(No Model.)

C. F. BRUSH.

AMMETER.

No. 466,953. Patented Jan. 12, 1892.

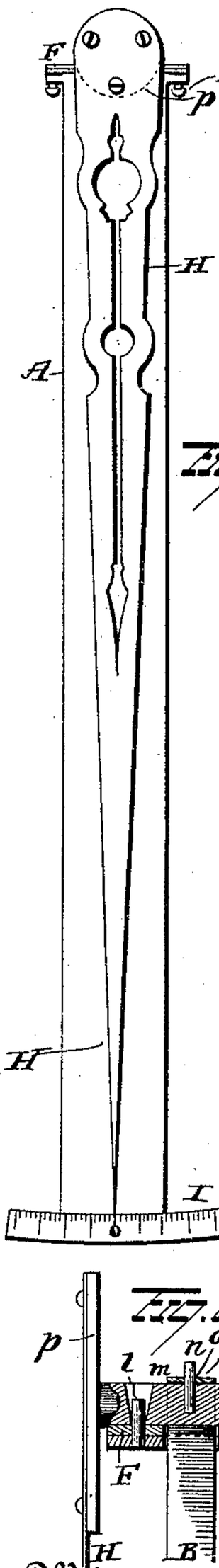

Fig. 3.

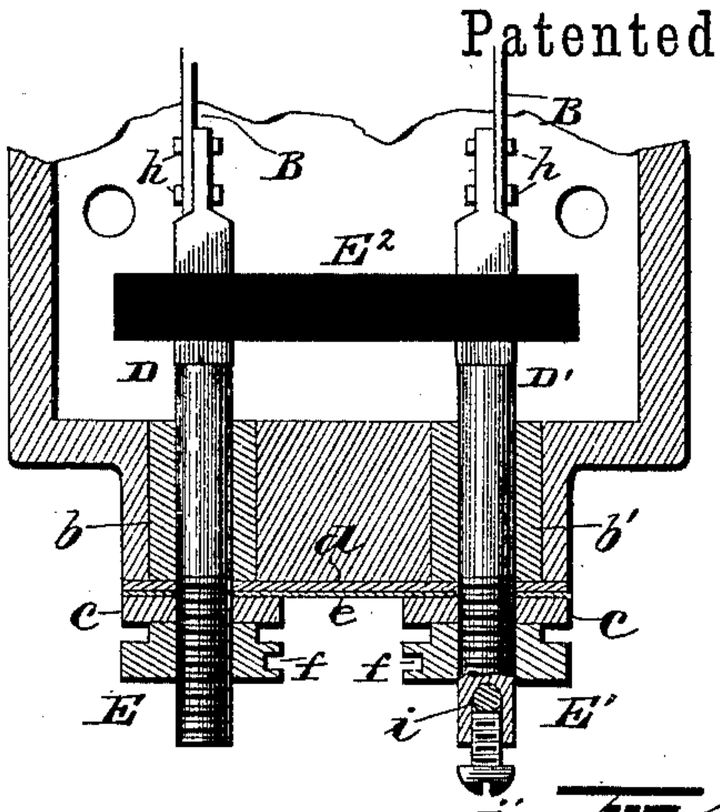

Fig. 1.

Fig. 4.

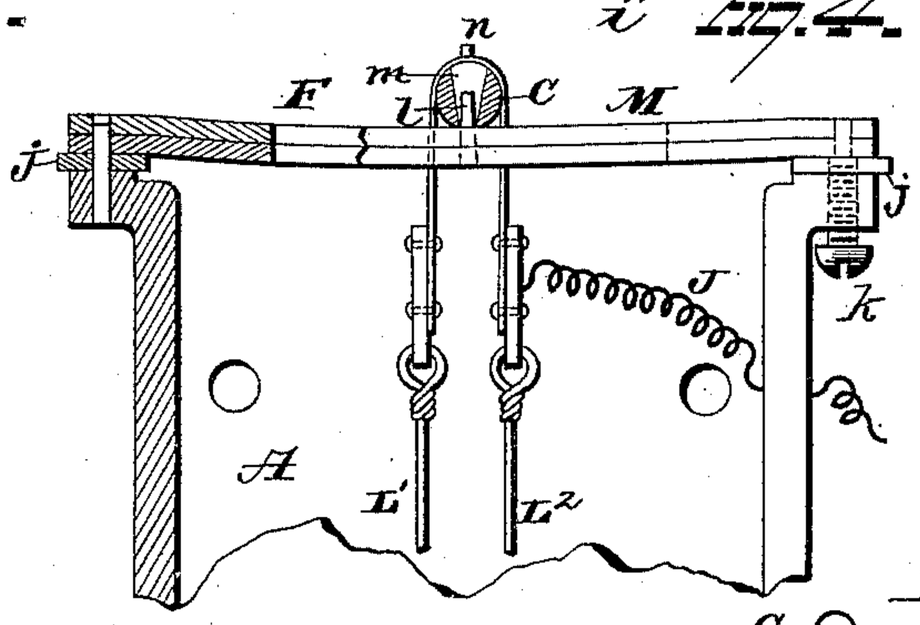

Fig. 5.

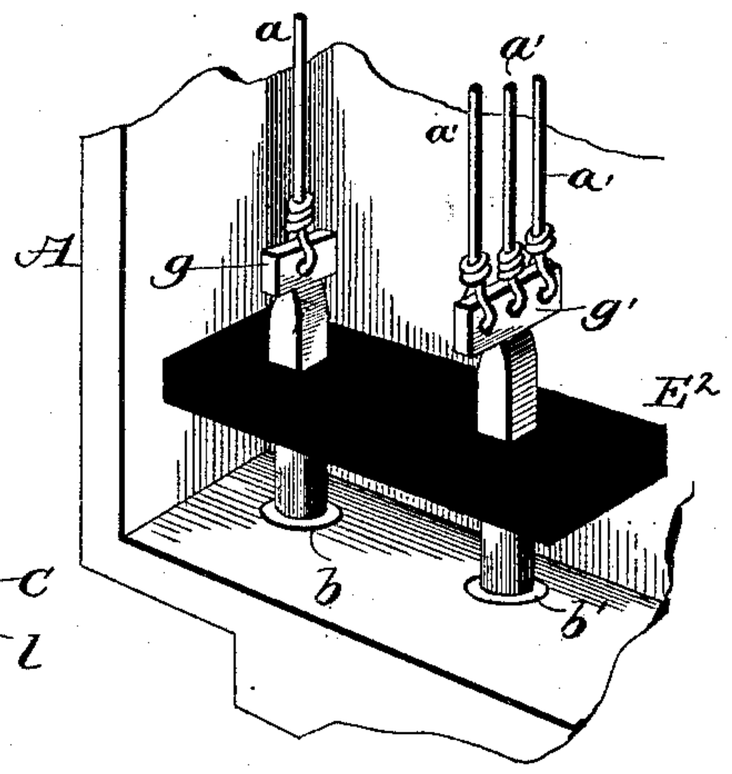

Fig. 2a.

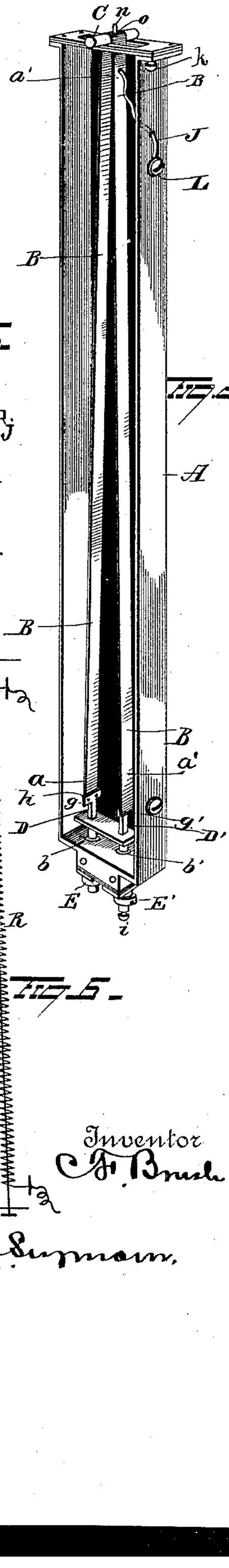

Fig. 2.

Fig. 5.

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CHARLES F. BRUSH, OF CLEVELAND, OHIO.

AMMETER.

SPECIFICATION forming part of Letters Patent No. 466,953, dated January 12, 1892.

Application filed November 21, 1889. Serial No. 331,120. (No model.)

To all whom it may concern:

Be it known that I, CHARLES F. BRUSH, a resident of Cleveland, in the county of Cuyahoga and State of Ohio, have invented certain new and useful Improvements in Ammeters; 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 invention relates to an improvement in ammeters, the object being to measure and indicate the strength of an electrical current by the differential action of mechanism due to the heat generated by the current to be measured or by a portion of it; and with this end in view the invention consists in certain features of construction and combinations of parts, as will hereinafter be described, and pointed out in the claims.

In the accompanying drawings, Figure 1 is a view of one embodiment of my invention. Fig. 2 is a similar view showing the parts inside the casing. Fig. 2ª is a detached view partly in section, illustrating the rock-shaft and adjacent parts. Fig. 3 is a detached sectional view of the screw-rods, insulating-sleeve, and adjusting-nuts. Figs. 4, 5, and 6 are details and modifications.

A is box or casing, which may be made of cast-iron or other material,

B represents a thin flexible ribbon of German silver or other suitable alloy or metal, which passes around a rock-shaft C. At the lower end of the casing the ends *a a'* of the ribbon are fastened to the screw-rods D D', which extend through insulating-sleeves *b b'*, inserted in the lower end of the box. Washers *c c'* surround the screw-rods and are seated upon suitable insulating material, such as asbestus *d* and mica *e*, or both, as shown, in order that the washers and screw-rods shall be insulated from the casing and from each other.

E E' are adjusting-nuts, which may be square for the attachment of a wrench or provided with radial holes *f* for the insertion of a pin to rotate and adjust them to regulate the tension of the ribbons. To connect the ends of the ribbons firmly to the screw-rods, I construct the latter with enlarged flattened ends *g g* and fasten the ends of the ribbon to them by rivets *h*. Screw-rod D' is provided with a hole *i*, into which is inserted one end of the circuit in which the instrument is to be included, and with a set-screw *i'* for clamping the end of the conductor, whereby the screw D' forms a binding-post.

E^2 is a block of vulcanized fiber or other suitable insulating material, which is perforated at its ends for the reception of the screw-rods and serves as a spacing-block and guide for them.

At the upper and open end of casing A is located a spring F, which may be made of a single steel plate or of two or more, two being shown in the drawings. Spring F is seated upon washers *j j* and a set-screw *k*, by which it may be adjusted so as to bring the pointer H in proper relation with the scale I. The rock-shaft is constructed and arranged to have a rocking or rolling bearing on the spring, as will be hereinafter explained. To the spring are secured the pins or studs *l*, which enter the smaller ends of the conical holes *m* in the rock-shaft, and while serving to retain the latter against displacement permit it to rock backward and forward on the spring. In view of the fact that the rock-shaft presses with great force against the spring F, owing to the high tension to which the ribbon is subjected, it is important that provision be made for decreasing the friction and wear of the bearing-surfaces of the rock-shaft and spring to the minimum to insure a sensitive and reliable operation of the instrument for any considerable period of time. I have found by practical tests that a knife-edge bearing will soon deteriorate to such an extent as to impair the action of the instrument, and hence I have adopted the construction shown in the drawings, by which I secure a rolling contact of the parts and very much lessen their wear and friction. A pin *n*, fastened to the rock-shaft, passes through a hole *o* in the ribbon and prevents the latter from slipping on the rock-shaft and causes the latter to rotate in response to the contraction and expansion of the ribbon, as will be hereinafter explained. On one end of the rock-shaft is fastened a disk *p*, to which is secured the hand or pointer H, the free end of which

moves over an indicating-plate I, which latter may be furnished with a scale such as is ordinarily used in ammeters. The pointer is made quite long and the rock-shaft quite small in its diameter, in order that a slight rocking movement of the latter will move the free end of the pointer through a considerable space to indicate clearly on the plate I such movement, however slight it may be. To the part a' of ribbon B is connected a flexible electric conductor J, which latter is secured at its opposite end to the binding-post L, attached to the casing.

Having described the construction and arrangement of the several parts of the instrument, I will now briefly describe its operation. The adjusting-nuts E E' are first turned down, so as to impart considerable strain upon and tension to the two parts a a' of the ribbon B and spring F. When properly adjusted, the hand H will point to zero on the indicating plate or scale I. When the current to be measured is passed through the instrument, it enters at the binding-post and flows through part a' of the ribbon and escapes through the flexible conductor J and binding-post L. Hence it will be observed that while both parts a a' of the ribbon B and the spring F are under tension such two forces counterbalance each other and the rock-shaft is retained in a state of equilibrium, being always acted upon by these two counterbalancing forces. While varying temperatures will modify the force exerted by spring F upon the rock-shaft, owing to the expansion and contraction of the two parts a a' of the ribbon, due to changes in temperature, still such variations will have no effect upon the pointer, because both parts a a' are acted upon alike, and hence an equilibrium of forces is maintained. However, when the electric current is caused to flow through the instrument the current heats part a' of the ribbon, owing to its resistance to the passage of the current, and the degree of heat to which the part a' is subjected varies with the strength of the current flowing through it. The heating effect of the current operates to expand part a', and as it slackens it relieves spring F of a portion of its restraining force, and thus allows it to retract; but, owing to the fact that the part a of the ribbon is not expanded by the heat generated by the current, it still exerts its normal restraining force on the spring, the result of which is that the latter will partially rotate the rock-shaft and cause the pointer to move over the indicating-plate, the extent of movement being dependent upon the strength of the current flowing through part a' and the consequent degree of heat to which it is subjected thereby. It will thus be observed that the operation of the instrument is not due to the amount of heat to which part a' of the ribbon is subjected, but to the difference in heat to which the two parts a a' of the ribbon are subjected, which difference is due to the passage of the electric current through one of them. The metal is preferably disposed in the form of a ribbon, because in such form it is best exposed to the action of the air and readily expands and contracts, and thus insures a prompt and sensitive action of the instrument.

Instead of employing a ribbon B, I may use two wires L' L^2, as illustrated in Fig. 4, the wires being connected at their upper ends to the opposite ends of a short strip of metallic ribbon M, which passes around the rock-shaft.

Instead of using one conductor in the form of a ribbon or wire for the passage of the current to be measured, I may use any desired number. In Fig. 5 I have represented three wires a' a' a' for the passage of the current and one wire a as a counter-balance. In this construction two of the wires a' are adjusted so as to be slack, while the tension of one of the wires a' is adjusted so as to equal the tension of the wires a. When the instrument is placed in the circuit of the current to be measured, the current will divide itself equally between the three wires a', and hence in this construction the pointer will be actuated by the heat due to one third of the total strength of the current flowing in the circuit. Again, instead of passing the current through the wire a' the current may be caused to flow through a long helix R, encircling wire a' and transmit heat to the latter, as illustrated in Fig. 6.

As it is evident that many changes in the construction and relative arrangement of the parts of my improvement in ammeters may be made without involving a departure from the principle of the invention, I would have it understood that I do not restrict myself to the particular construction or arrangement of parts shown and described; but,

Having fully described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. In an ammeter, the combination, with a yielding plate, of a rock-shaft mounted thereon, means for limiting the movements of said rock-shaft in both directions, a pointer or indicator secured to one end of said rock-shaft, a double flexible conductor secured at its ends and connected at a point between its ends with said rock-shaft, and means for causing one part of said conductor to have its temperature altered relatively to the other part of the conductor by the current to be measured and thereby cause a partial rotation of the rock-shaft and with it a movement of the indicator or pointer to indicate the strength of the current on a scale or graduated plate, substantially as set forth.

2. In an ammeter, the combination, with a spring provided with studs, one or more, of a rock-shaft provided with conical holes into which said studs project, and a conductor connected with said rock-shaft and arranged to have the comparative temperatures of the

two parts of said conductor altered by the current to be measured, substantially as and for the purpose specified.

3. In an ammeter, the combination, with a spring and a rock-shaft fulcrumed thereon, of a metallic ribbon passing around the rock-shaft, means whereby the comparative temperatures of the two parts of said ribbon may be altered by the current to be measured, and a pin for retaining the ribbon against displacement, substantially as and for the purpose specified.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

CHARLES F. BRUSH.

Witnesses:
J. POTTER,
SIDNEY H. SHORT.