No. 877,251. PATENTED JAN. 21, 1908.

W. J. STILL.

ELECTRICAL MEASURING INSTRUMENT.

APPLICATION FILED JUNE 23, 1905.

2 SHEETS—SHEET 1.

Fig. 1.

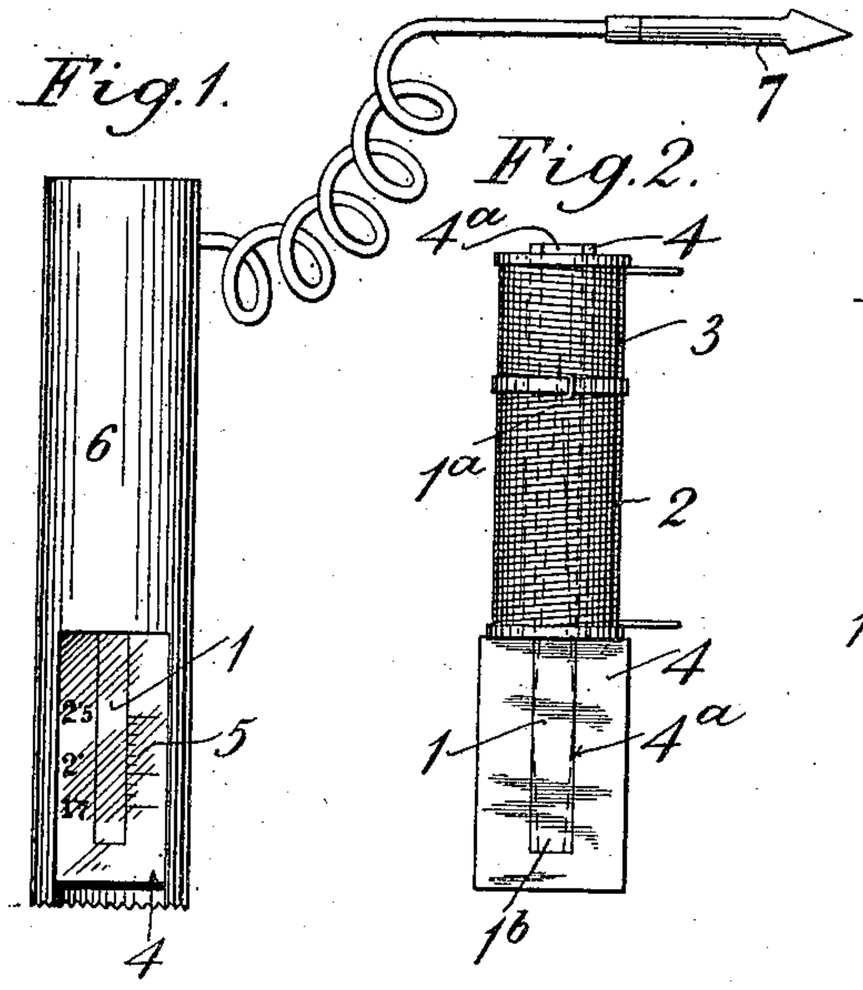


Fig. 2.

Fig. 3.

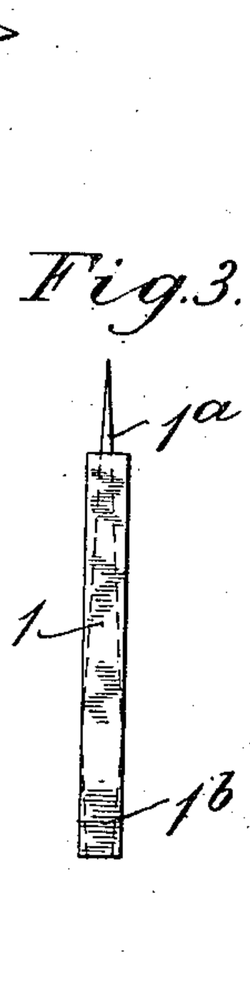


Fig. 4.

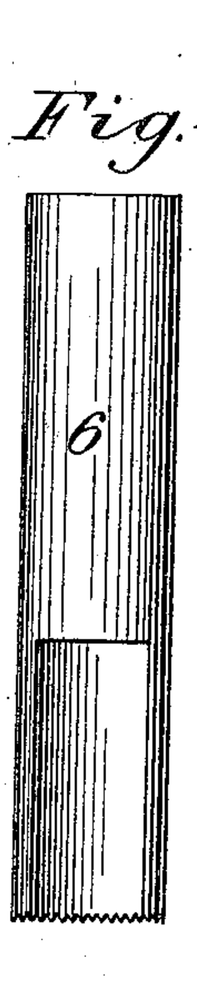


Fig. 5.

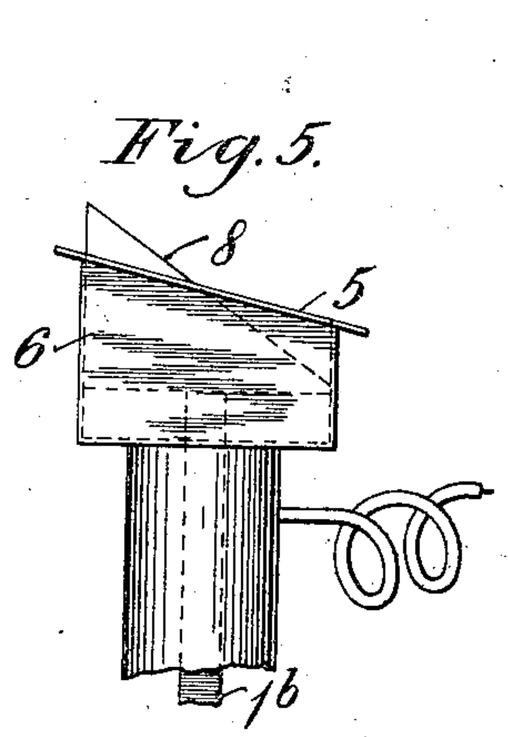
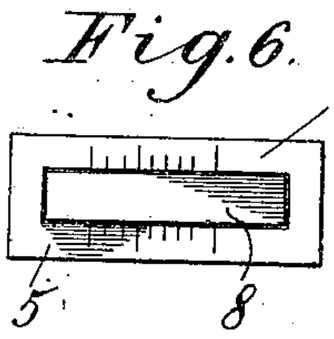


Fig. 6.



Witnesses

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ELECTRICAL MEASURING INSTRUMENT.

APPLICATION FILED JUNE 23, 1905.

2 SHEETS—SHEET 2.

Fig. 8.

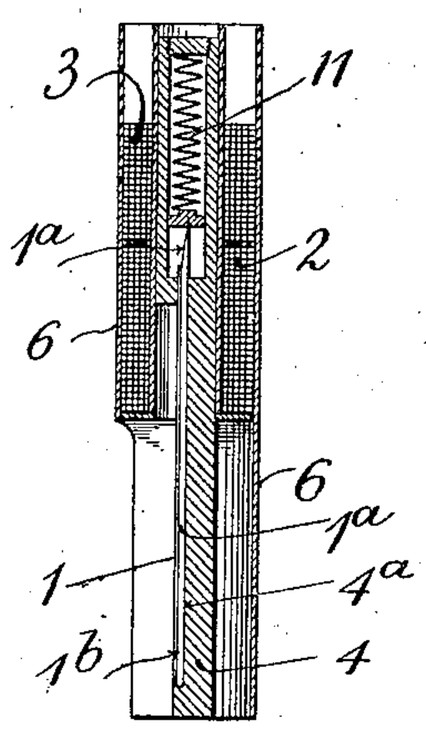


Fig. 9.

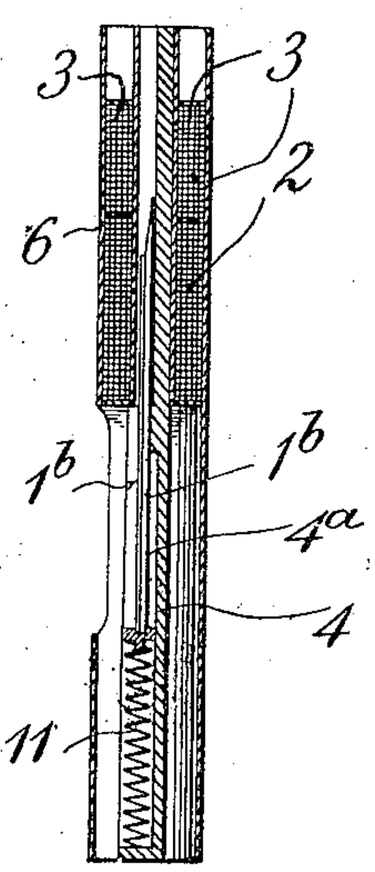
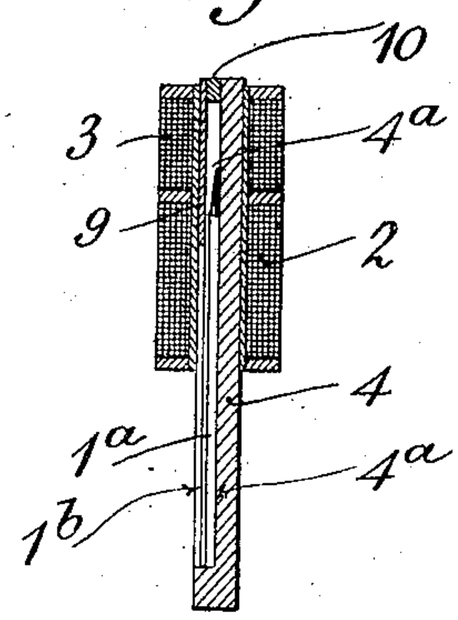


Fig. 7.



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UNITED STATES PATENT OFFICE.

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ELECTRICAL MEASURING INSTRUMENT.

No. 877,251. Specification of Letters Patent. Patented Jan. 21, 1908.

Application filed June 23, 1905. Serial No. 266,619.

To all whom it may concern:

Be it known that I, WILLIAM JOSEPH STILL, a subject of the King of Great Britain and Ireland, residing at Ealing, in the county of Middlesex, England, have invented Improvements in Electrical Measuring Instruments, of which the following is a specification.

The construction of electrical measuring instruments according to this invention will be described with the aid of the accompanying illustrative drawings, whereof

Figures 1 to 4 inclusive represent by way of example a pocket instrument, Fig. 1 being an elevation of the complete instrument, Fig. 2 an elevation of the instrument as it appears after the removal of the external casing, Fig. 3 an elevation of the armature, and Fig. 4 an elevation of the casing alone, while Figs. 5 and 6 illustrate a modification that may be made therein. Figs. 7, 8 and 9 respectively illustrate three other modifications that may be made therein.

The instrument comprises an armature 1 which, as shown in Fig. 3, is composed of two metal portions, namely a portion 1^a of a magnetic, and a portion 1^b of a non-magnetic, nature, secured together, as for example by soldering, or by means of other suitable adhesive. The relative weights of the portions 1^a and 1^b depend upon the work that the instrument is desired to perform.

The armature is operated, and has its movement regulated, by two coils 2 and 3 wound in opposition to each other, and it is acted upon in a varying ratio by the two coils during its movement. To insure this varying relative action of the coils upon the armature, the arrangement of the coils and the armature when no current is passing through is, as shown in Fig. 2, such that while the magnetic portion 1^a of the armature extends upwards only a short distance into the upper coil 3 it extends downwards through and beyond the lower coil 2 so that when the armature is raised by the passage of current through the coil 2 the resistance to its rise offered by the coil 3 gradually increases until the force tending to raise the armature and exerted by the coil 2 is balanced by the weight of the armature plus the force of the coil 3; and any increase in the value of the current passing through the coil 2 raises the armature until a similar balance is produced with the armature in a higher position by the equalization of the increase of the force exerted by the coil 3 to that of the force exerted by the coil 2 owing to the increase of the amount of the portion 1^a of the armature projecting into the coil 3, the ratio of the force exerted by the coil 2 to that exerted by the coil 3 thus decreasing with the rise of the armature conseqeunt upon increase in the value of the current.

I find that if the cross section of the magnetic portion of the armature be reduced towards each end, as shown in Figs. 2 and 3, the scale employed may be uniformly divided; the upper taper is the more important and the longer, the lower taper affecting only the upper portion of the movement of the armature so that in many cases it may be omitted.

By properly proportioning the magnetic and non-magnetic materials employed, the armature can be caused to remain unmoved at the bottom of the scale until the current has reached its lowest normal condition, and thus the whole of the scale can be usefully employed on the amount of variation that it is desired to read.

In the pocket instrument shown, the armature 1 slides in a plate 4 which has a vertical groove 4^a fitting the armature and round which the coils 2 and 3 are wound; the scale 5 is attached to the plate 4.

The whole is inclosed in a metal tube 6 (Fig. 4) which is electrically connected to the coil 2 and forms one terminal of the instrument, and the lower edge of which is preferably serrated to facilitate the making of a good connection with, say, one terminal of a battery the electromotive force of which is to be measured; the other terminal 7 of the instrument is formed by a conductor electrically connected to the coil 3, the two coils 2 and 3 being in series with each other. The strength of the current flowing through the coils, or the electromotive force between the two terminals of a source of electric energy to which the terminals of the instrument are connected, can be read off by noting the position of the lower edge of the armature relative to the indication marks on the scale 5. To enable the reading to be readily made the front of the armature may be colored.

When it is necessary to read such an instrument from above or below its level, a vane and a scale inclined to each other can be used, and the readings taken at their intersection. Figs. 5 and 6 are respectively

a side elevation and a plan illustrating the modification of an instrument in this manner to enable it to be read from above, the vane 8 being carried by an extension of the non-magnetic portion 1^b of the armature and the scale 5 being attached to the top of a correspondingly formed casing 6. Obviously, the instrument can be similarly modified to enable it to be read from below.

Where a long range of reading is required, extending from zero or near zero, to the maximum, it can be obtained by an auxiliary spring control that will tend to restrain or to accelerate the lifting action of the coil; the former will be most accurate on low and the latter on high readings. Such control may be effected by a single compression spring 11 located above the armature 1 as shown in Fig. 8 for low readings, or located below the armature for high readings as shown in Fig. 9. Or, assuming the springs 11 to be in tension, Fig. 8 would represent the arrangement for high readings and Fig. 9 that for low readings respectively

The groove may advantageously be covered and plugged at the portion at and near the end towards which the armature is moved by increase of current value, or at both ends, so as to form a tube or pocket and make the action of the armature dead beat. Fig. 7 is a view illustrating in vertical section an instrument so modified; the front of the groove 4^a is covered by a plate 9 at its upper end, and is closed by a plug 10 so as to form of the upper portion of the groove 4^a a tube or pocket, in which the part 1^b of the armature fits to produce a dashpot and consequently a dead-beat action of the armature.

In the case of an instrument intended to be used for a purpose such as that of testing the electromotive force of a battery, it is advantageous to make the resistance of the coils 2 and 3 approximately equal to that under which the battery is normally discharged; if the resistance of the instrument were greater than the normal resistance under which the battery works, as is usually the case with potential-measuring instruments, the indication would be liable to be inaccurate.

What I claim is:—

1. An electrical measuring instrument comprising a movable armature and two stationary opposing coils arranged to be traversed in common by the current to be measured and arranged in axial alinement with like poles in close proximity to each other so that a portion of the armature while normally wholly influenced by one coil is only partially influenced by the other whereby the resistance to its movement within the last named coil gradually increases with such movement.

2. An electrical measuring instrument comprising an armature, two coils adapted when traversed by a current to act in opposition to each other upon said armature in varying ratio according to the position thereof and so to raise said armature into a position which is indicative of the value of said current and in which the difference between the forces of the two coils will just support said armature, and a body formed with a groove in which said armature is adapted to slide under the action of said coils.

3. An electrical measuring instrument comprising an armature, two coils adapted when traversed by a current to act in opposition to each other upon said armature in varying ratio according to the position thereof and so to raise said armature into a position which is indicative of the value of said current and in which the difference between the forces of the two coils will just support said armature, and a body around which said coils are placed and which is formed with a groove in which said armature is adapted to slide under the action of said coils.

4. An electrical measuring instrument comprising an armature and two coils adapted when traversed by a current to act in opposition to each other upon said armature in varying ratio according to the position thereof and so to raise said armature into a position which is indicative of the value of said current and in which the difference between the forces of the two coils will just support said armature, said armature being composed partly of magnetic metal movable within said coils and partly of non-magnetic material.

5. An electrical measuring instrument comprising an armature and two coils adapted when traversed by a current to act in opposition to each other upon said armature in varying ratio according to the position thereof and so to raise said armature into a position which is indicative of the value of said current and in which the difference between the forces of the two coils will just support said armature, said armature being gradually reduced in effective cross sectional area towards the upper end thereof.

6. An electrical measuring instrument comprising an armature and two coils adapted when traversed by a current to act in opposition to each other upon said armature in varying ratio according to the position thereof and so to raise said armature into a position which is indicative of the value of said current and in which the difference between the forces of the two coils will just support said armature, said armature being gradually reduced in effective cross sectional area towards both ends.

7. An electrical measuring instrument comprising an armature, two coils adapted when traversed by a current to act in opposition to each other upon said armature in

varying ratio according to the position thereof and so to raise said armature into a position which is indicative of the value of said current and in which the difference between the forces of the two coils will just support said armature, and a metal casing inclosing said coils and having a notched end forming one terminal of the instrument.

8. An electrical measuring instrument comprising two coils which are connected in series and wound in opposite directions and of which one is above and close to the other, and an armature of which the magnetic portion extends only a short distance up into the upper coil but extends through the lower coil so as to be adapted to be raised by current passing through said lower coil until the upward pull of the lower coil minus the downward force of the upper coil is just sufficient to support the armature.

9. An electrical measuring instrument comprising an amature, two coils adapted when traversed by a current to act in opposition to each other upon said armature in varying ratio according to the position thereof and so to raise said armature into a position which is indicative of the value of said current and in which the difference between the forces of the two coils will just support said armature, said armature being composed partly of magnetic metal movable within said coils and partly of non-magnetic metal and forming an indicator, and a scale adapted to be read off by means of said indicator.

10. An electrical measuring instrument comprising two coils which are connected together in series and wound in opposite directions and of which one is above and close to the other, an armature of which the magnetic portion extends only a short distance up into the upper coil but extends through the lower coil so as to be adapted to be raised by current passing through said lower coil until the upward pull of the lower coil minus the downward force of the upper coil is just sufficient to support the armature, a guide which is located within said coils and in which said armature is adapted to slide under the action of said coils, and a scale which is attached to said coils and opposite to which an indicating portion of said armature is adapted to move.

Signed at London, England this fourteenth day of June 1905.

WILLIAM JOSEPH STILL.

Witnesses:
A. NUTTING,
H. D. JAMESON.