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A. ZELENY.

GALVANOMETER.

Application filed Jan. 20, 1902.

(No Model.)

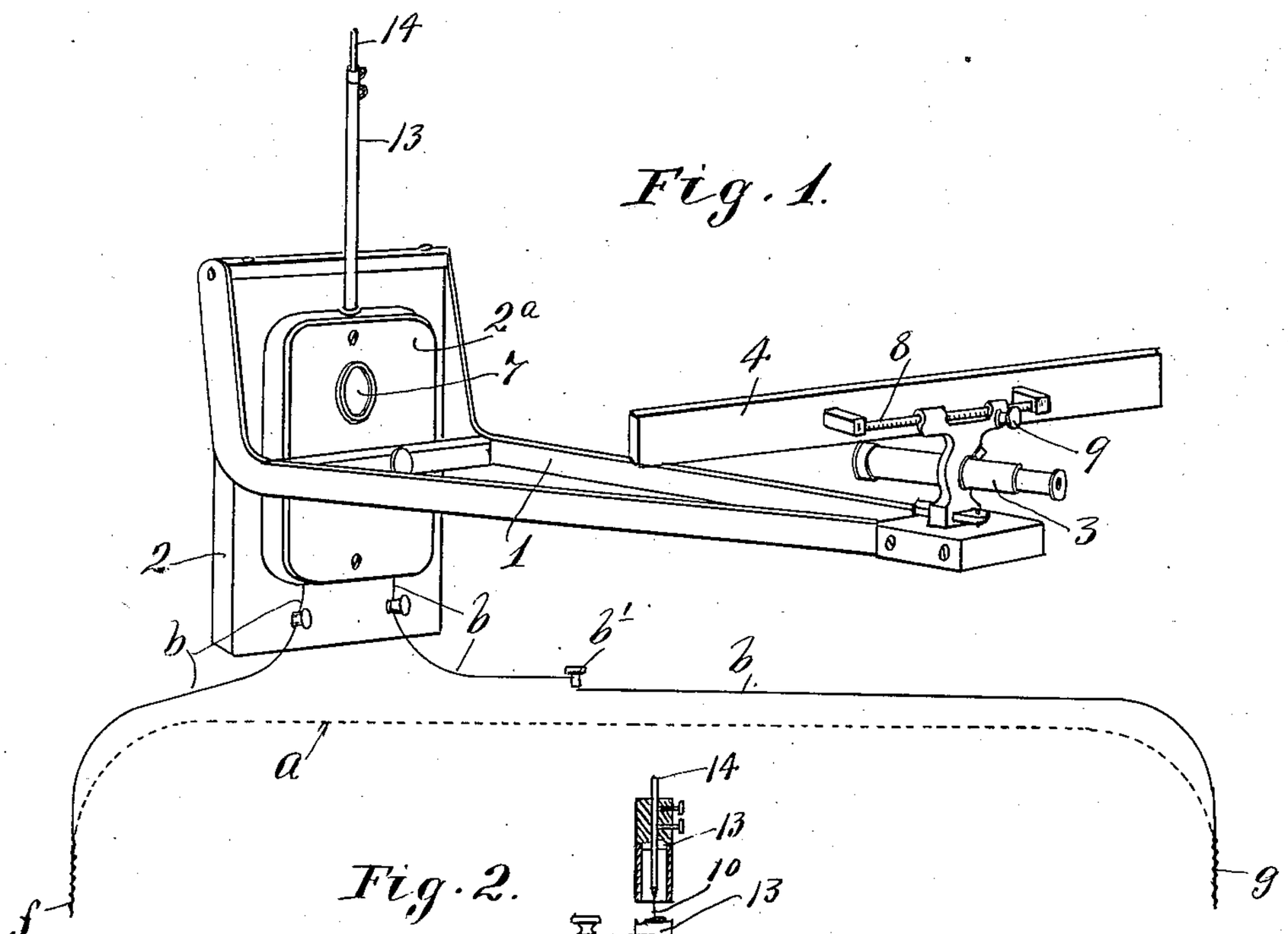

Fig. 1.

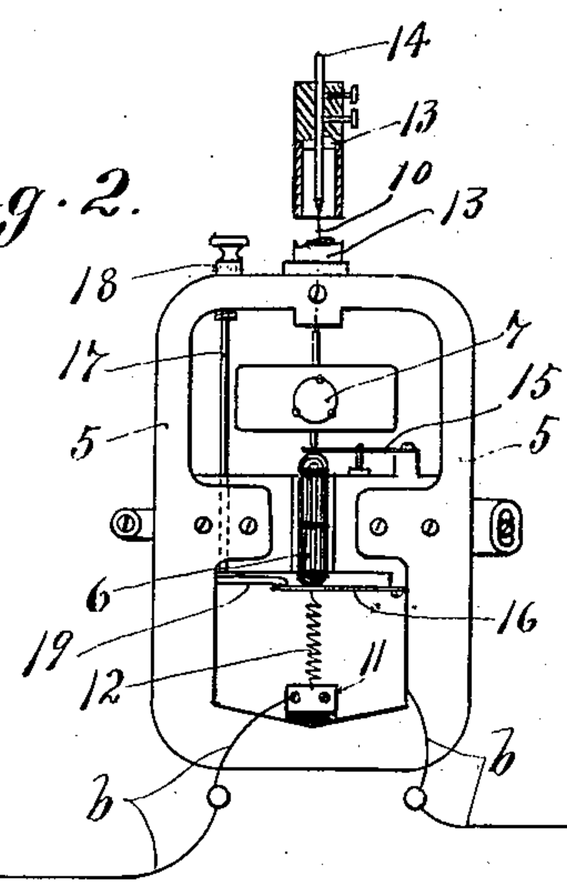

Fig. 2.

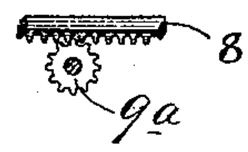

Fig. 4.

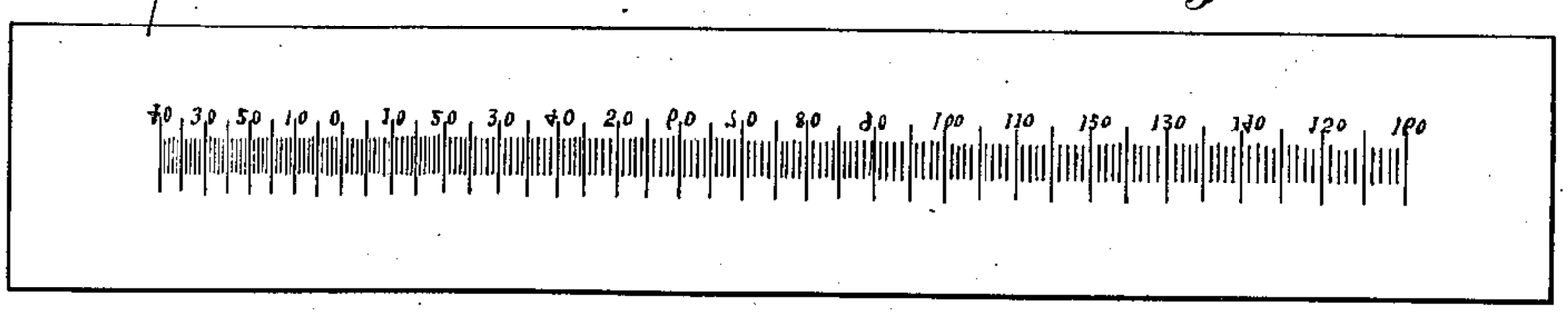

Fig. 3.

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UNITED STATES PATENT OFFICE.

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GALVANOMETER.

SPECIFICATION forming part of Letters Patent No. 705,186, dated July 22, 1902.

Application filed January 20, 1902. Serial No. 90,401. (No model.)

To all whom it may concern:

Be it known that I, ANTHONY ZELENY, a citizen of the United States, residing at Minneapolis, in the county of Hennepin and State of Minnesota, have invented certain new and useful Improvements in Galvanometers; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My present invention has for its object to provide an improved galvanometer for use in connection with thermo-electric couples or circuits, and is particularly directed to the improvement of the galvanometer-scale whereby the temperature of the opposing or so-called "unknown-temperature junction" will be directly indicated on the scale in degrees, fractions, or multiples thereof.

To the above ends the invention consists of the novel devices and combinations of devices hereinafter described, and defined in the claims.

I will first describe my invention as applied to what is known to the trade as the "Rowland D'Arsonval galvanometer."

The application of the device as above stated is illustrated in the accompanying drawings, wherein like characters indicate like parts throughout the several views.

Figure 1 is a perspective view of a galvanometer of the type above indicated, the thermo-electric couple being indicated in diagram. Fig. 2 is a detail view, in front elevation, with some parts sectioned and others broken away, showing the interior mechanism of a galvanometer. Fig. 3 is a face view of the improved scale, and Fig. 4 is a detail in front elevation showing the pinion and a portion of the coöperating rack for adjusting the scale-bar.

Of the ordinary parts of the galvanometer the numeral 1 indicates the telescope-support, the numeral 2 the base-plate, the numeral 3 the telescope, the numeral 4 the adjustable scale-bar, the numeral 5 the permanent magnet, the numeral 6 the needle-coil, the character 2^a an inclosing case, and the numeral 7 the indicating-mirror, which mirror is oscillated by said needle-coil. The scale-bar 4 is made adjustable in the ordinary way by means of a rack 8 and a thumb-piece 9, which thumb-piece is provided with a pinion 9^a, meshing with the teeth of said rack, as shown in Fig. 4.

The thermo-electric couple or circuit illustrated will be assumed to be afforded by a German-silver wire *a* and copper wires *b*, which wires are united to form thermo-electric junctions *f* and *g*. The junction *f* will be treated as the known-temperature junction and the junction *g* as the opposing or unknown-temperature junction. In one of the copper wires *b* there is, as shown, a switch-key *b'*. The extended end of one of the copper wires *b* is shown as connected to the permanent magnet 5 and from thence through the needle-supporting fiber 10 with the upper terminal of the needle-coil 6. The extended end of the other copper wire *b* is shown as connected to an insulated contact-piece 11 and from thence through a coiled conductor 12 with the lower terminal of the said coil 6.

The numeral 13 indicates a tubular support secured at its lower end to the permanent magnet 5 and provided with an adjusting-rod 14, to which, as shown, the upper end of the fiber 10 is secured.

The numerals 15 and 16 indicate, respectively, the relatively fixed and movable members of a pair of clamping-springs for securing the needle-coil 6 against movements when the instrument is being transported.

The numeral 17 indicates an adjusting-rod shown as guided by the magnet 5 and subject to an adjusting-nut 18 and provided at its lower end with a finger 19, attached to the free end of the clamp 16. When the rod 17 is drawn upward by the nut 18, it will clamp the needle-coil 6 against the clamp 15.

With almost all combinations of metals which may be used in the thermo-electric couple one degree variation of temperature at high temperatures will give either a materially greater or materially less flow of current than will the same variation of temperature at low temperatures. To illustrate by concrete example, with a thermo-electric couple composed of copper and German silver one degree of variation of temperature between the thermo-electric junctions when the said junctions are respectively 99° and

100° will produce a very much greater current, and consequently greater deflection of the galvanometer indicator or needle, than will be produced by the same variation in temperature when the said junctions have respectively the temperatures of 9° and 10°. To meet these conditions, I provide a scale which is proportionately graduated and in which any particular division thereof is equal to the deflection produced by the current when the temperatures of the two opposing junctions are respectively those indicated by the bounding-lines of the particular division. Such a scale is illustrated in Fig. 3. On this scale the graduations are made in degrees, and as the scale illustrated is to be used in connection with a reading-telescope and mirror the numbering of the scale is reversed, so as to appear natural when reflected from the galvanometer-mirror and seen through the telescope.

The principles involved in the construction of the scale and the relations thereof to the other parts of the galvanometer and to the thermo-electric couple will be made further apparent by a description of the operation.

We will assume for illustration that the known temperature of the junction *f* is found to be 80°. Hence while the circuit is broken the scale will be adjusted until its graduation-mark "80" is caused to coincide with the cross-hair of the telescope. The circuit is then closed by the key *b'* or other device, and the current which will then flow, due to the difference in temperature between the two junctions *f* and *g*, will cause such a deflection of the indicating-mirror as will indicate in degrees on the scale the temperature of the said opposing junction *g*. Otherwise stated, if the cross-hair line of the telescope is caused to coincide with the graduation indicating 60° on the scale then the reader will know that 60° is the temperature at the said junction *g*.

As a general statement it may be said that while the circuit is open the scale is always adjusted until the scale graduation corresponding to the temperature of the known-temperature junction *f* is caused to coincide with the cross-hair of the telescope, and the circuit being closed the deflection will indicate the temperature of the unknown or opposing junction *g*.

As already indicated, different combinations of metals may be used to form the thermo-electric couples. If copper and iron are used, a variation in deflection at different temperatures will be obtained which is approximately reverse to that obtained by the use of copper and German silver. On the other hand, by the use of German silver and iron an approximately uniform scale may be used, inasmuch as a given variation in temperature at high or low temperatures produces approximately the same current. It thus becomes apparent that the scale for any particular combination of metals must be precalculated and proportioned to the deflections which will be produced by given variations in temperature.

It will of course be understood that scales designed in accordance with my invention, as above set forth, may be applied to various forms of galvanometers, ammeters, voltmeters, electrometers, and similar reading instruments. In fact, the term "galvanometer" is herein used in a very broad sense and is intended to include all such instruments.

The term "indicator" is herein used in a broad sense and is intended to include pointers, reflectors, and other devices which serve as an index or to give a reading on the galvanometer-scale.

What I claim, and desire to secure by Letters Patent of the United States, is as follows:

1. The combination with a thermo-electric couple, of a galvanometer having a reading-scale graduated in degrees of temperature and set, when the circuit is open, so as to indicate the temperature of the "known-temperature junction," whereby, when the circuit is closed, the temperature of the opposing junction will be directly indicated, in degrees, on said scale.

2. The combination with a thermo-electric couple, of a galvanometer having a reading-scale and an indicator, one of which is adjustable with respect to the other, and which scale is graduated in degrees of temperature and, by said adjustment, is adapted to be set, when the circuit is open, to indicate the temperature of the "known-temperature junction," whereby, when the circuit is closed, the temperature of the opposing junction will be directly indicated, in degrees, on said scale.

3. The combination with a thermo-electric couple, of a galvanometer having a reading-scale variably graduated, each division thereof being equal to the deflection produced when the temperatures of the two opposing junctions are, respectively, those indicated by the numbers at the bounding-lines of that particular division, or by the numbers that said bounding-lines represent.

4. The combination with a thermo-electric couple, of a galvanometer having a reading-scale graduated in degrees of temperature, each division thereof being equal to the deflection produced when the temperatures of the two opposing junctions are, respectively, those indicated by the numbers at the bounding-lines of that particular division, or by the numbers that said bounding-lines represent.

5. The combination with a thermo-electric couple, of a galvanometer having a reading-scale variably graduated in degrees of temperature, each division thereof being equal to the deflection produced when the temperatures of the two opposing junctions are, re-

spectively, those indicated by the numbers at the bounding-lines of that particular division, or by the numbers that said bounding-lines represent, whereby the said scale being set, when the circuit is open, to indicate the temperature of the "known-temperature junction," the temperature of the opposing junction will be directly indicated, in degrees, on said scale, when the circuit is closed.

In testimony whereof I affix my signature in presence of two witnesses.

ANTHONY ZELENY.

Witnesses:

ELIZABETH KELIHER,

F. D. MERCHANT.