No. 686,561. Patented Nov. 12, 1901.

C. R. UNDERHILL.

BATTERY GAGE.

(Application filed Feb. 19, 1901.)

(No Model.)

Fig. 1.

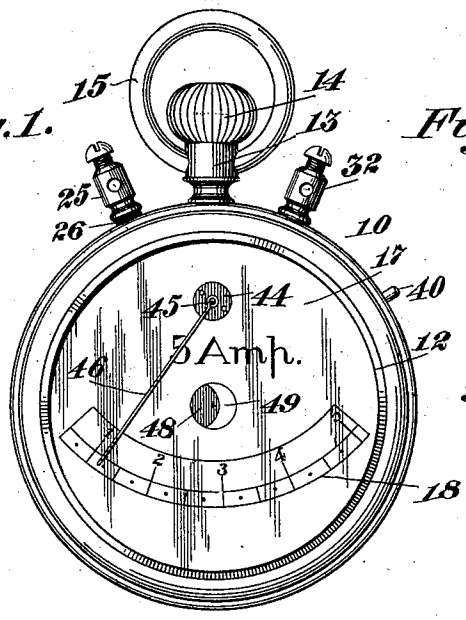


Fig. 3.

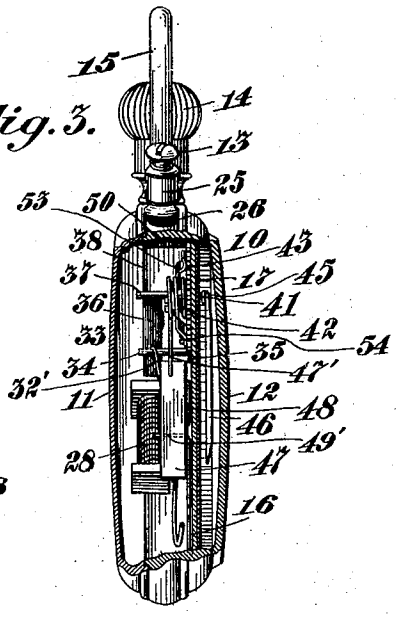


Fig. 2.

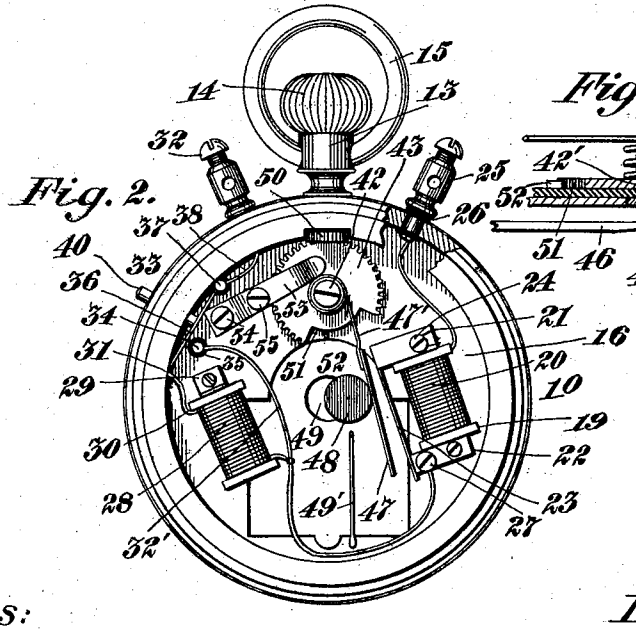
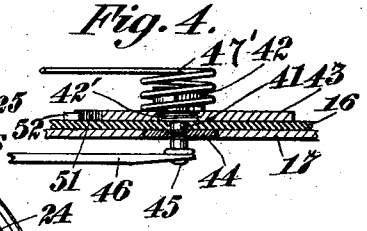


Fig. 4.



Witnesses:

A. C. Abbott

F. H. Haviland

Inventor:

Charles R. Underhill,

By his Attorney,

F. H. Richards.

UNITED STATES PATENT OFFICE.

CHARLES R. UNDERHILL, OF MONTCLAIR, NEW JERSEY, ASSIGNOR OF ONE-HALF TO THE VARLEY DUPLEX MAGNET COMPANY, OF JERSEY CITY, NEW JERSEY, A CORPORATION OF NEW JERSEY.

BATTERY-GAGE.

SPECIFICATION forming part of Letters Patent No. 686,561, dated November 12, 1901.

Application filed February 19, 1901. Serial No. 47,928. (No model.)

To all whom it may concern:

Be it known that I, CHARLES R. UNDERHILL, a citizen of the United States, residing in Montclair, in the county of Essex and State of New Jersey, have invented certain new and useful Improvements in Battery-Gages, of which the following is a specification.

This invention relates to battery-gages, and more particularly to the provision of a small compact instrument which may be easily carried in the pocket, by which the current strength, electromotive force, and internal resistance of an electric battery or like source of electrical energy may be readily determined with considerable accuracy.

In the accompanying drawings, Figure 1 is a front elevation of one embodiment of my invention. Fig. 2 is a rear elevation thereof with the wall of the case removed. Fig. 3 is a side elevation with a portion of the case broken away; and Fig. 4 is a detail in elevation, parts being broken away, showing the manner of attachment of certain parts to a pivot-pin.

Similar characters designate like parts throughout the several views of the drawings.

The numeral 10 designates as a whole a suitable inclosing and supporting case for the various elements of the gage, which is here shown in the convenient form of a watch provided with a removable back 11, a transparent front or crystal 12, and the usual watch-case pendant 13, upon which turns the fluted knob 14 and to which is attached a ring 15 for convenience in handling or for connecting to a guard-chain. Within the case is supported a plate 16, of some non-magnetic material, which carries upon the outer side under the crystal the face or dial 17, which may conveniently be of pasteboard, having inscribed upon it a suitably-graduated scale 18, here shown as divided into spaces reading in amperes and quarters thereof. Upon the opposite side of the plate is mounted near one side of the case an electromagnet 19, comprising a coil 20, and suitable pole-pieces 21 22 upon its central core, with a non-magnetic strip 23 between said pole-pieces. One of the terminals 24 of this magnet-coil is connected to a binding-post 25, mounted on the edge of the case near one side of the pendant and insulated therefrom by a suitable non-conducting bushing 26. The other terminal 27 of the magnet-coil is connected to one end of a resistance, preferably in the form of a coil or spool of insulated wire 28, mounted in some suitable manner near the opposite side of the case—as, for example, upon a bracket 29, secured to one of the heads of the spool and to the case. The other terminal 30 of the resistance-coil is shown as having metallic contact with the inside of the case, to which it may be soldered or otherwise connected at 31, permitting any current passing to flow to the binding-post 32, which is conveniently mounted upon the edge of the case at the opposite side of the pendant from the post 25 and is electrically connected with the case. With some point in the conductor between the magnet-coil and the resistance-coil is connected a conductor 32, which leads to one point of contact of a switch or cut-out, (designated as a whole by 33,) which contact is shown as a post or pin 34, supported upon the plate 16 and insulated therefrom by suitable non-conducting material 35. With this contact-post coacts the movable member of the cut-out, here shown as a strip 36, of spring sheet metal, secured to a stud 37 at one end and free at the other, standing normally away from the post 34. The stud 36 may be directly connected to the binding-post 32 by a conductor 38. Through an opening in the edge of the case projects a finger-piece 40 for operating the cut-out, which finger-piece may be attached to the strip 36. When pressed, this finger-piece serves to move the spring member into contact with the other member of the cut-out, and thereby into connection with the conductor 32', thus placing the binding-post 32 in direct connection with the magnet-coil through a low resistance and cutting the resistance-coil out of the circuit. Extending through an opening in the plate and turning therein is a pivot or pin 41, which may be formed at its inner end with a head 42 and threaded at 42' for a portion of its length. Threaded upon this

portion with one face resting against the plate is a gear 43, and at the outside of the plate the pivot carries a nut 44, resting in a recess in the dial, the gear and nut tending to retain the pivot against longitudinal movement through the plate. To a reduced portion 45 at the outer end of the pivot is secured a needle or pointer 46 with its end moving over the scale. Operating in connection with the electromagnet is an armature 47, preferably of sufficient length to extend between its pole-pieces and prevented from adhering thereto through residual magnetism by the strip 23. This armature is shown attached to one end of a coiled spring 47′, the opposite end of which spring is clamped between the head of the screw-pin 41 and the inner face of the gear 43. The armature and needle are so situated in relation to one another that when the former is resting against the strip 23 upon the pole-pieces of the magnet with its supporting-spring free from tension the latter will stand at zero on the scale. Secured to the armature at the opposite side from the magnet is a disk or indicator 48, so located that in certain positions of the armature it will appear at an opening 49 through the plate 16 and face. A stop 49′ is secured to the plate, extending into proximity with the opening and into the path of the armature, serving to prevent the indicator from moving by the opening.

Secured to and turning with the stem of the knob 14 is a pinion 50, meshing with the gear 43 to impart rotation to it. To limit the arc through which rotation may occur, thus preventing the needle from being moved off the scale, a segment of the gear is cut away at 51, and a stop 52, secured to the plate 16, extends into the opening. Upon the inner face of the gear presses a spring braking-finger or retainer 53, secured to the plate by screw 54 and having passing through it a screw 55, by which its tension may be adjusted.

In manufacture the instrument is provided with a magnet-coil of known resistance—for example, five ohms—and a resistance-coil of known resistance, which may also conveniently be five ohms. The face is then properly calibrated in amperes by comparison with a standard ammeter.

In use the gage is connected through the binding-post by suitable conductors from the terminals of the battery or other source of electrical energy which it is desired to measure. The current will then flow through the magnet-coil, the resistance-coil, and the body of the case, the two coils being in series, the entire current in the circuit flowing through both. The armature will be attracted to the magnet and held with a certain force proportional to the current strength passing in the circuit. The fluted knob, which serves as a rotary finger-piece, is then slowly turned to move the needle from zero over the scale, and the turning of the gear thereby will put a gradually-increasing tension upon the armature-spring, which will finally exert sufficient force to cause the armature to let go and fly away from the magnet, the indicator appearing at the opening in the face and the needle at the moment of appearance showing upon the scale the number of amperes of current passing in the circuit at the time of release of the armature. Upon seeing the indicating-disk at the opening the observer immediately ceases turning the knob and the needle will remain at the reading it gave upon the separation of the armature from the magnet, it being held against displacement from the movement and shock of contact of the armature with the stop by the pressure of the spring-finger upon the gear. The current through the resistance of the two coils in series (ten ohms) having been secured, giving a reading which may be called C^1, the finger-piece of the switch is pressed, bringing the spring member thereof against the stationary contact-piece and short-circuiting the resistance-coil. The current then passes through the conductor 32′, the members of the cut-out, and the conductor 38 to the binding-post 32. This gives an increased current reading through the resistance of the magnet-coil alone, (five ohms,) which may be called C^2, secured in the same way as was the previous reading. Then the external resistances of the circuit, ten and five ohms, respectively, and these two current values C^1 and C^2 being known and calling the unknown electromotive force of the battery E and its unknown internal resistance R and substituting these values and characters in the well-known expression of Ohm's law, $E=CR$, two equations will result:

$$E=C^1(R+10)$$

and

$$E=C^2(R+5).$$

As E is the same in both cases, the second member of each equation may be formed into the equation

$$C^1(R+10)=C^2(R+5).$$

Dividing and transposing,

$$\frac{C^2}{C^1}=\frac{10+R}{5+R}=1+\frac{5}{5+R}.$$

Therefore

$$R=\frac{5C^1}{C^2-C^1}-5,$$

which, upon substituting the known values of the current strength and reducing, will give the internal resistance of the battery in ohms. Substituting the above value of R in one of the equations for E and reducing gives

$$E=\frac{5C^1C^2}{C^2-C^1},$$

from which, upon substituting the current-readings, the electromotive force of the battery may be obtained.

While this instrument is particularly adapted to battery-work, obviously it may be ap-

plied to the measurement of any source of electrical energy which will give current strength within its capacity.

Having thus described my invention, I claim—

1. The combination, with a case or support, of a graduated scale; a needle or pointer adapted to move over said scale; an electromagnet carried by the case; an armature for said electromagnet flexibly attached to the needle; means for simultaneously moving the needle and putting tension upon the armature attachment; and a brake or retainer coacting with said means.

2. The combination, with a case or support, of a graduated scale; a needle or pointer adapted to move over said scale; an electromagnet carried by the case; an armature for said electromagnet flexibly attached to the needle; means for simultaneously moving the needle and putting tension upon the armature attachment; and an adjustable brake or retainer coacting with said means.

3. The combination, with a case or support, of a graduated scale; a needle or pointer adapted to move over said scale; an electromagnet carried by the case; an armature for said electromagnet flexibly attached to the needle; and an indicator movable with the armature.

4. The combination with a case or support, of a graduated scale; a needle or pointer adapted to move over said scale; an electromagnet carried by the case; an armature for said electromagnet flexibly attached to the needle; and a resistance also carried by the case and capable of being put into or cut out of the electromagnet-circuit.

5. The combination, with a case or support, of a graduated scale; a needle or pointer adapted to move over said scale secured to a pivot; an electromagnet carried by the case; a spring connected to the pivot; an armature for the electromagnet attached to the spring and an indicator attached to the armature.

6. The combination with a case or support, of a graduated scale; a needle or pointer adapted to move over said scale secured to a pivot; an electromagnet carried by the case; a spring connected to the pivot; an armature for the electromagnet attached to the spring; a finger-piece, and intermeshing gears carried by the finger-piece and pivot.

7. The combination, with a case or support, of a graduated scale; a needle or pointer adapted to move over said graduated scale secured to a pivot; an electromagnet carried by the case; a spring connected to the pivot; an armature for the electromagnet attached to the spring; a finger-piece geared to the pivot; and a brake or retainer coacting with the gearing.

8. The combination with a case or support, of a graduated scale; a needle or pointer adapted to move over said scale secured to a pivot; an electromagnet carried by the case; a spring connected to the pivot; an armature for the electromagnet attached to the spring; a finger-piece geared to the pivot; and means for limiting the movement of the gearing.

9. The combination, with a case or support, of a graduated scale; a needle or pointer adapted to move over said scale secured to a pivot; an electromagnet carried by the case; a spring connected to the pivot; an armature for the electromagnet attached to the spring; a spring-brake coacting with the gearing; and means for varying the pressure of said brake.

10. The combination, with a case or support, of a face or dial carried thereby provided with an opening; a needle or pointer adapted to move over the face; an electromagnet supported at the rear of said face; an armature therefor and an indicator attached to the armature and adapted to appear at the opening in certain positions of the armature.

11. The combination, of a case or support, of a face or dial carried thereby provided with an opening; a needle or pointer adapted to move over the face; an electromagnet supported at the rear of said face; an armature therefor, an indicator attached to the armature and adapted to appear at the opening in certain positions of the armature; and a stop for the armature in proximity to the opening.

12. The combination, with an inclosed case adapted to be carried in the pocket provided externally with two connectors or binding-posts and a rotary finger-piece, of a face or dial carried by the case; an electromagnet and a resistance in the case in circuit with the connectors; a needle or pointer movable over the face; and an armature for the electromagnet; both needle and armature being geared to the rotary finger-piece.

13. The combination, with an inclosed case adapted to be carried in the pocket and provided externally with two connectors or binding-posts, a rotary finger-piece and a finger-piece to actuate a switch or cut-out; of a face or dial carried by the case; an electromagnet, a resistance and a switch or cut-out in the case in circuit with the connectors; a needle or pointer movable over the face; and an armature for the electromagnet, both needle and armature being geared to the rotary finger-piece.

14. The combination, with an inclosed case adapted to be carried in the pocket and provided externally with two connectors or binding-posts, a rotary finger-piece and a finger-piece to actuate a switch or cut-out; of a face or dial carried by the case; an electromagnet, a resistance and a switch or cut-out in the case in circuit with the connectors; a needle or pointer movable over the face; and a flexibly-mounted armature for the electromagnet; both needle and armature being geared to the rotary finger-piece.

CHARLES R. UNDERHILL.

Witnesses:
JAMES A. MISHOOD,
ALFRED HOWELL.