critical resistance 65 ohms —period 6 seconds—and sensitivity 2 mm. per micro-volt.

It is probable that further experience with this design will suggest minor changes in the construction.

BUREAU OF STANDARDS,
WASHINGTON, D. C.

THE CONTROL OF THE WAVE-LENGTH-SENSIBILITY CURVES FOR SELENIUM.[1]

BY E. O. DIETERICH.

AN investigation of the conditions governing the shape of the sensibility curves for selenium led to the production of several new types of cells, which may be classified into two general groups; those that have a maximum sensibility for wave-lengths longer than 640 $\mu\mu$, and those that show very little sensitiveness in this region, but have a maximum for wave-lengths shorter than 640 $\mu\mu$. The location of the maximum for the different types produced thus far is as follows: 440 $\mu\mu$, 500 $\mu\mu$, 550 $\mu\mu$, 700 $\mu\mu$, 720 $\mu\mu$, and 800 $\mu\mu$. Those that show a maximum in the red also have a pronounced minimum at 640 $\mu\mu$, and a broad maximum at the shorter wave-lengths. Some, however, have two well-defined maxima; those that have a maximum at 440 $\mu\mu$ also show one at 700 $\mu\mu$ or 720 $\mu\mu$, and a minimum at 640 $\mu\mu$.

The location of the maximum seems to be determined entirely by the method of "annealing" the cells. The samples annealed at 210° C., or higher, all show a maximum below 640 $\mu\mu$, and no maximum at all in the longer wave-lengths. Those annealed at lower temperatures, 180° C., all show a maximum at wave-lengths greater than 640 $\mu\mu$, which is higher than the broad, undefined maximum in the shorter wave-lengths. When the samples are annealed at temperatures between 180° C. and 210° C., the height of the maximum in the red, relative to that in the blue, becomes less and less, until at about 210° C. it disappears. Further work, to determine more accurately the governing conditions, is in progress.

THE PHYSICAL LABORATORY,
STATE UNIVERSITY OF IOWA.

THE TESTING OF POTENTIOMETERS.[1]

BY FRANK WENNER AND ERNEST WEIBEL.

FOR precise measurements with a potentiometer the errors in the adjustment of the resistance sections or coils in the apparatus must be known.

[1] Abstract of a paper presented at the Washington meeting of the Physical Society, April 24–25, 1914. To be published in the Bulletin of the Bureau of Standards and reprinted as Scientific Paper No. 223.

These errors can be determined by measurements of the resistances of the various sections but, without some systematic method of applying corrections, are not easily allowed for, in the use of the potentiometer.

We have found that it is convenient to express the relation between the known electromotive force, the unknown electromotive force, the readings and the corrections by the formula

$$E = f[(e_1 + a_1) + (e_2 + a_2) + \text{etc.}]\,(1 + b + c + d) \qquad (1)$$

where E is the value of the unknown electromotive force

f is the range reading,

e_1 is the reading of the highest dial,

e_2 is the reading of the next highest dial, etc.,

$$c = \frac{S - s}{s},$$

where S is the value of the known electromotive force and s is the reading of the known electromotive force dial or dials, and b, d, a_1 and a_2, etc., are small corrections due to errors in the adjustment of the various resistance sections. The correction a_1 depends only on the reading e_1, a_2 depends only on e_2, etc.,

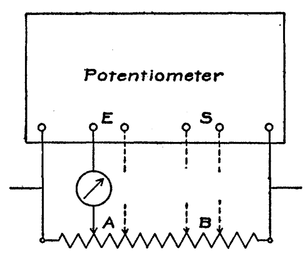

Fig. 1.

b depends only upon the reading s and d depends only upon f. A table can therefore be constructed for each dial giving the corrections corresponding to its various readings.

Let R_e be the resistance in the potentiometer between the E terminals and R_s that between the S terminals. Then if the total current is independent of the settings of the various switches, plugs, etc.,

$$E = SR_e/R_s = f[(e_1 + a_1) + (e_2 + a_2) + \text{etc.}]\,(1 + b + c + d). \qquad (2)$$

Thus if R_e/R_s is determined for the various readings of f, of e, and of s the corrections b, d, a_1, a_2, etc., can be determined.

In order to measure R_e/R_s readily to a reasonably high accuracy, a special piece of apparatus was designed and has been in use during the past two years. This apparatus, which we have designated a "Universal Ratio Set," is equivalent to 211110 resistance coils, of .01 ohm each, connected in series (connection to the terminals of any coil being possible). This is accomplished with 100 coils and 5 dial switches of the usual construction. If this apparatus be connected in parallel with the potentiometer to be tested a Matthiessen Hockin bridge is formed.

Now if for any setting of the potentiometer four balances are made as indicated in the figure we have

$$Re/R_s = A/B \tag{3}$$

The value of A/B is readily determined from the readings and known corrections to the ratio set. If such measurements are made for all settings of each of the dial switches, range switches or plugs, etc., we have data from which all the corrections of equation (1) can be calculated. In use certain adjustments are made (which cannot be explained in a short abstract) such that the calculations are very simple. The apparatus has been found to furnish a rapid and direct means for calibrating any type of potentiometer.

BUREAU OF STANDARDS,
WASHINGTON, D. C.

SOME RECORDS OF THE WIRELESS TIME SIGNALS MADE WITH A PHYSIOLOGICAL RECORDER.[1]

BY C. W. WAGGONER.

THE intensity of the wireless time signals from Arlington, Va., which are received on a small aerial at W. Va. University, led the writer to try a muscle-nerve preparation of a frog and it was found that this preparation responds very well to the stimulus sent from the navy station.

The sciatic nerve was connected to the receiving circuit in place of the high resistance telephones, the gastrocnemius muscle having been attached to a long lever operating over a smoked-drum kymograph. A number of complete five-minute records showing the fatigue of the muscle. Records of the weather reports were made, but the speed was too high to make it possible to follow with this type of recorder.

MORGANTOWN, W. VA.,
March 23, 1914.

AN ELECTROMAGNETIC PUZZLE.[1]

BY F. J. ROGERS.

IF an electric current flows through a long straight tube the return part of the circuit being at a great distance, or still better, symmetrically distributed on opposite sides of the tube, there will be *no magnetic field* inside of the tube at any time whether the current is constant or varying at any rate.

If a wire threads through the tube there will be an induced current in it when the current in the tube varies. This induced E.M.F. is proportional to the length of the tube and is equal (though slightly greater) to the induced E.M.F. in a wire just outside of the tube and very close to it.

This is a case of induction which is evidently not the same as is in mind when a conductor sweeps across lines of magnetic flux or when lines of magnetic flux are thought of as sweeping across a fixed conductor.

[1] Abstract of a paper presented at the Washington meeting of the Physical Society, April 24–25, 1914.