No. 819,355.

PATENTED MAY 1, 1906.

M. E. LEEDS & E. F. NORTHRUP.

POTENTIOMETER.

APPLICATION FILED AUG. 2, 1905.

3 SHEETS—SHEET 1.

Fig. 1.

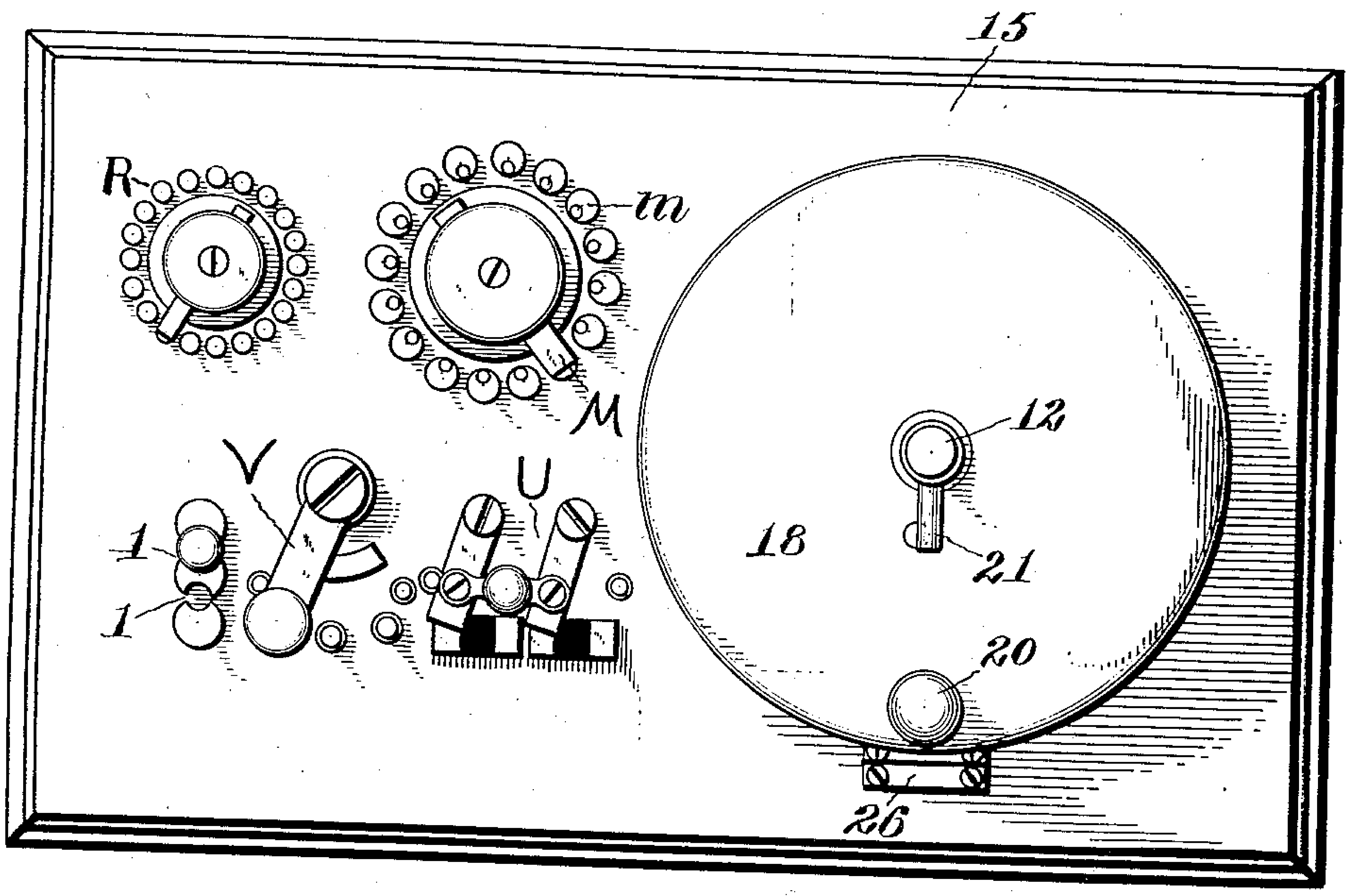
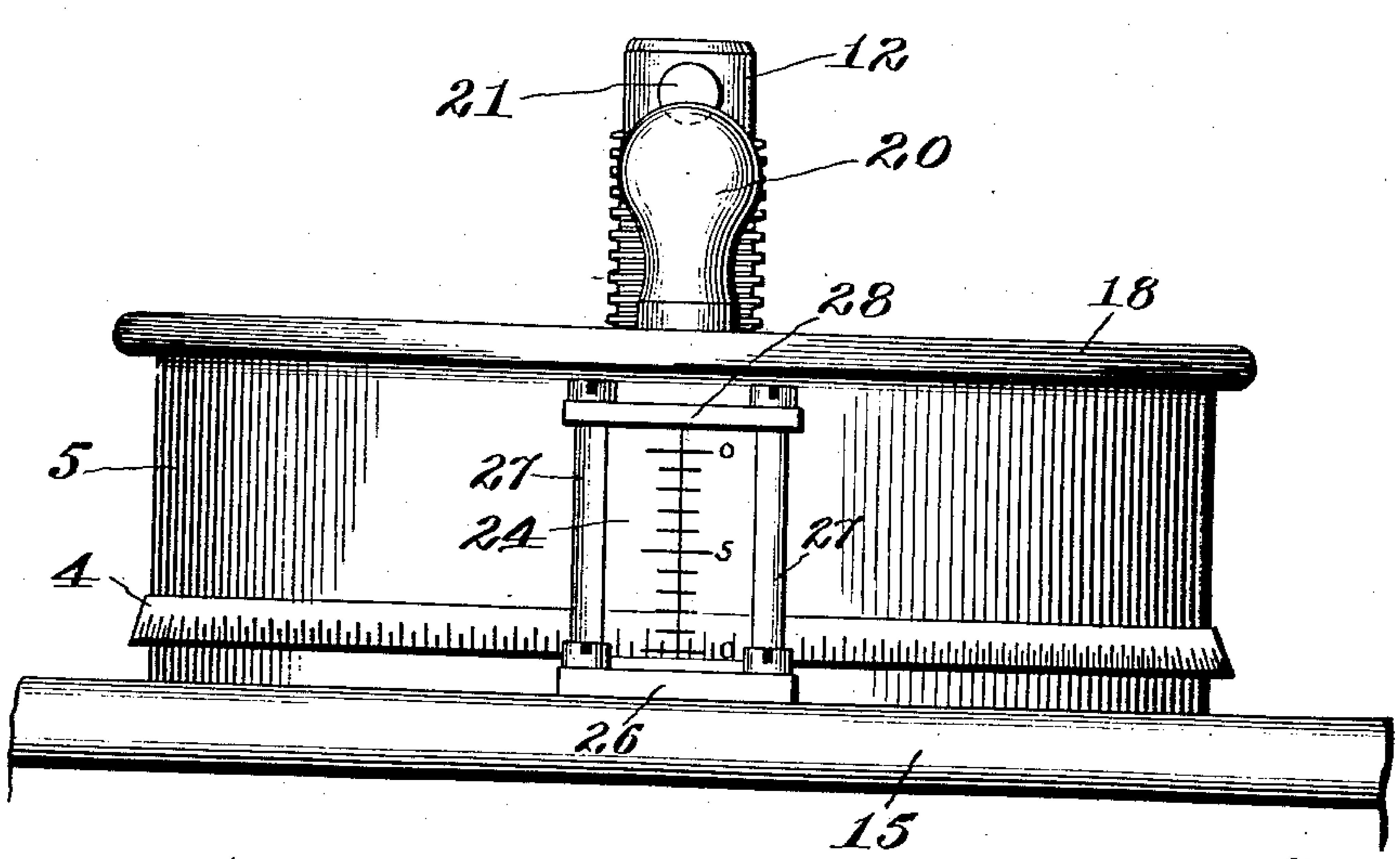


Fig. 2.



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3 SHEETS—SHEET 2.

Fig. 3.

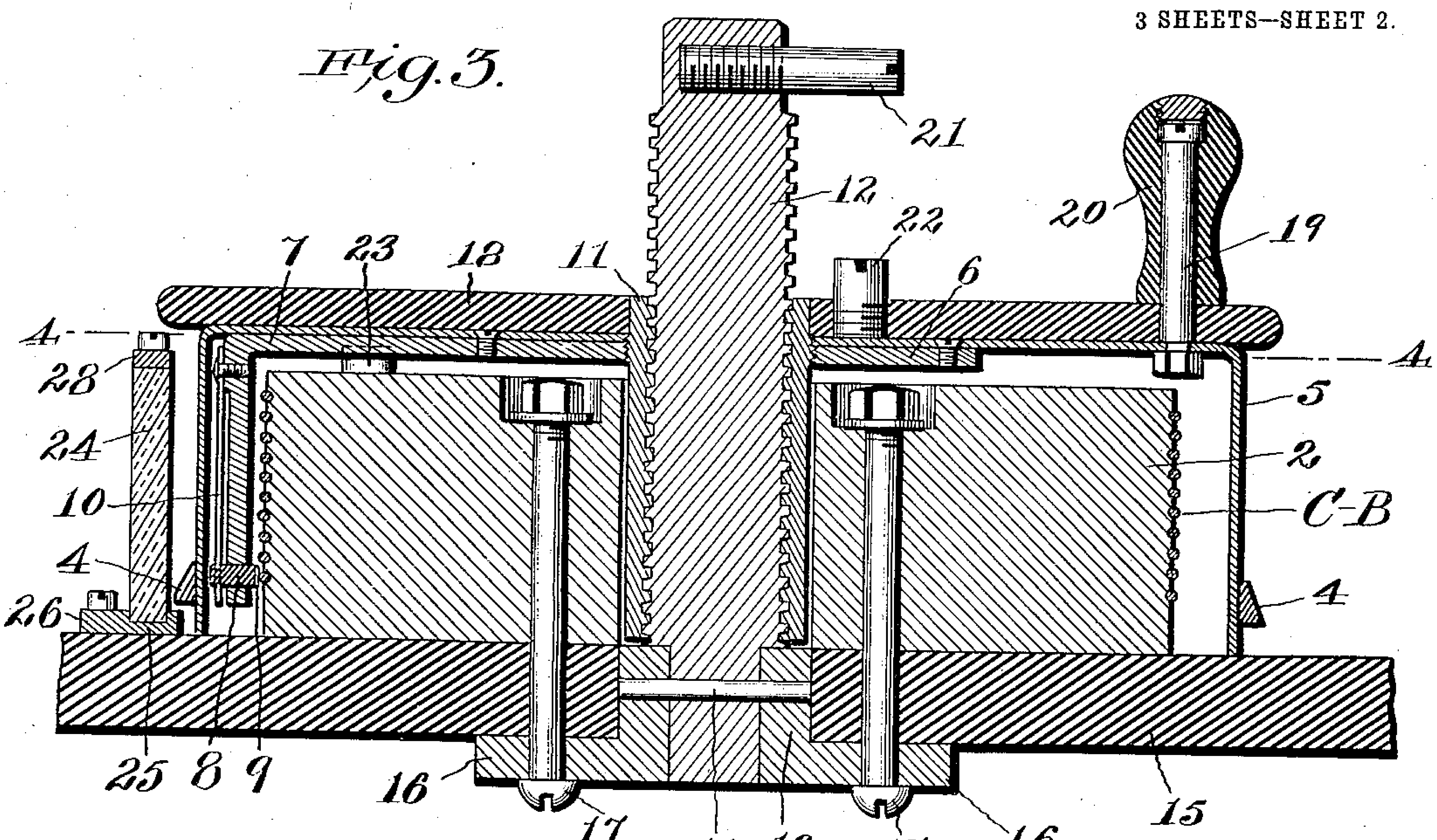


Fig. 4.

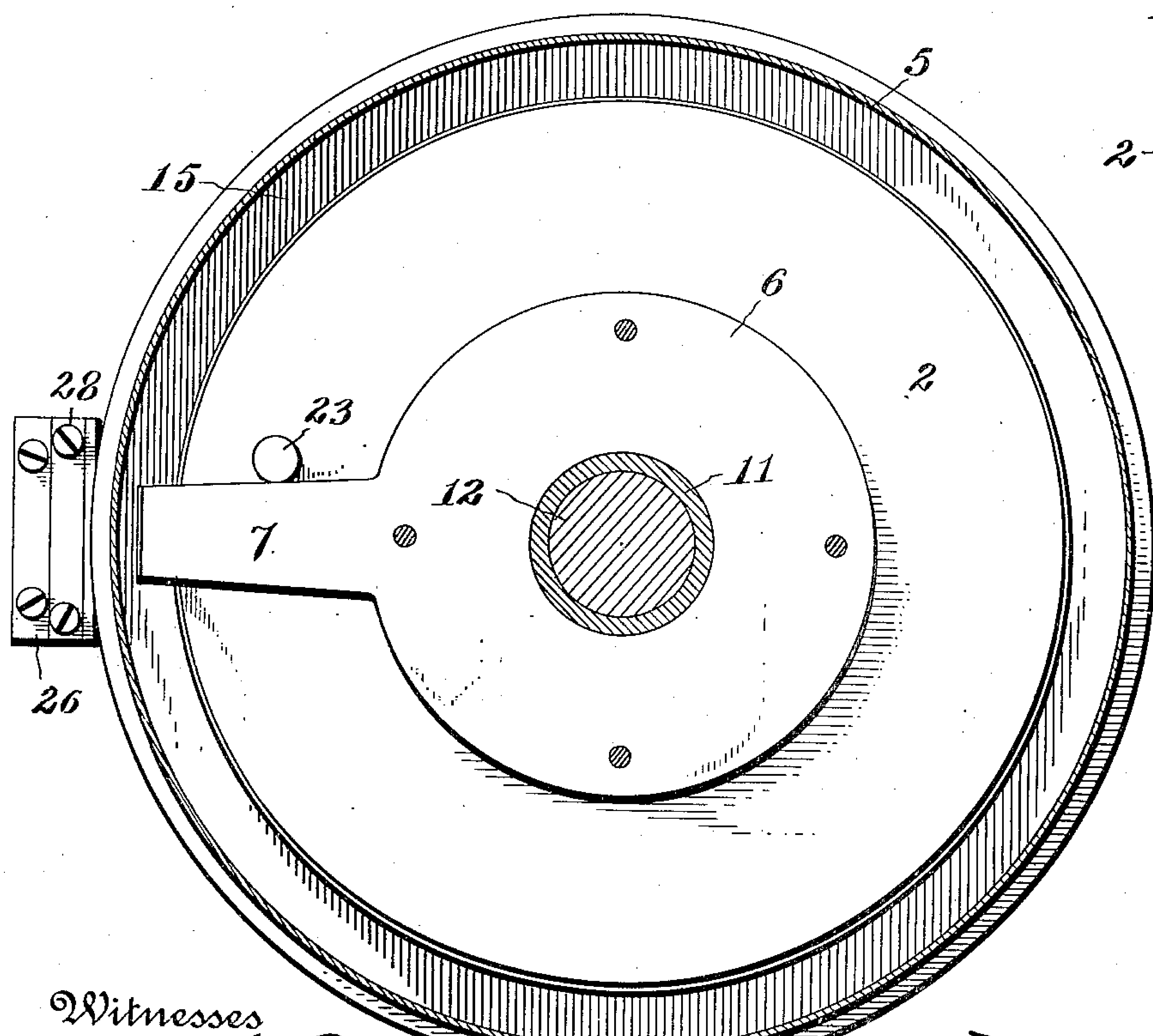


Fig. 5.

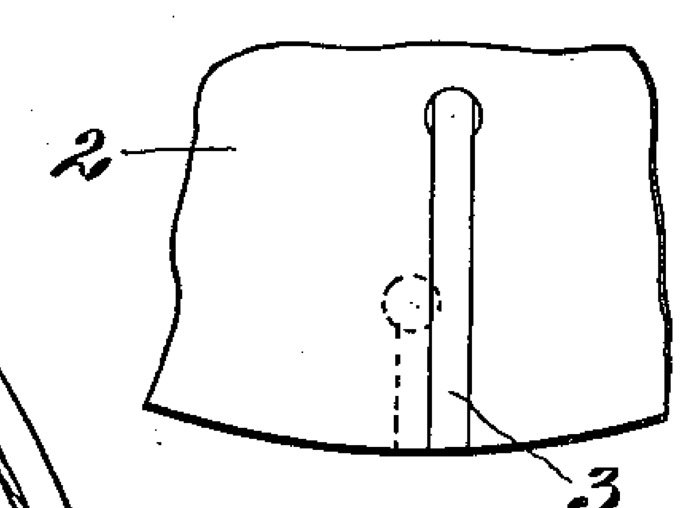
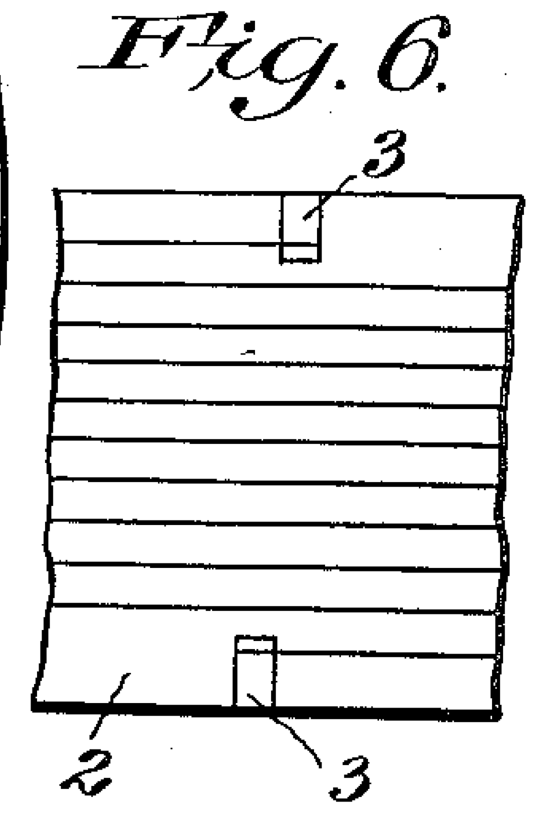


Fig. 6.



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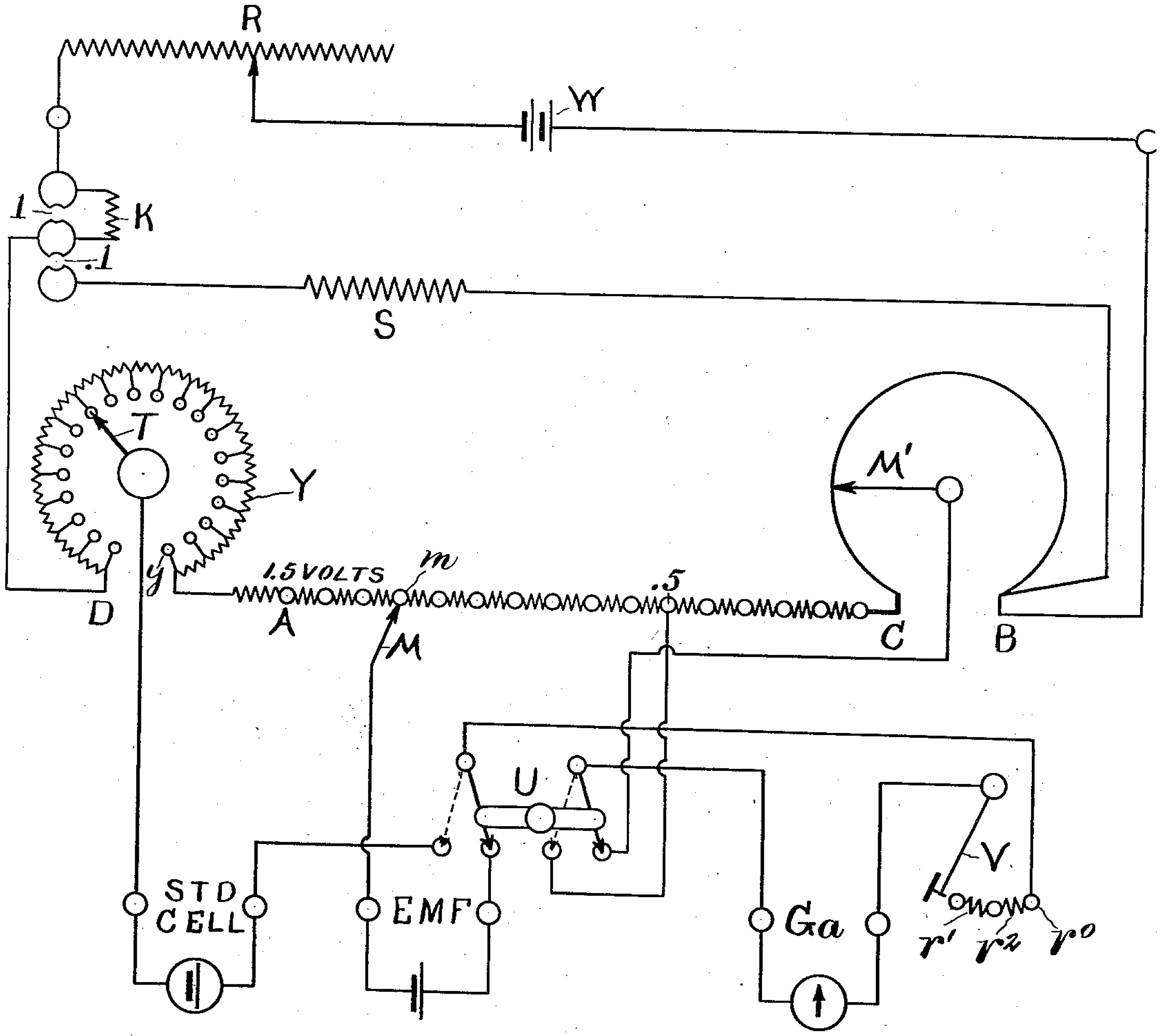
POTENTIOMETER.

APPLICATION FILED AUG. 2, 1905.

3 SHEETS—SHEET 3.

Fig. 7.



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UNITED STATES PATENT OFFICE.

MORRIS E. LEEDS AND EDWIN F. NORTHRUP, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNORS TO THE LEEDS & NORTHRUP COMPANY, OF PHILADELPHIA, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA.

POTENTIOMETER.

No. 819,355. Specification of Letters Patent. Patented May 1, 1906.

Application filed August 2, 1905. Serial No. 272,350.

To all whom it may concern:

Be it known that we, MORRIS E. LEEDS and EDWIN F. NORTHRUP, citizens of the United States, residing at Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented certain new and useful Improvements in Potentiometers, of which the following is a specification.

This invention relates to improvements in electrical measuring instruments, and more especially to that class of electrical measuring instruments known as "potentiometers;" and the said invention consists in the novel combination and arrangement of parts herein described, and more particularly pointed out in the accompanying claims.

Referring to the accompanying drawings, which illustrate one specific embodiment of the said invention, Figure 1 represents the instrument in top plan; Fig. 2, a side elevation of the extended wire attachment; Fig. 3 a vertical central sectional view of the same; Fig. 4, a section along the line 4 4 of Fig. 3, looking down; Fig. 5, a fragmentary detail top plan view of the extended wire cylinder, showing mode of attaching the extended wire. Fig. 6 represents the same in side elevation, and Fig. 7 is a diagram of the electric circuits.

The instrument shown consists, among other parts, of fifteen five-ohm series-connected resistance-coils A–C, accurately adjusted and connected in series with an extended wire C–B, which also has a resistance of five ohms. The resistances A–C and extended wire C–B are connected in series with a battery W and adjustable resistance R. The resistances A–C are provided with a movable contact M, arranged to engage the stationary contacts *m*, between which the said resistances are connected. The extended wire C–B is provided with a movable contact M′, arranged to make contact with the extended wire at any point throughout its length. The extended wire is divided by suitable scales, hereinafter described, into one thousand equal divisions.

An improved mechanical arrangement of the extended wire portion of the instrument, whereby the same may be most easily and accurately manipulated, forms an important part of the present invention and will be hereinafter described in detail.

The electromotive force to be measured is connected to the terminals (indicated E M F) in series with the galvanometer G^a, resistances r' r^2, and switch-key V between the movable contacts M and M′. The current from the battery W is regulated by the adjustable resistance R, so as to be exactly one-fiftieth of an ampere. The fall of potential across any one of the coils A–C would be consequently one-tenth of a volt and would be exactly the same across the extended wire C B. Therefore by placing the contact M′ at zero and moving the contact M the electromotive force between M and M′ may be varied by steps of one-tenth of a volt from 0 up to 1.5 volts. Also by moving tne contact M′ from 0 to 1000 the electromotive force between points M and M′ may be varied by continuous gradations of a volt.

In using the instrument to measure an unknown electromotive force this unknown electromotive force is connected between the terminals (indicated E M F) in series with the galvanometer and in opposition to the fall of potential along A B. The contact-points M and M′ are then adjusted until the galvanometer shows that no current is flowing, when the unknown electromotive force can be read from the positions of the contacts M and M′.

The switch-key V and resistances r' and r^2 are for the purpose of protecting the galvanometer against excessive deflections when the opposing electromotive forces are not approximately balanced. The switch-key V may rest on contact of resistance r', resistance r^2, or contact r^0. On contact of resistance r' it closes the circuit through a high resistance, on contact of resistance r^2 through a lower resistance, and on contact r^0 through no extra resistance.

To make the current flowing through the wires A–B exactly one-fiftieth of an ampere, a standard cell may be introduced at the binding-posts E M F, the points M and M′ set at the electromotive force of the standard cell, and regulating-resistances R adjusted until the galvanometer shows a balance.

There is always a possibility that the current will change between the adjustment of resistance R and a measurement. To provide against this, the current should be checked against the standard cell after each measurement. This usually involves the necessity of resetting the points M and M′ after a measurement has been made, which takes considerable time and results in a corresponding loss of accuracy and convenience. To obviate this, we employ an improved method of applying the standard cell. At the point .5 on the series of resistances A–C a lead-wire is permanently attached, and this is connected to one point of a double-throw switch U. Between points A and D is connected a series of resistances Y, with a sliding contact T. The resistance between point .5 and A is exactly that which corresponds with the electromotive force of one volt and that between A and the contact-point y of the first of the resistances Y a sufficient addition to make the resistance between point .5, and this point correspond to an electromotive force of 1.0185 volts. Between this point y and the end of the series of resistances Y there are nineteen coils, which increase the corresponding electromotive force by steps of .0001 up to 1.025 volts. This range corresponds with the range of the ordinary cadmium cell, and the circuits are so connected to the double-throw switch U that the two points T and .5 may be thrown in series with the galvanometer and the switch-key V. In this circuit are also the two binding-posts, (indicated "Std. cell,") to which posts the standard cell is to be connected. To adjust the current to one-fiftieth of an ampere, throw over the double-throw switch U to the position indicated by the dotted lines, set the point T to correspond with the electromotive force of the standard cell, and regulate R until the galvanometer shows no deflection. The unknown electromotive force may then be measured, as before, with the contact-points M and M′, the double-throw switch being put in the position indicated by the full lines, and after a balance has been obtained the current may be checked by simply changing the position of U and touching the contact-key V. A galvanometer-balance shows that no change has occurred. A slight deflection calls for a slight readjustment of resistance R and a corresponding readjustment of M′.

The scale of the instrument may be made low-reading by the employment of shunts. This is accomplished in the instrument shown by the employment of a resistance S, which may be made to shunt the wires D–B, and a resistance K, arranged to be connected in series with the resistance R when the resistance S shunts said wires. The resistance S is chosen of such value that when it shunts the wires D–B the total resistance between the wires D and B will be one-tenth of each resistance unshunted. Therefore when the shunt S is applied, provided the total resistance of the circuit remains constant, the fall of potential between any two points from A to B will be exactly one-tenth of what it was before. For this purpose the resistance K is so chosen that it exactly compensates for the reduction in resistance caused by plugging in the shunt-coil S. For the high scale a plug is inserted in hole 1. This short-circuits resistance K. To change from the high to the low scale, it is only necessary to remove the plug from hole 1 and place it in hole .1. With this change to the low scale the potentiometer reads from .15 of a volt down by steps of .00001 of a volt.

The practical arrangement of the extended wire, moving contact, and scales therefor is shown in Figs. 1 to 6, inclusive. The extended wire consists of ten turns of bare No. 22 manganin wire wound on the periphery of a marble cylinder 2 six inches in diameter, the ends of said wire being held securely by plugs 3, driven into horizontal slots in the marble cylinder. This wire is consequently about one hundred and ninety inches long, and each turn represents .01 of a volt, one-tenth of a turn .001 of a volt, and one one-hundredth of a turn .0001 of a volt. These divisions of the extended wire are indicated on a circular horizontal and preferably beveled scale 4 by divisions equal to .01 of a turn of the said wire. These scale divisions are about four millimeters apart and are subdivided by short lines indicating half-divisions.

The scale 4 is carried by and surrounds the lower portion of a preferably spun aluminium hood 5, which fits over the cylinder 2 and extended wire carried thereby, as shown. Attached to the inside of the top of this hood is a metal disk 6, having an arm 7, which is at one end bent substantially at right angles where it extends down the side of the cylinder 2 between the extended wire and the inside of the hood.

The arm 7 carries near its depending end a contact-plug 8, preferably of manganin, which is slidable therein, and this contact-plug is provided with a very small hardened-steel tip 9, which engages the extended wire. This tip is held in engagement with said wire under the tension of a phosphor-bronze spring 10, secured at one end to the contact-plug and made fast at its other end to the arm 7, as shown in Fig. 3.

In order to establish more perfect electrical connection, a fine wire (not shown) may be soldered at one end to the contact-plug 8 and at the other end to the arm 7.

An important point in the design of this instrument is the making of the contact-plug 8 of the same material as the extended wire, thus making the connection of the moving contact practically the same as a continuous wire.

The hood 5 and arm 7 are provided with a central aperture through which extends one end of an interiorly-screw-threaded sleeve 11, the said arm and hood being made fast to said sleeve to prevent relative rotation between them and said sleeve. This sleeve 11 is arranged to travel on a heavy screw 12, which extends upward through the center of the marble cylinder, the said screw passing at its lower end into a bushing 13, where it is made fast by means of a pin 14. This bushing 13 extends through a hard-rubber base 15, which forms the top of the retaining-box of the instrument. The bushing 13 is flanged, as at 16, where it engages the under side of said base. The marble cylinder and bushing 13 are held firmly against said base by means of the bolts 17.

A hard-rubber disk 18, provided with a central aperture, is slipped over the upper end of the sleeve 11 and covers the top of the hood, being secured thereto against rotation by a bolt 19 passing through the hood and disk and forming a means of securing a handle 20 to the latter.

Extending at right angles into the screw 12, near the upper end thereof, is a screw 21, which is adapted to engage a stop 22 to limit the upward travel of the hood and contact. A stop 23 limits its travel downward.

In front of the scale 4 is mounted a plate-glass index 24, having a vertical line up its center and ten scale divisions on this line, as shown in Fig. 2. For every complete revolution of the extended-wire contact the scale 4 moves vertically the distance of one of said vertical scale divisions, and the fractional parts of a turn are indicated on the horizontal scale 4 by means of the vertical line on the plate-glass index.

The index 24 rests in a slot 25 in a plate 26, made fast to the base 15, and is held between two vertical rods 27. A small metal bar 28 extends across the top of the index and is screwed down upon the tops of the rods 27, as shown. This arrangement of the extended wire affords a very quick and accurate way of obtaining the extended-wire readings. Moreover, the hood 5 by extending over the extended wire protects the same from injury.

The fixed and movable contacts of the rheostat R of the resistances A–C, the plug-contacts for the resistance K, the switch-key V, and double-pole switch U, together with the extended-wire attachment, are all mounted on the hard-rubber base 15, (see Fig. 1,) which forms the top or cover of the box which contains the other parts of the instrument. (Shown in diagram in Fig. 7.)

Having described a form of our invention, the same may be modified in many ways without departing from the spirit thereof.

What we claim is—

1. In a potentiometer, the combination with a potentiometer-circuit including a plurality of series-connected resistances and a coiled stationary extended wire, a movable contact for said plurality of resistances, a movable contact for the extended wire, and means to connect the source of electromotive force to be measured, in series with an indicating instrument, between said movable contacts, of means to check the current flowing through the potentiometer, consisting of an extra adjustable resistance connected in the potentiometer-circuit, a standard cell, and means to connect said standard cell from a point in said extra adjustable resistance through said indicating instrument to a point in said potentiometer-circuit.

2. In a potentiometer, the combination with a potentiometer-circuit including a plurality of series-connected resistances and a stationary extended wire, a movable contact for said plurality of resistances, a movable contact for the extended wire, and means to connect the source of electromotive force to be measured, in series with an indicating instrument, between said movable contacts, of a vertically-disposed stationary cylinder upon the periphery of which said extended wire is wound, means to check the current flowing through the potentiometer, consisting of an extra adjustable resistance connected in the potentiometer-circuit, a standard cell, and means to connect said standard cell from a point in said extra adjustable resistance through said indicating instrument to a point in said potentiometer-circuit.

3. In a potentiometer, the combination with a stationary cylinder having a vertical axis, of a potentiometer-circuit including a plurality of series-connected resistances and an extended wire, wound in helical formation, on the periphery of said cylinder, a movable contact for the said plurality of resistances, a movable contact for the extended wire, means to connect the source of electromotive force to be measured, in series with an indicating instrument, between said movable contacts, means to check the current flowing through the potentiometer, consisting of an extra adjustable resistance connected in the potentiometer, a standard cell and means to connect said standard cell from a point in said extra adjustable resistance through said indicating instrument to a point in said potentiometer-circuit, shunt, and means to connect said shunts around the potentiometer-circuit to extend the range of the readings.

4. In a potentiometer, a potentiometer-circuit including a plurality of series-connected resistances and a stationary extended wire, a movable contact for the said plurality of resistances and a movable contact for the extended wire, an extra set of series-connected resistances connected in the potentiometer-circuit to the end of said first-named resistances opposite said extended wire, a movable contact for the extra set of resistances, and a standard cell, one pole of which is connected to the movable contact of said extra resistance, a tap-off wire connected to a point

in said first-named series of resistances, and a double-throw switch arranged to connect the source of electromotive force to be measured in series with an indicating instrument, between said movable contacts when thrown in one direction, and to connect said tap-off wire in circuit with said standard cell and disconnect the first-made connections, when thrown in another direction.

5. In a potentiometer, a stationary cylinder with axis vertically disposed, an extended wire wound in the form of a helix upon the periphery of said cylinder, a contact arranged to bear upon said wire, a movable support for said contact mounted to cause said contact to follow the convolutions of the helical wire, a movable protecting-hood for said extended wire arranged to move with said contact, a scale carried upon the periphery of said hood, and a stationary index for said scale.

6. A potentiometer, comprising a potentiometer-circuit including a plurality of resistances connected in series with each other, a movable contact for said plurality of resistances, an extended wire in series with said resistances, a cylinder upon which said wire is wound in the form of a helix, a contact-plug having a hardened-steel tip arranged to bear upon said wire, a movable support for said contact-plug, mounted to cause the contact to follow the convolutions of the helical wire, and circuit connections for connecting the unknown quantity to be measured in series between the movable contact of said series-connected resistances and said hardened-steel tip.

7. In a potentiometer, an extended wire, a cylinder upon which said wire is wound in the form of a helix, a contact-maker arranged to bear upon said wire, a movable support for said contact mounted to cause said contact to follow the convolutions of the helix, and a protecting-hood mounted for movement with said contact-support and arranged to extend over the extended wire.

8. In a potentiometer, an extended wire, a cylinder upon which said wire is wound in the form of a helix, a contact-maker arranged to bear upon said wire, a movable support for said contact mounted to cause said contact to follow the convolutions of the helix, a protecting-hood mounted for movement with said contact-support and arranged to extend over the extended wire, an annular scale mounted on the outside of said hood, and a stationary scale and index mounted near said annular scale.

9. In a potentiometer, an extended wire, a cylinder upon which said wire is wound in helical formation, a screw extending upward through the center of said cylinder, a screw-threaded sleeve arranged to travel on said screw, an arm mounted fast on said sleeve, a spring-pressed contact carried by said arm and arranged to engage said extended wire, a protecting-hood mounted fast upon said sleeve, inclosing said arm and contact and adapted to extend over the extended wire and cylinder supporting the same, an annular scale carried upon the outside of said hood, a glass plate mounted near said hood and having thereon a stationary vertical index for said scale and a stationary vertical scale of which the said circular scale forms the index, substantially as described.

In testimony whereof we affix our signatures in presence of two witnesses.

MORRIS E. LEEDS.
EDWIN F. NORTHRUP.

Witnesses:
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JOHN B. HENKELS.