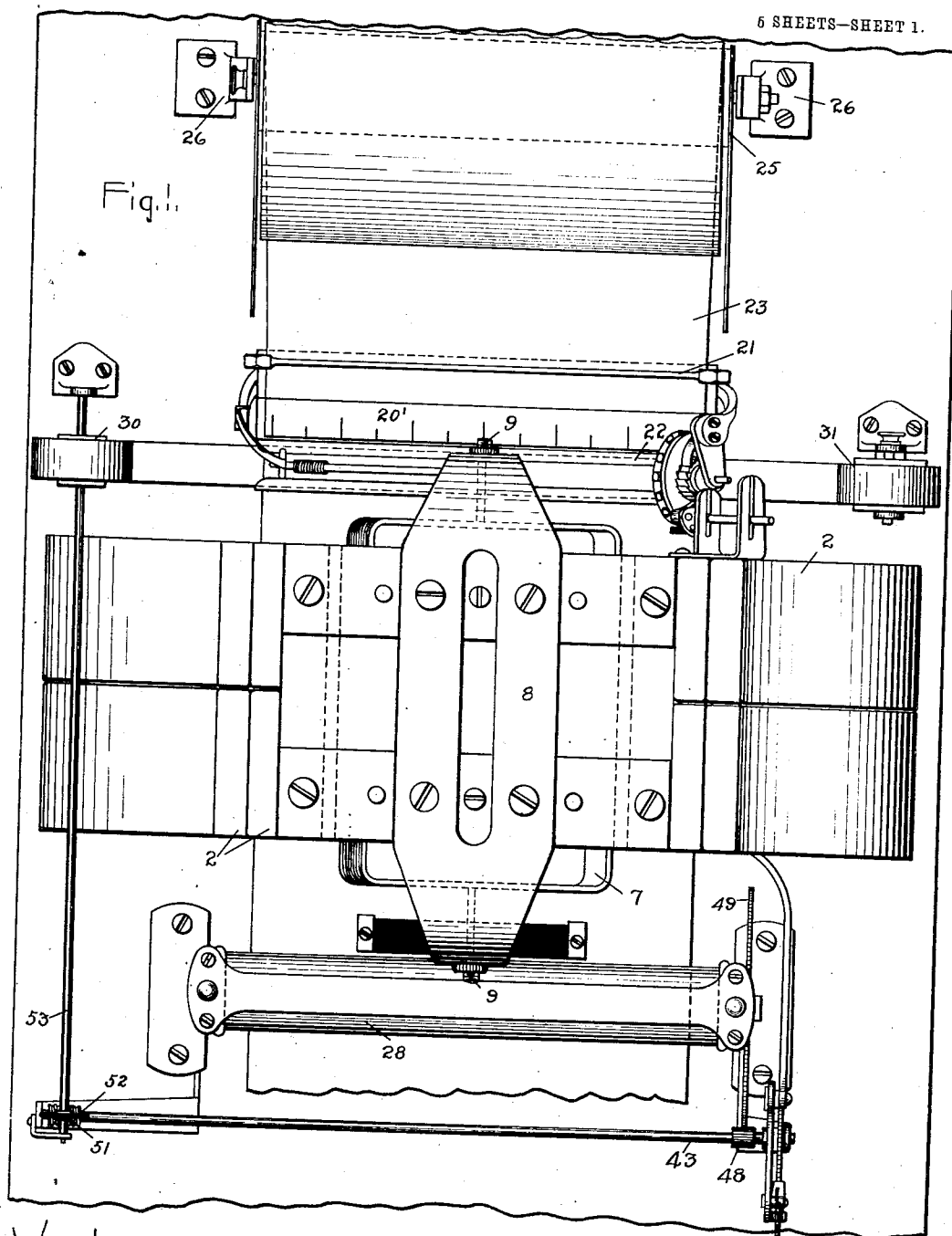


No. 839,436.

PATENTED DEC. 25, 1906.

E. THOMSON.
CURVE DRAWING INSTRUMENT.
APPLICATION FILED MAR. 30, 1903.

5 SHEETS—SHEET 1.



WITNESSES:

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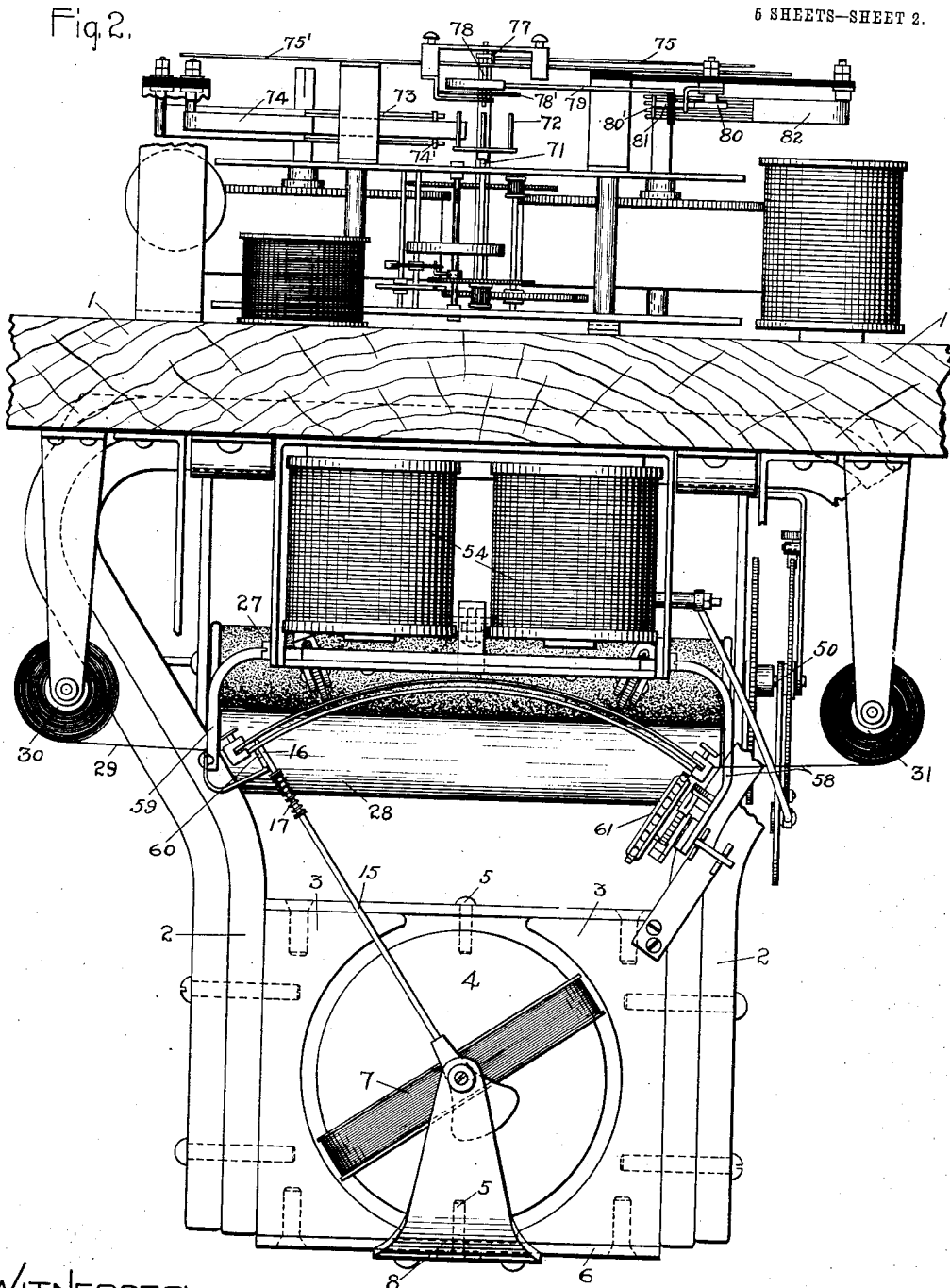
Elihu Thomson,
by *Albert H. Davis*
Att'y.

No. 839,436.

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E. THOMSON.
CURVE DRAWING INSTRUMENT.
APPLICATION FILED MAR. 30, 1903.

5 SHEETS—SHEET 2.



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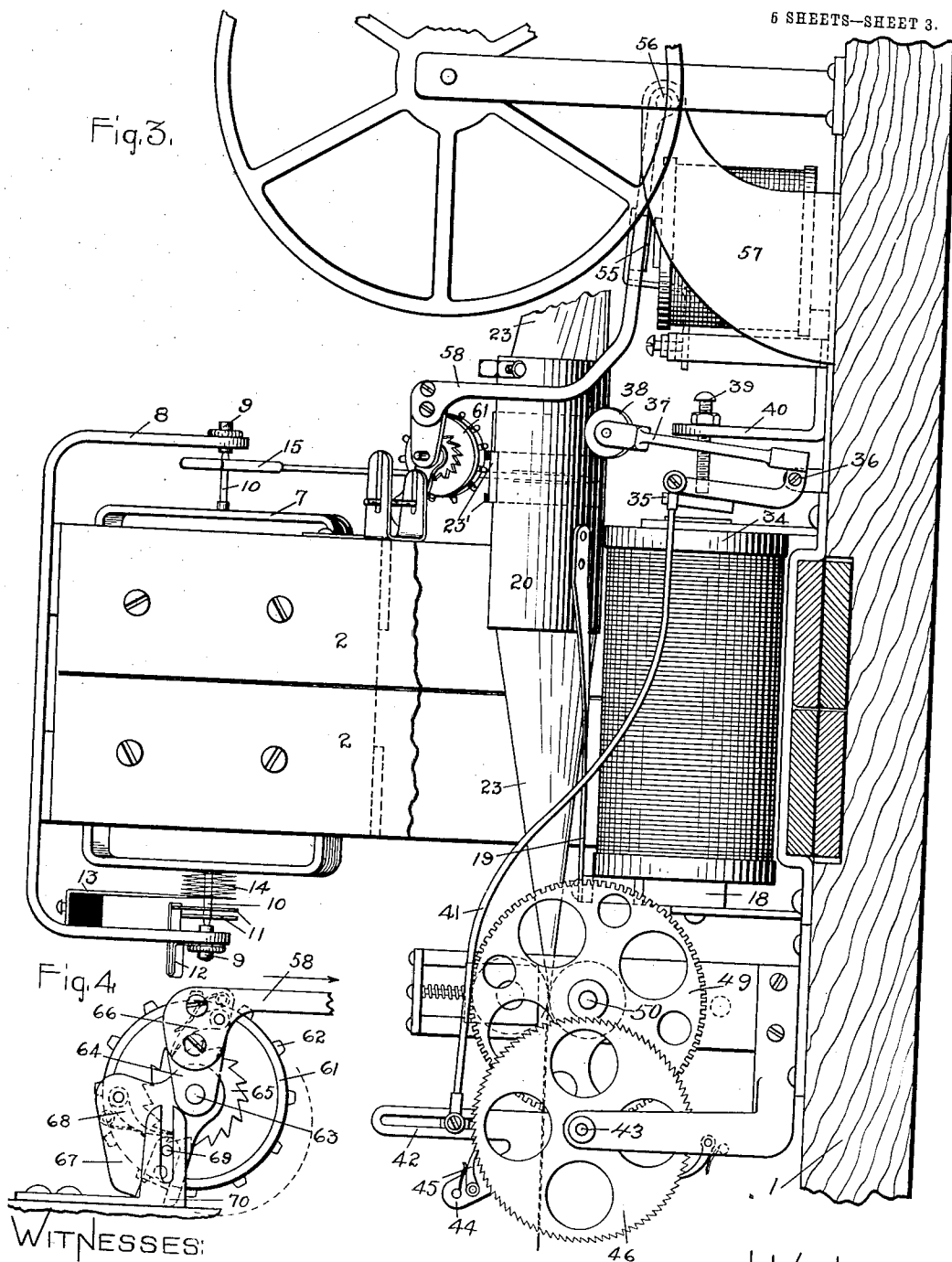
No. 839,436.

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E. THOMSON.
CURVE DRAWING INSTRUMENT.
APPLICATION FILED MAR. 30, 1903.

6 SHEETS—SHEET 3.

Fig. 3.



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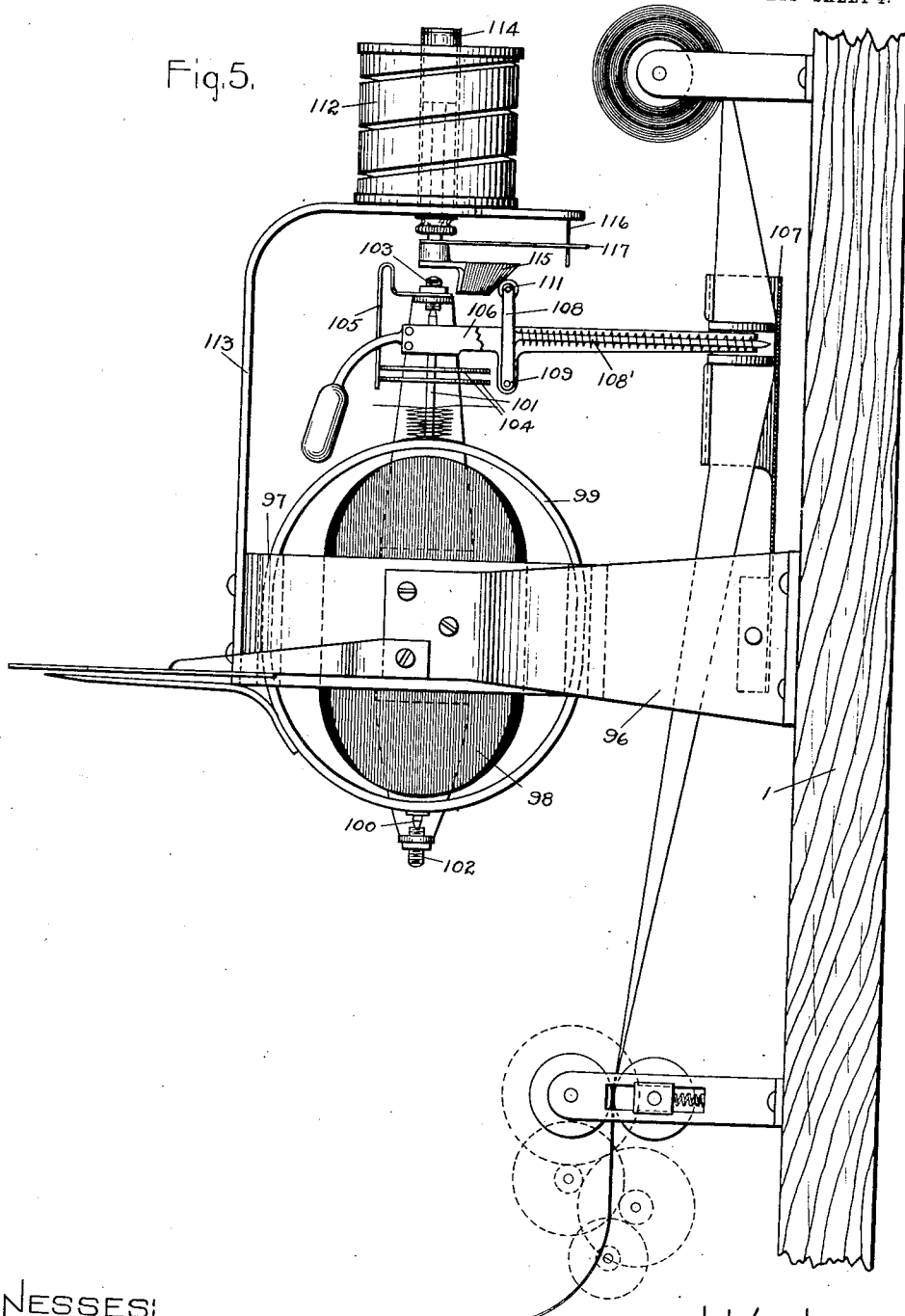
No. 839,436.

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CURVE DRAWING INSTRUMENT.
APPLICATION FILED MAR. 30, 1903.

5 SHEETS—SHEET 4.

Fig. 5.



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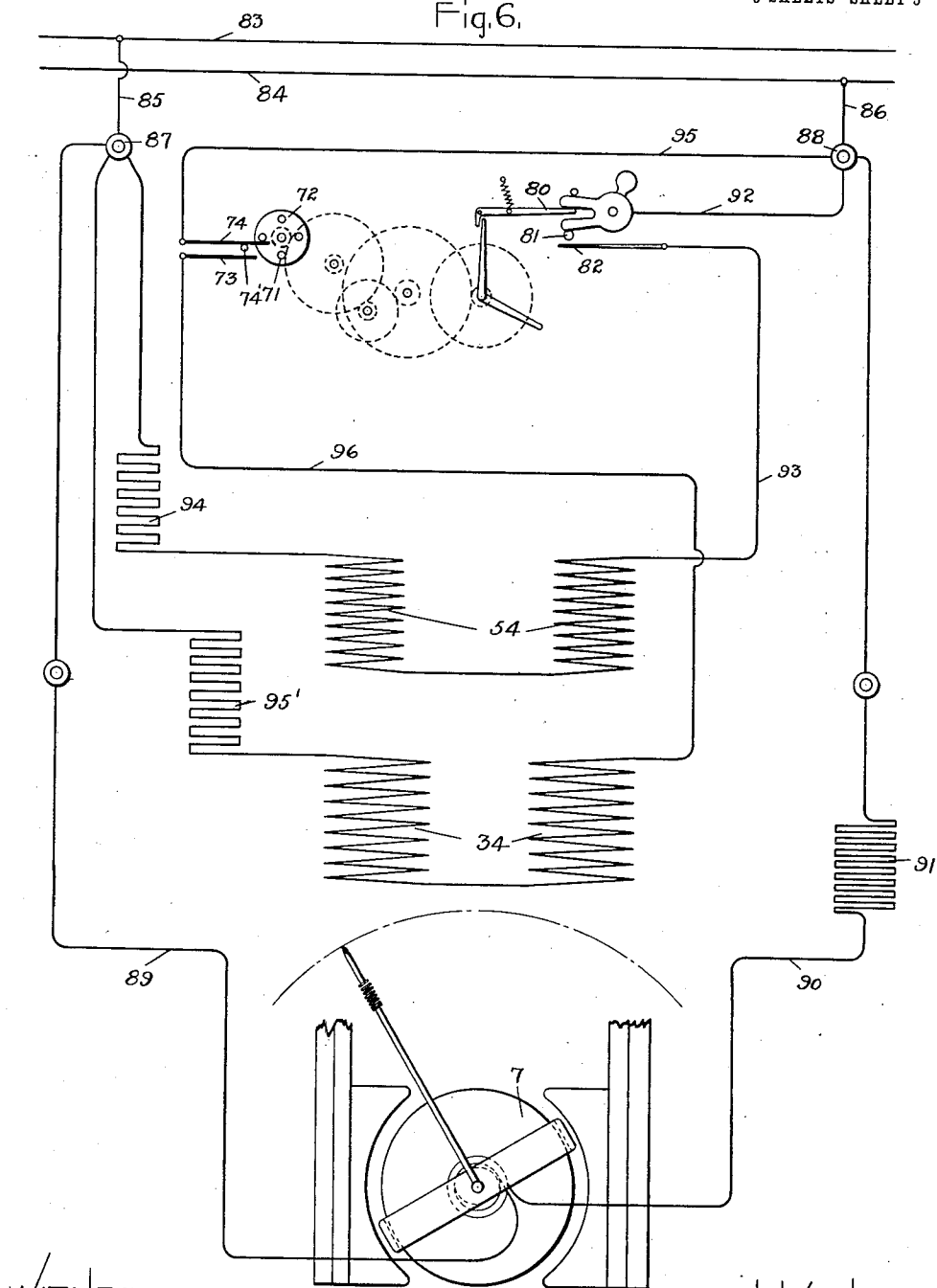
No. 839,436.

PATENTED DEC. 25, 1906.

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CURVE DRAWING INSTRUMENT.
APPLICATION FILED MAR. 30, 1903.

6 SHEETS—SHEET 5

Fig. 6.



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INVENTORI:

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by Alb. H. Davis
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UNITED STATES PATENT OFFICE.

ELIHU THOMSON, OF SWAMPSCOTT, MASSACHUSETTS, ASSIGNOR TO
GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

CURVE-DRAWING INSTRUMENT.

No. 839,436.

Specification of Letters Patent.

Patented Dec. 25, 1906.

Application filed March 30, 1903. Serial No. 150,135.

To all whom it may concern:

Be it known that I, ELIHU THOMSON, a citizen of the United States, residing at Swampscott, in the county of Essex, State of Massachusetts, have invented certain new and useful Improvements in Curve-Drawing Instruments, of which the following is a specification.

The object of my invention is to improve the construction of instruments in which a record is obtained showing the different values of a variable quantity.

More particularly, my invention relates to an instrument in which this record is obtained by marks made on a progressively-moving record-surface. In the particular instrument which I have hereinafter described in detail a movable record-surface is placed in proximity to but normally out of engagement with a marking element carried by the movable member of an electric meter. At intervals the marking element and record-surface engage to make an impression upon the surface. Heretofore instruments of this character have been constructed with the movable element constituted to move in a plane parallel to the surface upon which the marks are to be made. When the indicating element is pivoted and moves angularly to indicate different values of the variable quantity, the result is that unless the surface is especially ruled the different positions of the marks, corresponding to different values of the variable quantity, do not have the proper time indication. I have found that this can be avoided by causing the paper to travel along the surface of a cylinder having its axis coincident with the axis about which the pointer oscillates.

My invention also embodies other novel features of construction and arrangement to be more particularly hereinafter pointed out in the claims annexed to and forming a part of this specification.

For a better understanding of my invention reference may be had to the accompanying drawings, in which I have illustrated embodiments of my invention.

In the drawings, Figure 1 is a front elevation. Fig. 2 is a plan. Fig. 3 is a side elevation, partly in section. Fig. 4 is an enlarged view showing a detail of construction. Fig. 5 is a side elevation illustrating a modifi-

cation, and Fig. 6 is a diagram illustrating the arrangements of the circuits.

In the construction which I have illustrated in the drawings the various mechanisms are mounted upon a vertical board or support 1. In the construction illustrated in Figs. 1 to 4, inclusive, of the drawings a permanent magnet 2 is placed on the front side of the support 1. The magnet 2 consists of four horseshoe-shaped pieces of metal arranged as clearly shown in Figs. 1 and 2 of the drawings. To the outer ends of these horseshoe-shaped pieces are secured pole-pieces 3. The pole-faces are cylindrical, as shown in Fig. 2. In the space between the pole-faces is secured a cylindrical body of magnetic material 4 by means of screws 5, passing through bars or plates 6, which in turn are secured to the sides of the pole-pieces 3. A coil 7 forms the movable element of the instrument, which in the present instance is designed to be a voltmeter. The coil 7 is rectangular in shape and surrounds the cylindrical body 4. The coil 7 is pivotally supported by a bar 8, carried by the front pair of bars 6. The ends of the bar 8 are bent at right angles to the body of the bar and carry screws 9 in line with the axis of the cylindrical body 4. The screws 9 are formed with bearings in their ends, in which trunnions 10, carried by the coil 7, are supported in alinement with the axis of the cylinder 4. One or more spiral springs 11, each having one of its ends secured to the lower trunnion 10 and the other to an adjustable post 12, carried by the bar 8, exert a yielding torque, normally tending to hold the coil at one limit of its movement. Current passes to the coil 7 from insulated contacts 13 through flexible conductors 14. The upper trunnion 10 carries an arm 15, having a telescopic section 16 at its outer end. A spring 17 normally holds the section 16 extended.

A support 18, carried by the base 1, has mounted upon it a pair of substantially vertical flexible metallic arms 19. The arms 19 carry at their upper ends a cylindrical platen 20. The cylindrical platen 20 has its axis substantially coincident with the axis of oscillation of the coil 7 and is placed so that the outer end of the arm 15 swings in front of its middle portion, the platen being normally out of engagement with it.

Curved guides 21 and 22 and a scale 20' are placed on the front side of the platen. The guide 21 is placed at the top of the platen 20 and consists of a rod or wire curved concentrically with the platen and separated therefrom at a distance sufficient to allow the record sheet or strip of paper 23 to pass readily between the platen and the guide. The guide 22 consists of a strip of sheet metal also curved concentrically with the platen and having its edges turned over to form channels, as indicated at 23'. The strip 22 is cut away between its edges in front of the path of the end of the arm 15. The scale 20' is placed immediately above the guide 22. The scale 20' and the guide 22 are also spaced away from the platen sufficiently to allow the record-strip to pass between them and the platen.

The record-strip 23 is fed from a supply-roll 25, pivotally mounted in supports 26, carried by the base 1, in front of the platen 20 and behind the guides 21 and 22. A feed-roll 27, which may be sanded or otherwise roughened, if desired, coöperates with an idler 28 to feed the strip along the platen. A transfer-ribbon 29, such as the ink-ribbon employed in type-writers, is fed along the face of the platen in front of the record-sheet, being positioned by the overturned edges of the guide 22. This ribbon is wound upon the power-actuated feed-roll 30 from the idle roll 31. These rolls are carried by brackets which extend from the board 1.

The support 18, in addition to carrying the platen-supporting arms 19, forms the yoke connecting the two vertical cores of an electromagnet 34. The armature coöperating with this electromagnet is pivoted at 36 and carries a pair of arms 37. The arms 37 carry at their outer ends a pair of antifriction-rolls 38, which bear against the back side of the platen 20. The ends of the arms 37 are bent so that the rolls bear perpendicularly against the platen. The arms 37, however, do not extend perpendicularly to the support 1, but are inclined upward somewhat. When the armature 35 is attracted by the electromagnet 34, the arms 37 swinging downward act as cams to force the platen 20 away from the support. The movement of the platen thus produced is sufficient to cause the end 16 of the arm 15 to bear against the transfer-ribbon 29 and make an impression upon the record-sheet carried by the platen. When the armature is released, the resiliency of the arms 19 is sufficient to move the platen back far enough so that the pointer is entirely disengaged from the transfer-ribbon, and hence there is no friction between the record-sheet or the transfer-ribbon and the end of the arm 15. By making the arm 15 extensible, as hereinbefore described, it is not necessary to obtain the fineness of adjustment or the accuracy in curving of the platen 20 which

would otherwise be necessary and which would be difficult to obtain. The upward movement of the armature 35 is limited by its engagement with an adjustable screw 39, carried by a bracket 40, extending from the base 1.

The armature 35 has pivoted to it a depending arm 41. The other end of the arm 41 is adjustably connected to an arm 42, pivoted on the shaft 43, and forms a link for oscillating it. An extension 44 from the arm 42 carries a spring-pressed pawl 45, which engages with ratchet-teeth upon a disk 46, keyed to a shaft 43. As a result of this construction every upward movement of the armature 35 causes the disk 46 to be rotated one or more teeth, depending upon the angular movement given to the arm 42 by the link 41. The amount of this movement can be adjusted by varying the distance of the point of connection of the arms 41 and 42 from the shaft 43. The shaft 43 carries a small gear 48, which meshes with a gear 49, keyed to a shaft 50, upon which the feed-roll 27 is secured. The shaft 43 also carries a worm 51, which meshes with a gear 52 on a shaft 53, which carries at its upper end the transfer-ribbon feed-roll 30.

Mounted above the electromagnets 34 is an electromagnet 54, having its cores extending perpendicularly from the base 1. The armature 55 of this electromagnet is pivoted at 56 to brackets 57, which extend from the base. The armature has at its ends a pair of bent arms 58 and 59, which extend downward to points adjacent the front face of the platen 20. These arms carry at their lower ends devices which bear against the transfer-ribbon and make an impression upon the record-sheet whenever the armature is attracted by the electromagnet. The device carried by the arm 59 consists of a simple needle-point 60, adapted to make dots upon the record-sheet whenever it contacts with the transfer-ribbon. The arm 59 also acts as a stop against which the end 16 of the arm 15 abuts to limit the movement of the coil 7 under the action of the springs 11.

The indicating device carried by the lower end of the arm 58 comprises a disk 61, having upon its periphery a plurality of character-carrying studs 62. The disk 61 is rotatably mounted upon a post 63, rigidly mounted in a plate 64, which is screw-connected to the arm 58. A ratchet-disk 65 is rigidly connected to the disk 61. A spring-pressed pawl 66, carried by the plate 64, engages with the teeth of the ratchet-disk 65 and prevents rotation of the disk in one direction. An arm 67, also pivotally mounted on the post 63, carries a spring-pressed pawl 68, which engages with the disk 65. A stud 69, carried by the arm 67, engages with the walls of a slot in a bracket 70, mounted upon the top of the field-magnets 2. It will readily be understood

from an inspection of Fig. 4 that when the ends of the arm 58 move in the direction of the arrow shown in Fig. 4 the disk 61 will move into the position indicated by the dotted circle. This movement will not produce any rotation of the disk 61 relative to the plate 64. There will be, however, a relative rotation between the disk 61 and the arm 67, the pawl 68 yielding to allow this movement. As the arm 58 moves back into the position shown in Fig. 4, however, the pawl 68 prevents any relative rotation between arm 67 and the ratchet-disk 65, and a rotation between the disk 65 and the arm 64 will take place. As a result of this construction a movement of the arm 58 produced by the attraction and subsequent release of the armature 55 will move one character-carrying stud 62 against the transfer-ribbon 29 and will move the disk in such position that the subsequent movement of the arm 58 will cause another character-carrying stud to be forced against the ribbon.

On the back of the board 1 is mounted a clock mechanism, the function of which is to close circuits at predetermined intervals through the electromagnets 34 and 54. In the construction which I have shown the shaft 71 is adapted to make a complete revolution every minute and carries at one end a disk from which extend four studs 72. The studs 72 successively engage a flexible brush 74 and force it into contact with a brush 73 four times for every revolution of the shaft 71. The minute-hand 75, turning in front of the dial 75', engages an arm 77, secured on the end of a shaft 78, and oscillates it once every revolution—that is to say, once every hour. An arm 79, also carried by the shaft 78, is moved by the engagement of the hand 75 with the arm 77 in such a manner as to oscillate a pivoted contact member 80 and force it into engagement with a brush 82, forming an electrical connection between the contacts 81 and the brush 82. A spiral spring 78', having one end secured to the clock-dial and the other end secured to the shaft 78, normally holds the arm 79 up so that the contact 81 does not engage the brush 82. The brushes 73 and 82 may be slitted, as shown, and the brush 74 and contact member 80 provided with small contact-bars 74' and 80', respectively, if desired, in order to improve the contact obtained between the brushes 73, 74 and between the contact member 80 and brush 82.

Referring to the diagram in Fig. 6, 83 and 84 are supply-lines a record of the potential between which it is desired to obtain. Lines 85 and 86 connect the lines 83 and 84, respectively, with the terminal contact-points 87 and 88. Lines 89 and 90 carry current from these points to the movable coil 7. A suitable resistance 91 is included in the line 90. A line 92, extending from the contact-point 88 to the movable contact 80 and a line 93,

connects the contact-point 82 through the coils 54 and a suitable resistance 94 to the contact 87. A line 95 extends from the contact-point 88 to the brush 74. A line 96 extends from the brush 73 through the coils 34 and a suitable resistance 95' to the contact-point 87.

The operation of my device, which will be readily understood from the previous description, is as follows: As the shaft 71 of the clock mechanism rotates one of the studs 72 establishes an electrical connection between the brushes 73 and 74. This energizes the coils 34, whereupon the armature 35 is drawn downward. This moves the rolls 38 downward and outward against the platen 20, moving it inward, so that the end 16 of the pointer 15 presses against the transfer-ribbon and makes an impression upon the record-sheet. As soon as the connection between the brushes 73 and 74 is broken the armature 35 moves upward and the platen 20 moves back to the original position. The pointer 15 is then free to move without any frictional engagement between it and the record-ribbon. The upward movement of the armature 35 causes the shaft 43 to be rotated. This causes the feed-roll 27 to advance the record-sheet a predetermined amount. It also causes the shaft 53 to rotate, and thus advance the transfer-ribbon. At intervals of one hour the minute-hand 75 establishes an electrical connection between the brushes 80 and 82, whereupon the electromagnet 54 is energized. This causes the indicating-point 60 to engage the ribbon-strip at one edge and one of the character-bearing studs 62 to engage the record-strip at the other edge. If the electromagnet 54 is to be energized once every hour, the studs 62 will preferably be twelve in number and will be numbered consecutively from "1" to "12" and if properly set will mark the hour at which electromagnet 54 is energized.

With an instrument constructed in the manner described the angular movement of the pointer 15 will be substantially proportional to the amount of current carried by the coil 7 and it will not be necessary to rule any scale-lines upon the record-strip. Where the movement of the pointer is not proportional to the quantity to be measured, it will of course be necessary to mark the record-strips correspondingly.

In the construction shown in Fig. 5 a modified form of my invention is illustrated. In this embodiment of my invention a bracket or supporting-frame 96 extends from the support 1 and carries at its outer end an annular mass 97 of magnetic material, such as soft iron. A fixed coil 98, which may or may not have a core of magnetic material, is placed within the annular mass 97. A movable coil 99, having trunnions 100 and 101, pivoted between bearing-screws 102 and 103, car-

ried by extensions of the frame 96, embraces the coil 98 and turns within the annular mass 97. One or more springs 104, each secured at one end to the trunnion 100 and at the other end to an adjustable post 105, carried by the bracket which supports the bearing-screw 103, normally hold the movable coil at one limit of its movement. A suitable counterbalanced arm 106, carried by the trunnion 101, has a looped outer end which swings in front of the record-bearing cylindrical platen 107. A member 108, pivoted at 109 to the arm 106 between the sides of the loop, carries intermediate its ends a perpendicularly-projecting arm 108'. This projecting arm passes through the outer end of the loop, forming the free end of the arm 106. A helical spring surrounding the arm 108' and extending between the member 108 and the end of the arm 106 normally holds the arm 108' out of engagement with the record-surface traveling in front of the platen 107. The marking element 108 carries at its upper end an antifriction-roll 111. A solenoid 112, corresponding in function to the electromagnet 34, hereinbefore described, is carried by a bracket 113, extending upward from the annular mass 97. The core 114 of the solenoid 112 is in alinement with the axis of the coil 7 and carries at its lower end a conical cam-surface 115, which is in a position to engage the antifriction-roll 111 when the solenoid is energized. Normally the core of the coil of the solenoid is held upward out of engagement with the roll 111 by a suitable spring. Guides 116 and 117 prevent rotation of the core 114. In the operation of this form of my invention the record-strip is fed along the front of the platen 107 by any suitable mechanism. At intervals the time mechanism, which may be the same as that hereinbefore described, energizes the electromagnet 112. This causes the core 114 to move downward and force the marking-point outward. The conical shape of the cam 115 allows this engagement to take place regardless of the position which the arm 106 may assume under the influence of a current passing through the coils 99 and 98. The coils 98 and 99 may be traversed by the same current, in which case the movement of the arm 106 will be proportional to the square of the current passing through the coils, or the coil 98 may be connected to some source of constant potential, in which case the movement of the arm 106 will be directly proportional to the current passing through the coil 99.

While I have described my invention as embodied in a voltmeter in both of the forms illustrated, it will of course be understood that the invention may readily be embodied in other electrical measuring instruments or in curve-drawing instruments which do not record the variations of electrical quantities.

What I claim as new, and desire to secure by Letters Patent of the United States, is—

1. In combination, a marking element swinging about an axis, means for moving a record-surface parallel to said axis, and means for moving said surface into and out of engagement with said marking element at regular intervals.

2. In combination, a marking element movable about an axis, and means for moving a record-surface along the surface of a cylinder in a direction parallel to its axis, the axis of the cylinder and the axis of movement of the marking element being coincident.

3. In combination, a marking element swinging about an axis, means for moving a record-surface along the surface of a cylinder and parallel to its axis, the axis of the cylinder and the axis of movement of the movable element being coincident, and automatic means for causing an intermittent engagement between the marking element and the record-surface.

4. In combination, a movable marking element, means for supporting a record-surface normally out of engagement with said marking element, means independent of the movements of the marking element for moving said record-surface toward the marking element to make a record, and means for moving said record-surface transversely to said marking element after the making of such a record.

5. In combination, a movable marking element, means for supporting a movable record-surface in proximity to said element, a time mechanism, and means set in motion by but actuated independently of said time mechanism for moving the record-surface against the marking element to make an impression and for advancing the record-surface.

6. In combination, a marking element movable about an axis, a cylindrical platen having its axis substantially coincident with the axis of movement of the marking element, and mechanism for intermittently moving the platen toward and away from the axis of movement of the movable element at regular intervals.

7. In combination, a marking element movable in a plane, means for supporting a record-surface perpendicular to said plane and normally out of engagement with said marking element, and automatic means for causing engagement between said marking element and said record-surface at regular intervals.

8. In combination, a marking element, means for supporting a record-surface normally out of engagement with said marking element, and automatic means for intermittently forcing said record-surface into engagement with said element at regular inter-

vals, said marking element comprising a pivoted pointer made up of two sections, one of said sections being telescoped within the other, and a spring for normally holding said sections extended.

9. In combination, a pivoted marking element swinging in a plane, means for supporting a record-surface substantially perpendicular to said plane, and automatic means for causing an intermittent regular engagement between said marking element and said surface, said marking element being made in sections capable of being forced together by pressure against its marking end.

10. In combination, a pivoted marking element swinging in a plane, means for supporting a surface to be marked substantially perpendicular to said plane, said marking element being compressible in a radial direction, and automatic means for causing an intermittent and regular engagement between said marking element and said surface.

11. In combination, an electromagnet comprising a core, a base and a pivoted armature, a platen flexibly connected to said base, and connections between said armature and said platen for moving said platen whenever the electromagnet is energized.

12. In combination, a platen mounted on a pair of arms, the resiliency of said arms tending to hold the platen in one position, an electromagnet having its core or cores substantially parallel to said arms, and a pivoted armature for said electromagnet for engaging the platen and moving it outward against the resiliency of the arms when the electromagnet is energized.

13. In combination, a movable marking element, means for supporting a record-surface, a time mechanism, circuit-closers, a pair of electromagnets, means actuated by said time mechanism for closing a circuit at comparatively short intervals through one of said electromagnets, mechanism actuated by such electromagnet for causing engagement between the record-surface and the marking element to take place and for causing the record-surface to be advanced whenever the circuit through said magnet is opened and closed, means actuated by the time mechanism for closing the circuit of the other of said magnets at somewhat longer intervals, and means actuated by said second magnet for causing an impression to be made upon said record-surface indicating the time at which said impression was made.

14. In combination, a movable meter element, a member having a to-and-fro movement, and means cooperating with said member for moving a record-surface in one direction upon one movement of the movable member and for moving the record-surface in a direction at an angle to said first-mentioned direction upon a movement of the movable member in the opposite direction.

15. In combination, a marking element movable in a plane, means for supporting a record-surface perpendicular to said plane and normally out of engagement with said element, and automatic means for causing an engagement to be made between said marking element and said surface and for moving said surface perpendicularly to said plane after said engagement.

16. In combination, a marking element movable in a plane, means for supporting a record-surface perpendicular to said plane and normally out of engagement with said marking element, means for moving said record-surface in a direction parallel to said plane to cause an engagement to be made between said marking element and said surface, and means for moving the record-surface in a direction perpendicular to said plane after said engagement.

17. In combination, a movable element, a rotatable member carried thereby, means carried by the element for preventing rotation of the element in one direction, a stationary support, another movable element pivotally connected to the first-mentioned element and loosely connected to the stationary support so that a movement of the movable element causes a relative rotation between the two elements, and means for preventing relative rotation in one direction between the second element and the rotatable member.

18. In combination, an element having a to-and-fro motion, a rotatable member mounted thereon, a ratchet carried by the rotatable member, a pawl carried by the movable element, the ratchet and the pawl cooperating to prevent rotation of the rotatable member in one direction, a second element pivoted to the movable element and movably connected to a fixed support, and a pawl carried by the second element which engages with the ratchet carried by the rotatable member whereby a to-and-fro movement of the first-mentioned element causes a rotation of the movable member.

19. In combination, a marking element movable about an axis, and means for moving a record-surface continuously in one direction along the surface of a cylinder in a direction parallel to its axis, the axis of the cylinder and the axis of the movement of the marking element being coincident.

20. In combination, a marking element pivoted to turn about an axis, means for supporting a record-surface substantially cylindrical about said axis, mechanism for causing a regular relative to-and-fro movement of said axis and record-surface, and mechanism for moving said record-surface parallel to said axis.

21. In combination, a marking element pivoted to turn about an axis, means for supporting the marking-surface substantially

cylindrical with respect to said axis, mechanism for producing a relative regular to-and-fro movement of the marking-surface and the marking element in a direction substantially transverse to said axis, and mechanism
5 for moving the record-surface in a direction substantially parallel to said axis.

In witness whereof I have hereunto set my hand this 23d day of March, 1903.

ELIHU THOMSON.

Witnesses:

DUGALD McK. McKILLOP,
ROBERT SHAND.