No. 854,777. PATENTED MAY 28, 1907.

E. THOMSON.

ELECTRIC METER.

APPLICATION FILED. APR. 21, 1902.

4 SHEETS—SHEET 1.

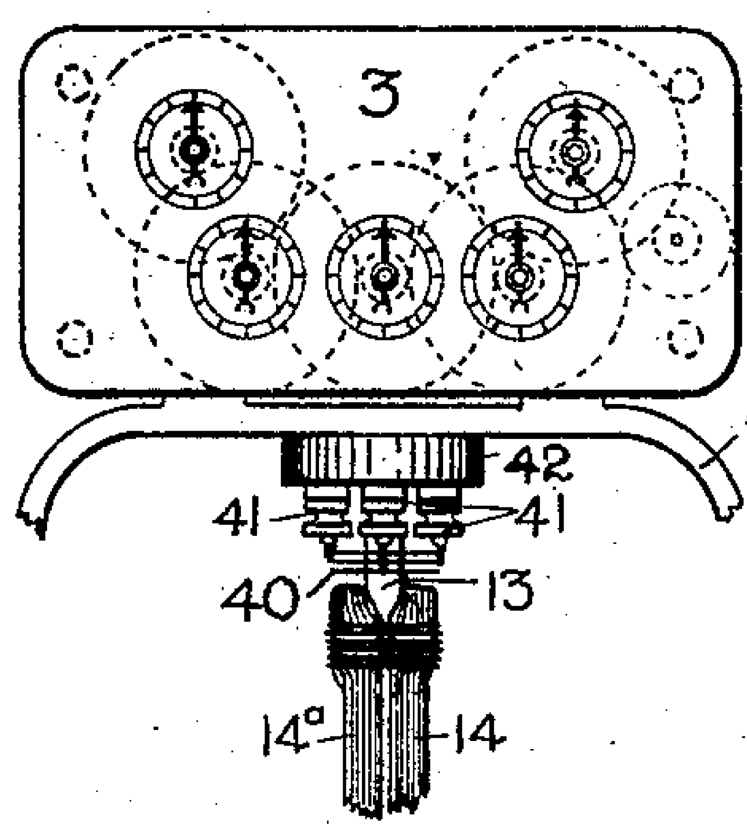


Fig. 3

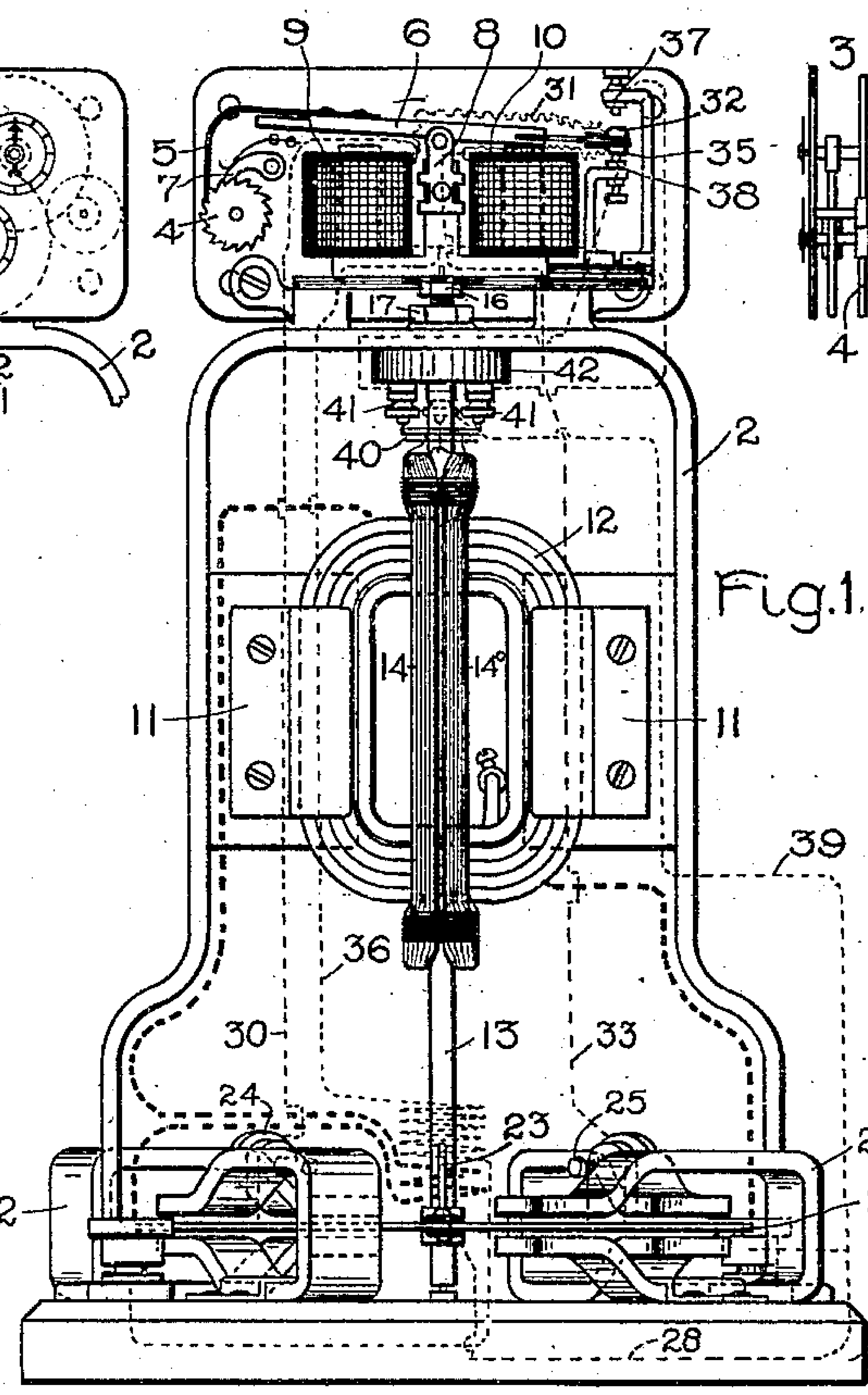


Fig. 1.

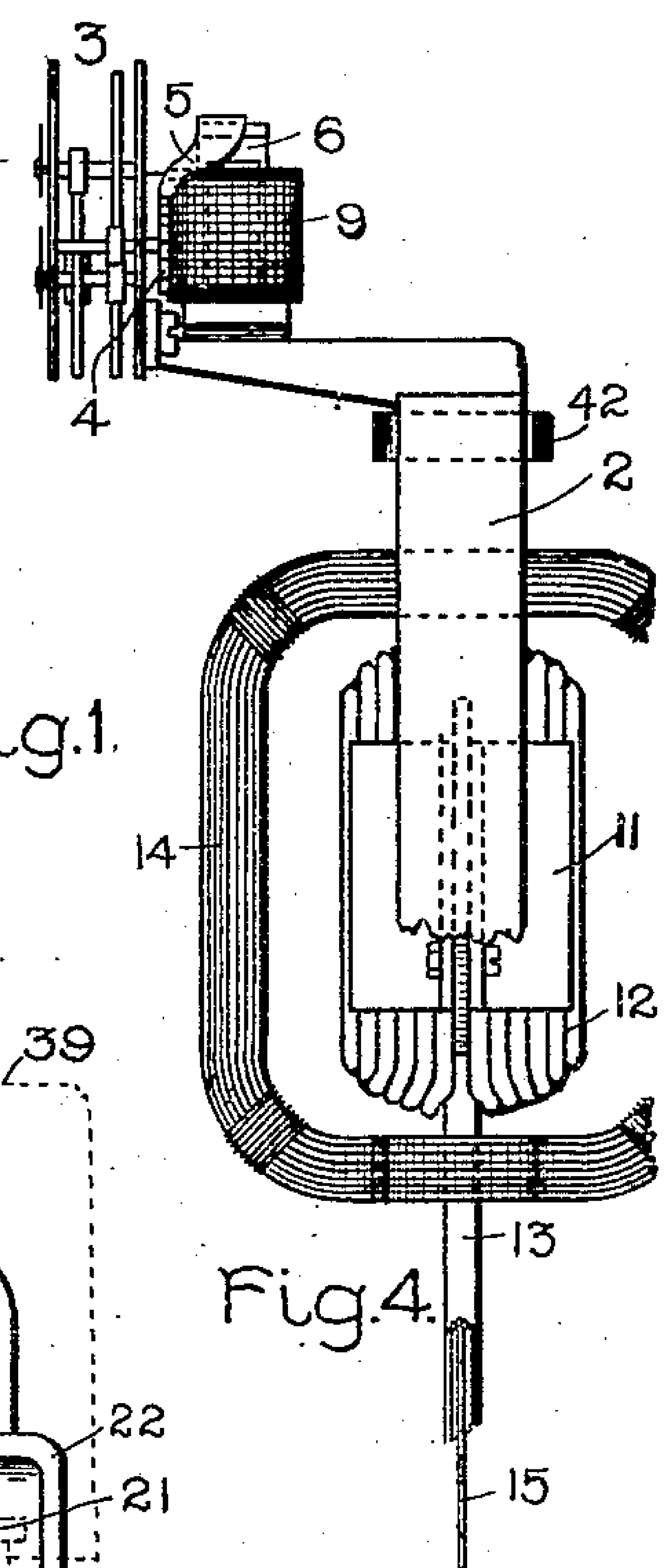
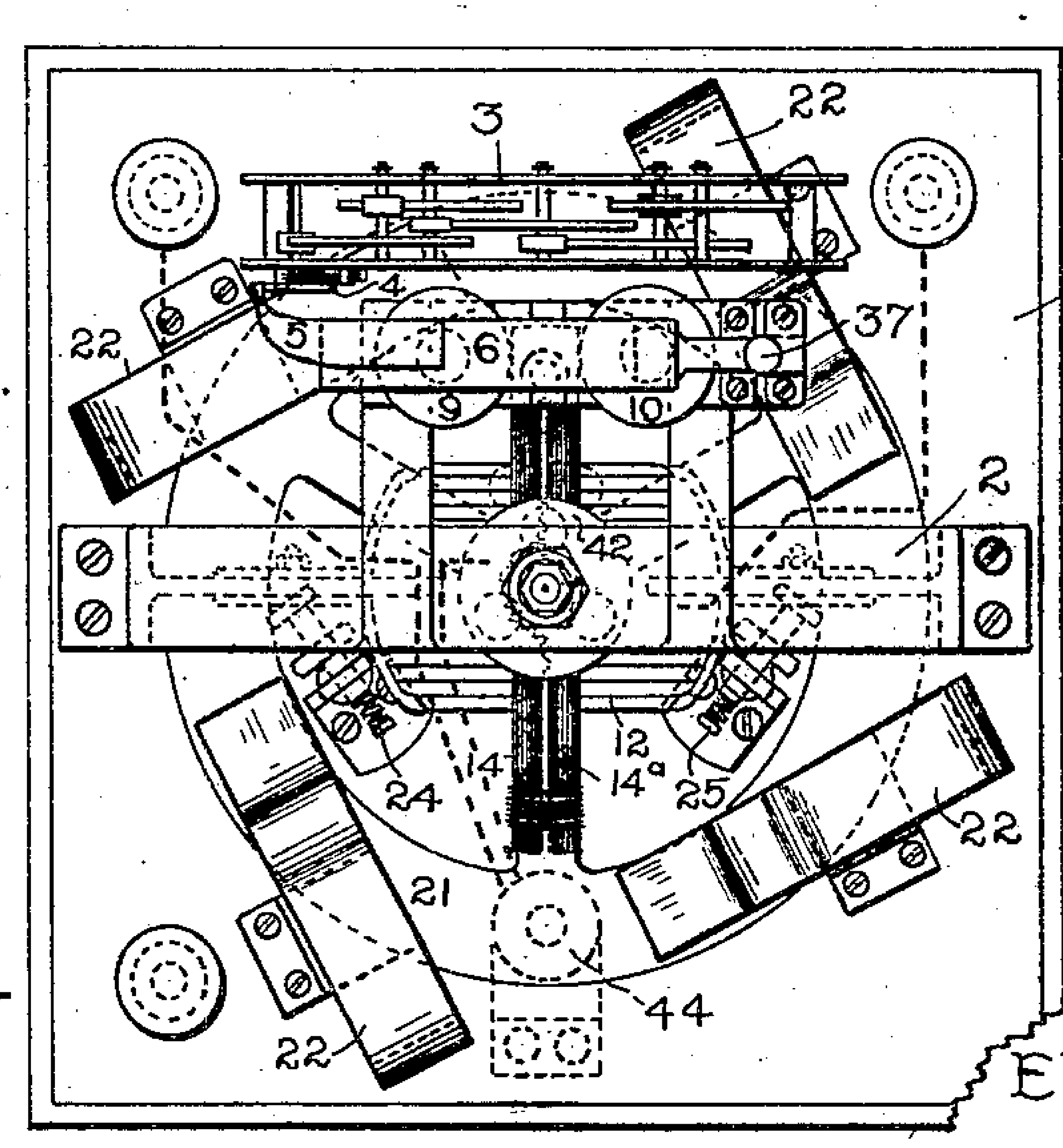


Fig. 4.

Fig. 2.



WITNESSES.

[illegible]

[illegible]

INVENTOR.

Elihu Thomson

By Albert G. Davis.

Atty.

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Fig. 7.

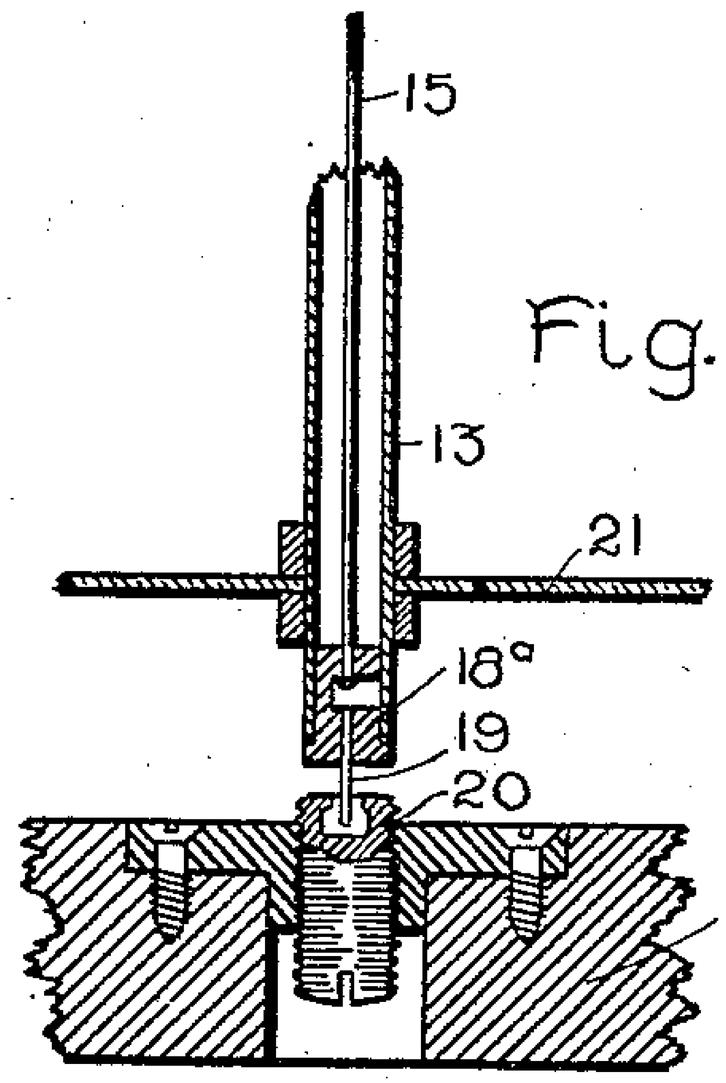


Fig. 5.

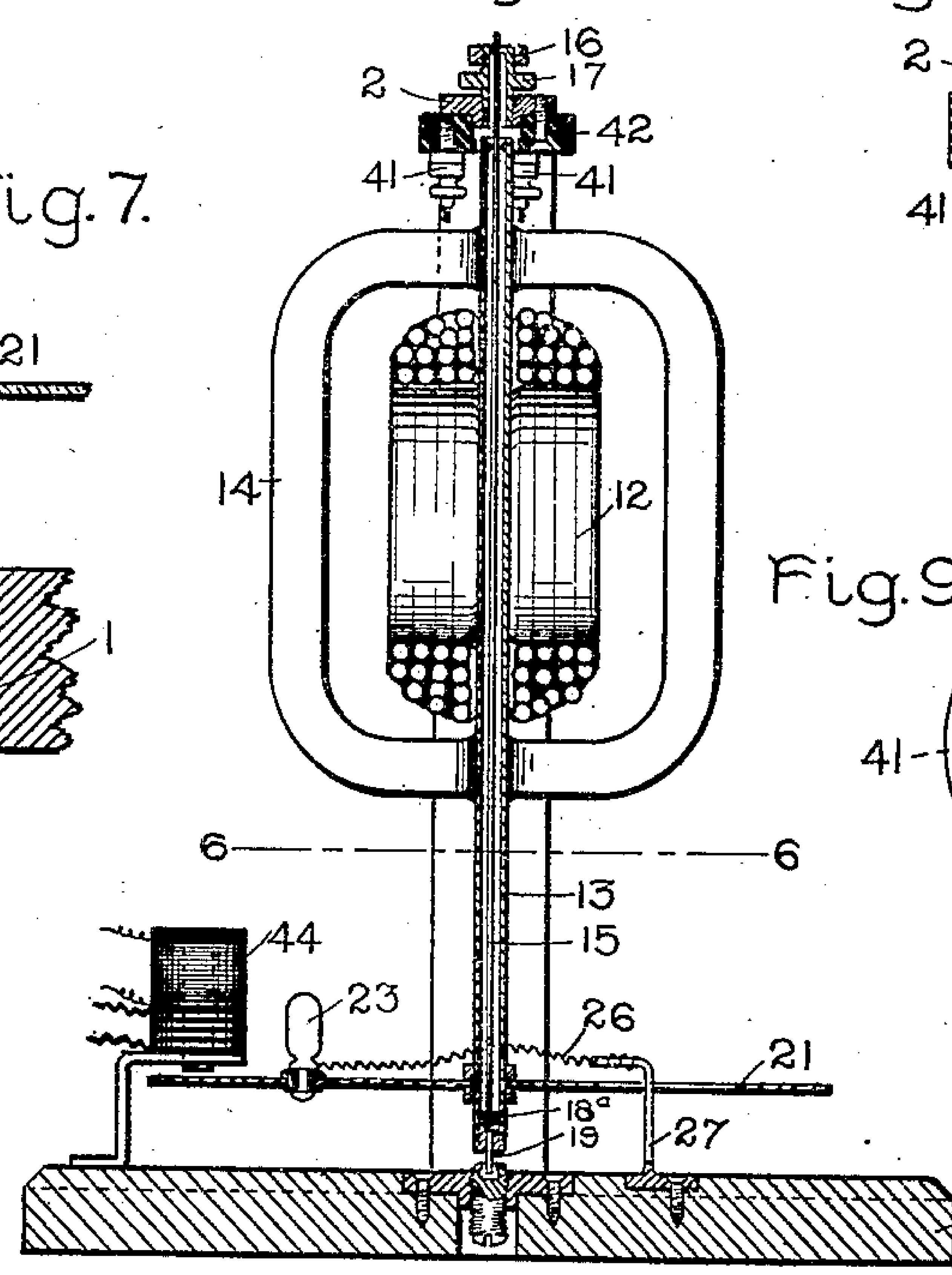


Fig. 8.

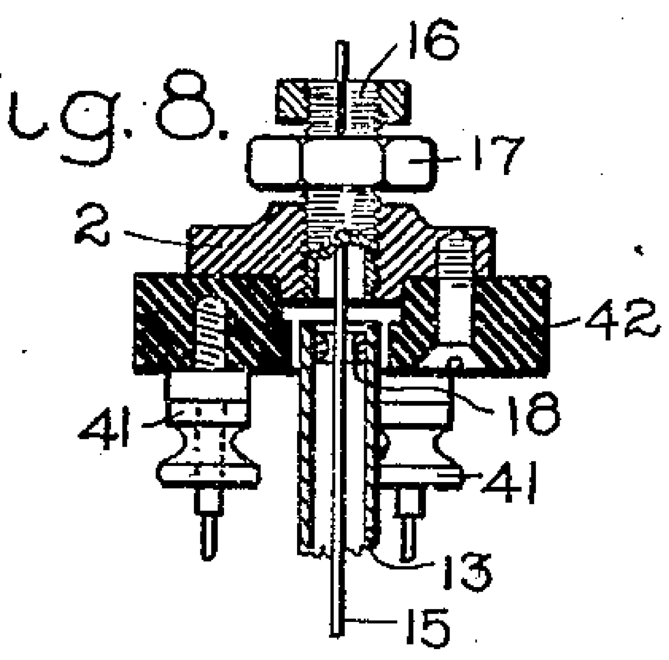


Fig. 9.

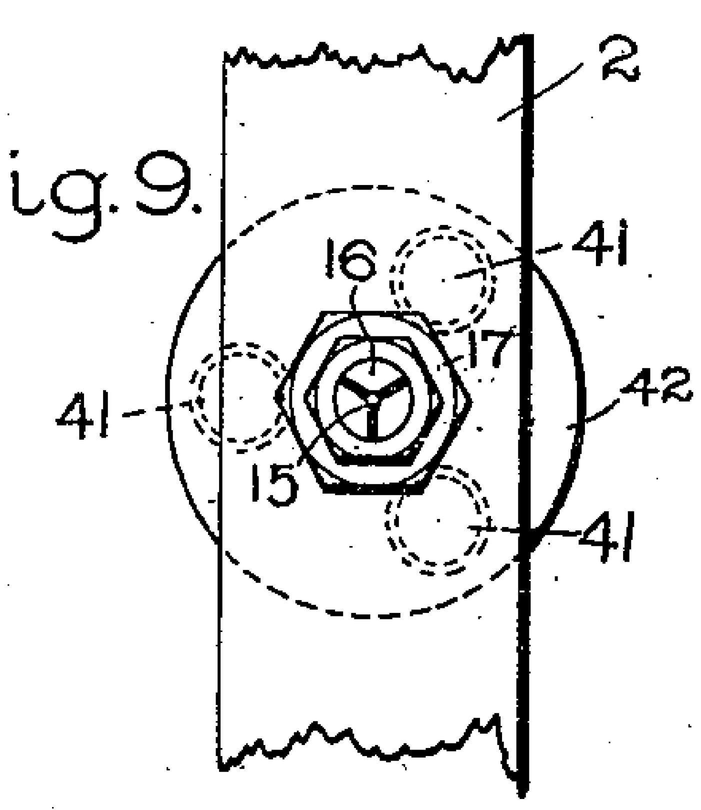
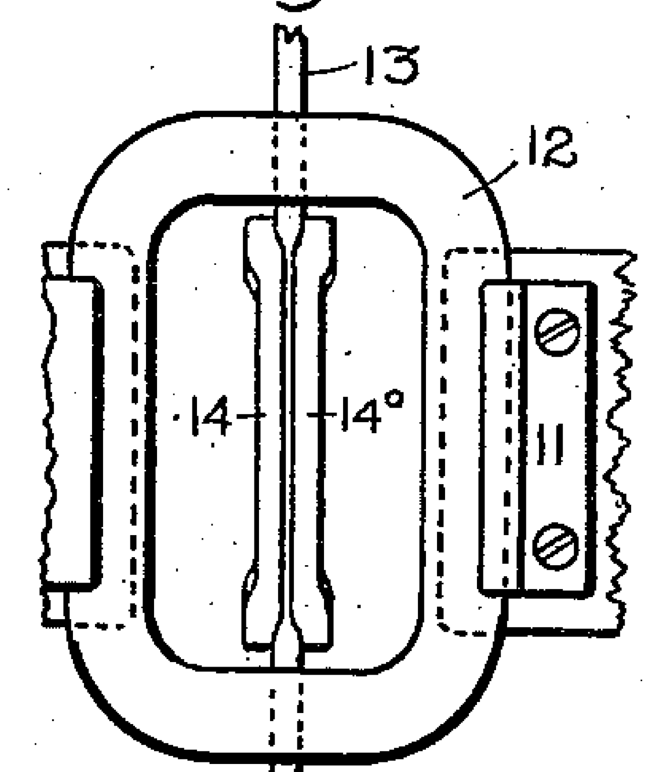


Fig. 10.



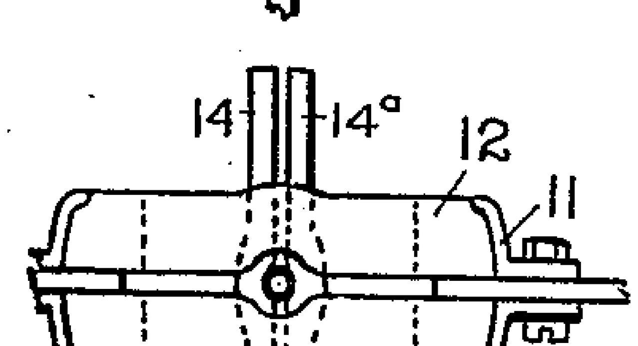


Fig. 11.

Fig. 6.

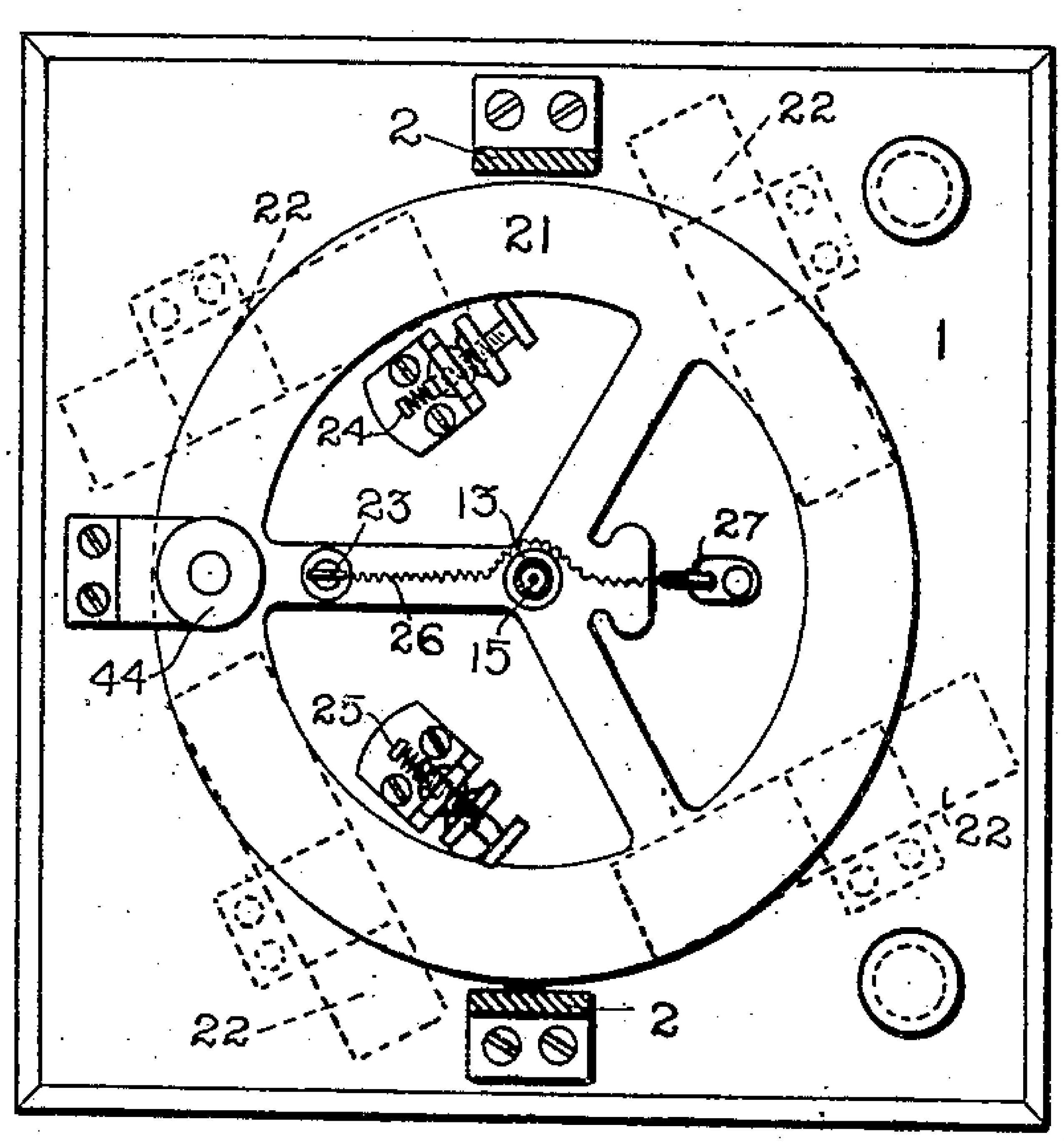


Fig. 21.

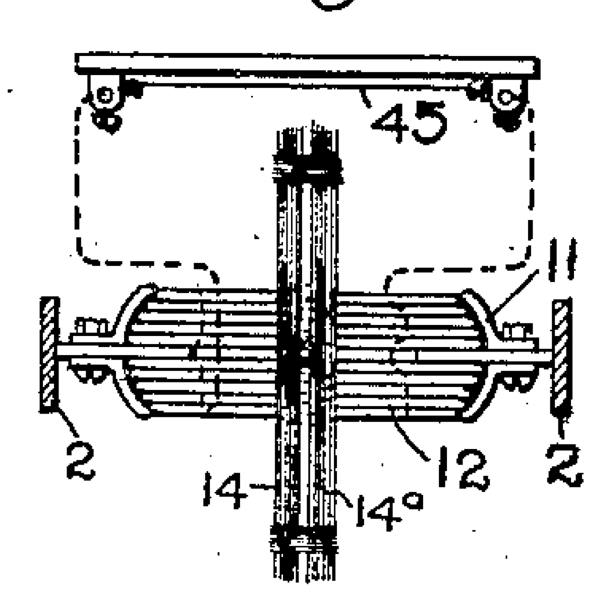


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Fig. 12.

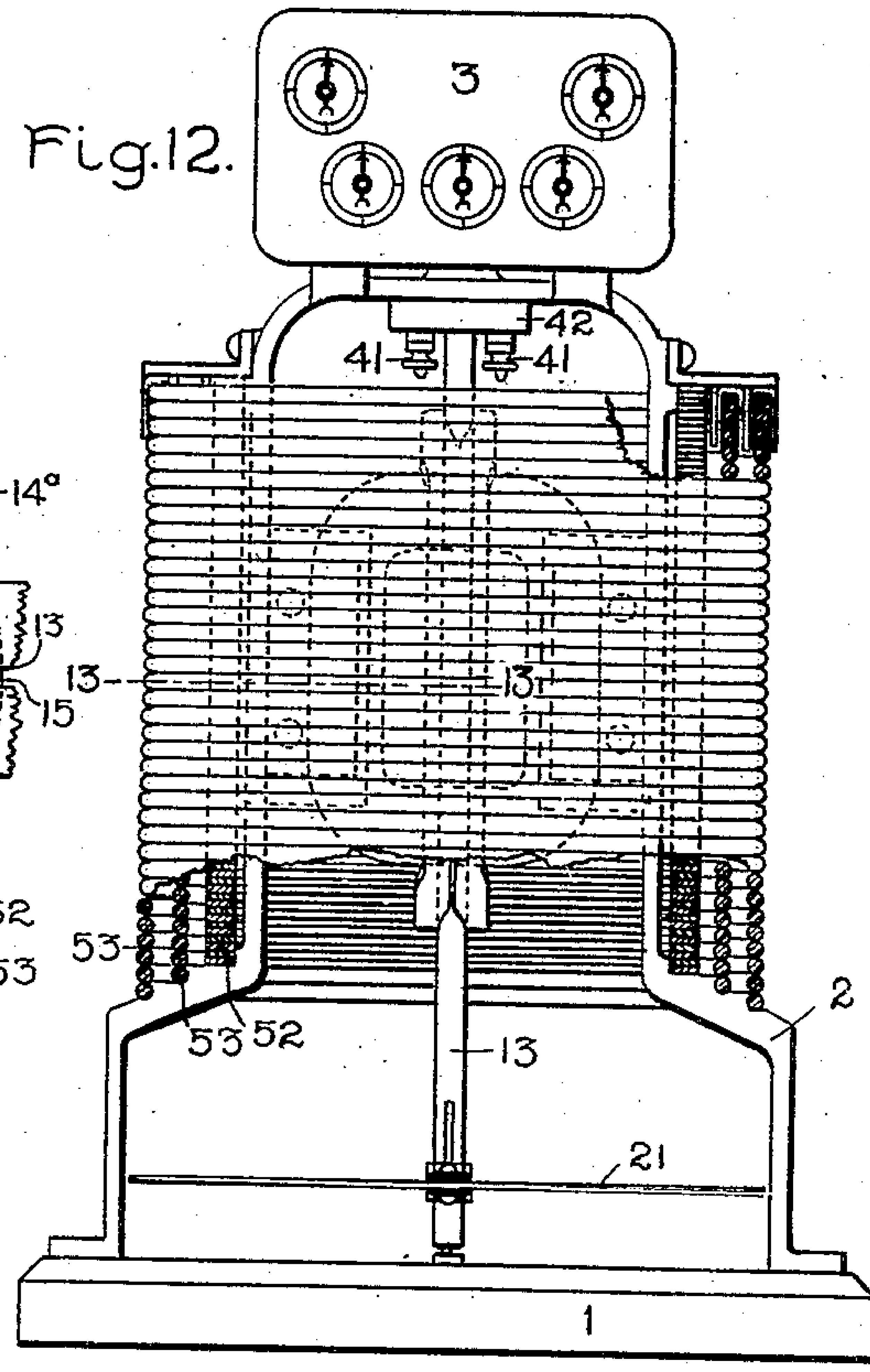


Fig. 13.

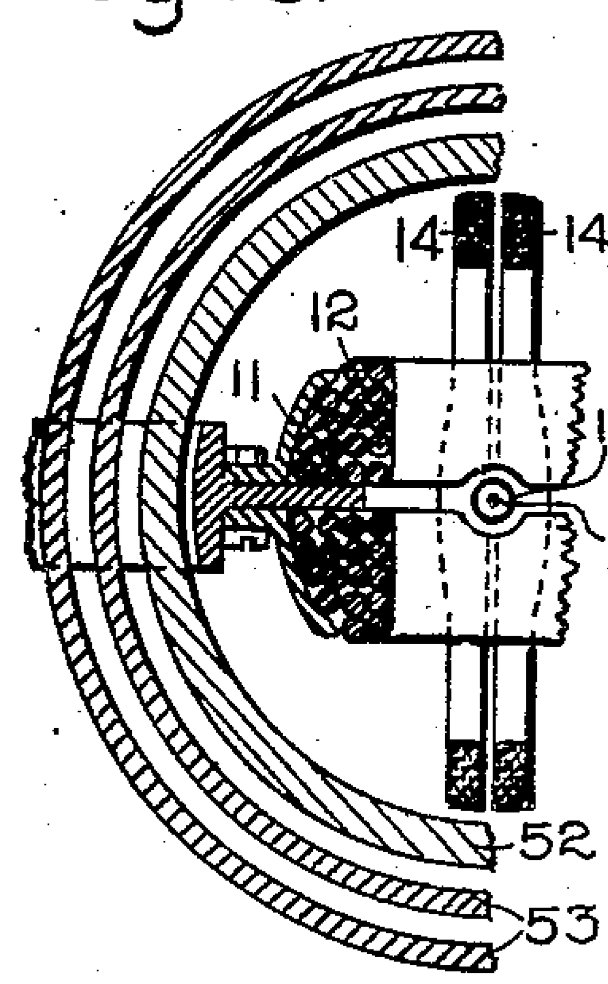


Fig. 16.

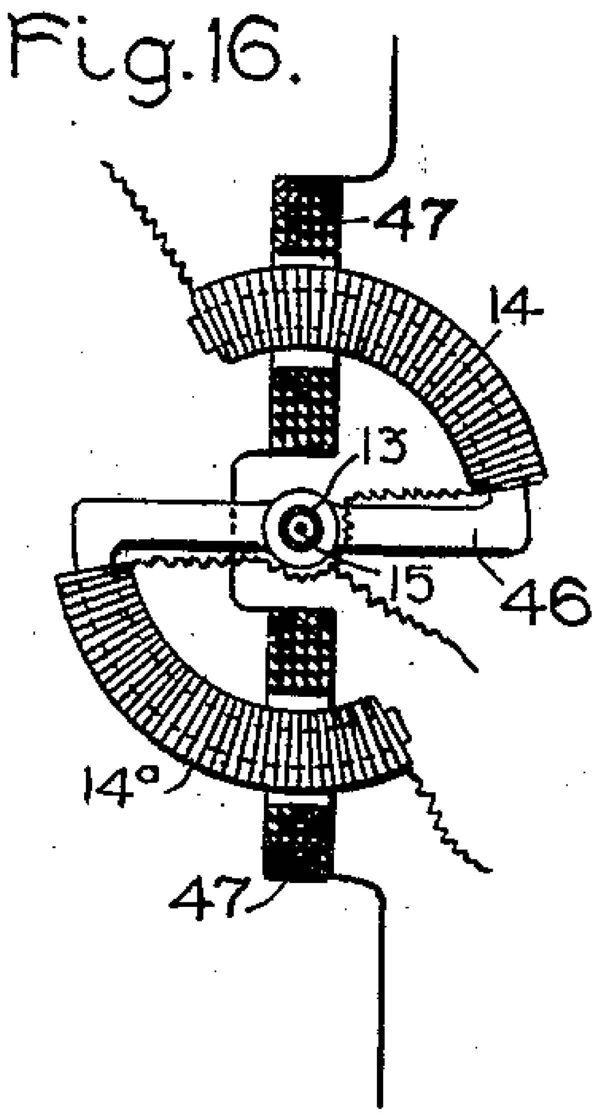


Fig. 15.

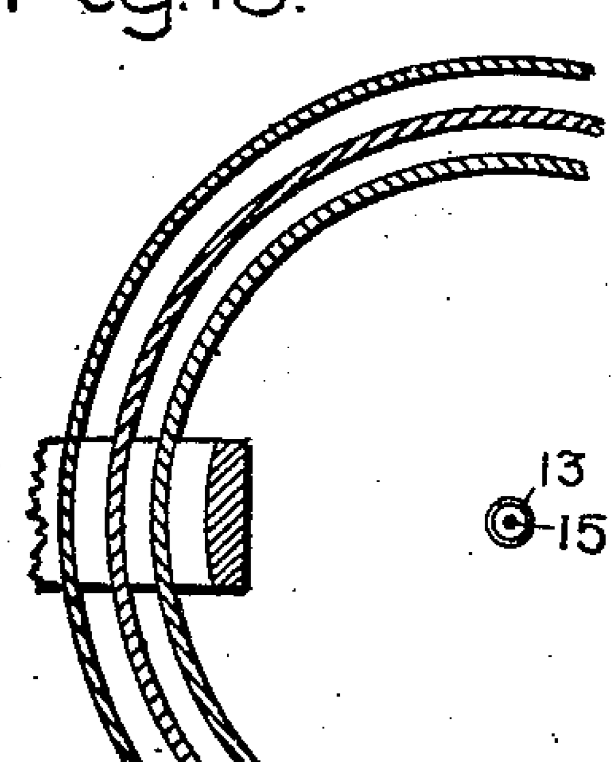


Fig. 14.

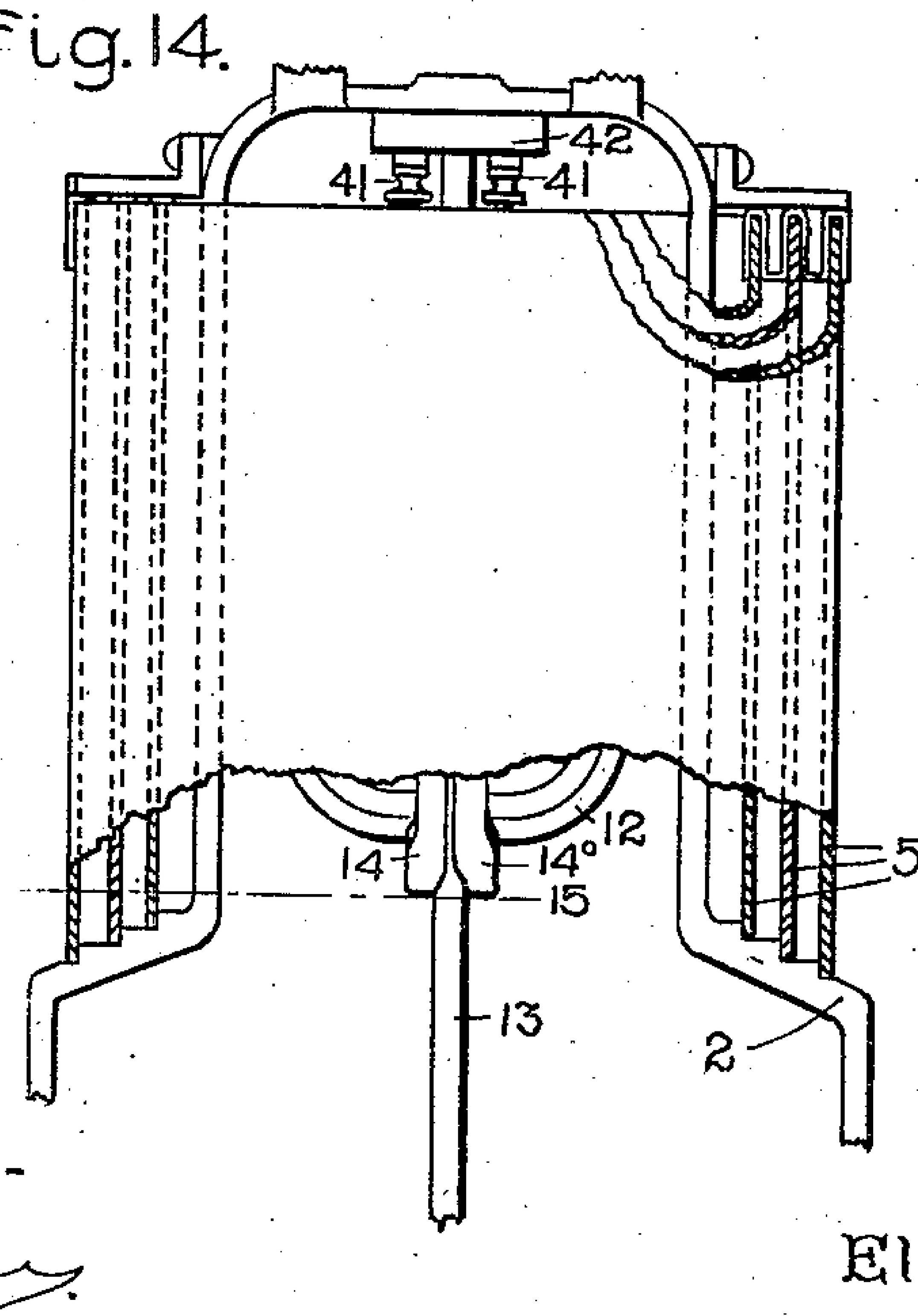
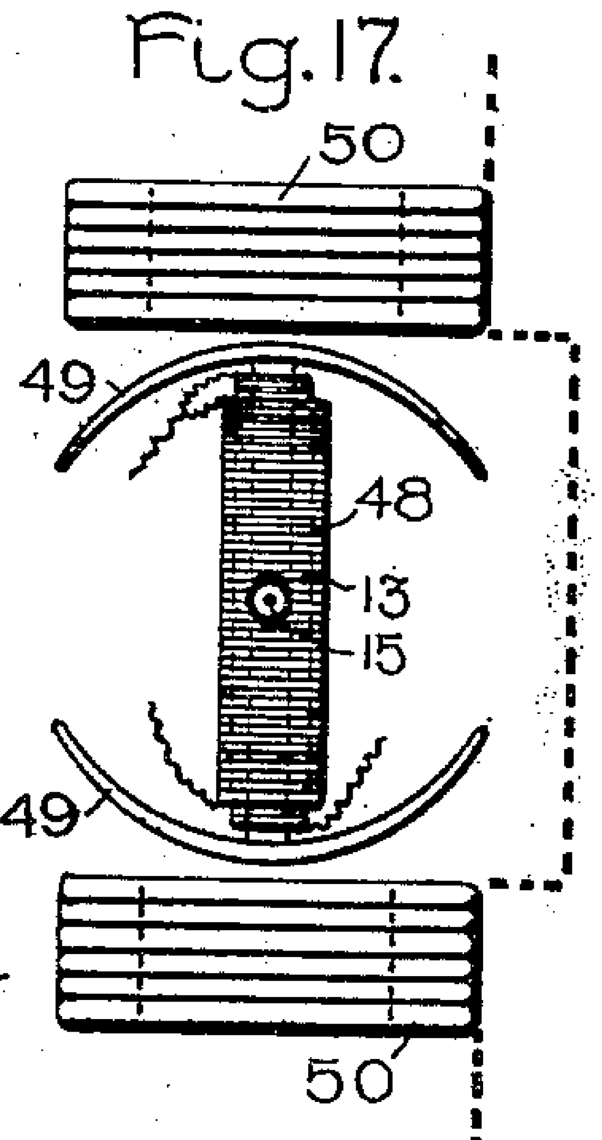


Fig. 17.



WITNESSES.

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4 SHEETS—SHEET 4.

Fig. 18.

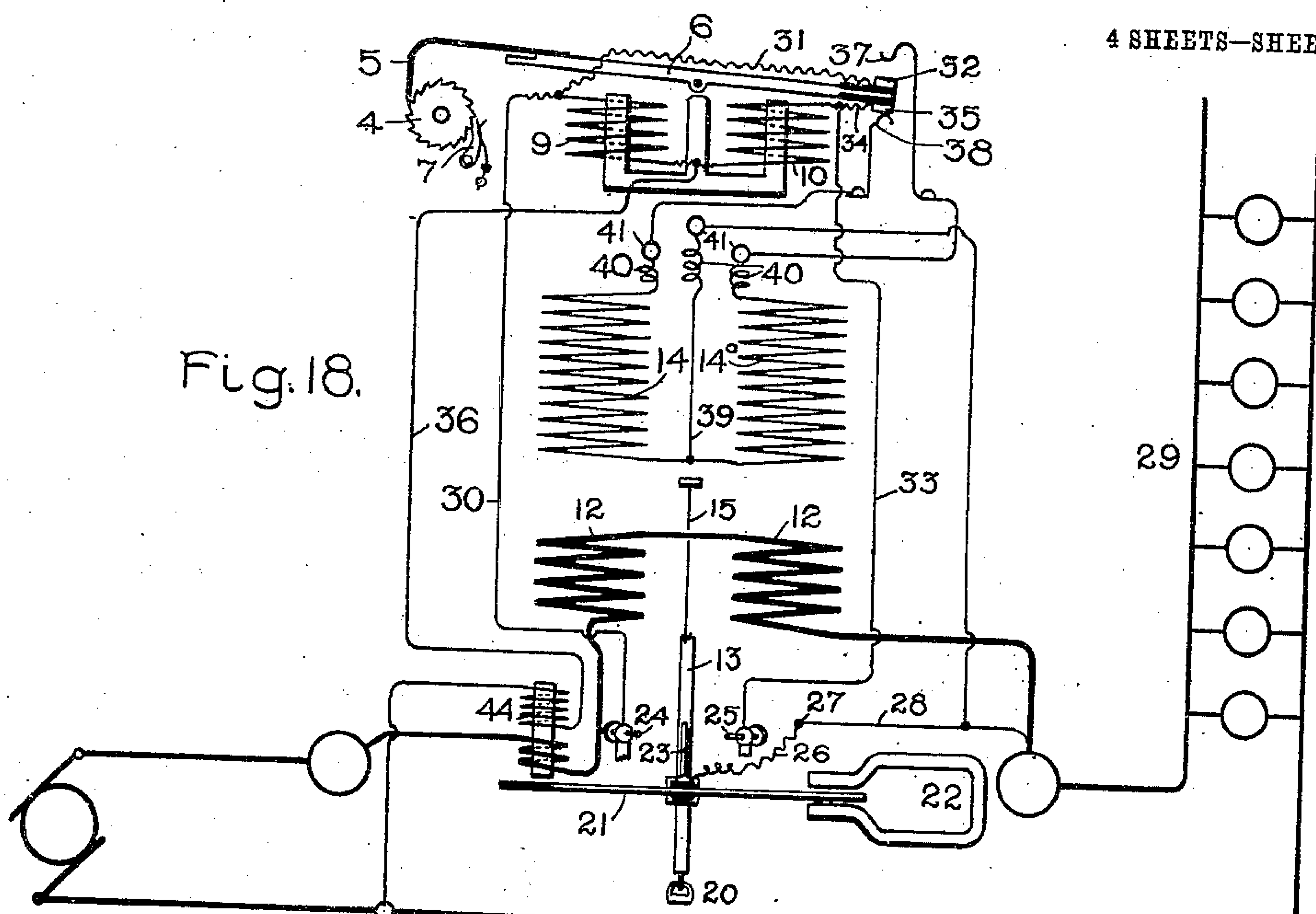


Fig. 19.

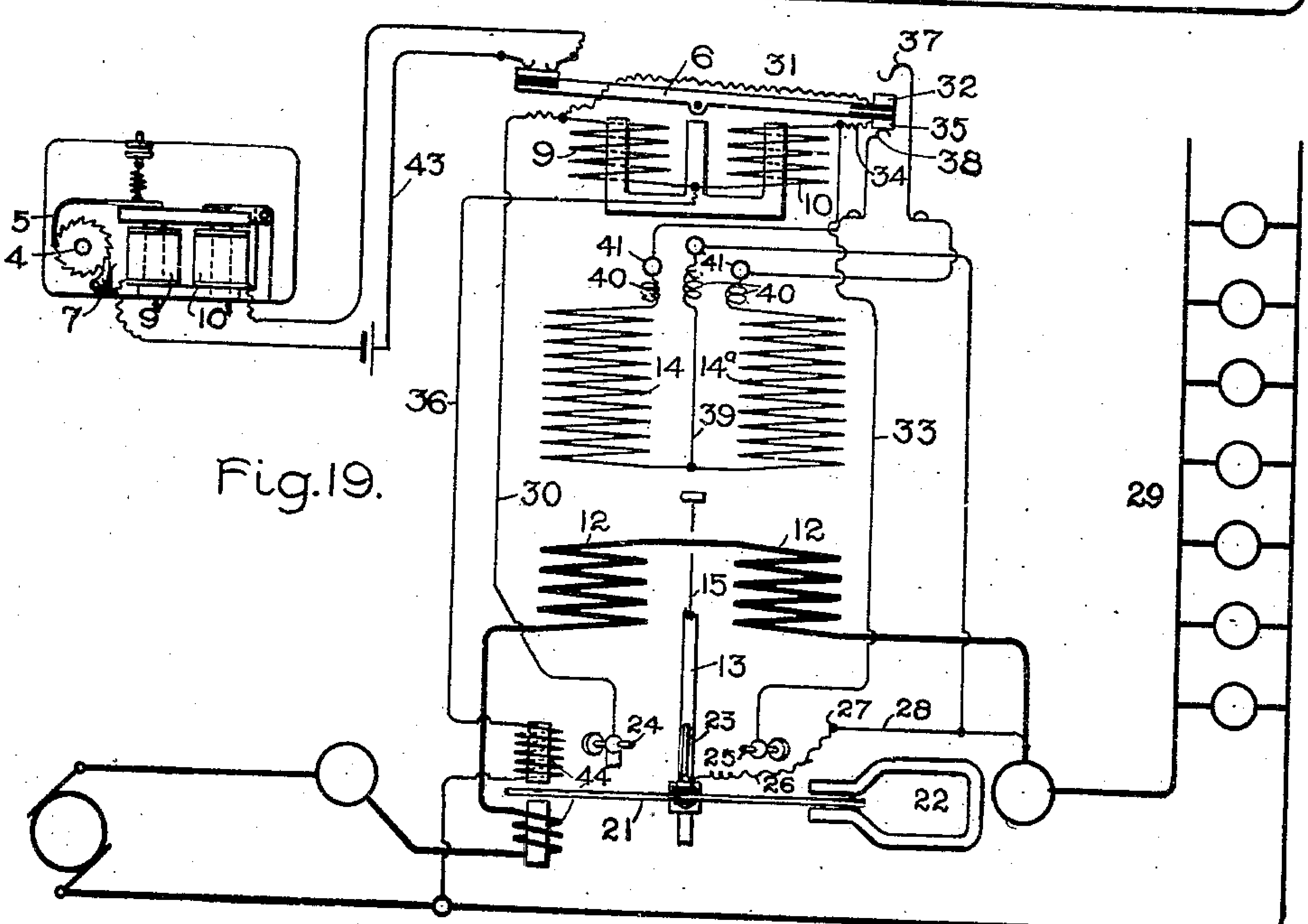
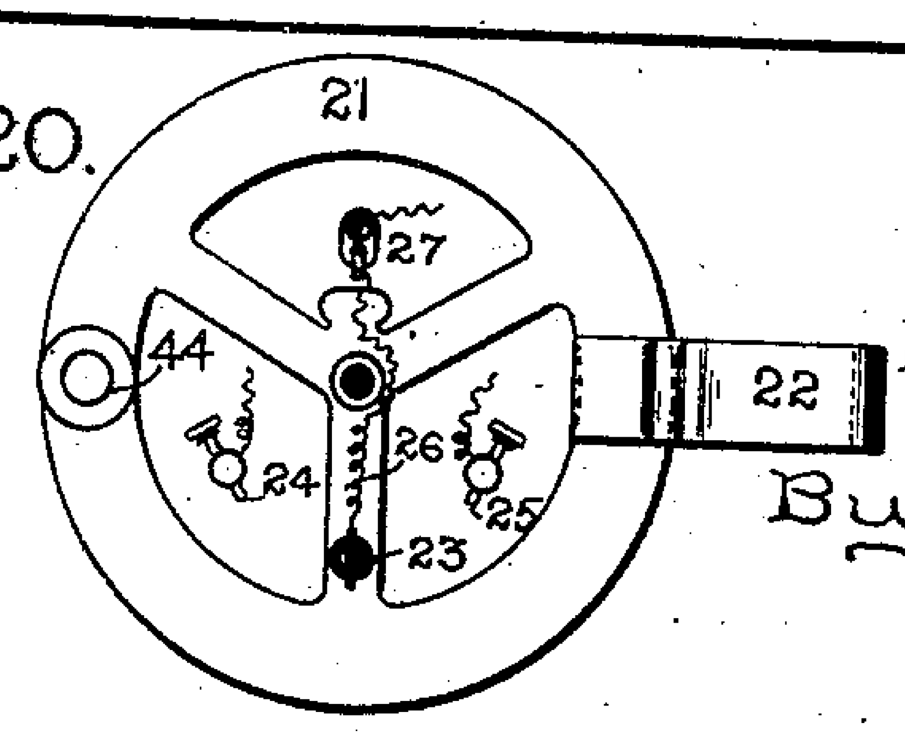


Fig. 20.



WITNESSES.

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Elihu Thomson

By Albert G. Davis

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UNITED STATES PATENT OFFICE.

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

ELECTRIC METER.

No. 854,777. Specification of Letters Patent. Patented May 28, 1907.

Application filed April 21, 1902. Serial No. 103,874.

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 Electric Meters, of which the following is a specification.

This invention relates to electric meters for registering the watts consumed in a load circuit. The meter is of the oscillating type, the armature or potential coils being divided between two shunt circuits which are alternately energized. One coil produces an oscillation in one direction, and the other coil in the other direction, suitable damping devices being provided to cut down the rapidity of motion to a reasonable speed. The registering train is driven by a rocking beam actuated by two electro-magnets, respectively in circuit with the two potential coils. At each oscillation a shunt around the potential coil is closed temporarily to primarily energize an electro-magnet and rock the beam. On the beam are contacts which coact with stationary terminals of the two potential coils. The beam and electro-magnet thus serve as an electro-magnetic switch to control the circuits of the potential coils.

Other details of construction will appear in the description which follows.

In the accompanying drawings, Figure 1 is a rear elevation of a meter embodying my improvements, the casing being removed; Fig. 2 is a top plan view of the same; Fig. 3 is a front elevation of the upper portion showing the registering dials; Fig. 4 is a side elevation of the series and potential coils and the registering train; Fig. 5 is a sectional elevation of the shaft, coils and damping devices; Fig. 6 is a top plan view of the same on the line 6 6, Fig. 5; Fig. 7 is a vertical section, on a larger scale, of the lower end of the shaft and its supporting device; Fig. 8 is a similar section of the upper end thereof; Fig. 9 is a top plan view of Fig. 8; Figs. 10 and 11 show a modification of the arrangement of the series and potential coils; Fig. 12 is an elevation, partly broken away, and showing the multiple magnetic shields; Fig. 13 is a cross-section of the same on the line 13 13, Fig. 12; Fig. 14 is a sectional elevation of a modified construction of said shields; Fig. 15 is a cross-section of the same on the line 15 15, Fig. 14; Figs. 16 and 17 show modified constructions of the series and potential coils; Figs. 18 and 19 are diagrams of circuit connections; Fig. 20 is a detail of circuit connections; and Fig. 21 shows a modified compensating device.

On a suitable base 1 is erected a frame 2, which supports a registering-train 3 containing a ratchet-wheel 4 actuated by a pawl 5 on a rocking beam 6, and provided with a detent pawl 7. The beam 6 is pivotally supported near its middle, as by means of a pedestal 8 mounted on the frame 2, and each end serves as the armature for an electro-magnet 9′ 10′. By energizing the magents alternately, the beam is rocked and the registering-train is actuated.

In order to automatically close the circuits of these magnets alternately and at a regular rate proportional to the energy consumption, I provide an oscillating motor driven by the current and carrying contacts controlling the magnet circuits. This motor is preferably constructed as follows: Clamped securely in brackets 11 on the frame 2 are load or series coils 12 arranged preferably in vertical planes with a space between them. An upright shaft 13 preferably passes between said coils without touching them. The potential coils 14 14^a are mounted on the shaft 13 normally at right angles with the load coils 12. They may surround said load coils, as shown in Figs. 1, 4 and 5, or pass through them, as shown in Figs. 10 and 11.

The shaft is preferably tubular and has a fine suspending wire 15 extending down through it. The upper end of the wire is clamped securely in a chuck 16 supported in the upper end of the frame 2, and having three or more jaws tightened by a nut 17, like an ordinary small centering chuck. The wire passes freely through a jewel 18 at the upper end of the tubular shaft 13, and its lower end is secured to a small block 18^a firmly held in the lower end of the said shaft. A small stiff pin 19 projects centrally from the block 18 into a restraining hole or cavity in the stud 20 mounted in the base 1. This steadies the shaft and its load against side shocks or from swinging under slight changes of load. The weight of the shaft and the potential coils and other parts attached thereto is carried by the wire 15.

Near its lower end the shaft carries a damping wheel or disk 21 of copper or aluminium mounted to oscillate between the poles of a series of permanent magnets 22. Moving with the shaft and preferably carried on said disk, is a contact-plate 23 adapted to make contact at the end of each oscillation of the motor with stationary adjustable contacts 24 25, in circuit respectively with the electro-magnets 9 10. The contacts 24 25 are preferably resilient, as shown, to cushion the shock when the moving contact 23 strikes them. If the contact-plate 23 is made thin, so as to bend slightly when it strikes the stationary contacts 24, 25, the latter need not be made resilient.

The contact-plate 23 is insulated from the disk, and is connected by a fine flexible wire 26 with the stationary terminal 27 connected by wire 28 with one side of the load circuit, 29. The contact 24 is connected by wire 30 with one terminal of the electro-magnet 9 and by a fine flexible conductor 31 with an insulated contact 32 on the rocking beam 6. The contact 25 is connected by wire 33 with one terminal of the electro-magnet 10, and by a fine flexible conductor 34 with an insulated contact 35 on the rocking beam 6. The other terminals of the two electro-magnets are connected by a common conductor 36 with the other side of the load circuit.

The contacts 32 35 are for the purpose of closing the circuits of the potential coils alternately in order to produce an oscillating movement of the shaft. Adjacent to each contact 32 35 is a stationary contact 37 38 connected respectively with one terminal of the two potential coils, the other terminals being connected by a common conductor 39 with the other side of the load circuit from the conductor 36. The connections with these terminals of the potential coils are preferably made by means of thin flexible or spirally-wound conductors 40 running from said terminals to three binding posts 41 mounted on an insulating washer 42 secured to the upper end of the frame 2 concentric with the hollow shaft.

The operation of the meter as hereinbefore described is as follows: When the apparatus is not in use, or when there is no load of translating devices on the circuit 29, the series coils 12 are unenergized. But one or the other of the potential coils will be carrying current in accordance with the position in which the rocking beam happens to stand. If the position be that shown in Fig. 18, the current will flow from one side of the circuit through the conductor 36 and magnet-coil 10 to the contacts 35 38 and thence pass through the potential coil 14 and conductor 39 to the opposite side of the circuit. The magnet 10, being energized, holds the contacts 35 38 firmly closed. But no oscillatory movement of the potential coils would take place until part or all of the load is turned on, thereby energizing the series coils 12. In such case, on account of the chosen relation of the turns in the two sets of coils, the electro-dynamic effect of the energized load coils upon the energized potential coil is to turn the shaft 13 and carry the movable contact 23 against the stationary contact 24. This closes the circuit through the electro-magnet 9, and as this circuit is parallel to that through the magnet 10 and the potential coil 14, and offers less resistance, the excess of current which flows through it energizes the magnet 9 more strongly than the magnet 10, and the rocking beam is therefore tilted down toward the magnet 9, breaking the circuit at the contact 38 and thereby cutting out the magnet 10 and potential coil 14, and closing the circuit through the magnet 9, contact 37, and potential coil 14^a. This coil at once exerts a torque in the opposite direction, and the shaft begins its reverse oscillation. The magnets and rocking beam therefore constitute an electro-magnetic switch controlling the circuits of the potential coils, and the alternate action of the coils and magnets is thus automatically repeated. The registering-train counts up the oscillations, the time of oscillation being inversely proportional to the load, by reason of the damping effect of the disk 21, and permanent magnets 22.

It will be noted that the closing of the circuits through the contacts 24 25 is only momentary, being merely long enough to cause one magnet or the other to rock the beam and open-circuit the other magnet and its corresponding potential coil. The potential coil which is to produce the reverse movement is not energized until the beam is rocked, so that it does not separate the contacts 23 and 24 or 25 the instant they touch, but only after a momentary dwell during which the beam is tilting.

The registering-train may be driven directly by the rocking beam, as shown in Figs. 1 and 18, or the beam may open and close a relay circuit 43 whose electro-magnet operates the registering-train, as shown in Fig. 19.

Under the larger loads, there is a slight tendency for the meter to fall off in its rate of registration. To compensate for this I provide an auxiliary damping device whose effect varies inversely with the load. This consists preferably of a small electro-magnet 44 mounted adjacent to the damping disk 21 at a point not covered by the permanent magnets 22. The magnet 44 is wound with two coils, one of fine wire and the other of coarse. The fine wire coil is connected permanently in the potential circuit, while the coarse wire coil on the same magnetic axis is in series with the load, or so arranged that it responds to the current in the load circuit or load coil. Assume for the moment that no load exists: then the coarse coil on the magnet 44 does not affect the state of the magnetism, but the fine coil in the constantly energized potential circuit exerts its full effect. If now a small load is turned on, the current in the coarse coil is comparatively insignificant, and the current in the fine coil, acting at its full value, produces nearly its full auxiliary damping effect on the disk 21. This is but a small amount relatively to the total damping effect of all the magnets acting on the disk, and is purposely so chosen. As the load is increased it will be seen that the magnet 44 becomes weaker on account of the differential action of the two windings, and its damping effect tends to disappear. By starting out, then, with the magnet 44 having a maximum of the damping action when the load is at a minimum, and causing the current to oppose the damping action as the load reaches a maximum, there is a slight tendency to an acceleration on the heavier loads, which is useful in some cases in compensating for the slight droop in the rate of registration before mentioned. This compensating device is only well adapted for direct-current service, for which the meter is best adapted. For use with alternating currents the iron masses should be well laminated, and the compensating magnet is not necessary.

In Fig. 19 the magnet 44 is divided, one part being above the disk 21 and the other below it, the poles of the two parts opposing each other. A similar action occurs as when the two windings are placed on a common core, provided the directions of the windings are so chosen that the result is difference and not summation of effect.

Another compensating device is shown in Fig. 21, where the series coils are shunted by a fine wire 45 having a temperature coefficient either the same or greater than the wire of the coils. Under load, it reaches a much higher temperature than the coils and consequently its resistance is relatively higher with greater loads. The shunt therefore becomes of less and less conductivity as the load increases, so that the effect of increase of load is exaggerated somewhat in the series coils. This exaggeration can readily be made to compensate for the aforesaid slight falling off of the rate of registration with increased load.

For alternating currents, the shunt wire must be coiled in such a way as to give it a time constant nearly or quite equal to that of the load coil itself, the relation of the resistance and temperature being retained as in the case of direct current.

In Figs. 10 and 11 a modified arrangement of the potential and load coils is shown. Other arrangements are possible, it being only necessary that the two sets of coils be in motor relation whereby the current in one set affects that in the other so as to cause relative movement. Thus in Fig. 16 the potential coils are wound on the arc-shaped arms of the iron piece 46 mounted on the shaft, and the load coils 47 are two in number, each concentric with its respective potential coil. It will be understood that when one potential coil is in circuit an attraction takes place tending to move it so that it enters the series coil. When the other potential coil is in circuit, however, the motion is in the opposite direction, being due to a repulsion between the potential and the series coils. This results in producing successive oscillations of the shaft, the circuit connections being as above described.

In Fig. 17 the potential coils 48 are superposed upon a bar of iron rotatively mounted on the shaft and carrying at its ends arc-shaped extensions 49, to which the stationary load coils 50 are tangent. The iron might be omitted, if desired. The action is such that when one potential coil is energized, a motion in one direction, takes place, while when the other potential coil is energized, the motion is in the opposite direction.

When it is desired to guard the mechanism from outside stray fields, it may be inclosed in a multiple iron shield, composed of a plurality of alternate iron tubes and air spaces.

In Figs. 12 and 13 is shown an inner shield tube 52, made of sheet iron rings piled one above the other, and outer shield-tubes 53 composed of helices of iron wire. In Figs. 14 and 15 the shields are simply sheet-iron cylinders 54 surrounding the apparatus. In both modifications the shields are separated by air spaces. By employing multiple shields much less material is required for effective shielding, as the magneto-motive force reaching the apparatus or produced by the apparatus is enfeebled by the first shield, which is separated from the next by a considerable air-gap, the reluctance of which is high, and a second enfeeblement is caused by the shunting effect of the second shield; after which comes a second high-reluctance air-gap before the third shield is reached; and so on, if more than three are used.

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

1. In an electric meter, the combination with a shaft, of a switch-arm actuated by the movement of said shaft, two stationary contacts each coöperating therewith, and two motor-coils on said shaft each adapted to have its circuit made and broken by the operation of said contacts.

2. In an electric meter, the combination with a shaft carrying a switch arm or contact, two stationary contacts adapted to be engaged by said switch arm or contact, of an electro-magnetic switch controlled by the oscillations of said shaft, and two motor-coils on said shaft each adapted to have its circuit made and broken by said switch.

3. In an electric meter, the combination

with a shaft, of a contact carried thereby, two stationary contacts each adapted to be engaged by the first mentioned contact, two electro-magnets each in circuit with one of said stationary contacts, a rocking beam actuated by said magnets and carrying two insulated contacts, stationary contacts coöperating therewith, and motor-coils on said shaft in circuit with said latter stationary contacts.

4. In an electric meter, the combination with a shaft, of a contact carried thereby, two stationary contacts each co-operating with the first mentioned contact, two electro-magnets each in circuit with one of said stationary contacts, a rocking beam actuated by said magnets and carrying two insulated contacts, each in circuit with one of said magnets, stationary contacts coöperating with the contacts on the beam, and motor-coils on said shaft each in circuit with one of said last-named stationary contacts.

5. In an electric meter, the combination with the load coils, the damping disk and the permanent magnets therefor, of a magnetic shield, consisting of a plurality of sheet-iron rings separated by air spaces.

6. In an electric meter, a protective shield surrounding said meter and consisting of a plurality of concentric soft iron tubes.

In witness whereof, I have hereunto set my hand this eighteenth day of April, 1902.

ELIHU THOMSON.

Witnesses:

DUGALD McK. McKILLOP,

JOHN A. McMANUS.