synthesis. Presumably, the genes for converting anthranilic acid or indole into tryptophane have become inactive or have been lost in the course of evolution of insects, as in mammals.

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An Instrument for Use in Measuring Electrical Resistance of the Skin[1]

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For many years, a dermometer designed by Levine (*1*) has been in use in this laboratory to measure the electrical resistance of the skin in a variety of neurological, physiological, and psychological studies. It proved to be very useful in studies on normal and hypnotic sleep, peripheral nerve injuries and spinal cord sections, and in detecting physiological differences between different types of neuroses and psychoses (*3, 4*). Although for most purposes it gave satisfactory service, it has proved over the course of time to have several shortcomings. It does not have a sufficiently wide range, since it gives accurate readings only up to 4½ million ohms and skin resistance may greatly exceed this value in a number of conditions. It is too fragile and delicate to be moved from place to place without danger of damage. And owing to its sensitive construction, it is too expensive for general use.

To overcome these drawbacks, a new instrument (Fig. 1) has been designed that has all of the advantages of the Levine machine, but none of its disadvantages, and in addition has several new features. At the same current used in the Levine instrument (2 μa) it has a range of from 1,000 ohms to 45,000,000 ohms. Within this range it has an accuracy of about 5%. This degree of accuracy suffices for most skin-resistance studies. The new instrument is much more rugged, is smaller (outside dimensions 7 in. × 12 in. × 3 in.), and more readily portable, weighing 9¼ lb as compared to 20 lb.

Fig. 2 gives the wiring plan. The instrument consists essentially of a voltage source (9- and 90-v batteries), a means for varying the voltage applied to the unknown resistance (between any two of the posts marked 1, 2, 3, and 4), a microammeter (A) for measuring the current, and a voltmeter (V) calibrated directly in ohms at 2 μa.

For resistances up to 4.5 megohms the voltage source is a pair of small 4½-v batteries connected in series. When the power switch (S1) is turned on, this voltage is connected across a series combination of two rheostats. One of these, 500 ohms (P1), is used as a fine adjustment, and the other, 15,000 ohms (P2), is used as a coarse adjustment of the voltage applied to the unknown resistance, which is connected between the two variable taps on the rheostats.

The microammeter (A) has a range of 10 μa on either side of zero. Since in measuring the electrical skin resistance a small current sometimes flows before any external voltage is applied, a zero-centered meter allows this resting current to be measured and compensated for regardless of its direction. The microammeter is automatically short-circuited when the power switch (S1) is turned to the "Off" position.

The voltmeter (V) is a 0–1-ma d-c meter having a resistance of about 100 ohms. A three-position lever switch (S4) is used as a range switch connecting the proper resistances (R1 or R2) in series with the meter to give ranges of 0–45,000 ohms (R), 0–450,000 ohms (R × 10), and 0–4.5 megohms (R × 100).

There are four binding posts (1, 2, 3, and 4 in Figs. 1 and 2) for connecting electrodes to the palm and back of each hand (or to any other four locations) and a jack (J) for plugging in the ear clip and roller electrode combination ordinarily used with the neurodermometer for mapping skin-resistance patterns (*2*). A two-pole, six-position rotary switch (S6) connects the jack or various combinations of the binding posts to the measuring circuit. A double-pole, double-throw toggle switch (S5) is provided in order to reverse the polarity of the electrodes and of the jack. The reversing switch and jack are features not included in the Levine instrument.

In order to measure resistances between 4.5 and 45 megohms, two 45-v batteries connected in series are provided. A double-pole, double-throw switch (S3) connects this 90-v battery in place of the 9-v battery, and at the same time connects the necessary resistance (R3) in the voltmeter circuit to enable this high voltage to be read. The range switch (S4) is disconnected when the 90-v battery is used.

If it is desired to measure resistances below 1,000 ohms, a higher measuring current can be used. For example, by using a current of 10 μa, resistances as low as 200 ohms can be measured. Although the electrical skin resistance as measured at 10 μa is not the same as would have been determined if the measurements were made at 2 μa, nevertheless it does give a numerical value which is a good approximation of the 2-μa value. Similarly, for measuring resistances above 45 megohms, lower measuring currents can be used. A double-pole, double-throw switch (S2) disconnects the internal microammeter, connecting in its stead two binding posts on the panel to which an

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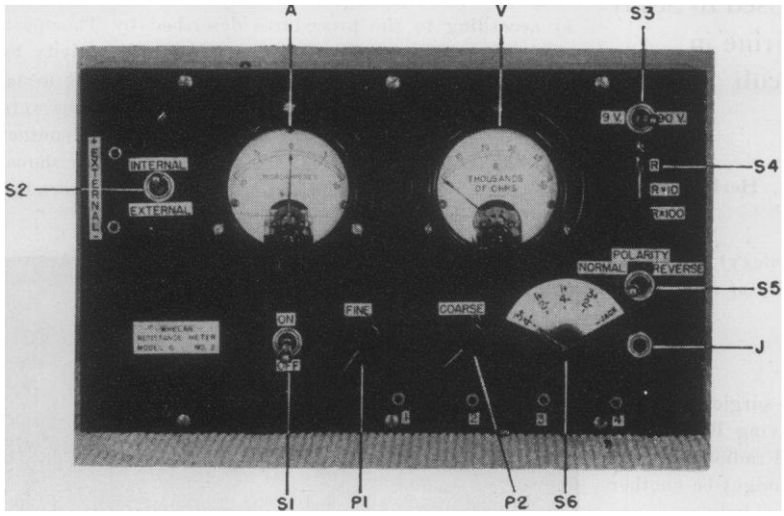

FIG. 1. Photograph of dermometer.

external meter can be connected. If a galvanometer with a range of 0.1 μa is used, resistance up to 900 megohms can be measured. One must exercise caution in comparing such readings with others taken at 2 μa, as the electrical skin resistance varies markedly with the measuring current, especially at low values of the current (*6*).

The operation of the instrument is simple. When not in use the power switch (S1) should be turned to the "Off" position, the range switch (S4) should be in the "R × 100" position, the "Coarse" and "Fine" adjustment knobs should be turned to their extreme counterclockwise position, and the voltage switch should be turned to the "9 volt" position. Before turning on the instrument, from two to four electrodes should be placed on the patient and connected to the binding posts at the bottom of the instrument panel, or if the mapping electrodes are used, the ear clip should be placed on the patient and the plug inserted in the jack in the instrument panel. The power switch (S1) is then turned on, and the "Coarse" and "Fine" adjustment knobs are turned until the microammeter reads 2 μa. If the voltmeter reads between 4,500 and 45,000 ohms, this reading multiplied by 100 is the value of resistance being measured. If the reading is below 4,500 ohms, the range switch (S4) should be moved to the "R × 10" position and the current reset to 2 μa. If the reading is now between 4,500 and 45,000 ohms, this reading multiplied by 10 is the value of resistance being measured. If the reading is still below 4,500 ohms, the range switch (S4) should be moved to the "R" position and the current reset to 2 μa. The voltmeter now reads directly the true value of resistance being measured. If originally it was impossible to raise the current as high as 2 μa with the range switch set on "R × 100," the "Coarse" and "Fine" adjustment knobs should be turned back (counterclockwise), the voltage switch (S3) turned to the "90 volt" position, and the "Coarse" and "Fine" adjustment knobs reset to give 2 μa. The true resistance reading is then the voltmeter reading multiplied by 1,000.

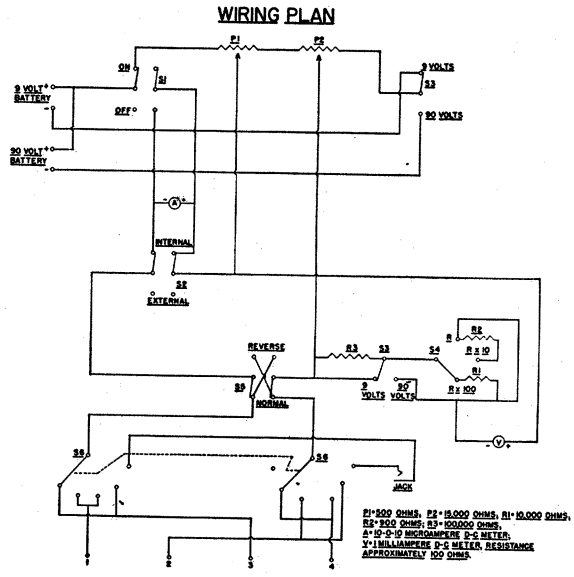

FIG. 2. Wiring plan of dermometer.

Several of these instruments have been in use for some time in this laboratory to measure the effects produced by sympathectomy, by section of peripheral nerves, by natural sleep and sleep produced by drugs, by circulatory disturbances (either those seen in arteriosclerosis or in those produced experimentally in animals), and by cold or warm temperatures. They have also been used to measure healing times of wounds produced by skin punctures, burns, and other lesions (*5*).

They have been used in place of the regular mapping dermometer to outline areas of skin that become sympathectomized by peripheral nerve injuries or spinal cord lesions; also to outline areas of skin that show altered functions in various types of peripheral vascular diseases.

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