No. 639,053. Patented Dec. 12, 1899.

C. L. JAEGER.

ELECTRIC RECORDING SYSTEM.

(Application filed Feb. 8, 1898.)

(No Model.) 10 Sheets—Sheet 1.

Fig. 2.

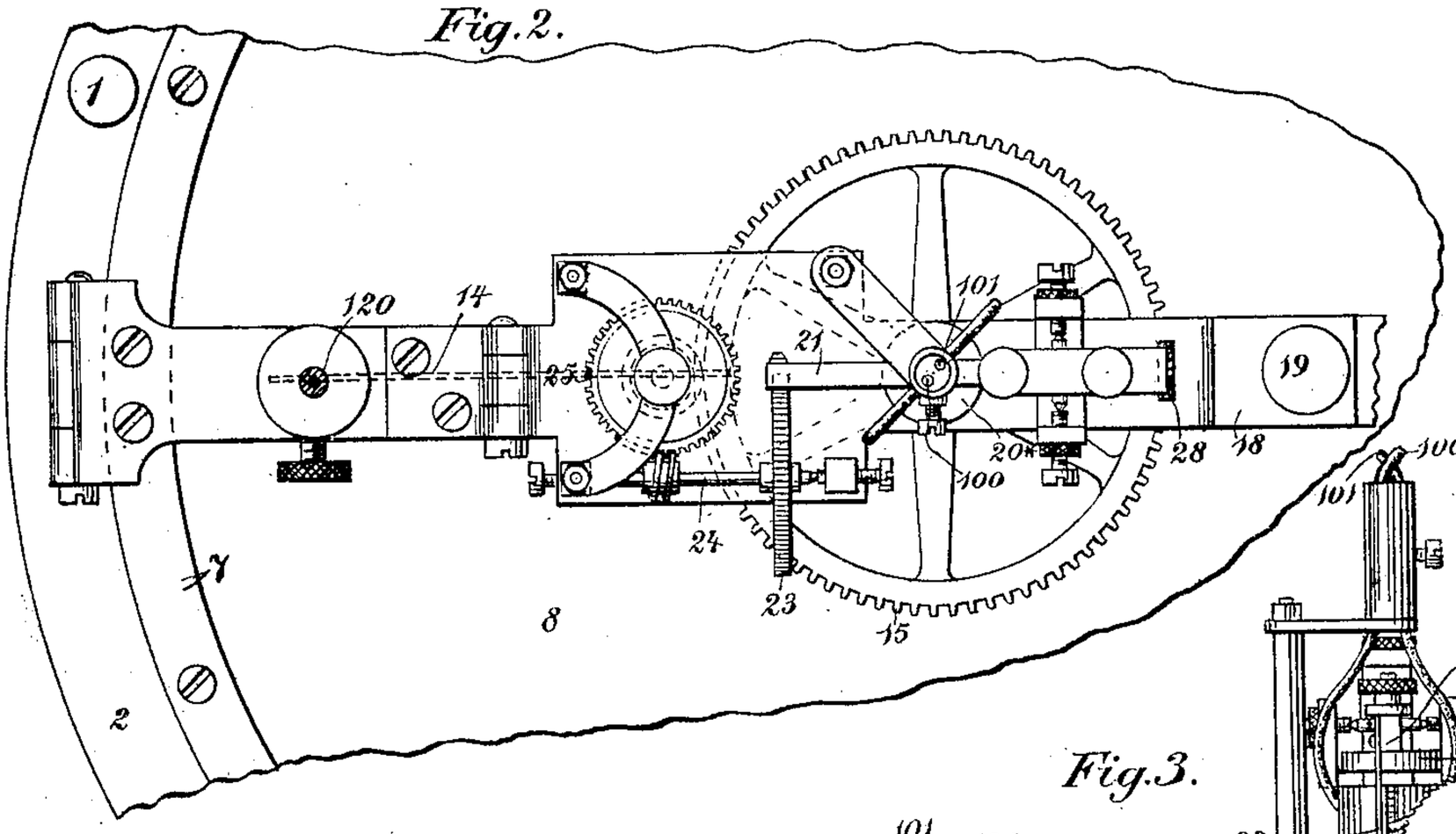


Fig. 3.

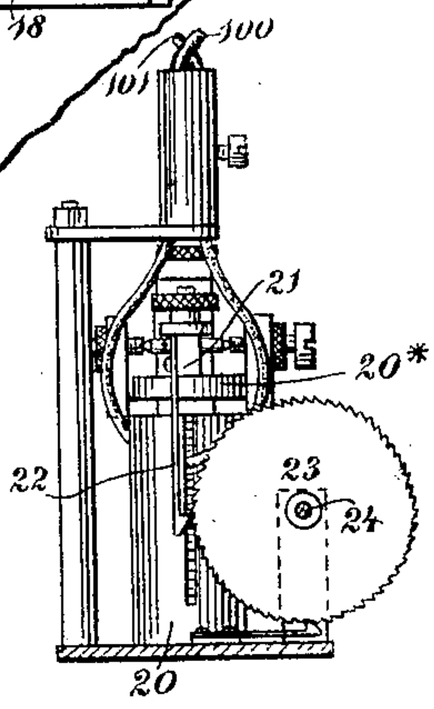


Fig. 5.

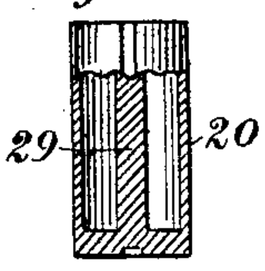


Fig. 1.

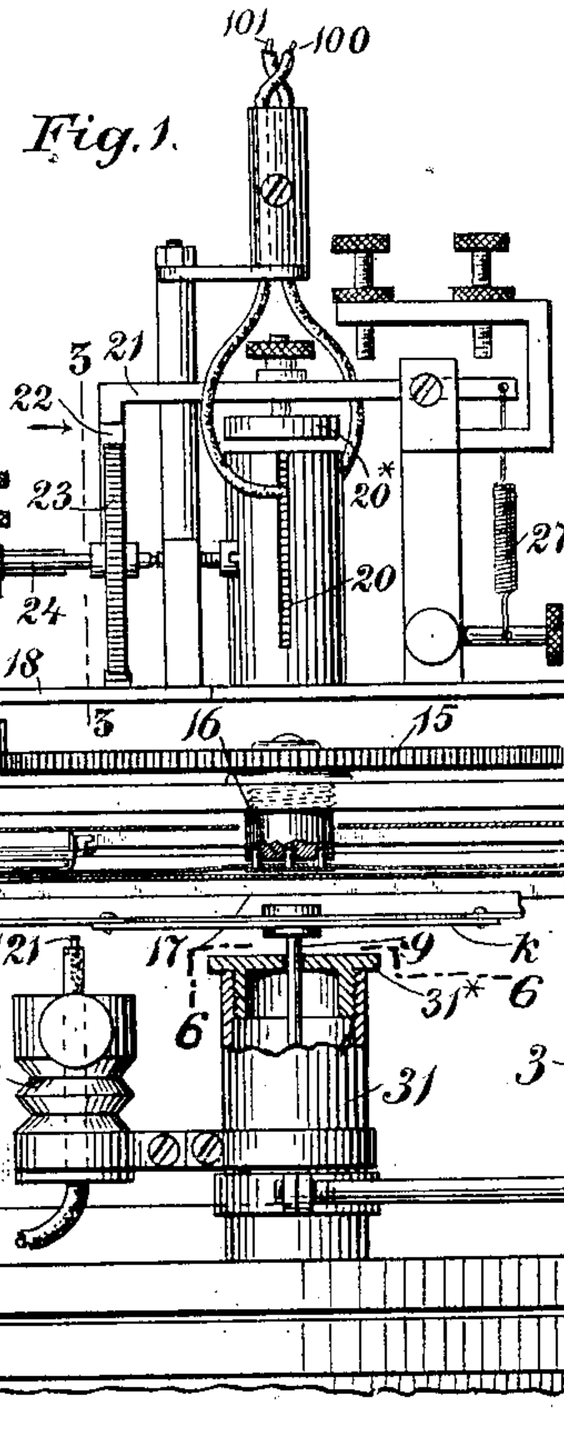
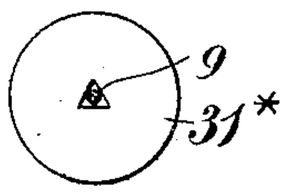


Fig. 4.

Fig. 6.



WITNESSES:

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No. 639,053 Patented Dec. 12, 1899.

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Fig. 7.

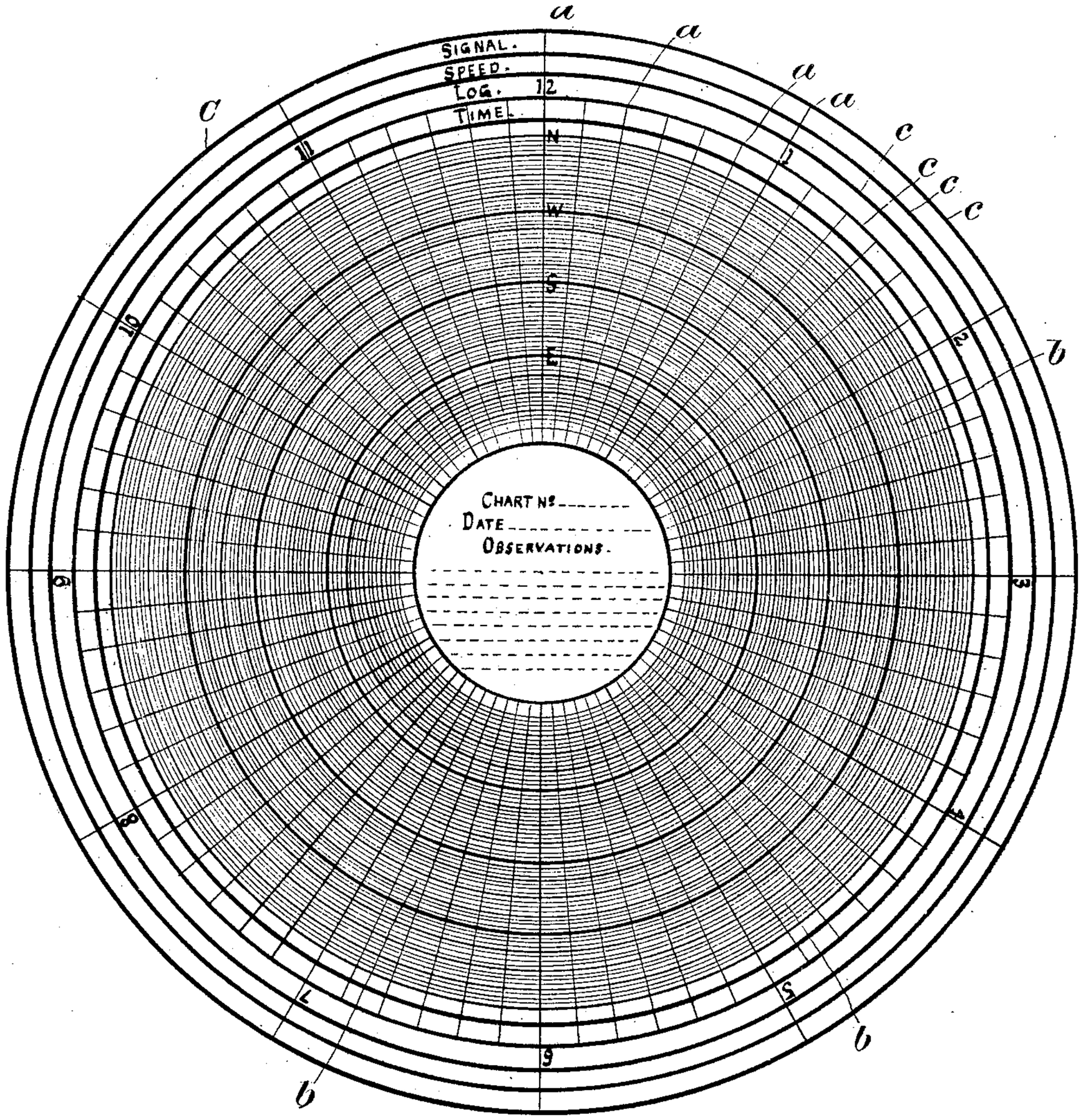

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Fig.10.

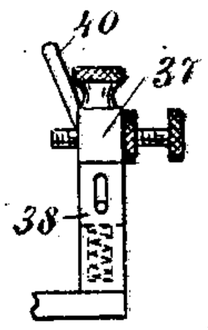

Fig.8.

Fig.11.

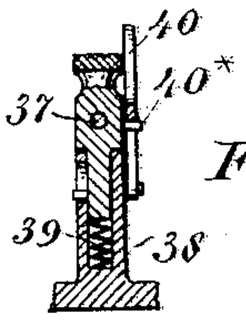

Fig.9.

WITNESSES:

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No. 639,053. Patented Dec. 12, 1899.

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ELECTRIC RECORDING SYSTEM.

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Fig. 12.

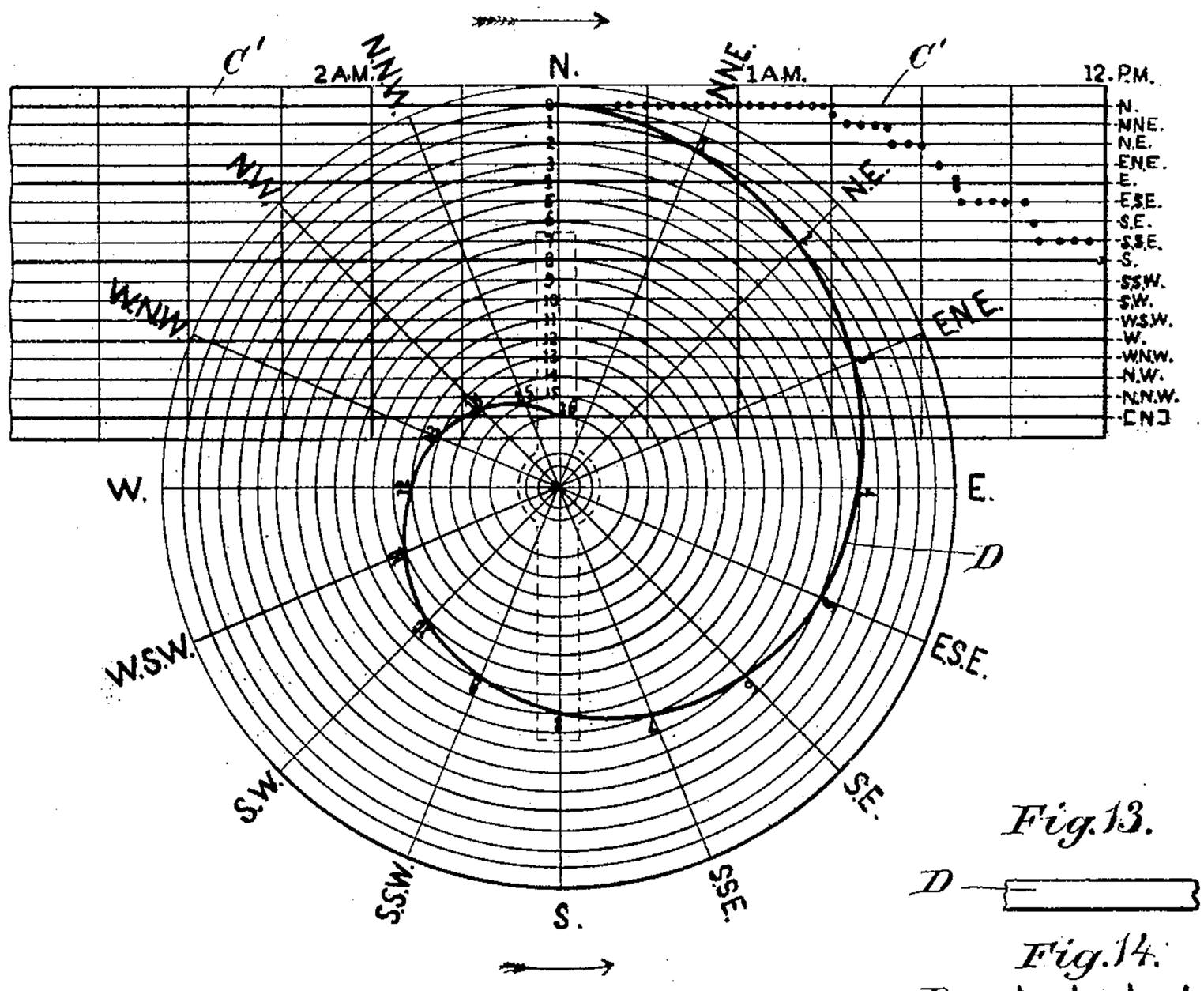


Fig. 13.

Fig. 14.

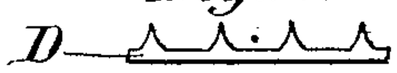


Fig 30

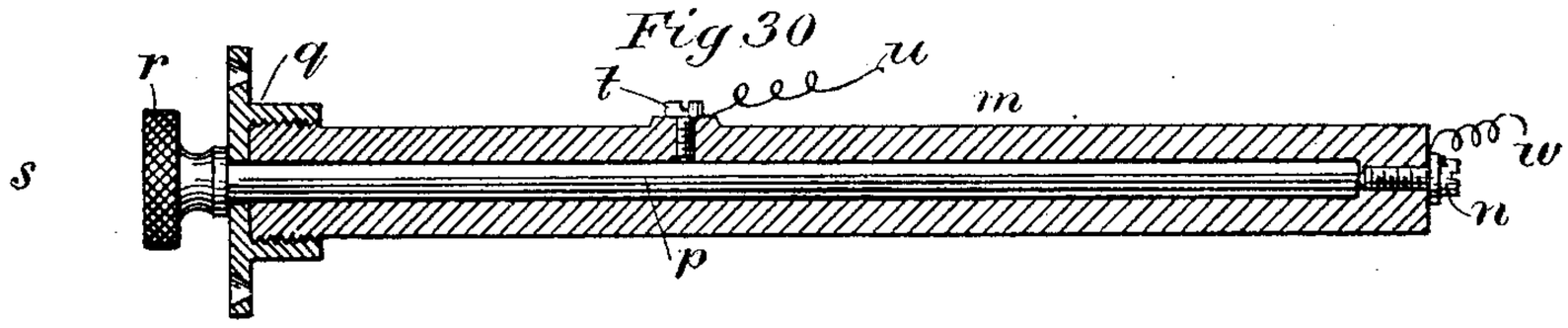
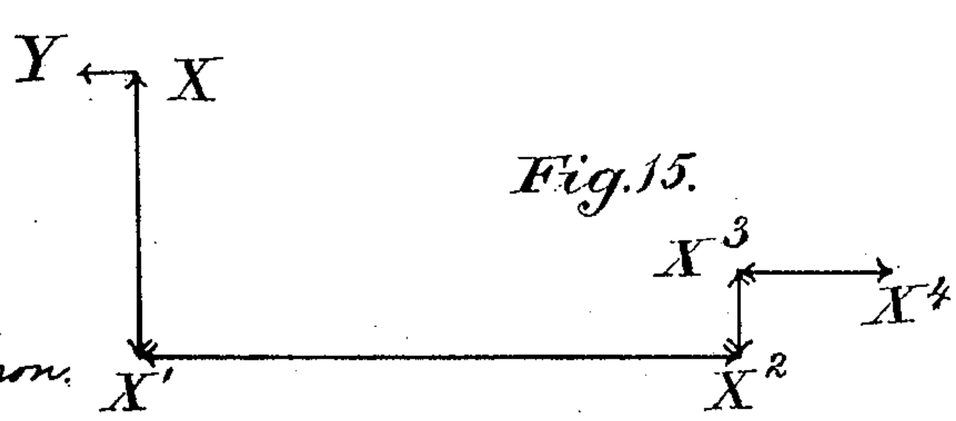


Fig. 15.



WITNESSES:

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ELECTRIC RECORDING SYSTEM.

(Application filed Feb. 8, 1898.)

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Fig. 16.

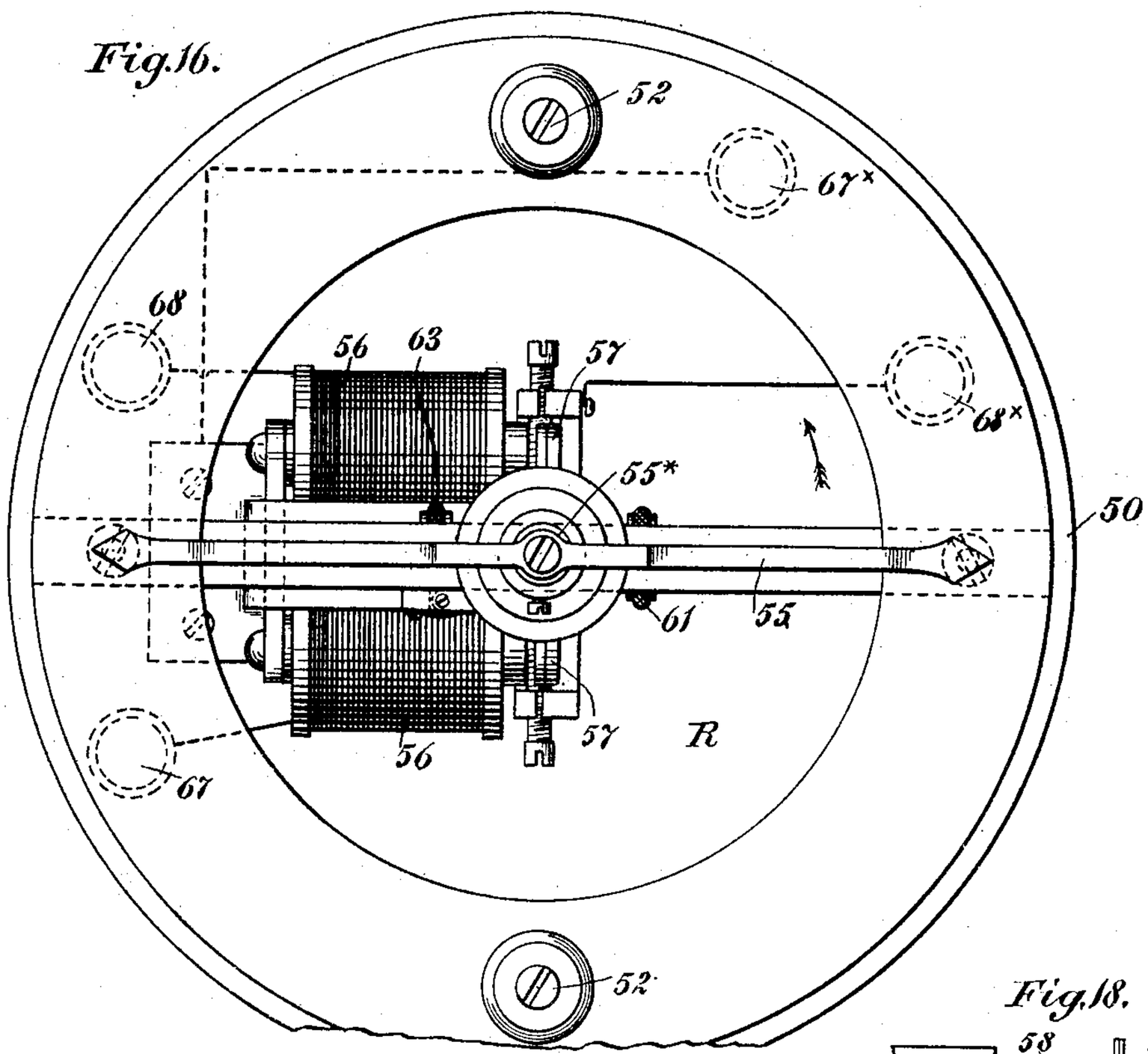

Fig. 17.

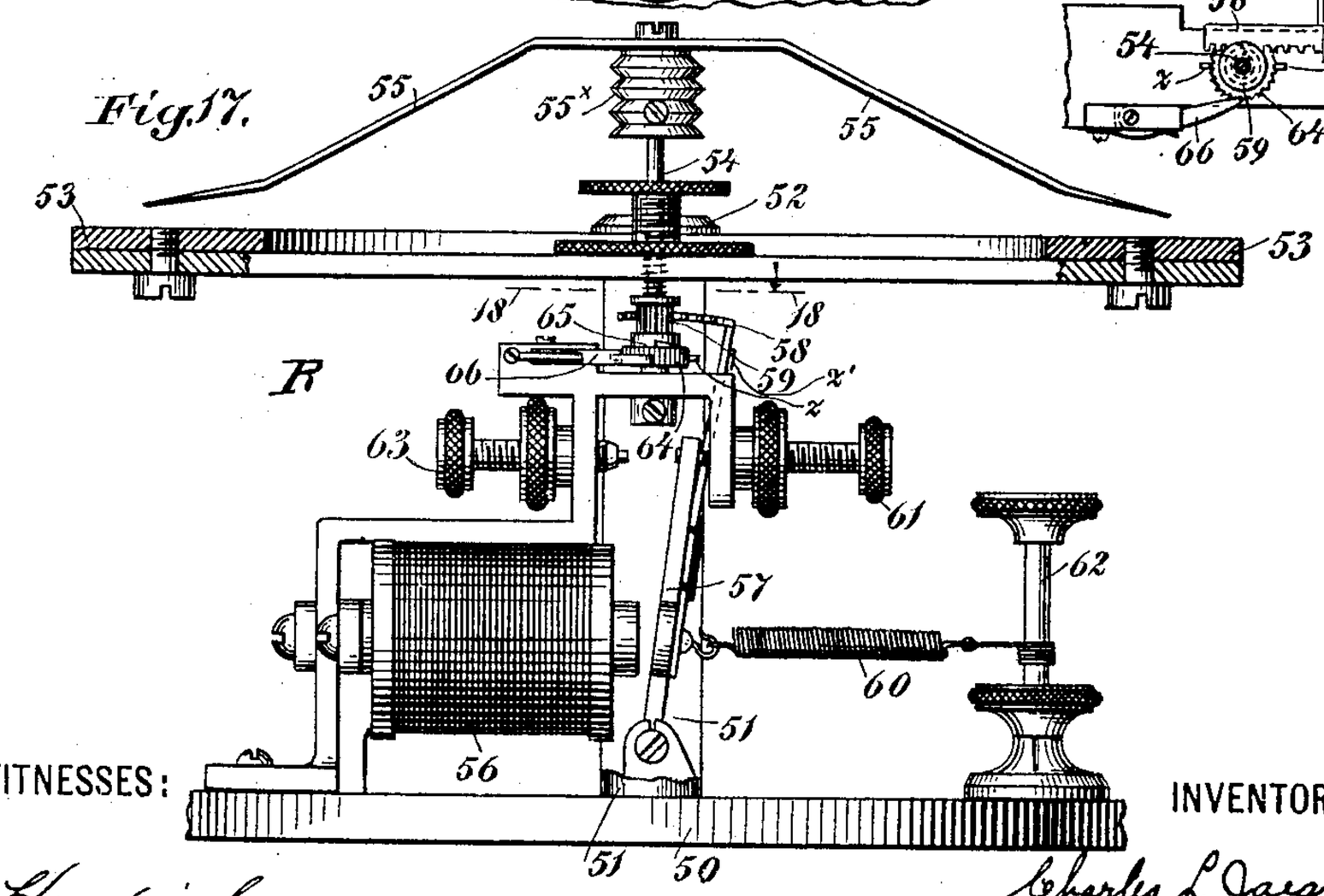

Fig. 18.

WITNESSES:

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No. 639,053. Patented Dec. 12, 1899.

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ELECTRIC RECORDING SYSTEM.

(Application filed Feb. 8, 1898.)

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Fig. 19.

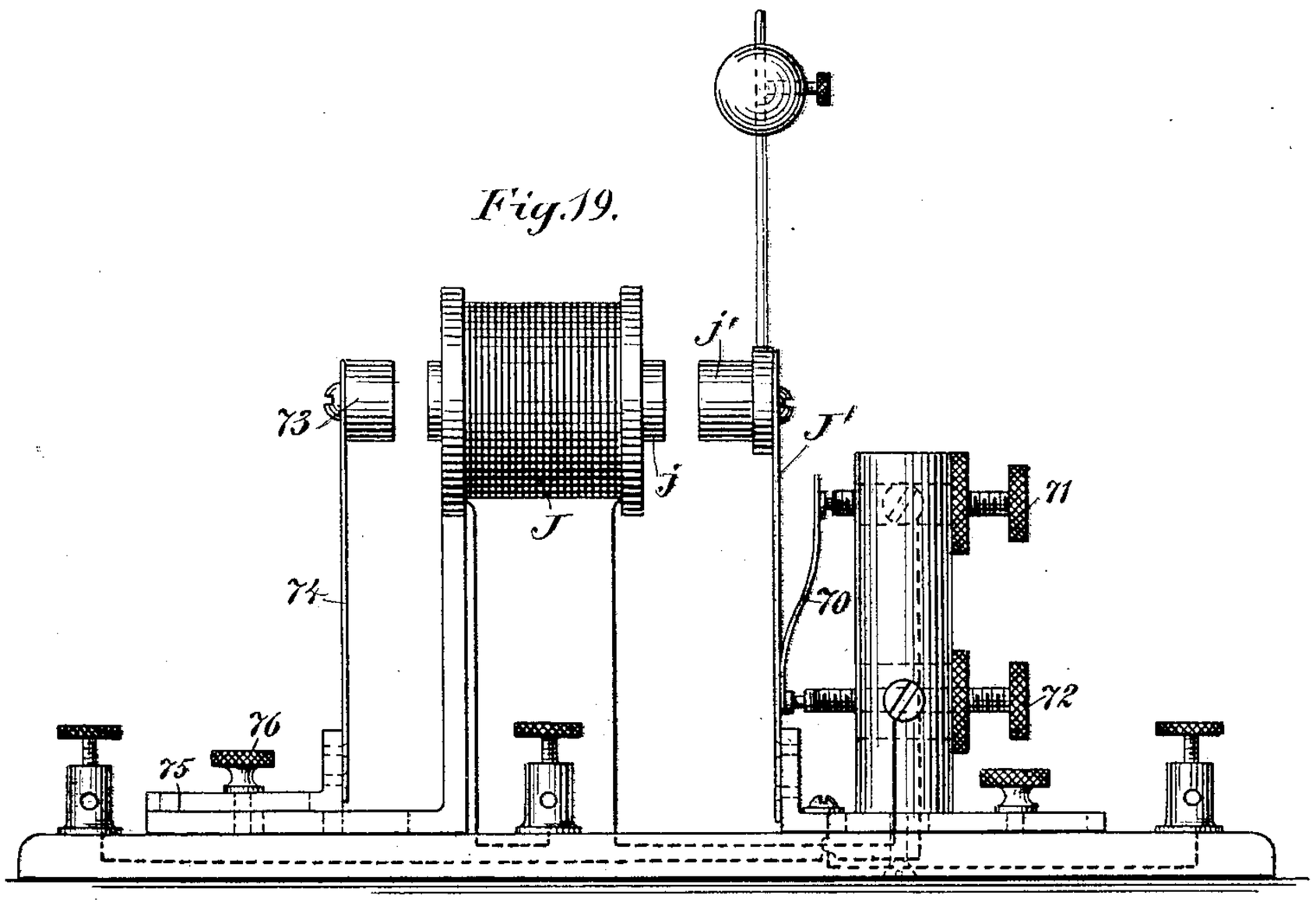
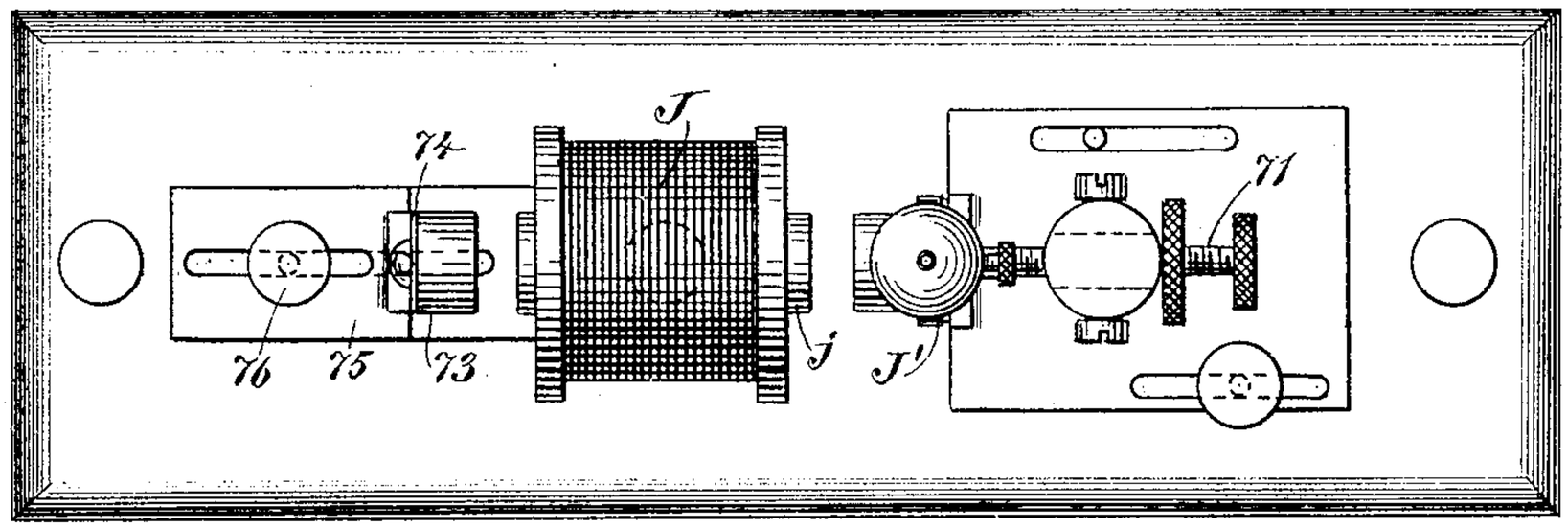


Fig. 20.



WITNESSES:

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No. 639,053. Patented Dec. 12, 1899.

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ELECTRIC RECORDING SYSTEM.

(Application filed Feb. 8, 1898.)

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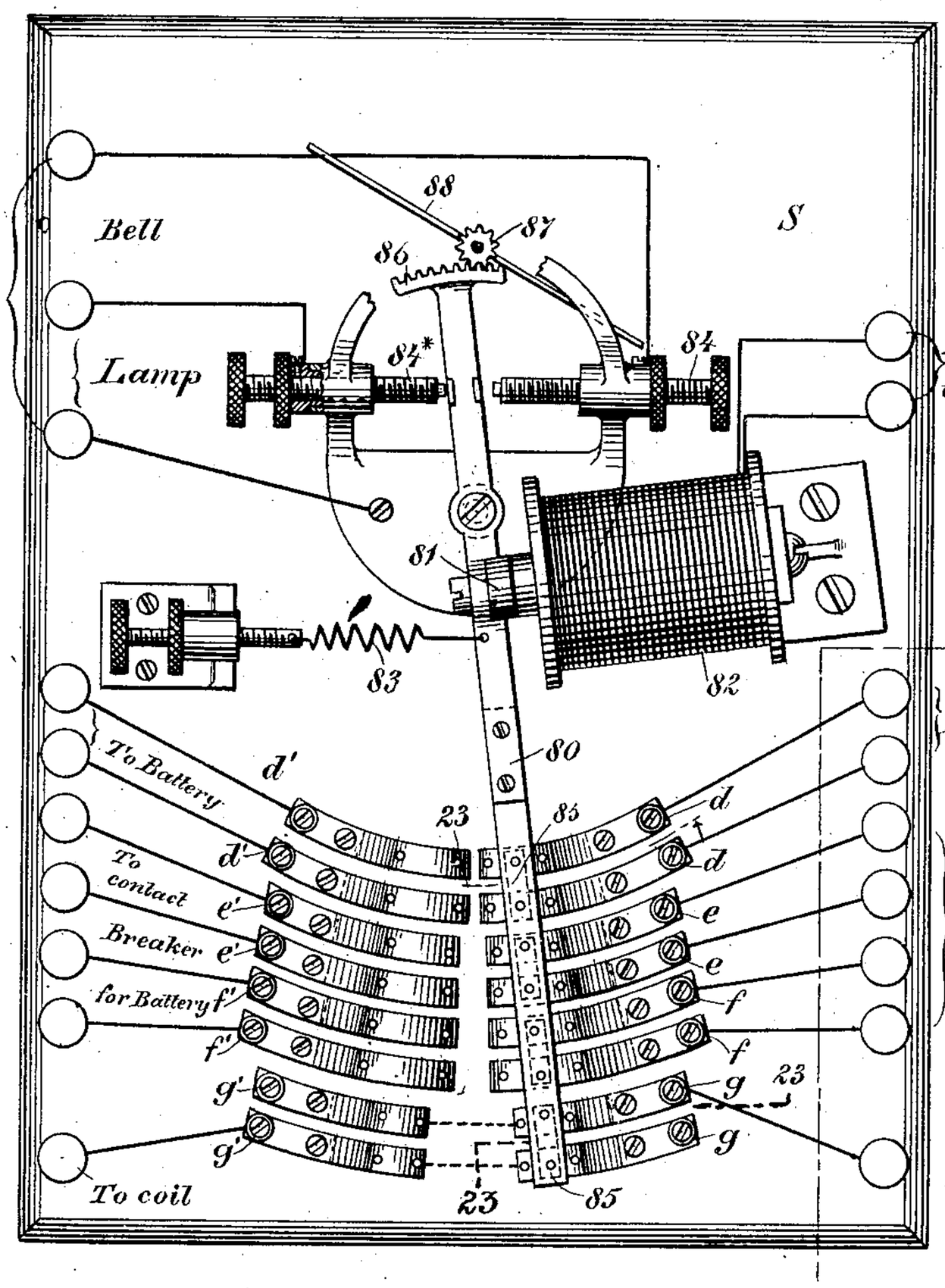

Fig. 21.

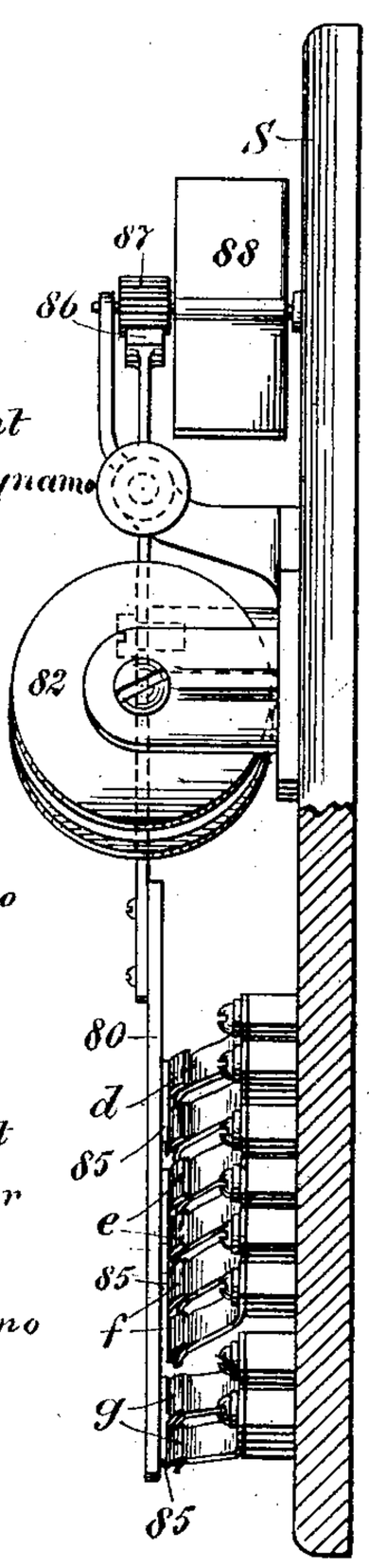

Fig. 22.

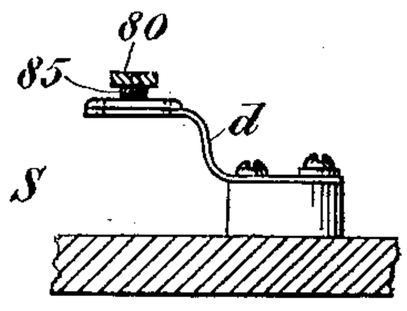

Fig. 23.

WITNESSES:

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No. 639,053. Patented Dec. 12, 1899.

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ELECTRIC RECORDING SYSTEM.

(Application filed Feb. 8, 1898.)

(No Model.) 10 Sheets—Sheet 8.

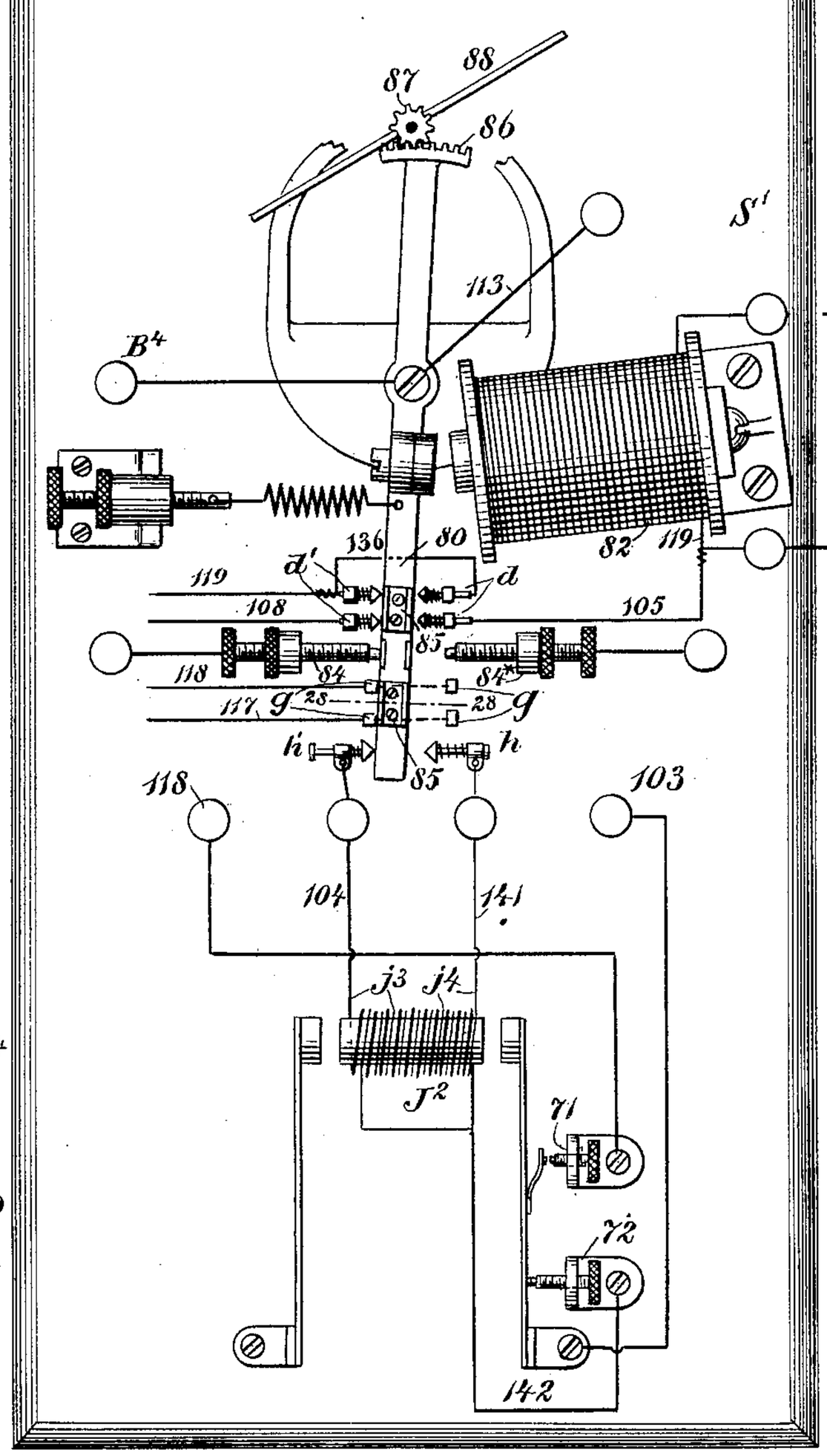


Fig. 24.

Fig. 28.

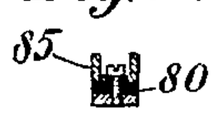


Fig. 25.

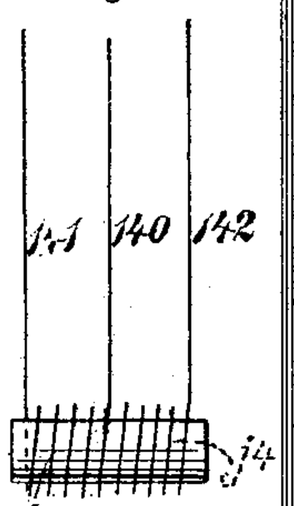


Fig. 26.

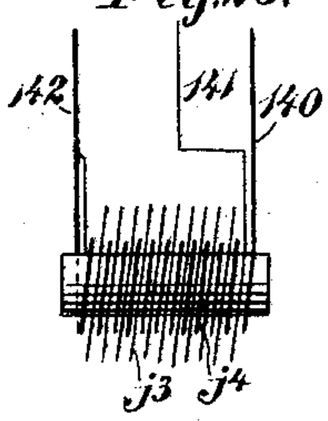
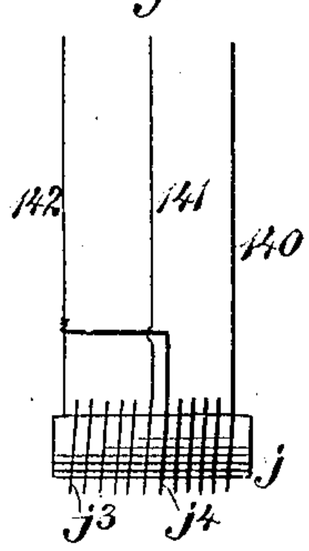


Fig. 27.



WITNESSES:

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No. 639,053. Patented Dec. 12, 1899.

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ELECTRIC RECORDING SYSTEM.

(Application filed Feb. 8, 1898.)

(No Model.) 10 Sheets—Sheet 9.

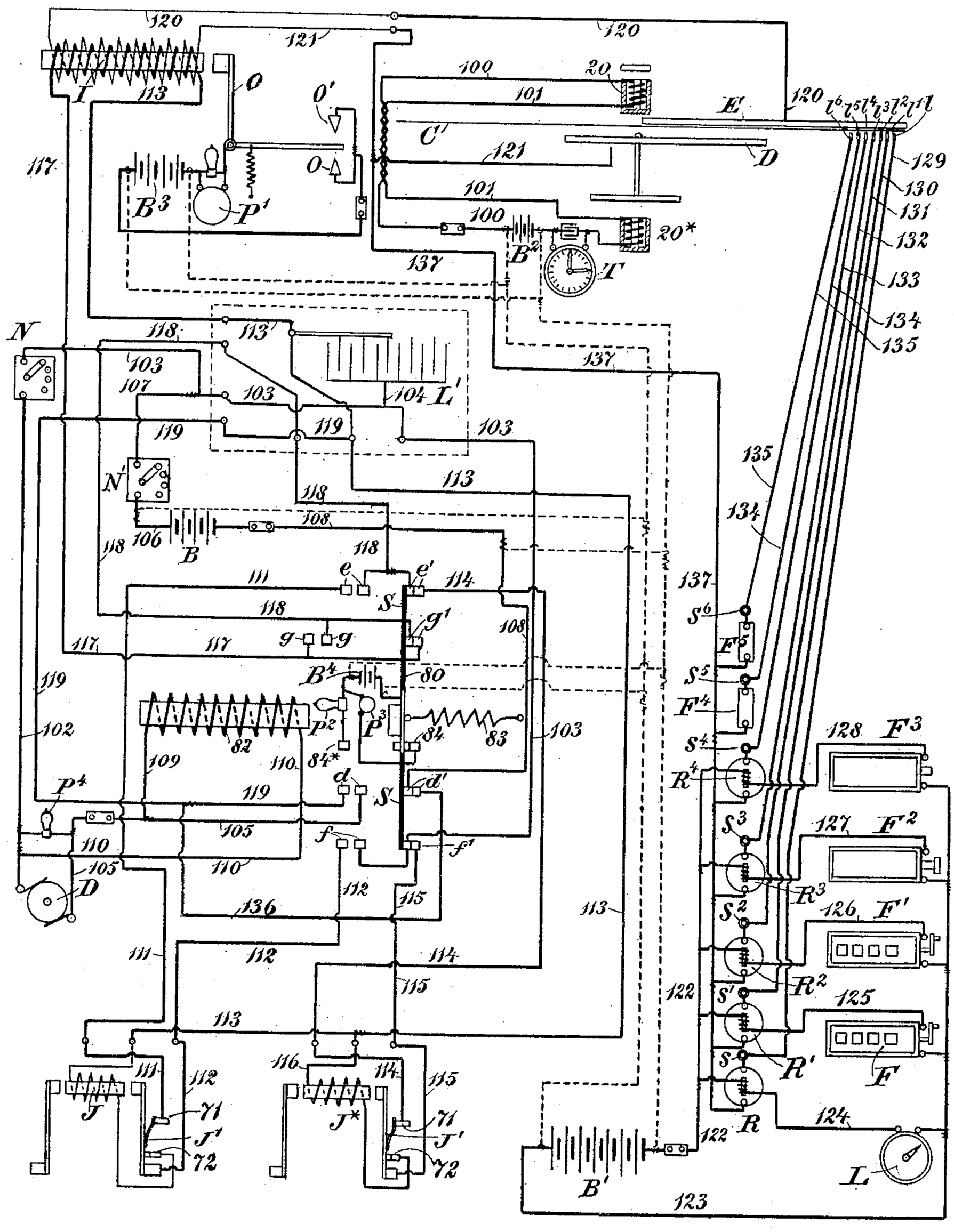

Fig. 29.

WITNESSES:

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No. 639,053. Patented Dec. 12, 1899.

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ELECTRIC RECORDING SYSTEM.

(Application filed Feb. 8, 1898.)

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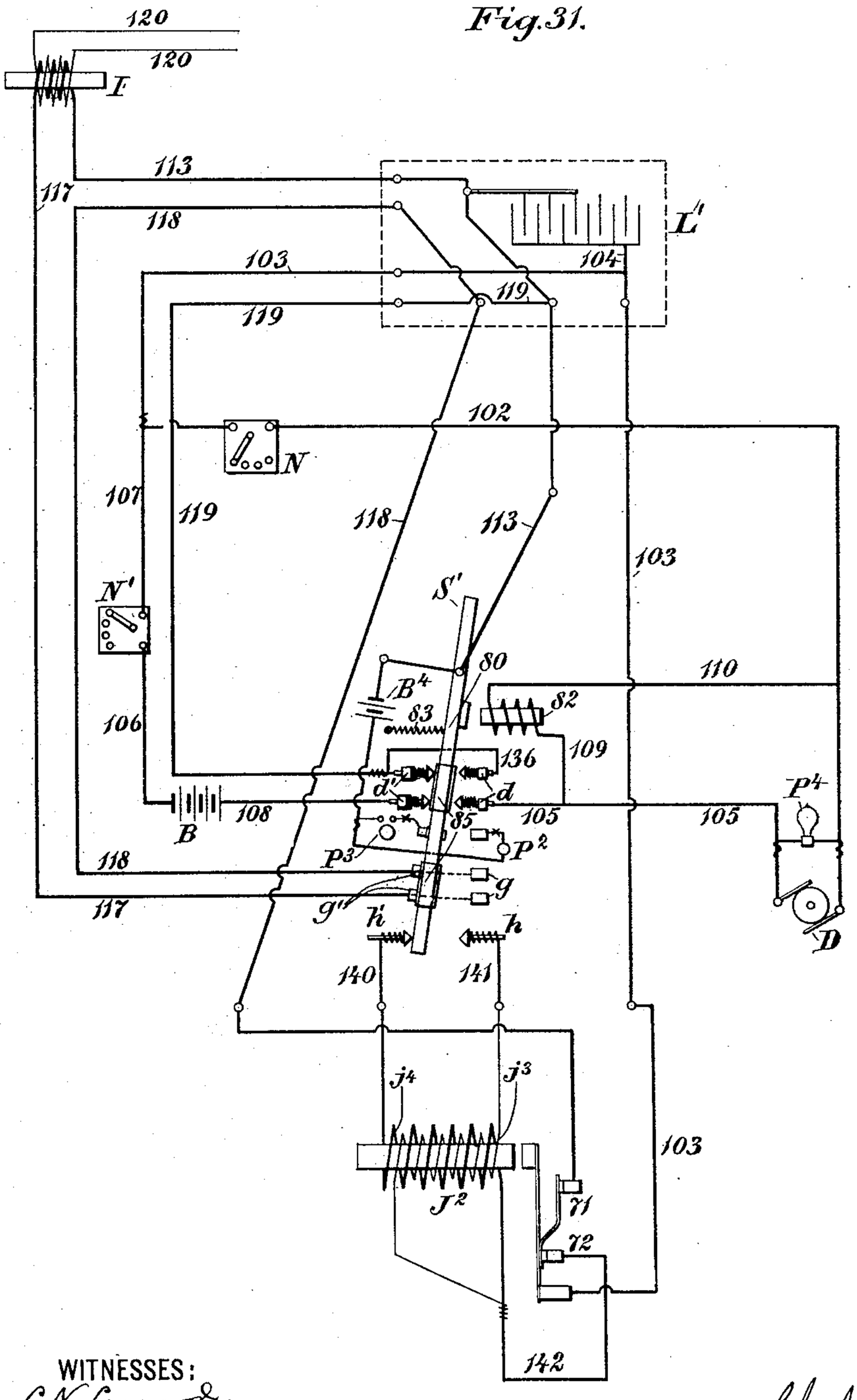
Fig. 31.



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E. P. Hendrickson.

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Baker & Hartley
ATTORNEY.

UNITED STATES PATENT OFFICE.

CHARLES L. JAEGER, OF MAYWOOD, NEW JERSEY.

ELECTRIC RECORDING SYSTEM.

SPECIFICATION forming part of Letters Patent No. 639,053, dated December 12, 1899.

Application filed February 8, 1898. Serial No. 669,546. (No model.)

To all whom it may concern:

Be it known that I, CHARLES L. JAEGER, a citizen of the United States of America, residing at Maywood, in the county of Bergen and State of New Jersey, have invented certain new and useful Improvements in Electric Recording Systems, of which the following is a specification.

My invention has reference to improvements in electric apparatus for continuously recording on one piece or strip of paper the direction, distance, speed, time, variations of and signals used during a vessel's movements—in other words, for recording the distance sailed, the direction sailed, the variation of the compass, the speed and the variation of the speed, the signals given, and the time of the several records. To this end I provide, first, a recording attachment for the compass composed of a light metallic curved conductor which moves freely with the compass card or needle and constitutes a recording-conductor. Adjacent to the recording-conductor, but not touching the same, is arranged a straight conductor which is usually placed parallel to the keel and participates in the movements of the vessel. Between the straight conductor and the recording-conductor is arranged a chart or continuously-moving strip of paper, which is actuated by an electromagnetic feed controlled by a chronometer. The record chart or paper is previously printed with continuous lines representing the various points on the compass-card and with intersecting lines representing the time and also with a series of continuous lines for the various other records. The spiral and radial conductors are each separately connected with wires to an induction-coil, and consequently a disruptive discharge from this coil is continually passing between the spiral and straight conductors at the point where they cross, but do not touch, this point corresponding to the position of the vessel in relation to the magnetic needle and is recorded by the position of the perforation through the paper. Secondly, I provide a log arranged to record in the compass and on the same paper the knots covered by the vessel, which log is constructed with a contact device that closes the circuit connected with the compass and the coil used for the compass-record. The circuit is closed every knot or fraction of a knot, the current passing through a special division on the paper. By counting the number of perforations between the hour-lines the speed and variations thereof can be ascertained. I also provide, thirdly, revolution and other indicators, the operation of which is recorded on the same paper, suitable relay-circuit closers being interpolated between the instruments and the induction-coil, as well as between the latter and the log, so as not to necessitate the passage of a high-tension current through the several indicators and the log and to insure the formation of perforations at individual points only, so as not to form continuous lines or slits in the paper. Signal-keys may also be provided and indications of their use made on the same paper. I also provide, fourthly, an automatic switch for throwing in a battery-circuit in case of failure of the dynamo, combined with means for giving visible and audible indications of such transfer from one generator to another. I provide, fifthly, means for indicating an interruption in the action of the induction-coil; sixthly, an improved form of vibrator for the induction-coil, and, lastly, I so construct the automatic contact-breaker that it is rendered self-starting and is not liable to become inoperative, all for the object of providing a plant not liable to become inoperative and so cause a loss of record on the chart or strip.

My invention consists in general in improvements in the apparatus shown in my prior patents, No. 472,124, dated April 5, 1892; No. 524,636, dated August 14, 1894; No. 533,902, dated February 12, 1895; No. 556,987, dated March 24, 1896, and No. 605,548, dated June 14, 1898, and also in my prior application, Serial No. 647,159, filed August 5, 1897.

The nature of my invention will best be understood when described in connection with the accompanying drawings, in which—

Figure 1 represents a side elevation, partly in section and partly broken away, of a compass embodying my improved recording attachment. Fig. 2 is a plan view with part broken away. Fig. 3 is a vertical section on the line 3 3, Fig. 1, illustrating part of the electromagnetic device for uniformly turning the chart. Fig. 4 is a detail view illustrating

part of the means for attaching the chart to its actuating mechanism. Fig. 5 is a vertical section of the electromagnet of the chart-actuating mechanism, the winding being omitted. Fig. 6 is a horizontal section on the line 6 6, Fig. 1, showing part of the support for the recording-arm. Fig. 7 is a face view of the chart adapted for use in the compass shown in Fig. 1. Fig. 8 is a side elevation, partly in section, showing an actuating mechanism for an endless strip or tape to be used in place of the chart. Fig. 9 is a plan view of the same, part being broken away. Fig. 10 is an elevation of a detail of said actuating mechanism. Fig. 11 is a vertical section of the same. Fig. 12 is a diagrammatic view illustrating the construction and operation of the spiral recording-conductor. Fig. 13 is a side view, on an enlarged scale, of a portion of said conductor. Fig. 14 is a similar view illustrating a modified form for the same. Fig. 15 is a diagram illustrating the relative distance between the several conductors. Fig. 16 is a plan view of one of the relay-circuit closers used in connection with the log and the several indicators. Fig. 17 is an elevation of the same, partly in section. Fig. 18 is a section on the line 18 18, Fig. 17, illustrating the construction of a detail part of the relay-circuit closer. Fig. 19 is an elevation of an automatic contact-breaker used in connection with the induction-coil and the switch. Fig. 20 is a plan view of the same. Fig. 21 is a plan view of the switch for changing the circuits in case the primary generator breaks down. Fig. 22 is a side elevation of the same. Fig. 23 is a section on the line 23 23, Fig. 21. Fig. 24 illustrates in elevation a modified form of said switch. Figs. 25, 26, and 27 are diagrams illustrating different methods of winding the coil of the automatic contact-breaker used in connection with said switch. Fig. 28 is a section on the line 28 28, Fig. 24, taken through the switch-lever. Fig. 29 is a diagrammatic view showing the connections and arrangement of the several coöperating devices of the apparatus. Fig. 30 is a longitudinal section of a circuit-closer used in connection with the relay-circuit closer of the log, speed, and signal indicators. Fig. 31 is a diagram illustrating the electrical connections when the switch shown in Fig. 24 is used.

Similar letters and numerals of reference designate corresponding parts throughout the several views of the drawings.

Referring at present to Figs. 1 to 7 of the drawings, wherein I have shown the recording attachment for the compass and the chart on which the record is made, the letter A designates the bowl of a compass constructed in the usual manner. In the present example I have shown what is known as a "liquid" compass; but it is of course to be understood that the invention could be equally well applied to a dry compass. The stationary part or head of the recording apparatus is connected with the bowl A by the leveling-screws 1, passing through an annular base 2, to which is secured by suitable posts 3 two rings 4 and 5, having between them a disk 6, made of mica or other suitable insulating material. To the rings is hinged a cover 7, carrying a mica disk 8, located between suitable rings, and also the mechanism for rotating the chart C. The cover 7 is secured to the rings 4 and 5—that is, to the lower part of the head—by a suitable latch, (not shown,) so that it may be readily opened for the insertion of the chart C. The curved conductor D, which is made spiral in form, as shown in Fig. 12, and which I shall hereinafter term the "recording-conductor," is attached by means of a spindle 9 to the axis of the magnetic needles (not shown) and participates in the movements thereof. It is arranged directly below the mica disk 6, and above said mica disk and connected to the cover 7 is arranged a radial conductor E, preferably made of platinum and attached to a strip of insulating material 10, secured to the central cross-bar on the cover 7. The terminal 121 of a wire is brought in close proximity to the spiral recording-conductor D, it being secured in a binding-post 12 of non-conducting material, and the terminal 120 of a wire passing through a similar binding-post, carried by the cover 7, extends through the insulating-strip 10 and touches the radial conductor. Said wires are connected with the induction-coil I, Fig. 29, in a manner hereinafter to be described. It is evident that sparks will continuously pass between that point of the recording-arm D directly opposite to the radial conductor E and the latter, thus perforating the paper and making a record of the ship's course. The mica disk 6 is provided with a radial slit 14, adjacent to the radial conductor E, through which the sparks pass.

For actuating the chart C, I have provided a peculiar driving mechanism, constructed for the purpose of insuring accuracy and uniformity in the turning of the chart when a circuit is closed once every second by a chronometer. In the present instance I have shown the mechanism adapted to turn the chart through one revolution every twelve hours; but of course it could be turned once in every twenty-four hours, if so arranged. The chart is attached to the arbor of a gear-wheel 15, having a bearing formed in the cross-bar of the cover 7 and provided with a head 16, having therein a series of holes for the reception of prongs formed on a cap 17, by means of which cap the chart can be secured to said head, Figs. 1 and 4. The driving mechanism for the chart is mounted on a swinging frame 18, hinged to the cross-bar of the cover and secured by means of a screw 19, entering said cross-bar, thus permitting the driving mechanism to be swung clear of the gear 15 for permitting the adjustment of the chart to the proper time with respect to the radial conductor E. Said driving mechanism consists of an electromagnet 20, attached to the swing-

ing frame and having its armature-lever 21 provided with a feed-pawl 22, Figs. 1, 2, and 3, adapted to engage a ratchet feed-wheel 23, mounted on a horizontal worm-shaft 24. The worm-shaft engages a worm-wheel 25, mounted on a vertical shaft having at its lower end a pinion 26, meshing with the gear-wheel 15. The armature-lever 21 is provided with a spring 27 and an adjusting-screw 28, by means of which the stress on the pawl 22 can be regulated as the pawl acts to turn the feed-wheel 23 on its return stroke, and its movement is limited by the set-screws on opposite sides of its fulcrum. The armature 20* is adjustably secured to the lever 21 by a usual adjusting-screw. The electromagnet 20 is connected by wires 100 and 101 with a chronometer T, Fig. 29, provided with a circuit-breaker of a usual construction, adapted to close the circuit every second. In order to obtain the greatest magnetic efficiency and to concentrate the magnetic field near the armature of the electromagnet for operating the feed device for the chart, I construct the electromagnet 20 in the form of a hollow cylinder of soft iron, slotted as usual and having a central core 29, around which the wire is wound to form the coil, Fig. 5. The electromagnet 20 is placed in line with the axis of the magnetic needles to prevent the magnet action from affecting the latter. The weight of the compass-head and driving mechanism may be balanced by a suitable weight 30, mounted to swivel.

To the top of the glass plate forming part of the cover of the bowl A and in line with the axis of rotation of the magnetic needles is secured a vertical cylinder 31, closed at its top by a cap 31*, provided with an opening forming a bearing for the spindle 9. The purpose of this cylinder is to prevent the liquid in the compass-bowl from spilling. To prevent evaporation of the liquid, the cylinder may be partially filled with oil. To insulate the spiral recording-conductor from the cylinder 31 and the lower part of the compass, a mica disk *k* is attached to the said conductor, as shown in Fig. 1.

The chart C, Fig. 7, is divided by radial lines *a*, representing time, and by circular lines *b*, representing direction, and also by circular lines *c*, dividing it into spaces for the various other records.

In place of the rotary chart a traveling strip may be used to indicate the ship's course, &c. In the example illustrated in Figs. 8 to 12 I have shown the compass adapted for an endless strip C′, propelled by a time mechanism. The endless strip is provided on opposite sides with rows of perforations 32, adapted to be engaged by teeth 33 on a feed-roll 34, said strip being stretched over suitable guide-rolls 35 and 36 and passing below a radial conductor E′, which may be made in the form of a roll. The wheel 23 is actuated, as described in connection with Figs. 1 to 3, by an electromagnet 20 and armature-lever 21, provided with a feed-pawl 22. The worm on the worm-shaft 24 engages with a worm-wheel 25, rigidly mounted on the shaft of the feed-roll, and so turns the latter to advance the endless strip. The outer end of the worm-shaft 24 is mounted in a box 37, which can be moved vertically in a support 38 and is subjected to the action of a spiral spring 39, located in said support and tending to move said box upwardly. To the support 38 is pivoted a latch 40, adapted to engage with a pin 40* on the box to hold the same down upon the support. When the latch is withdrawn to release the box, the worm on the shaft 24 becomes disengaged from the worm-wheel 25, and so permits the strip to be adjusted by hand to the correct time. To facilitate this adjustment, I provide an indexed head 41 for the shaft of the feed-roll 34 and a second indexed head 42 on the worm-shaft 24, both said heads being provided with stationary index-hands 43 and 44, respectively. By means of the head 41 the strip can be set approximately to the correct time while the worm on shaft 24 is out of engagement with the worm-wheel 25, and then the strip can be set accurately, according to the time indicated by the chronometer, by means of the head 42 after the worm and worm-wheel have been thrown into engagement.

The tension of the endless strip may be adjusted by any suitable means—for instance, by mounting the guide-roll 35 in a movable bearing 45 on the cover 7, subjected to the action of a spring 46. A lever 47, engaging with said bearing and with a rack 48, serves to adjust the position of said guide-roll, and consequently the tension on the paper strip. To permit the endless strip to be slipped on the rollers, the lever 47 is thrown over to draw in the roll 35.

By inserting feed-rolls of different diameters in place of the feed-roll 34 the speed of the endless strip C′ can be varied with the same number of contacts at the chronometer. It is of course to be understood that a magnetic time-feed could be used for feeding a strip by winding from one roll to another, as described in my prior patents.

In Fig. 12 I have shown a diagrammatic view illustrating the construction of the spiral recording-arm and also the divisions on the endless strip for indicating direction and time.

The recording-arm D or the radial conductor E, or both, may be in the form shown in Fig. 14—that is, provided with a series of equidistant projections corresponding to the points on the compass.

In connection with the compass I also provide means for indicating on the chart or strip C or C′ the distance covered by the vessel, said means being adapted to form perforations in one of the spaces formed by the lines *c* on the chart or strip. This record of the distance sailed is made from a log L, Fig. 29, provided with a circuit-closing attachment—such, for instance, as that shown in my prior

patent, No. 556,987, dated March 24, 1896, or that shown in my application, Serial No. 647,159, filed August 5, 1897, and in my Patent No. 605,548, dated June 14, 1898—and I provide an improved relay-circuit closer R for obtaining a momentary closing of the circuit only, the object being to produce points and not lines. As shown in Figs. 16, 17, and 18, the relay-circuit closer, which is interpolated in the circuit of the log and conductor *l*, arranged adjacent to the radial conductor E, as shown in Figs. 1 and 29, consists of a base 50, supporting on pillars 51 a table 53, made of non-conducting material and provided with two metallic contacts 52, arranged diametrically opposite and screwed into the pillars. Above this table is mounted to turn on a spindle 54 a diametrical contact-arm 55, which is insulated from said spindle at 55* and is adapted to sweep over the contacts 52, but not to come into actual contact with the same. The contact-arm is turned through half a revolution whenever a circuit is closed by the log or other instrument by the following means: On the base-plate 50 is mounted an electromagnet 56, the armature-lever 57 of which is provided with a segment 58, engaging a pinion 59, mounted on the spindle 54. The armature-lever is subjected to the action of the spring 60 to draw it normally against the stop 61, in which position of the armature the contact-arm 55 is in a position midway between the two contacts 52. The tension of the spring 60 is regulated by an adjusting-screw 62, as usual. When the magnet 56 is vitalized and the armature attracted and drawn against stop 63, the segment 58 quickly turns the contact-arm through half a revolution, thus closing the circuit through the induction-coil I momentarily. To prevent retrograde movement of the contact-arm 55 on the return stroke of the armature 57 when the magnet 56 is devitalized by the breaking of the circuit at the circuit-closing instrument, the pinion 59 is loosely mounted on the spindle 54 and a ratchet-wheel 64 is connected to the pinion 59 by a clutch 65, said ratchet-wheel being made fast to the spindle and engaged by a spring-pressed holding-pawl 66. The armature-lever 57, therefore, on its return stroke merely turns the pinion 59 on the spindle 54 without turning the latter. The stops 61 and 63 are both adjustable, so as to obtain the proper throw for the armature. To the periphery of the ratchet-wheel are secured two tappets *z*, arranged diametrically opposite to each other and adapted to engage with an abutment *z'* on the armature-lever 57 at each half-revolution of the spindle 54, thereby abruptly arresting the movement of the contact-arm 55 midway between the contacts 52, so as to prevent multiplicity of contacts. The stop 61 and the segment 58 are both insulated from the metallic frame. Suitable binding-posts 67 and 68 are connected with the electromagnet 56, and binding-posts 67* and 68* are connected, respectively, with the metallic frame and with the armature-lever for closing a bell or other signal-circuit when the armature is against the stop 63, which also forms a contact.

To obtain reliability of action at the induction-coil, which is so essential for the proper operation of the instruments, I have provided means to insure the attraction of the contact-breaker and to prevent its sticking to the contacts. The means for accomplishing this end I have shown in Figs. 19 and 20, where J designates the bobbin of the electromagnet, placed in the circuit of the generator of electricity, *j* its core, and J' the contact-breaker. The contact-breaker is provided with a spring-arm 70, arranged adjacent and adapted to engage with two contacts 71 and 72 for making and breaking the circuit, as usual. On the opposite side of the electromagnet and in line with its core is arranged an armature 73, carried by a very flexible arm 74, suitably attached to a bracket 75, adjustably mounted on the base of the instrument by means of the screw 76 and a slot formed in said bracket, so that the distance of the auxiliary armature from the core may be adjusted. The coil J and the contact 72 are in shunt with the source of electricity. The contact 71 is used to make and break the circuit through the coil. When the core *j* is magnetized, the auxiliary armature 73 is attracted immediately and strikes the core *j* before the armature *j'* of the contact-breaker, and by the increased amount of soft metal so obtained for the core the magnetic lines are lengthened. When the auxiliary armature 73 strikes the core, the blow, as well as the increased magnetic force caused by the virtual increase in the magnetic material in the core, causes the immediate release of the contact-breaker J' from the contacts 71 and 72 in case it sticks to the breaker, thus forming a self-starting contact-breaker. After the contact-breaker has been started by the first movement of the auxiliary armature toward the core of the electromagnet and the contact-breaker continues to vibrate the current becomes intermittent and the magnetic force at the core is decreased. By properly adjusting the position of the auxiliary armature relatively to the core *j* said armature assumes its normal position and retains the same owing to the diminution in the strength of the magnetic field. In case the contacts stick during the further operation of the contact-breaker the increase in magnetic force again causes the auxiliary armature to strike the core for effecting the release of the contact-breaker, as before.

For automatically switching in a battery in case of failure of the dynamo-circuit and to give audible and visible indications of such change I make use of the switch S, (shown in Figs. 21 to 23,) in which 80 designates the switch-lever, provided with an armature 81, arranged opposite the core of an electromagnet 82, placed in shunt-circuit with the dy-

namo or other source of electricity. The switch-lever 80 is subjected to the action of a spring 83, tending to draw it away from the electromagnet and against a stop 84. The several contacts *d d*, *e e*, *f f*, *g g* for the several instruments in the dynamo-circuit and those *d' d'*, *e' e'*, *f' f'*, *g' g'* for the instruments in the battery-circuit are arranged on opposite sides of the center line of motion of the switch-lever, and said switch-lever is provided with a series of insulated contacts 85, adapted to bridge and connect the several contacts *d d e e*, &c., or the contacts *d' d' e' e'*, &c., when in a position over either of said series of contacts. The contacts *d e*, &c., are made in the form of spring-arms bent upwardly and inwardly, but may have any other suitable form. The upper end of the switch-lever 80 is provided with a segment 86, engaging a pinion 87 on the shaft of a fan 88, which fan acts as a check or break to the motion of the switch-lever. In case of interruption of the dynamo-circuit the spring 83 draws the switch-lever 80 from its position over the contacts *d d*, &c., to a position over the contacts *d' d'*, &c., thus closing the circuit from a battery or other source of electricity, as the contacts *d' d'* are those closing the circuit through the battery and the contacts *d d* are those closing the circuit of the dynamo. The remaining contacts close the circuit through the automatic contact-breakers, induction-coil, &c., as will be hereinafter explained. The contacts are so disposed that the contacts *g g* for the induction-coil are broken during the first movement of the switch-lever 80, when the magnet 82 is devitalized by the failure of the dynamo to act, and the battery-circuit is closed at the contacts *d' d'* before the circuit through the induction-coil is closed at the contacts *g' g'*. The contacts *e' e' f' f'* for the contact-breaker are then closed, and finally the contacts *g' g'* are closed, thereby giving the automatic contact-breaker an opportunity to act before the induction-coil is vitalized.

In Fig. 24 I have shown a modified form for the switch and the automatic contact-breaker in which the switch S' controls but one automatic contact-breaker J^2 common to both the dynamo and battery circuits. In this construction the contacts *e e f f* and *e' e'* and *f' f'* are omitted, and in place of the same two contacts *h h'* are used, and the current from either the battery or the dynamo is conducted through the switch-lever 80 by wire 113. These contacts *h h'* are made yielding so as to follow up the movements of the switch-lever 80 in order that the circuit to the contact-breaker J^2 is closed before the circuit to the induction-coil I, and the wire 142, leading to one of the contacts 72 of the contact-breaker J^2 is common to both the dynamo and battery coil. The contacts *d d d' d'* are also made yielding.

In Fig. 24 the battery and dynamo wires are wound about the core in two helices j^3 and j^4. In Fig. 25 the dynamo-wire is coiled about the entire core, as at j^3, and the battery-wire connected to the same at or about the center of the coil. In Fig. 26 the battery-coil j^4 is surrounded by the dynamo-coil j^3, and in Fig. 27 one half of the core is covered with the dynamo-coil j^3 and the other half with the battery-coil j^4.

In connection with the several apparatus above described devices are also employed for indicating the number of revolutions of the engines ahead and back, the time, number, and duration of the whistles, and other special signals, as may be required. The means for indicating the number of revolutions ahead may be a usual speed-indicator F, arranged to make and break a circuit through a relay, such as R', previously described, at any predetermined number of revolutions, thereby closing a circuit through the induction-coil to the contact-point *l'*, located below the radial conductor E, Fig. 29, the indications thus made showing the number of revolutions of the wheel or propeller shaft. A similar indicator F' may be used to indicate the number of revolutions of engine after reversal. Signal contact-keys F^4 F^5 of proper construction may also be used for perforating the strip or chart.

Referring now to Fig. 29 of the drawings, wherein I have shown diagrammatically the several instruments and their electrical connections for forming the indications on the chart or strip and for giving the several signals, numeral 20 designates the feed-magnet for imparting the necessary motion to the chart or strip, and 20* is the compensating coil or magnet for neutralizing the magnetic action of the feed-magnet on the magnetic needles. This magnet may or may not be used. The make-and-break chronometer T is connected by wires 100 and 101 to the terminals of the coil of the feed-magnet, the compensating-magnet, and local battery B^2. I is the induction-coil which is operated, primarily, by the current produced by the dynamo D and secondarily, in case of failure of the dynamo, by the battery B, both of which are connected to the primary coil of the induction-coil with the interpolation of a switch S, the contact-breakers J J*, (described in Figs. 19 and 20,) and an adjustable condenser L', connected in a usual manner. The electrical connections are made as follows: One wire 102 from the dynamo is connected with a rheostat N, which latter is connected by a wire 103 with one of the contacts *f'* of the switch S and also by a wire 104 with the condenser L'. The second wire 105 is connected with one of the contacts *d*. One wire 106 from the battery B is connected with a rheostat N', which is connected by wire 107 to wire 103, leading to the contact *f'*. The second wire 108 from the battery B connects with one of the contacts *d'*. The coil 82 of the switch S is in shunt-circuit with the dynamo-circuit by wires 109 and 110. The contact-breaker J for the dynamo-circuit is con-

nected with one of the contacts *e* of switch S by a wire 111 and by a wire 112 with one of the contacts *f*, the other contact *f* being connected with the contact *f'* adjacent to that in connection with wire 103, connected to the dynamo and the battery. The wire 113 from the coil of the contact-breaker J is connected with one end of the primary coil of the induction-coil I, and said wire is also connected with the condenser L'.

The contact-breaker J* for the battery-circuit is connected by a wire 114 to one of the contacts *e'*, and the contact *e'* adjacent to said contact is connected with the contact *e* opposite to the contact *e* to which the wire 111 from the contact-breaker J is connected. The second wire 115 is connected with one of the contacts *f'* adjacent to the contact *f'* to which the wire 112 is attached. The coil of J* is connected by a wire 116 to the wire 113, leading to the induction-coil I. The other wire 117 of the induction-coil is connected with one of the contacts *g'* and with one of the contacts *g*. A wire 118 connects the opposite contacts *g* and *g'* with the connection between the contacts *e* and *e'* of the switch S. The contact *d* adjacent to the contact *d* connected with the dynamo is connected by a wire 119 with wire 113, connecting with the induction-coil I and the condenser L'.

The secondary coil of the induction-coil is in connection with the radial conductor E by wire 120 and with the recording-conductor D by a wire 121.

In the example illustrated in Fig. 29 I have shown seven circuits for making records on the chart or strip besides the regular direction-record.

F is a register for indicating the revolutions of the engines ahead, and F' a similar register for indicating the revolutions with engines reversed. F^2 and F^3 are similar devices for closing circuits for special purposes.

F^4 and F^5 are signal-keys, one of which may be used to record the time and duration of whistles and the other for any special purpose.

l l' l^2 l^3 l^4 l^5 l^6 are the conductors arranged adjacent to the chart or strip and directly opposite the radial conductor E, the same corresponding to the several instruments L, F, F', F^2, F^3, F^4, and F^5.

R, R', R^2, R^3, and R^4 are the relays of the instruments L, F, F', F^2, and F^3, said relays being shown in Figs. 16 and 17 and adapted to give a momentary contact for producing a single perforation at a time, as previously described.

B' is the battery for the various relay-circuits. A primary wire 122 leads from one pole of said battery and is common to all the relays R. The other wire 123 from the battery forms a common return from all the contact instruments L, F, F', F^2, and F^3. The intermediate wires 124, 125, 126, 127, and 128 connect the separate contact devices with the relays. The contacts of the relays R R', &c., are connected by wires 129, 130, 131, 132, and 133 with the conductors l, l', l^2, l^3, and l^4. The signal-keys F^4 and F^5 are connected by wires 134 and 135 with the conductors l^5 and l^6.

To indicate visibly and audibly when the induction-coil I is not working properly, I make use of the device O, illustrated in my prior patent, No. 524,636, dated August 14, 1894, which is adapted to close the circuit at either of the contacts *o o'*, and so close the circuit of the battery B^3 through the lamp P and the bell P'. To obtain similar indications when the switch-lever 80 of the switch is moved to close the circuit of the battery B, I make use of a circuit including a battery B^4, lamp P^2, and bell P^3, which circuit is closed in this movement of the switch-lever by contacts 84 and 84*, (see also Figs. 21 and 24,) and so causes the lamp to be lighted and the bell to ring. As a further precaution a lamp P^4 is placed in the dynamo-circuit, which remains lighted so long as the dynamo is running normally.

Ordinarily the dynamo-circuit is used for operating the induction-coil; but in the diagram I have assumed that the action of the dynamo has been suspended. As before described, the cessation of the dynamo-current has caused the magnet 82 of the switch S to become devitalized and the spring 83 to draw the switch-lever 80 to throw in the battery B and to disconnect the contact-breaker J for the dynamo and to throw in the instrument J* for the battery-circuit previously to the closing of the circuit of said battery through the induction-coil I. The current from battery B passes over wire 108, contact *d'*, wire 136, wire 119, wire 113, induction-coil I, wire 117, contacts *g'*, wire 118, contacts *e'*, wire 114, automatic contact-breaker J*, wire 115, contacts *f'*, wire 103, wire 107, rheostat N', wire 106, back to the battery. This starts the contact-breaker J* and opens and closes the current through wires 114 and 115 automatically. The secondary current passes over wire 120 to the radial conductor E, through the moving chart or strip C to the spiral conductor D, thence over wire 121 back to the coil.

When the circuit is closed momentarily at the relay R of the log, the current passes over the wire 121, wire 137, relay R, switch S, wire 129, to the small conductor *l*, through the chart or strip, leaving a single perforation, thence to the radial conductor E, wire 120, back to coil I. The action with the other instruments F, F', F^2, and F^3 is the same, they being similarly connected. In closing the signal-keys F^4 and F^5 the current passes through the switches s^5 and s^6 over wires 134 and 135 to the conductors l^5 and l^6, through the paper, leaving a dot or dash in the chart or strip C, according to the duration of the contact, as in telegraphy.

Instead of employing separate batteries B, B^2, B^3, and B^4 a common battery B' may be used and the connections made as indicated by broken lines in Fig. 29.

The switches *s*, above referred to, are shown in Fig. 30, and consist each of a casing *m* of non-conducting material, having at its bottom a contact-screw *n*, and containing a metallic plunger *p*, extending through a cap *q* of insulating material screwed to the top of the casing *m* and provided with an insulated handle *r*. A binding-screw *t* is passed radially through the casing and is in contact with the plunger *p*. If the plunger is drawn away from the radial binding-screw *t*, the circuit is broken between wires *u* and *v* and the passage of sparks is prevented.

In Fig. 15 I have shown a diagram illustrating the proper relative distances between the recording-conductors to insure the passage of sparks at the proper points. The length of the line X Y indicates the distance between the conductor 121 and the curved recording-conductor; length of line X X′ indicates the distance between the curved and the radial conductor; length X′ X^2, the distance between the extreme outside of the curved recording-conductor and the innermost signal-conductor l^6; length X^2 X^3, the distance between the conductors l l' l^2 l^3, &c., and the radial conductor, and length X^3 X^4 the lateral distance between the said conductors l l' l^2, &c.

The rheostats N and N′ (shown in Fig. 29) are utilized for adjusting the current to obtain the same length of spark from the induction-coil I with the use of either the battery or the dynamo.

In the diagram Fig. 31 I have shown the circuits when the switch S′ (shown in Fig. 24) is used. The electrical connections from the battery B and dynamo D to the induction-coil I and the condenser L′ are substantially the same as described in connection with Fig. 29. The battery-contact *h′* is connected by a wire 140 with one end of the coil j^4 of the automatic contact-breaker J^2, and the dynamo-contact *h* is connected by a wire 141 with one end of the other coil j^3 of the same. Wire 113 is connected to the pivot of the switch-lever 80. A common wire 142 connects both coils j^3 j^4 with the contact 72 of the contact-breaker J^2.

I do not wish to confine myself to the use of instruments embodying the exact constructions herein described or to the particular arrangements of circuits, as it is evident that both can be modified without departing from my invention. It will also be readily understood that the several devices described can be embodied in various recording instruments—such as voltmeters, ammeters, &c.—although I have only shown the same used in connection with ships' apparatus.

What I claim as new is—

1. In an electric recording instrument, the combination of a curved recording-conductor, a conductor arranged adjacent to said curved conductor, electromagnetic means arranged in line with the axis of the needle for moving a paper between said two conductors, and means for causing the passage of sparks between the two conductors, substantially as described.

2. In an electric recording instrument, the combination of a curved recording-conductor, a conductor arranged adjacent to said curved conductor, an electromagnet arranged in line with the axis of the needle, a chronometer provided with a circuit-closer actuated at predetermined intervals and placed in circuit with the electromagnet, means operated by said electromagnet for moving a paper between the two conductors, and means for causing the passing of sparks between the two conductors, substantially as described.

3. In an electrical recording instrument having a magnetic needle, the combination of a curved recording-conductor, a conductor arranged adjacent to said curved conductor, an electromagnet arranged in line with the axis of the needle, a circuit-closer for making and breaking an electric circuit through said electromagnet, means operated by said electromagnet for moving a paper between the two conductors, and means for causing the passage of sparks between the two conductors, substantially as described.

4. In an electrical recording instrument, the combination of a curved recording-conductor, a conductor arranged adjacent to said curved conductor, an electromagnet, a chronometer provided with a circuit-closer actuated at predetermined intervals and placed in circuit with the electromagnet, means operated by said electromagnet for moving a paper between the two conductors, means for causing the passing of sparks between the two conductors, and means for disconnecting the driving mechanism of the paper for setting the latter to the time with reference to the conductor, substantially as described.

5. In an electric recording instrument, the combination of two conductors arranged adjacent to each other and relatively movable, a non-conducting plate interposed between the two conductors and having a slit to permit the passage of sparks between the conductors, means for feeding a paper between the two conductors above the non-conducting plate; which latter bodily supports the paper at all points, and means for causing the passage of sparks between the two conductors, substantially as described.

6. In a recording instrument, a conductor provided with a series of equidistant projections, a conductor relatively movable with respect to the first conductor, combined with means for feeding a paper between said two conductors, and a spark-producing device connected with said two conductors, substantially as described.

7. In an electric recording system, the combination of an induction-coil, a contact-breaker for the same, two electrical circuits, and a switch adapted to close either circuit, by first closing the circuit through the contact-breaker and subsequently thereto the

circuit of the induction-coil, substantially as described.

8. In an electric recording system, the combination of an induction-coil, two contact-breakers for said induction-coil, two electrical circuits, each including one of said contact-breakers, and a switch adapted to close either circuit by first closing the circuit through the corresponding contact-breaker and subsequently thereto the circuit of the induction-coil, substantially as described.

9. In a contact-breaker, the combination of a core wound with two coils, and an armature, substantially as described.

10. In an electric recording system, the combination of a recording instrument provided with means for moving a paper and with conductors between which the paper is moved, an induction-coil provided with a contact-breaker, two sources of electricity, a switch controlling the circuits of said two sources and adapted to throw in the secondary source when the primary source fails, means operated by the movement of the switch to give audible or visible indications of such change, a series of contact instruments, a series of relay-circuit closers included in the circuit of the contact instruments, and a series of conductors, one for each relay-circuit closer arranged adjacent to one of the conductors at the recording instrument and placed in the circuit of the induction-coil for making records of the contacts made by the contact instruments, substantially as described.

11. In an electric recording system, the combination of a recording instrument provided with means for moving a paper and with conductors between which the paper is moved, an induction-coil provided with a contact-breaker, two sources of electricity, a switch controlling the circuits of said two sources and adapted to throw in the secondary source when the primary source fails, a series of contact instruments, a series of relay-circuit closers included in the circuit of the contact instruments, and a series of conductors, one for each relay-circuit closer arranged adjacent to one of the conductors at the recording instrument and placed in the circuit of the induction-coil for making records of the contacts made by the contact instruments, substantially as described.

12. In an electric recording system, the combination of a recording instrument having two conductors, means for moving a paper between said conductors, a break-and-make-circuit chronometer for actuating said means, an induction-coil, a contact-breaker for said coil, two sources of electricity, a switch in the circuit of the primary source and controlling the circuits of both sources and adapted to close the circuit of the secondary source when the primary source fails and to close the circuit of the contact-breaker in advance of that of the induction-coil, means operated by the movement of the switch to give audible or visible indication of the change from the primary to the secondary source, a series of contact instruments, a series of relay-circuit closers included in the circuit of the contact instruments, a series of conductors at the recording instrument placed in the circuit of the induction-coil for making records of the contacts made by the contact instruments, signal-keys placed in the circuit of the induction-coil, and conductors arranged adjacent to one of the conductors of the recording instrument, for making records of the contacts made at said signal-keys, substantially as described.

13. In an electric recording system, the combination of a curved recording-conductor D, a series of recording-conductors l, l', l^2, &c., arranged opposite a straight conductor E and the curved conductor D and the series of conductors l, l', &c., means for moving said paper continuously between said several conductors at a uniform rate of speed, a series of magnetic relays s, s', s^2, &c., connected electrically with said series of recording-conductors and adapted to close the circuits for an instant only, a series of contact devices F, F', F^2, &c., adapted to operate electrically the said magnetic relays s when the contact devices are operated by the log, engine-shaft, signal apparatus, &c., a primary source of electricity D', an automatic switch S, a set of signals P^2, P^3 operated by said switch, a magnet 82 operating said switch and placed in the circuit of said source of electricity D', an auxiliary source of electricity B or B' of which the circuit is closed when the switch S is thrown over upon failure of the primary source D', an induction-coil I placed in the circuit of both sources of electricity D' and B or B' and controlled by the switch S, automatic vibrators J, J with hammers 73, 74 one for each of the sources of electricity D' and B or B', said vibrators being controlled also by the switch S, and said vibrators being electrically connected to be thrown into action before the circuit is closed through the induction-coil from either source of electricity D' and B or B', and electrical connections for causing the formation of sparks between the radial conductor E and the spiral conductor D and the series of conductors l, l', l^2, &c., and through the paper, substantially as described.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses.

CHARLES L. JAEGER.

Witnesses:
E. P. HENDRICKSON,
E. F. PERSIDES.