

June 2, 1931.

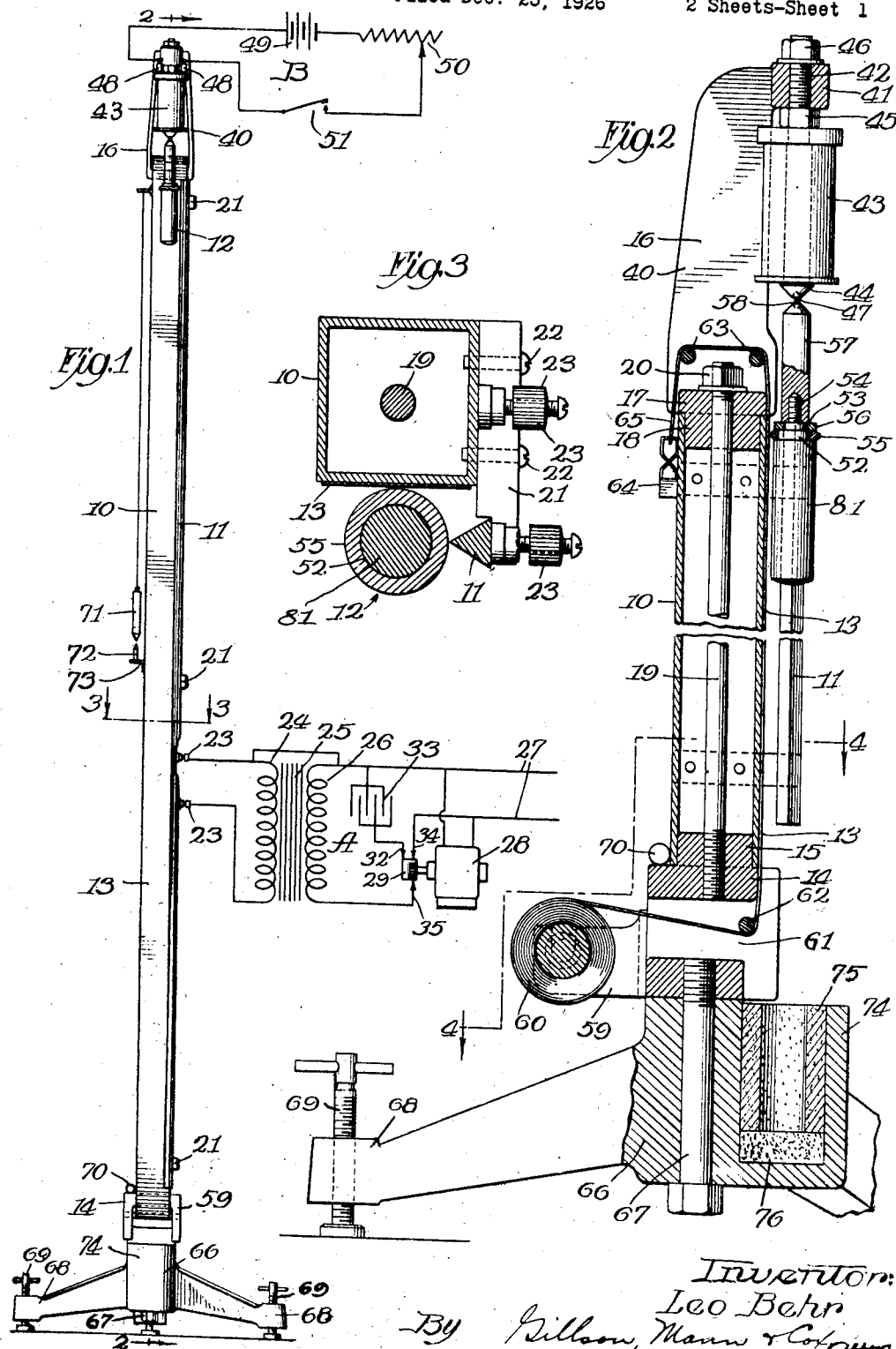
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EDUCATIONAL APPARATUS

Filed Dec. 23, 1926

2 Sheets-Sheet 1



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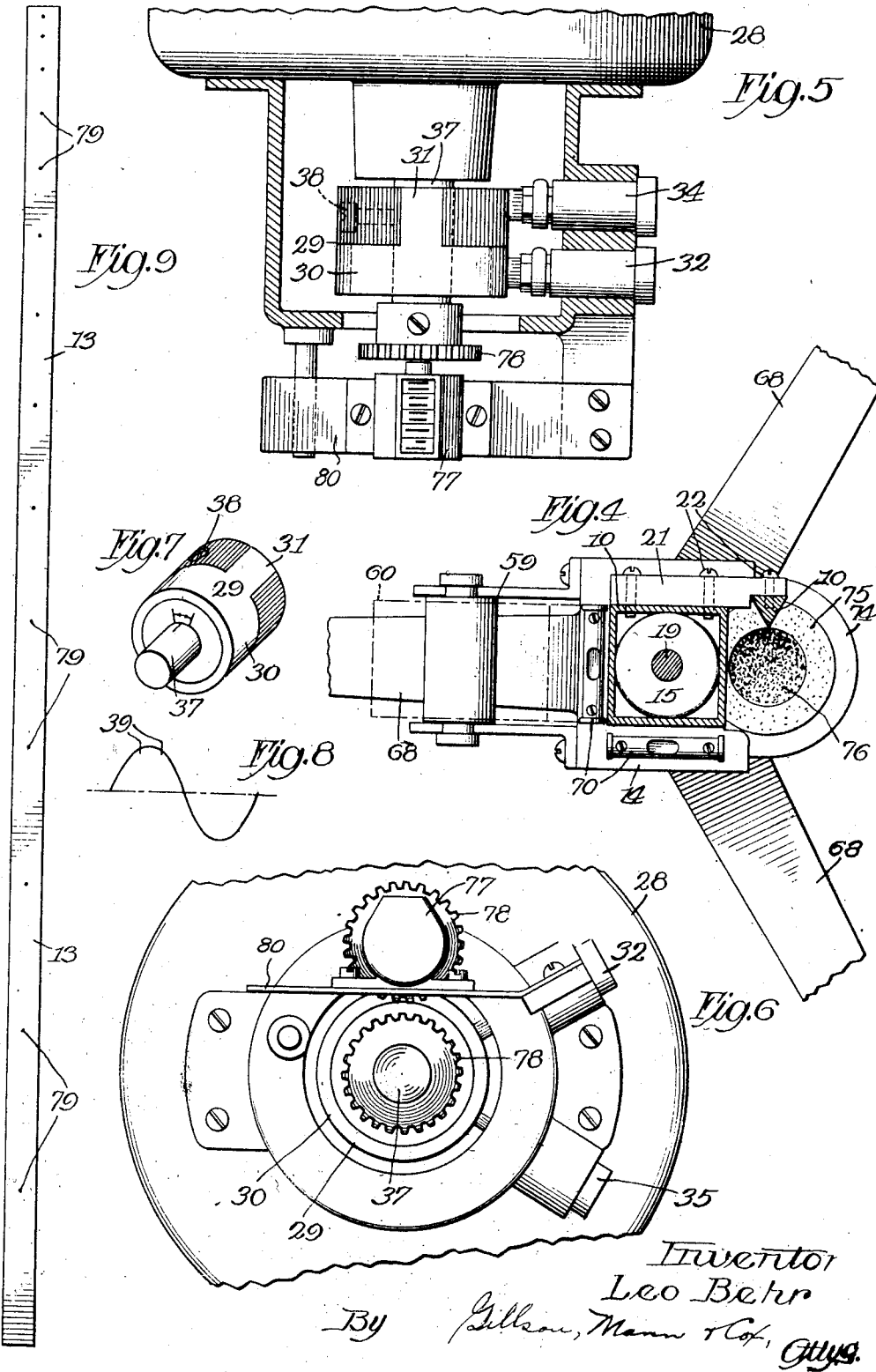
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UNITED STATES PATENT OFFICE

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EDUCATIONAL APPARATUS

Application filed December 23, 1926. Serial No. 156,564.

This invention relates to educational appliances and has for its principal object to provide simple apparatus by which students can successfully and accurately demonstrate the law of falling bodies. Other objects and advantages of the invention will be revealed in the specification as the description is read in connection with the accompanying drawings, in which

Fig. 1 is a diagrammatic front elevation of the preferred form of apparatus, showing among other elements, two vertical conductors.

Fig. 2 is a vertical section taken on the line 2—2 of Fig. 1 with the intermediate portion of the apparatus removed.

Fig. 3 is a transverse sectional view taken on line 3—3 of Fig. 1, the drop 12 being also shown in section on a horizontal line passing through a ring 55.

Fig. 4 is a similar view taken on the line 4—4 of Fig. 2, with the ends of the tripod legs broken away.

Fig. 5 is a partial horizontal section through the means for creating potential difference in the two conductors.

Fig. 6 is an end view of that means.

Fig. 7 is a perspective view of a rotating switch element driven by a motor and operating to make the appropriate electrical connections.

Fig. 8 is a diagram indicating that portion of the curve representing the current that is communicated to the conductors.

Fig. 9 is a plan view of a record strip illustrating the successive positions of a falling body in equal successive intervals of time.

Referring to Fig. 1 of the drawings, the general organization includes two vertical conductors 10 and 11, means generally indicated by "A" for producing a high potential difference between those conductors at equal intervals of time, magnetic drop 12 adapted to fall along the conductors 10 and 11, permitting sparks to penetrate the record strip 13 and means generally indicated by "B" for supporting the drop and releasing it at the desired time.

The drop 12 carries a conducting element

and is located in the air gap between the conductors 10 and 11. The position of the drop therefore determines the point of lowest resistance between the conductors 10 and 11, and as the drop 12 falls this point of low resistance travels down with the drop.

The conductor 10 is a metallic tube shown in vertical section in Fig. 2 and transverse section in Figs. 3 and 4. It is mounted upon a base casting 14 having a reduced boss 15 received within the lower end of the tube. At the upper end of the tube 10 is a head casting 16 of aluminum, the bottom 17 of which is equipped with a boss 18 projecting into the upper end of the tube. A rod 19 threaded into the boss 15 extending through the bottom 17 of the head casting and equipped with a nut 20, connects the tube, the base casting, and the head casting into a rigid assembly.

The tube 10 is given a lacquer finish which is scratched away on a line about the center of the front face of the tube, exposing the metal.

As is well known the lacquer finish furnishes an insulating coating for the conductor and where this coating is scratched away the surface of the conductor is exposed. The lacquer coating is removed on a line along the center of the front face of the tube immediately behind the center of the record strip and which line exposes the conductor 10 at its points nearest the path of the drop 12.

The conductor 11 is a bar, triangular in cross section, and it is supported in spaced relation to the tube 10 by a plurality of brackets 21, of insulating material secured to the tube and the conductor by screws 22. The tube 10 and the bar 11 are equipped with binding posts 23, by which they are connected with the secondary 24 of a transformer 25, whose primary 26 is connected with a source of alternating current, indicated by the line 27. A synchronous motor 28 connected to the same line drives a rotating switch member 29, having a metallic contact (Fig. 7) 30 incircling it, and provided with a lateral projection 31. The contact 30 runs against a fixed contact 32 connected with a

condenser 33, the opposite side of which is connected with one side of the line 27. The opposite side of the line 27 is connected with a fixed contact 34 in position to close with the projection 31. A third fixed contact 35 is also in position to close with the projection 31 after it has passed the contact 34.

The rotating switch element 30 is fixed to the shaft 37 of the motor by set screw 38 whereby, the position of the projection 31 may be so adjusted that the circuit is closed on the conductors during that portion of the phase lying between the lines 39 in Fig. 8. This corresponds to the interval during which the projection 31 is running against the fixed contact 34. Immediately afterwards the projection closes with the fixed contact 35 and discharges the condenser through the primary 26 of the transformer, with the result that a high potential difference is created between the conductors 10 and 11.

The four pole synchronous motor shown makes thirty revolutions per second and when connected to the ordinary power line will give an interval of one-thirtieth of a second, plus or minus .005 second.

Thus the apparatus will create a high potential difference between the conductors 10 and 11 at substantially equal intervals of one-thirtieth of a second.

The head casting 16 includes side pieces 40 converging slightly and connected at their upper ends by the overhanging top piece 41, which is threaded to receive a bolt 42, that forms the core of a magnet 43. The bolt is threaded at 42, passed through the spool of the magnet, receives a nut 45 below the top piece 41, and a second nut 46 above the top piece.

The head 44 is made conical and a hardened ball 47 forms the point, a hemispherical pocket having been formed at the center of the head and the material spun about the ball on the lower side of the horizontal diameter.

The winding of the magnet is connected to the binding posts 48 which in turn are connected in a circuit including a battery 49, a variable resistance 50, and a switch 51. By means of the variable resistance, the magnet can be adjusted to just hold the drop whereby, when the switch 51 is opened, the drop is released immediately.

The drop includes a body portion 81 of brass having stepped shoulders 52 and 53, and a threaded stem 54. A case hardened steel ring 55 rests against the shoulder 52. A washer 56 rests against the ring 55 and an iron head 57 is threaded on the stem 54, and holds the washer and ring in place. The ring 55 is sharpened to an edge lying in a horizontal plane. The upper end of the head 57 is substantially, a duplicate of the head 44 and is equipped with a similar ball 58.

A bracket 59 secured to the base casting 14 supports a roll of record paper 60. This

paper is lead through a passage 61 in the base casting 14 about a pin 62 traversing that passage, upward along the tube 10, about the pins 63, extending between the arms 40 of the head casting, and is equipped with a weight 64 carried by a snap clip 65.

The base casting 14 is secured to a tripod 66, by a bolt 67, and the feet 68 of the tripod are provided with screws 69 by which the column may be plumbed with the aid of spirit levels 70, on the base casting, and a plumb bob 71 suspended from the upper end of the column and adapted to aline with an index point 72, carried by a bracket 73 on one side of the tube 10.

The tripod is equipped with a cup 74 lined with felt 75 above a body of sand 76 and forms a butt into which the drop is received at the end of the fall. The opening in the felt lining is approximately the same diameter as the body portion 81 of the drop.

The motor 28 is equipped with a revolution counter 77, mounted on a leaf spring 80, and driven from the motor shaft 37 through gears 78 when the leaf spring has been deflected sufficiently to cause the gears to mesh.

Upon starting the motor 28, the conductors 10 and 11 become charged at equal intervals. Upon opening the switch 51, the drop 12 is released and proceeds to the butt, passing along the conductors 10 and 11 and the strip 13 and permitting sparks to pass through the strip leaving perforations indicated in Fig. 9 by 79.

The air gap between the conductors 10 and 11 is uniform from top to bottom. The ring 55 however substantially fills this gap, leaving two narrow air gaps between it and these conductors. The potential of the transformer is not high enough to force a spark across the gap between 10 and 11, but is high enough to cause sparks to pass across the two gaps provided by the ring 55 and to perforate the strip 13. The drop 12 with ring 55 therefore defines a path of low resistance between the conductors 10 and 11, and when the drop falls this path moves down with the drop and permits the sparks to perforate the strip 13 in equal intervals of time but at increasing spacing on the strip as the drop accelerates.

The student can easily obtain the necessary data from which to calculate the period between the sparks and he can easily measure the distances between the successive perforations, and from all this he can verify the formula $V^2 = 2GH$.

The sharp flange 55 on the drop insures that the spark will always jump from the same relative position on the drop and this insures that the spacing between the sparks on the record strip will correspond exactly to the distance the drop has traveled between sparks.

Specific description and illustration have

been used in order that the preferred form of the invention may be clearly understood, but it is not intended that such specific disclosure shall require an interpretation of the claims more narrowly than is made necessary by the prior art.

I claim as my invention:

1. In a device of the class described, an article of manufacture comprising a supporting column including a vertical conductor, a second vertical conductor carried by a column in spaced relation to and insulated from the first conductor, means to plumb the column, means for creating a high potential difference between said conductors at equal intervals of time, a record strip between said conductors, a third relatively short conductor, means for supporting and releasing the short conductor from an elevated position in proximity to the vertical conductors adjacent to their upper ends whereby the third conductor is adapted to fall freely alongside the vertical conductors and a yielding butt carried by the column for catching the third conductor.

2. In a device of the class described, a column constituting a first vertical conductor, a second vertical conductor carried by said column and insulated from said first conductor, means creating a high potential difference between said conductors at equal intervals of time, a record strip between said conductors, and supported by said column, a third relatively short conductor located between said conductors and forming a point of low resistance between the said two conductors, means supported by the column for supporting and releasing said third conductor from an elevated position whereby said third conductor may fall freely along said first and second conductors and thereby shift the point of low resistance and thereby enable the means creating the potential difference to cause sparks to perforate said record strip at equal time intervals.

3. In a device of the class described, a pair of vertical conductors, means for creating a high potential difference between the conductors at equal intervals of time, a vertical record strip between the conductors, a conducting drop elongated vertically and provided with a removable annular flange presenting a sharp edge to the vertical conductors in a substantially horizontal plane, and means to release the drop in position to fall alongside said conductors.

4. In a device of the class described, an electro-magnet, a pair of spaced vertical conductors descending from the magnet, means for producing a high potential difference between the conductors at equal intervals of time, a source of electric current, a variable resistance and circuit connections including the source, the magnet and the resistance,

whereby the attraction of the magnet may be adjusted.

5. In a device of the class described, an upright column including two parallel conductors, means for plumbing the column, means for producing a high potential difference between the conductors at equal intervals of time, a magnet carried by the column adjacent to the upper ends of the conductors, a record strip carried by the column and interposed between the conductors, a drop adapted to be held and released by the magnet in position to fall alongside the conductors and decrease the resistance of the gap between them thereby enabling a series of sparks to pass through the record strip at equal intervals of time, and a butt to receive the drop at the bottom of its flight.

6. In a device of the class described, an upright hollow metallic column, means to plumb the column, an insulating coating covering said column except for a narrow strip running lengthwise thereto, a sharp edged conductor supported on and insulated from the column in spaced relation to the bare strip, a magnet carried by the column adjacent to its top, means for supporting a record strip over the bare strip of the column, means for creating a high potential difference between the column and the sharp edged conductor at equal intervals of time, a drop adapted to be supported by and released by the magnet in a position to fall alongside the column.

7. In a device of the class described, a pair of spaced vertical conductors, a drop, means to support the drop and release it in a position to fall alongside the conductors, and means for creating a high potential difference between the conductors at equal intervals of time comprising a transformer, a source of alternating current, connected with the primary of the transformer, a condenser in parallel with the primary, a switch for alternately closing the circuit on the condenser, and the primary, a synchronous motor driving said switch, and connections between the secondary of the transformer and the vertical conductors.

8. In a device of the class described, a pair of spaced vertical conductors, a drop, means to support the drop and release it in a position to fall alongside the conductors, and means for creating a high potential difference between the conductors at equal intervals of time comprising a transformer, means connecting the secondary with the vertical conductors, a condenser, a source of alternating current and means for alternately charging the condenser and discharging it through the primary of the transformer including a synchronous motor, a switch driven by the motor for closing the circuit on the condenser for a short interval adjacent to the peak of the phase.

9. In a device of the class described, a pair of vertical conductors, means for producing a high potential difference between the conductors at equal intervals of time, a drop adapted to descend alongside the conductors and comprising an elongated body having a ball point at its upper end, and a flange encircling the body and presenting a sharp edge in a substantially horizontal plane. 70
10. In a device of the class described, a pair of spaced vertical conductors, means for producing a high potential difference between the conductors at equal intervals of time, a drop adapted to descend alongside the conductors and comprising a base portion of brass and an upper reduced portion of iron terminating in a ball point and a flange of steel encircling the brass portion and presenting an edge in a substantially horizontal plane. 80
11. In a device of the class described, a pair of spaced vertical conductors, a drop, means to support the drop and release it in a position to fall alongside the conductors, and means for creating a high potential difference between the conductors at equal intervals of time comprising a transformer, a source of alternating current, connected with the primary of the transformer, a condenser in parallel with the primary, a switch for alternately closing the circuit on the condenser and the primary, a synchronous motor driving said switch, means for determining the frequency of operation of the switch and connections between the secondary of the transformer and the vertical conductors. 85
12. In a device of the class described, a pair of spaced vertical conductors, a drop, means to support the drop and release it in a position to fall alongside the conductors, and means for creating a high potential difference between the conductors at equal intervals of time comprising a condenser, and a transformer having its secondary connected with the vertical conductors and means for alternately charging the condenser and discharging it through the primary of the transformer, comprising a rotary switch and a synchronous motor for driving said switch. 90
13. In a device of the class described, a pair of spaced vertical conductors, a drop, means to support the drop and release it in a position to fall alongside the conductors, and means for creating a high potential difference between the conductors at equal intervals of time comprising a source of current, a condenser, a transformer having its secondary connected with the vertical conductors, a rotary switch means alternately connecting said condenser to said source of current and to the primary of said transformer, and a synchronous motor for driving said switch. 95
14. In a device of the class described, a pair of spaced vertical conductors, a drop, means to support the drop and release it in a position to fall alongside the conductors, and means for creating a high potential difference between the conductors at equal intervals of time comprising a condenser, a transformer having its secondary connected with the vertical conductors, means for charging the condenser and means for rapidly discharging the condenser through the primary of the transformer. 100
15. In a device of the class described, a pair of spaced vertical conductors, a drop, means to support the drop and release it in a position to fall alongside the conductors, and means for creating a high potential difference between the conductors at equal intervals of time comprising a condenser, means for charging said condenser, a transformer, connections between the secondary of the transformer and the vertical conductors, a circuit including the condenser and the primary of the transformer, and means for closing that circuit at equal intervals of time. 105
16. In a device of the class described, a pair of spaced vertical conductors, a drop, means to support the drop and release it in a position to fall alongside the conductors, and means for creating a high potential difference between the conductors at equal intervals of time comprising a condenser, means for charging a condenser, a transformer, connections between the secondary of the transformer and the vertical conductors, a circuit including the condenser and the primary of the transformer, and a rotatable switch device for closing that circuit at equal intervals of time. 110
17. In a device of the class described, a pair of spaced vertical conductors, a drop, means to support the drop and release it in a position to fall alongside the conductors, and means for creating a high potential difference between the conductors at equal intervals of time comprising a condenser, means for charging a condenser, a transformer, connections between the secondary of the transformer and the vertical conductors, a circuit including the condenser and the primary of the transformer, a rotatable switch device for closing that circuit at equal intervals of time, and including a source of alternating current and a synchronous motor. 115
18. In a device of the class described, a pair of spaced vertical conductors, a drop, means to support the drop and release it in a position to fall alongside the conductors, and means for creating a high potential difference between the conductors at equal intervals of time comprising a transformer having a secondary connected with the vertical conductors, a circuit including a source of power and the primary of the transformer and means for making and breaking said circuit including a motor of constant speed. 120
19. In a device of the class described, a pair of spaced vertical conductors, a drop, 125

means to support the drop and release it in a position to fall alongside the conductors, and means for creating a high potential difference between the conductors at equal intervals of time comprising a transformer having a secondary connected with the vertical conductors, a circuit including a source of alternating current and the primary of the transformer, a synchronous motor, a switch driven by the motor and means for so adjusting the switch to the motor that the circuit will be closed adjacent to maximum phase of electro-motive force.

20. In a device of the class described, an electromagnet including a winding and a core, a hardened ball secured to the lower end of the core, a pair of spaced vertical conductors extending downwardly from the magnet, means for producing a high potential difference between the conductors at equal intervals of time, a magnetic drop, and a hardened ball fixed to the magnetic drop and adapted to cooperate magnetically with the first mentioned ball to support said drop when said balls are in contact.

21. In a device of the class described, a supporting column including a base having a passage therethrough, a roll of paper supported at one side of the column adjacent to the passage, a paper strip extending from the roll through the passage and upwardly along the opposite side of the column, a conductor carried by the column adjacent to the strip, a magnet adjacent to the upper end of the conductor and a drop adapted to be temporarily supported by the magnet.

22. In a device of the class described, a column constituting a first vertical conductor, a second vertical conductor carried by said column and insulated from said first conductor, said column being of metal covered with an insulating coating except for a strip adjacent to and parallel with said second conductor, means creating a high potential difference between said conductors at equal intervals of time, a record strip between said conductors, and supported by said column, a third relatively short conductor located between said conductors and supported by said column and forming a point of low resistance between the said two conductors, means for supporting and releasing said third conductor from an elevated position whereby said third conductor may fall freely along said first and second conductors and thereby shift the point of low resistance and thereby enable the means creating the potential difference to cause sparks to perforate said record strip at equal time intervals.

In testimony whereof I affix my signature.
LEO BEHR.