(No Model.) 2 Sheets—Sheet 1.

E. WESTON.

ELECTRICAL MEASURING INSTRUMENT.

No. 427,022. Patented Apr. 29, 1890.

Fig. 1.

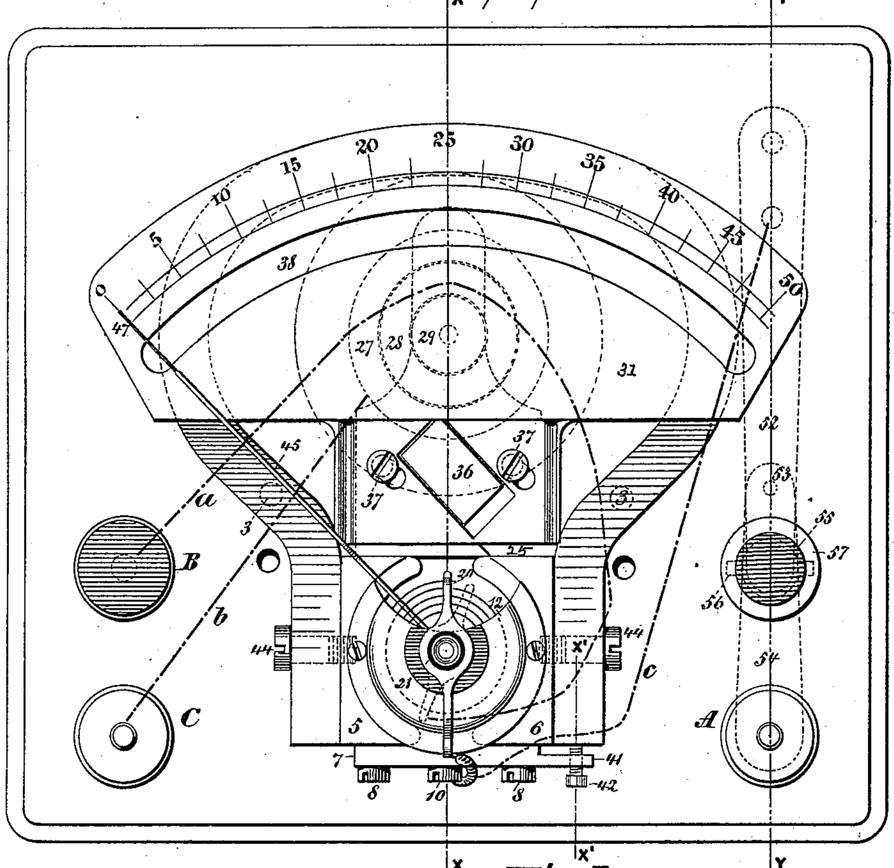


Fig. 2.

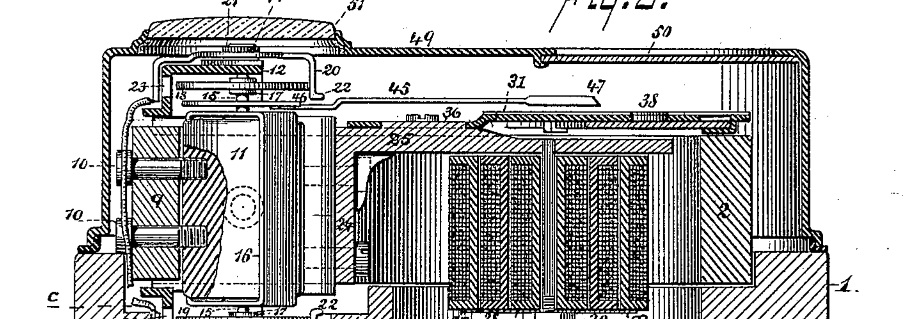
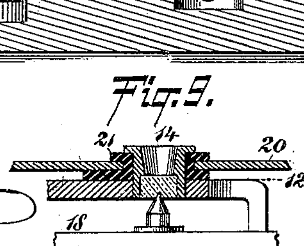


Fig. 9.



WITNESSES:

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THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

(No Model.) 2 Sheets—Sheet 2.

E. WESTON.

ELECTRICAL MEASURING INSTRUMENT.

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Fig. 3.

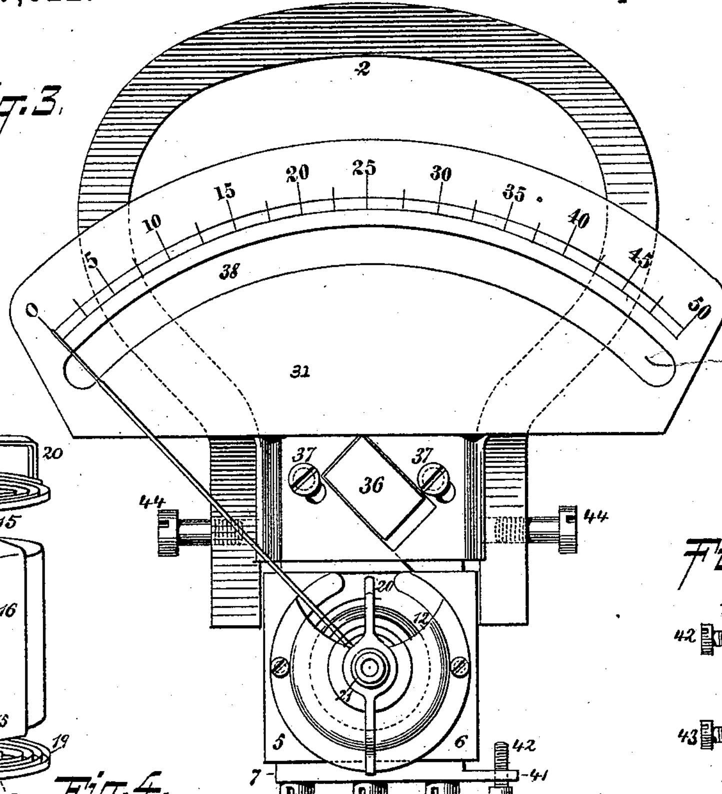


Fig. 7.

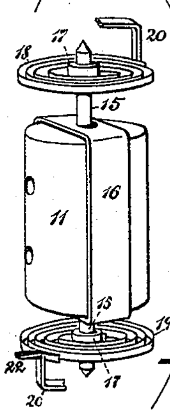
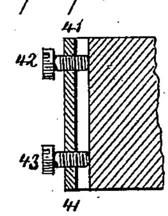


Fig. 4.

Fig. 8.



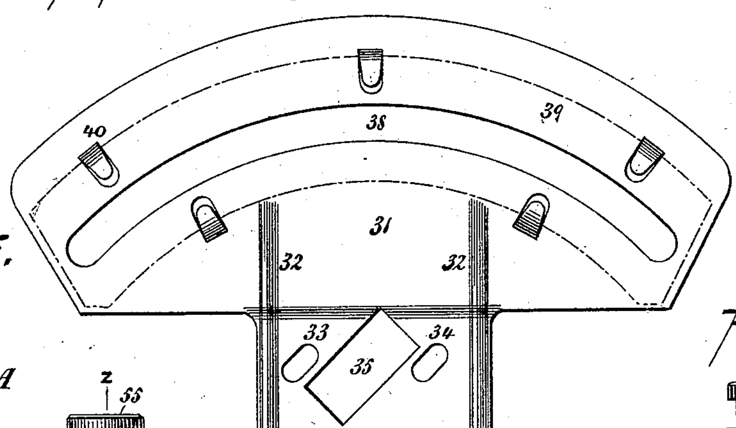


Fig. 5.

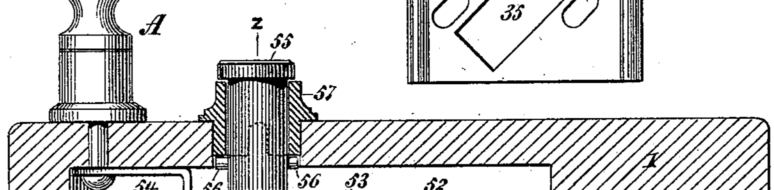
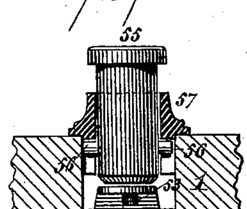


Fig. 6.



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UNITED STATES PATENT OFFICE.

EDWARD WESTON, OF NEWARK, NEW JERSEY.

ELECTRICAL MEASURING-INSTRUMENT.

SPECIFICATION forming part of Letters Patent No. 427,022, dated April 29, 1890.

Application filed January 18, 1890. Serial No. 337,380. (No model.)

To all whom it may concern:

Be it known that I, EDWARD WESTON, of Newark, Essex county, New Jersey, have invented a new and useful Improvement in Electrical Measuring-Instruments, of which the following is a specification.

My invention relates to an electrical measuring-instrument of the same general type as that described and claimed in Letters Patent No. 392,387, granted to me on the 6th day of November, 1888; and it consists more particularly in certain improvements in the construction of the instrument whereby the same is rendered more efficient in operation, its manufacture simplified, and cost reduced.

The principal novel features embodied in my present invention are the use of oppositely-acting springs in combination with the rotating coil, the construction of said springs of non-inductive or non-magnetic material, the devices for tightening or loosening said springs, the guard to prevent catching of the inner turns of said springs over the outer abutments, the arrangement of the scale-plate and its support on the pole-pieces instead of on the magnet, the construction of said plate and combination therewith of the mirror, the uniting together of the pole-pieces, coil, and scale-plate, so that these parts may be separated as a unit from the magnet, the construction and arrangement of the concentric resistance-coils, the novel form of circuit-closer, and the disposition of the circuit-connections, together with other combinations and instrumentalities, all as hereinafter more particularly set forth.

In the accompanying drawings, Figure 1 is a plan view of the instrument with the case or cover removed. Fig. 2 is a section on the line X X of Fig. 1. Fig. 3 is a plan view showing the working parts of the instrument detached from the permanent magnet and displaced in position, so as to exhibit the separation of all the working portions as a unit from said permanent magnet. Fig. 4 is a rear view of the scale-plate. Fig. 5 is a section on the line Y Y, Fig. 1. Fig. 6 is a section on the line Z Z of Fig. 5. Fig. 7 is a perspective view showing more particularly the reversely-wound springs. Fig. 8 is a section on the line X′ X′ of Fig. 1; and Fig. 9 is also a section on the line X X of Fig. 1, showing in detail the construction of the step or bearing for the coil-pivots.

Similar numbers and letters of reference indicate like parts.

1 is the base-board of the instrument, provided with suitable openings for the reception of the mechanism and the permanent magnet 2. Said magnet is secured to the base 1 by screws entering openings in the under side of said magnet, as indicated at the dotted circles 3, Fig. 1. The openings in the base-board 1 are closed by the cover 4, which is fastened to the under side of the base-board 1.

5 and 6 are two pole-pieces having their opposing faces hollowed to form a cylindrical opening between them. The said pole-pieces are connected together by a plate 7, of brass or other non-inductive material, which is secured to said pole-pieces by the screws 8. The middle portion 9 of the plate 7 extends between the pole-pieces 5 and 6, and through said middle portion pass screws 10, which enter and support a cylindrical mass 11, of iron or other magnetic material, in the cylindrical space between the pole-pieces. Supported upon the upper and lower sides of the pole-pieces 5 and 6 are covers or caps 12 and 13. Passing through the center of each cap or cover 12 and 13 is a bushing 14, Fig. 9, in which is set a jewel. These jewels form bearings for the pivot-pins 15, which are secured to the copper frame 16, which frame surrounds the cylinder 11, of magnetic material, and moves in the annular space between said cylinder 11 and the pole-pieces 5 and 6. Around the frame 16 is wound the coil of the instrument, said coil being of insulated wire, with its terminals connected to the pivots 15. Upon said pivots 15 are fixed collars 17, to which collars are secured the ends of coiled springs 18 and 19. These springs are to be made of non-magnetic material, such as platinum-iridium alloy, and are wound in opposite directions, as shown in Fig. 7. The object of making the springs of non-magnetic material is to prevent the effects of magnetic induction upon them, and the purpose of winding them in opposite directions is, first, to prevent changes in the position of the nee-

dle arising from variations in temperature acting upon the springs, thus avoiding disturbance of the position of the zero-point which would otherwise follow from changes in temperature of the instrument; second, to render their resilient resistance more uniform to movement of the coil either way, and, third, to allow of delicate adjustment of the needle. Their outer extremities are fastened to arms 20. These arms are pivoted upon the bushings 14, but are insulated therefrom by interposed sleeves 21, of rubber or other insulating material.

The springs 18 and 19 are fastened to the bent extremities of the arms 20, and said extremities are then turned and bent at right angles, as shown at 22. The object of thus forming the extremities of the pivoted arms 20 is to prevent any turns of the springs, when the instrument is inverted or shaken, from being caught over the end of the arm, the bent portion 22 acting as a guard for this purpose.

The object of pivoting the arms 20 is to allow them to be rotated, and so to tighten or loosen the coils of the springs. In this way the opposition offered by the springs to the movement of the coil of the instrument may be nicely regulated. In each cap or cover 12 or 13 is made a slit or opening 23, which comes directly opposite the springs 18 and 19. The object of these openings is to allow an edge view of the springs 18 and 19, so that it may be seen that all the turns of each spring lie in the same plane and that there is no distortion of the spring. Secured to the pole-pieces 5 and 6 on opposite sides thereof to that on which the bar 7 is secured is a plate 24, having a horizontal portion 25. From said portion 25 depends a rod 26, which receives three concentric resistance-coils 27 28 29. I may increase or diminish the number of said coils. The purpose of using several coils is to allow of each being independently made and adjusted to any desired resistance, and all afterward being connected together. These coils are secured upon the rod 26 by the nut 30, the rod and nut forming a simple and convenient holding device, from which they can be easily removed. On the upper side of the plate 25 is fastened a scale-plate 31, Fig. 4. This plate is made of sheet metal and is provided with stiffening-ribs 32 and with three diagonally-disposed openings 33 34 35. The opening 35 receives a rectangular diagonally-placed projection 36 on the plate 25 and has a slight play thereon. Slots 33 and 34 receive the screws 37, by which the scale-plate 31 is fastened to the plate 25. In the body of the plate 31 is a curved opening 38, and on the under side of said plate is a mirror 39, which is seen through said opening. ~~The~~ mirror is secured in place upon the plate 31 by clips 40, which are here formed integrally from the metal plate itself. Entering on one side of the plate 7 is a projection 41, through which pass two screws 42 43. These screws bear against one end of the permanent magnet 2, but do not enter the same. Their purpose will be described farther on.

The arrangement of the rectangular frame 16, of copper or other diamagnetic metal, carrying the coil of the instrument, surrounding a fixed cylinder of magnetic metal and vibrating in the space between said cylinder and the pole-pieces of the magnet 2, is substantially the same as is described and claimed in my above-named prior patent; and I have also shown in said prior patent a coil supported on pivoted bearings in combination with coiled springs which oppose the motion of the coil, the said springs being arranged substantially as herein represented, but not wound in opposite directions; but on comparing my present device with that illustrated in my prior patent with regard to the coil and the adjacent mechanism the following important differences will appear: First, the two pole-pieces 5 and 6 are in my present device united together by the plates 7 and 24, which plates are not connected to the magnet 2. The two pole-pieces, therefore, with the remainder of the working parts of the instrument connected to them, form an assemblage of mechanism united and easily detachable from the magnet. In my prior apparatus the pole-pieces were connected by the cap-plates, in which the pivot-pins of the coil were stepped. In my present device the pole-pieces are connected also by the plates 7 and 24, so that they are thus much more rigidly secured together. The pole-pieces thus united are held between the arms of the magnet by the pivoted screws 44, which pass through the arms of the magnet. It will be evident then that by simply loosening the screws 44 all the working parts of the instrument, being united, may be slid out of place from between the arms of the magnet; or, in other words, the magnet and the rest of the instrument may be conveniently separated, as indicated in Fig. 3. Reference to my former patent above named will also show that in the device there set forth I secure the scale-plate to the edge of the magnet, so that it became necessary, therefore, to face off said edge and make the same true and flat. This is no longer necessary, as the plate is not supported in my present device on the magnet at all, but upon the flat bar 25. The object of the projection 41 and adjusting-screws 42 and 43 therein is to furnish a convenient means of leveling the scale-plate. It will be apparent that the connected pole-pieces 5 and 6 turn on the screws 44 as pivots, and that the screw 42 is above the pivot-points and that the screw 43 is below the same. It follows, therefore, that if the screw 42 be turned inward and the screw 43 be turned outward then the scale-plate will be slightly depressed, whereas if the screw 43 be turned inward and the screw 42 outward then the scale-plate will be slightly raised. In this way the scale-plate may be adjusted level with nicety. The object of the slits 33 34 35, by means of which the scale-plate may be moved slightly in the direction parallel to the radial line passing through the zero-mark, is to allow an adjustment of the scale in length to be made without altering or disturbing the coil of the instrument. In this way small errors of calibration may be corrected. This mode of adjusting the scale in an electrical measuring-instrument is not a part of my present invention, but is the invention of Madison M. Garver, and hence is not claimed herein by me.

The index-needle of the instrument is shown at 45, and may be fastened to a thin disk 46, which is secured to the upper pivot-pin 15. It extends over the scale-plate 31. Near its extremity it takes the form of a flat bar on edge, as shown at 47. The object of the mirror 39 is to allow the reflected image of the needle therein to be brought directly under the position of the needle, so as to obviate any error due to parallax in observing the scale-reading. To the base-board 1, and directly under the opening which receives the lower cap 13 and arm 20, is secured a cover 48 to prevent access of dust to the working portion.

The entire instrument is covered by a case 49, in which there is an opening 50, provided with glass, through which the scale and needle can be seen, and another opening 51, also covered with glass, through which the position of the upper adjusting-arm 20 may be observed.

Referring now to Figs. 5 and 6, in a recess in the lower side of the base-board 1 is secured a contact-spring 52, having a contact-point 53. To the binding-post A of the instrument is also secured a contact-spring 54. 55 is a push-button, of rubber or other insulating material, from the side of which project stops 56, which normally enter recesses in a sleeve 57 in the base-board 1, as shown in Fig. 6. The spring 52 normally holds the stops 56 in the upper portion of the recesses in the sleeve 57, so that the contact-point 53 does not then meet the spring-plate 54. When the pin 55 is pushed down, the contact-point 53 meets the plate 54, and this contact may be maintained by holding the pin 55, as long as may be desired, depressed; or, inasmuch as the stops 56 then leave the recesses in the sleeve 57, it is necessary, simply, to turn the pin 55 on its axis, when the stops 56 will catch under the lower edge of the sleeve 57, and the pin 55 will thus be maintained in its lowest position and the contact-point 53 held against the spring 54, and the circuit will thus be kept permanently closed.

The circuit in the instrument proceeds as follows: from the binding-post A to the contact-springs 52 and 54, by wire *c* to the lower pivoted arm 20, spring 19, the lower pivot-pin 15, the coil of the instrument, upper pivot-pin 15, spring 18, upper arm 20, and thence by the wire *a* to the binding-post B. A branch wire *b* leads from the upper arm 20 to the resistance-coil 27, then to resistance-coil 28, then to resistance-coil 29, (these coils being connected in series,) and to binding-post C. When the current passes between binding-post A and binding-post C, it proceeds through the resistance-coils, and when it passes between binding-post A and binding-post B it does not pass through said coils.

The operation of the instrument is substantially the same as described in my prior patent aforesaid, the deflection of the needle measuring the difference in potential between the terminals of the circuit connected to the binding-posts, and the electromotive force being indicated in volts and fractions on the scale, which is suitably marked.

I claim—

1. A means of producing a field of force, a body movable in said field under the influence of an electric current, and a body of non-inductive resilient material also in said field and interposed between said movable body and an abutment.

2. A magnet, a body in the field of force of said magnet and movable under the influence of an electric current, and a body of non-magnetic resilient material also in said field and interposed between said movable body and an abutment.

3. A magnet, an electrical conductor in core or loop form supported and vibrating in the field of force of said magnet, and a spring of non-magnetic material interposed between said coil and an abutment.

4. In an electrical measuring-instrument, a body movable under the influence of an electric current and two resilient bodies interposed between said movable body and abutments and respectively opposing the motion of said movable body in relatively different directions.

5. In an electrical measuring-instrument, a body movable under the influence of an electric current and two resilient bodies of equal elasticity interposed between said movable body and abutments and respectively opposing the motion of said movable body in relatively opposite directions.

6. In an electrical measuring-instrument, a body movable under the influence of an electric current, two resilient bodies interposed between said movable body and abutments and respectively opposing the motion of said movable body in relatively different directions, and means for varying the resiliency of each of said bodies.

7. In an electrical measuring-instrument, a magnet, an electrical conductor in coil or loop form supported and vibrating upon axial pivots in the field of force of said magnet, and two spiral springs wound in opposite directions and having their inner ends connected to said pivots and their outer ends to abutments.

8. In an electrical measuring-instrument, a magnet, an electrical conductor in coil or loop

form supported and vibrating upon axial pivots in the field of force of said magnet, and two spiral springs wound in opposite directions and connected at their inner ends, respectively, to said pivots, and two independently-supported arms pivoted concentrically with said springs, the outer ends of said springs being secured, respectively, to said arms and the said arms being rotary on their pivots to contract or expand said springs.

9. In an electrical measuring-instrument, a magnet, an electrical conductor in coil or loop form supported and vibrating in the field of force of said magnet, and a spiral spring interposed between said coil and an abutment, the said spring being secured at its outer end to said abutment and the said abutment being movable to contract or expand said spring.

10. In an electrical measuring-instrument, a magnet, an electrical conductor in coil or loop form supported and vibrating on axial pivots in the field of force of said magnet, a coiled spring connected at its inner end to one of said pivots, and an independently-supported arm pivoted concentrically with said spring, the other end of said spring being secured to said arm, and the said arm being rotary on its pivot to contract or expand said spring.

11. In an electrical measuring-instrument, a magnet, an electrical conductor in coil or loop form supported and vibrating on axial pivots 15 in the field of force of said magnet, the support 12, bushing 14 in said support receiving and forming a bearing for one of said pivots, the sleeve 21, of insulating material, surrounding said bushing, the arm 20, rotary on said sleeve, and the spiral spring 18, having its inner end attached to said pivot 15 and its outer end secured to said arm 20.

12. In an electrical measuring-instrument, a magnet, an electrical conductor in coil or loop form supported and vibrating in the field of force of said magnet, an abutment, and a spiral spring interposed between said coil and said abutment, and circuit-connections whereby said coil and spring are brought into electrical circuit.

13. In an electrical measuring-instrument, a magnet, an electrical conductor in coil or loop form supported and vibrating on axial pivots in the field of force of said magnet, an adjustable abutment, a spiral spring having its inner end secured to one of said pivots and its outer end to said abutment, and circuit-connections whereby said abutment, spring, and coil are brought into electrical circuit.

14. In an electrical measuring-instrument, a magnet, an electrical conductor in coil or loop form supported and vibrating on axial pivots in the field of force of said magnet, two spiral springs having their outer ends connected to abutments and their inner ends to said pivots, and circuit-connections whereby said springs and coil are brought into electrical circuit.

15. In an electrical measuring-instrument, the combination of a pivoted rotating coil 16 and a flat spiral spring 18, connected at its inner end to said coil-pivot and at its outer turn to an abutment 20, the said abutment having a projecting arm 22, extending beyond the connecting-point of said spring.

16. The combination, in an electrical measuring-instrument, with a magnet, of pole-pieces on said magnet, an electrical conductor in coil or loop form supported and vibrating between said pole-pieces, an index-needle actuated by said coil, and a scale-plate supported by said pole-pieces.

17. The combination, in an electrical measuring-instrument, with a magnet, of the pole-pieces rigidly secured together, an electrical conductor in coil or loop form supported and vibrating between said pole-pieces, an index-needle actuated by said coil, a scale-plate supported by said pole-pieces, and a means of detachably fastening said pole-pieces to said magnet.

18. The combination, in an electrical measuring-instrument, with a magnet, of the pole-pieces 5 and 6, rigidly secured together and received between the arms of said magnet, an electrical conductor in coil or loop form supported and vibrating between said pole-pieces, an index-needle actuated by said coil, a scale-plate supported by said pole-pieces, and the pivots 44, passing through the arms of said magnet and entering said pole-pieces.

19. The combination, in an electrical measuring-instrument, with a magnet, of the connected pole-pieces 5 and 6, the plate 25, secured to said pole-pieces, the scale-plate 31, supported on said plate 25, an electrical conductor in coil or loop form supported and vibrating between said pole-pieces, and an index-needle actuated by said coil and extending over said scale-plate.

20. The combination, in an electrical measuring-instrument, with a magnet, of the connected pole-pieces 5 and 6, the plate 25, secured to said pole-pieces, the scale-plate 31, of sheet metal, having stiffening-ribs 32, supported upon said plate 25, an electrical conductor in coil or loop form supported and vibrating between said pole-pieces, and an index-needle actuated by said coil and extending over said scale-plate.

21. The combination, in an electrical measuring-instrument, with a magnet 2, of the pole-pieces 5 and 6, received and pivoted between the arms of said magnet, the plate 7, securing said pole-pieces together and provided with the projection 41, an electrical conductor in coil or loop form supported and vibrating between said pole-pieces, an index-needle actuated by said coil, a scale-plate supported by said pole-pieces, and the adjusting-screws 42 and 43, passing through said projection 41 and bearing against said magnet.

22. In an electrical measuring-instrument, the combination of a scale-plate of sheet metal having a curved slot or opening and a

mirror showing the reflecting-surface through said slots and secured to said plate by clips formed integrally of the metal of said plate.

23. In an electrical measuring-instrument, and in combination with a vibrating needle or pointer, a scale-plate having an elongated curved slot or opening and a mirror supported on the under side of said plate and reflecting the said needle through said slot.

24. In an electrical measuring-instrument, two or more hollow spools or bobbins each wound with a resistance-coil and disposed one within the other, the said coils being connected in circuit.

25. In an electrical measuring-instrument, a series of detachable spools or bobbins each wound with a resistance-coil and secured concentrically one within the other upon a common support, the said coils being connected in circuit.

26. In an electrical measuring-instrument, two or more hollow spools or bobbins each wound with a resistance-coil and disposed one within the other, a spindle passing through the central spool, means for securing said spools upon said spindle, the said coils being connected in circuit.

27. The combination, in an electrical measuring-instrument, with a magnet, of the connected pole-pieces 5 and 6, plate 25, secured to said pole-pieces, a resistance-coil secured to the under side of said plate 25, an electrical conductor in coil or loop form supported and vibrating between said pole-pieces, and circuit-connections including said vibrating coil and said resistance-coil in circuit.

28. The combination, in an electrical measuring-instrument, with a magnet, of the connected pole-pieces 5 and 6, plate 25, secured to said pole-pieces, two or more concentric resistance-coils detachable from one another and secured to the under side of said plate 25, an electrical conductor in coil or loop form supported and vibrating between said pole-pieces, and circuit-connections including said vibrating coil and said resistance-coils in circuit.

29. The combination, in an electrical measuring-instrument, with a magnet, of the connected pole-pieces 5 and 6, plate 25, secured to said pole-pieces, rod 30, secured to said plate, resistance-coil 29 upon said rod 30, resistance-coil 28, inclosing said coil 29, a means of securing said coils to said rod, an electrical conductor in coil or loop form supported and vibrating between said pole-pieces, and circuit-connections including said vibrating coil and said resistance-coils in circuit.

30. The combination, with the magnet 2, of the connected pole-pieces 5 and 6, the bearing-plates 12 and 13, secured to said pole-pieces, the coil 16, pivoted in said plates 12 and 13 and vibrating in the space between said pole-pieces, the spiral springs 18 and 19, connected at their inner ends to the pivots 15 of said coil, the arms 20, pivoted upon said plates 12 and 13 and having their ends secured to the outer extremities of said springs, and circuit-connections, substantially as set forth.

31. In combination with the pole-pieces 5 and 6, the vibrating coil 16, supported on pivots 15 between said pole-pieces, and the flat spiral spring 18, connected at one end to a pivot 15 and at the other end to an abutment, and the bearing-plate 12, supported on said pole-pieces, receiving a pivot 15, and provided with a sight-aperture 23 in the plane of the spring 11.

32. The combination of two contact-pieces normally separated and a pin or press-button rotary on its axis and longitudinally movable, the said pin operating when depressed to move one of said pieces into contact with the other and when rotated to become locked in said depressed position.

33. The combination of a support, a sleeve 57 therein, provided with recesses in its lower edge, a pin or press-button 55, longitudinally movable and rotary in said sleeve, a stop 56, projecting from said pin and entering the recess therein, and two contact-plates 52 and 54, normally separated, the aforesaid parts being arranged so that when said pin is depressed the said plates 52 and 54 are brought into electrical contact, and when said pin is thereafter rotated the said stop 56 leaves said recess, engages under the edge of said sleeve, and maintains said pin in depressed position.

34. In an electrical measuring-instrument containing a magnet and coil rotary in the field of force thereof, a pin or press-button longitudinally movable and rotary on its axis, two spring-arms constructed to be moved into contact by said pin when depressed, a means of locking said pin in depressed position when said pin is thereafter rotated on its axis, and circuit-connections, as set forth, the said device operating to close circuit through the said coil when said pin is depressed and to maintain said circuit closed when said pin is locked in said depressed position.

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Witnesses:

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