Oct. 25, 1932. T. J. SMULSKI 1,885,052

ELECTROTHERMAL APPARATUS

Original Filed May 31, 1930

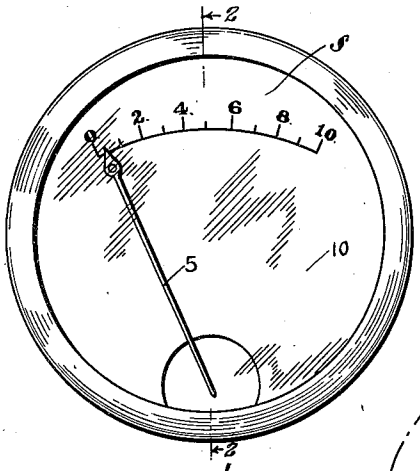


Fig. 1.

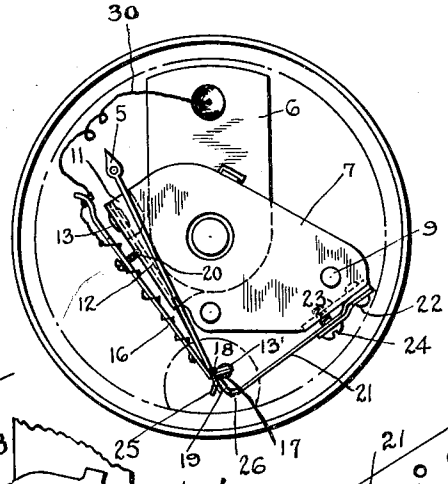


Fig. 3.

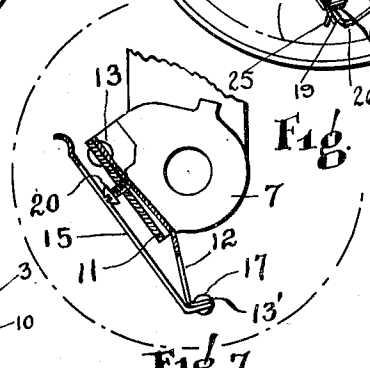


Fig 7

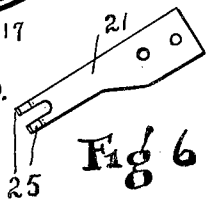


Fig 6

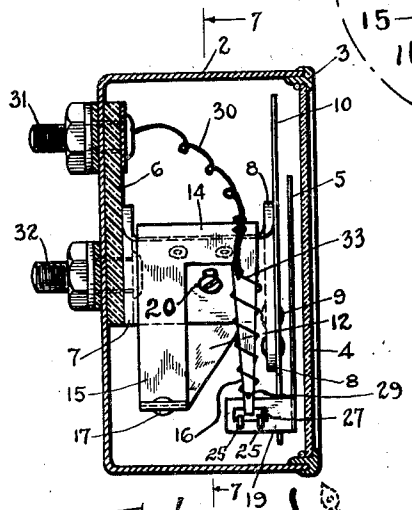


Fig. 2.

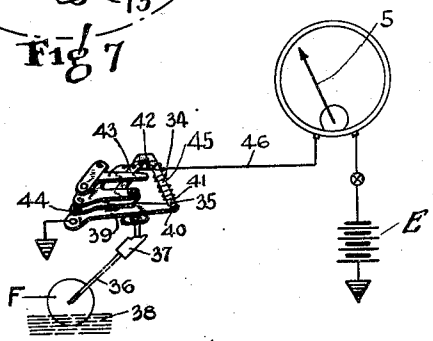


Fig. 5.

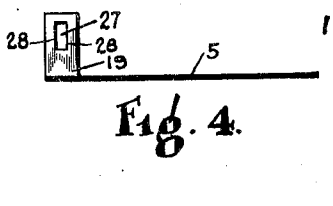


Fig. 4.

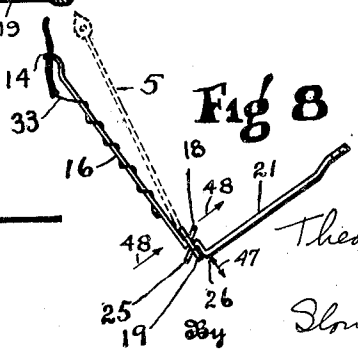


Fig 8

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UNITED STATES PATENT OFFICE

THEODORE J. SMULSKI, OF GARY, INDIANA, ASSIGNOR TO THE ANDERSON COMPANY, OF GARY, INDIANA, A CORPORATION OF INDIANA

ELECTROTHERMAL APPARATUS

Application filed May 31, 1930, Serial No. 458,595. Renewed April 28, 1932.

My invention relates to electro-thermal apparatus and relates more particularly to the provision of improved electro-thermal apparatus susceptible of use as a receiving unit of electrical systems of certain improved types.

My invention pertains particularly to the provision of an improved electro-responsive mechanism adapted to continuously indicate the integrated value of a force exerted or movement taking place at a point disposed remotely to the mechanism.

An object of my invention is to provide an improved electro-responsive mechanism for the continuous indication of a remotely exerted force.

Another object of my invention is to provide an improved electro-responsive mechanism for remotely indicating the value of a remotely exerted force, and/or movement.

Another object of my invention is to provide an improved efficient and reliable indicator mechanism, which may be inexpensively manufactured in quantity production.

Another object of my invention is to provide an improved efficient and reliable indicator mechanism, which is capable of being readily adjusted in factory quantity production so as to interchangeably commensurably indicate the value of a remotely exerted force, and/or movement.

Another object of my invention is to provide improved adjusting means for an electro-responsive mechanism.

Another object of my invention is to achieve in an improved substantially frictionless manner, in an electro-responsive mechanism, the multiplication of a slight movement to effect a greatly increased movement of a part of the mechanism such as an indicator hand.

Another object of my invention is to provide an improved zero-setting adjustment for an electro-responsive mechanism of the general type herein disclosed.

Another object of my invention is to provide an improved adjustment to predetermine the responsiveness of the instrument to any operative electrical effort effective upon it.

Other objects of my invention and the invention itself will be readily understood from the following description of an embodiment of my invention, in which reference is had to the accompanying drawing, wherein—

Fig. 1 is a plan view of an instrument embodying the principles of my invention;

Fig. 2 is a section taken on the line 2—2 of Fig. 1;

Fig. 3 is a view in plan of the indicator mechanism of the foregoing figures with the dial plate of Fig. 1 removed to expose the inner parts;

Fig. 4 is a side elevational view of the indicator hand of the foregoing figures;

Fig. 5 is a diagrammatic view of an electrical system wherein the indicator of the foregoing figures is susceptible of being advantageously included;

Fig. 6 is an elevational view of a leaf spring tensioning element for the apparatus of Figs. 1 to 3 inclusive;

Fig. 7 is a section taken on the line 7—7 of Fig. 2;

Fig. 8 is a plan view of certain only of the operative parts of the apparatus of Figs. 1 to 3 inclusive, the other parts being omitted in this view.

Referring now to the different figures of drawing in all of which like parts are designated by like reference characters, the mechanism which is an embodiment of my invention, illustrated therein is provided with a case comprising a sheet metal cup 2, supporting on its rim an annulus 3 which in turn supports a glass disk 4 through which the indicator hand 5 may be viewed.

The cup 2 is provided with cylindrical side walls and a planular end wall and to the latter interiorly of the cup is secured an insulating plate 6 and a metal bracket 7 superposed on said plate 6 and insulated thereby from the metal wall of the cup 2.

The bracket 7 is provided with a dial supporting flange 8 to which by means of rivets 9 a dial plate 10 is secured disposed in close spaced parallel relation to the glass disk 4, underlying the same, and the indicator hand 5 is disposed intermediate said dial frame and glass disk. To the web 11 of the bracket 7 a leaf spring 12 is secured by its end at 13, and is provided with an obtusely bent tip 13′ which supports a substantially U-shaped bi-

metallic strip 14 by its arm 15 which preferably is made wider than its other arm 16, the tip 13′ and the end of the bi-metallic arm 15, likewise obtusely bent, being riveted together by a rivet 17.

The narrower arm 16 of the bi-metallic strip terminates in an acutely bent tip 18 for engagement with the slotted thin sheet metal support 19 for the integrally formed hand 5. An adjustment screw 20 screw threaded through the bracket web 11 engages by its end with the spring 12 and thereby is adapted to deflect the spring 12 to move the bi-metallic strip supported by it, to adjust the zero position of the pointer hand 5. A second leaf spring 21 is secured by its end by a rivet 22 to a flange 23 of the bracket 7 and an adjustment screw 24 screw threaded into said flange is adapted when adjustably rotated to tend to swing the free end of the spring 21 about its fixed end. At the free end of the spring 21 the spring is bent abruptly at right angles to provide a short portion 26 which in turn supports an acutely bent tip end 25.

The tips 18 and 25 for the bi-metallic strip arm 16 and the spring 21 respectively are preferably disposed in approximately parallel spaced relation, when in normal operative position as shown and under such conditions the portion 26 of the spring 21 extends in a plane parallel to that of the main portion of the bi-metallic strip 16.

The hand 5 is provided with a supporting plate portion 19 in the form of a rectangular piece of thin sheet metal with an elongated rectangular aperture 27 therethrough having its parallel bordering edges 28 preferably rounded or pointed, to produce so-called knife edges adapted to be engaged by the hook-like tips 18 and 25 of the bi-metallic strip 16 and spring 21 respectively, when these tips are projected through the rectangular aperture 27, and the spring pressure of the spring 21 exerted outwardly from the end of the bi-metallic strip to place a hand supporting apertured plate in tension under suspension therebetween.

By referring particularly to Figs. 2 and 6, the spring 21 is shown to be bifurcated at its free end to provide two of the hooks 25, whereas the narrowed end of the bimetallic arm 16 is provided with only one hook adapted for positioning within the aperture 27 between the companion hooks 25 for the spring 21.

This provides a three-point contact with the portions of the plate 19 bordering the aperture whereby greater uniformity of result is had, particularly in cases where the plate 19 may be slightly bent or otherwise deranged during manufacturing processes.

The outward pull on the thin plate 19 is regulated by varying the tension of the spring 21 by turning the screw 24. With the parts in normal position, substantially as shown, the plate will tend to assume the position shown wherein it occupies a plane intermediate and parallel to the planes of the main portion of the bi-metallic strip 16 and the portion 26 of the spring 21.

The leaf spring 21 tends to move its hooked end 25 in the directions indicated by the arrow 47, which is in longitudinal alignment with the bi-metallic strip 16 which supports the hook 18. Therefore, any adjustment by the screw 24 tending to increase or decrease the pull exerted by the hook 25 on the plate 19, when the instrument is in normal de-energized condition, as shown in Fig. 3, will not tend to rotate the plate 19. The hand 5 supported by the plate 19 will therefore remain in a stationary position at the zero point on the scale 10.

Should the bimetallic strip 16 be heated so as to move its hooked tip 18 in the arcuate direction indicated by the arrows 48, which will change the angular position of the plate 19 to move the end of the pointer hand 5 over the scale 10 towards the higher numerals on such scale, then in such a case turning the screw 24 to increase the pull exerted by the hook 25 on the plate 19 will reduce the amount of movement of the hand 5 because of such arcuate movement of the tip end of the bimetallic strip 16.

I find that the adjustment of the pull exerted by the free end of the spring 21, is of such a nature that the effect on the deflection of the hand 5 is proportional over the entire range of movement of the hand 5 so that the sensitiveness of the instrument may be accurately predetermined in this manner.

The arm 16 of the bi-metallic strip 14 is provided with an electrically heating element 33 preferably in the form of an electrical resistance conductor wound thereon in good thermal relation thereto, one end thereof being preferably soldered, as at 29, to the arm 16, the other being connected with an electrical circuit conductor of preferably relatively low resistance shown at 30, which leads to and is connected to the electrical terminal bolt 31, which is employed, as well, to clamp the insulating plate 6, to the end wall, but which is electrically insulated therefrom.

A second electrical terminal 32 in the form of a bolt serves also to clamp the bracket 7, the insulating plate 6, and the cup end wall, together, and electrically conducts current from the soldered end of the electrical heating conductor through the bi-metallic strip 14, supporting spring 12 and bracket 7 to the exterior of the casing. The yoke portion intermediate the arms 14 and 16 is bent to prevent longitudinal flexure thereof.

The apparatus described is energized by directing an electrical current through the heating element 33, by connecting electrical circuit conductors conveying such current

thereto, from a source of current, and thereby heating the motivating arm 16 of the bi-metallic strip, which thereupon according to a well known principle, is warpingly defected to move its free end carrying the hook 18 in such a direction as to swing the plate 19 about its point of engagement with the hooked end of the spring 21. This, because of the considerable length of the hand 5 relative to the width of the aperture 27, of said plate, results in a greatly multiplied movement of the pointer end of said pointer hand over the scale S which is suitably inscribed on the face of the dial plate 10.

The strip arm 16 will warp and therefore move its free end commensurably to its rate of heating and inversely commensurably to the rate of which it loses heat, and therefore according to the amount of current flow through the heating element 33, and the hand pointer will move over the marked scale commensurably to the amount of electrical current flow.

The arm 15 of the bi-metallic strip 14, does not have an electrical heating element in thermal relation especially thereto, but supports the motivating arm 16, and being alike exposed therewith, to the temperature of ambient air in contact with both strips, independently of electrical heating, compensates the motivating strip for changes in atmospheric temperatures to which the indicator mechanism is exposed.

Referring now to Figure 5, a simple system embodying the principles of a system to which the embodiment of my invention is particularly applicable, is shown diagrammatically. In said system an electrical current from a source E is serially directed through the indicator mechanism I disclosed herein and an electrical heating element and pair of contacts 34 and 35 respectively of an actuating mechanism responsive to a liquid level.

In the said liquid level actuated mechanism a float F, carried on an arm 36 rigidly extending from an eccentric pivoted cam 37 rotates the cam upon changes of level of liquid 38 to laterally deflect an element herein shown, for simplicity of illustration, as a contact carrying leaf spring 39. Lateral deflection of the spring 39 advances or retracts its carried contact 40 relative to the contact 41 carried on the free end of a U-shaped bi-metallic strip 42 supported by its compensating arm 43 at 44, and whose motivating arm 45 carries a heating element 34, one end of which is connected to a circuit conductor 46 and the other end to the contact 41 of the set of contacts 35 comprising contacts 40 and 41.

Whenever the contacts are closed current flows therethrough simultaneously through the heating elements of the actuating mechanism and the indicating mechanism from the source E and effects a movement of the hand 5 of the indicator in the manner previously described and thermally warps the bi-metallic arm 45 of the actuator until contact is broken between the contacts of the set 35.

Thereupon, and periodically thereafter, the contacts of the set 35 are broken and reengaged to keep the contacts in engagement for such a part of the total time as will so warp the strip 45 to a position corresponding to the position at the time taken by the contact 40. As the contact 40 is advanced the periods of current flow due to closure of the contacts will be relatively longer compared to the intervening periods when no current is flowing due to separation of the contacts, and vice versa.

The indicator will be energized by the heating effect of the periodic impulses of electrical current through the element 34, commensurably to the strength of the current impulses, the length of the current impulses relative to the intervening periods when no current is flowing and the thermal properties of the heated parts, such as the ability to store heat and the rate at which heat is dissipated therefrom.

The spring plate 12 is made relatively stiff by increasing its width from the tip portion 13' towards the supported end where it is secured to the web 11 of the bracket 7. The compensating arm 15 of the bi-metallic strip 14 is likewise made relatively stiffer than the motivating arm 16 by making it of substantially greater width. In this manner, the supporting parts 12 and 15 for the electrically heated bi-metallic strip 16 are relatively more rigid to provide a relatively firm support therefor.

Having described an indicator mechanism which is an embodiment of my invention, specifically, my invention is not to be considered as limited thereto, or to indicators, since the principles of my invention are susceptible to embodiment in mechanisms varying widely from that shown and described and may be embodied in such mechanisms as recorders or the like.

I claim as my invention:

1. In an indicator mechanism the combination with an indicator hand, an apertured support therefor, said hand secured to said support and projecting therefrom, an actuating element for said hand comprising an actuating arm and a hook projected through said apertured support movable by said arm in a direction lateral to said support, a second hook projected through said apertured support and spring means tending to separate said hooks, said hooks engaging oppositely disposed edges of the support bordering the aperture.

2. In an indicator, an indicating element therefore, a motion multiplying communicating link mechanism for said element, com-

prising a thin frame, means comprising a pair of nooks both projected between closely adjacent elements of said frame and engaging opposing edges of the said frame elements and means resiliently tending to separate said hooks so as to exert a pull on the frame, and motivating means for the indicator adapted to move one of said hooks laterally of said frame.

3. In an indicator mechanism, the combination with an indicator element, a support therefor comprising a pair of spaced arms, a sheet metal strip supported by a fixed end and having a free end arcuately movable within a range of movement so small that its movement is substantially rectilinear, energizing means for said strip to cause it to variably move its free end within said range according to the intensity of said energization, a resilient calibrating element, said strip and said calibrating element hingedly connected to different of said arms, said calibrating element exerting a pull on its associated arm to place the support under tensile stress between said calibrating element and the free end of said strip.

4. In an indicator, an indicating element, a motion multiplying link comprising a relatively thin frame, a pair of hooks inserted between closely adjacent elements of said frame and engaging opposing surfaces thereof, a spring tending to move one of said hooks in a direction opposite to the other hook in the plane of said frame, and motivating means adapted to move the other hook laterally of said frame.

5. In an electro-responsive mechanism, a movable element therefor, a motion multiplying link mechanism for said element comprising a frame, motivating means having an actuating portion movable approximately rectilinearly and adjustable resilient means, said resilient means and the actuating portion of said motivating means making slightly separated hinging engagement with said frame, said resilient means exerting an adjustable resilient pressure effort on the frame tending to move it in a direction at right angles to said motivating means portion.

6. In an electro-responsive mechanism, a movable element, a support therefor, said support and element rotatable as a unit about an axis disposed within a portion of said support, motivating means for the support making hinging engagement therewith by a portion of the support slightly spaced from said axis and adjustable resilient means for calibrating said mechanism, hingedly engaging said support by its portion containing its said axis, and exerting an effort thereupon in a direction approximately at right angles to the direction of movement of said motivating means portion when moving from normal position thereof.

7. In an electro-responsive mechanism, a movable element, an apertured support therefor, a resilient motivating and an adjustable resilient retractive means therefor, both hingedly engageable with said support at slightly separated portions thereof, said motivating means operatively movable approximately rectilinearly, said retractive means exerting an adjustable stress upon said support, in a direction at approximately right angles to the direction of said motivating means.

8. In an electrical indicator, the combination of a bi-metallic strip, thermally compensating means therefor, an electrical heating element disposed on said strip and adapted to communicate heat thereto upon a flow of electrical current through the element, said strip supported by an end and having a free end laterally movable in a nearly rectilinear direction upon changes of temperature experienced by the strip, a pointer, a rotatable support for the pointer, resiliently yieldable retractive means for the support engageable therewith by a portion thereof approximately disposed in the axis of rotation of the support, tending to move said support in a direction at approximately right angles to the direction of movement of the free end of said strip, said strip making hinging engagement with said support by a portion disposed slightly out of the axis of rotation thereof.

9. In an electrical indicator, the combination of a bi-metallic strip, thermally compensating means therefor, an electrical heating element disposed on said strip and adapted to communicate heat thereto upon a flow of electrical current through the element, said strip supported by an end and having a free end laterally movable in a nearly rectilinear direction upon changes of temperature experienced by the strip, a pointer, a rotatable support for the pointer, resiliently yieldable retractive means for the support engageable therewith by a portion thereof approximately disposed in the axis of rotation of the support, tending to move said support in a direction at approximately right angles to the direction of movement of the free end of said strip, said strip making hinging engagement with said support by a portion disposed slightly out of the axis of rotation thereof, supporting means for the fixed end of said strip and adjustable means to slightly adjustably rotate the strip by its fixed end.

10. In a thermostatically operable indicating device, the combination with a thermostatically movable means, an electrical heating element therefor, an indicator element, retractive means, and a support for the indicator element suspended entirely between a movable portion of said thermostatically operated means and said retractive means.

11. In an electro-responsive mechanism, a movable element therefor, a motion multi-

plying link mechanism for said element comprising a frame, a motivating means having an actuating portion movable approximately rectilinearly and resilient means, said resilient means and the actuating portion of said motivating means making slightly separated hinging engagement with said frame, said resilient means exerting resilient pressure effort on the frame tending to move it in a direction at right angles to said motivating means portion.

12. In an electro-responsive mechanism, a movable element therefor, an apertured support, a resilient motivating and resilient retractive means therefor, both hingedly engageable with said support at slightly separated portions thereof, said motivating means operatively movable approximately rectilinearly, said retractive means exerting stress upon said support, in a direction at approximately right angles to the direction of said motivating means.

In testimony whereof I hereunto affix my signature this 26th day of May, 1930.

THEODORE J. SMULSKI.