(No Model.) 6 Sheets—Sheet 1.

A. G. NEW, A. J. MAYNE & R. N. LUCAS.

AUTOMATIC SWITCH FOR ELECTRIC TRANSFORMERS.

No. 548,266. Patented Oct. 22, 1895.

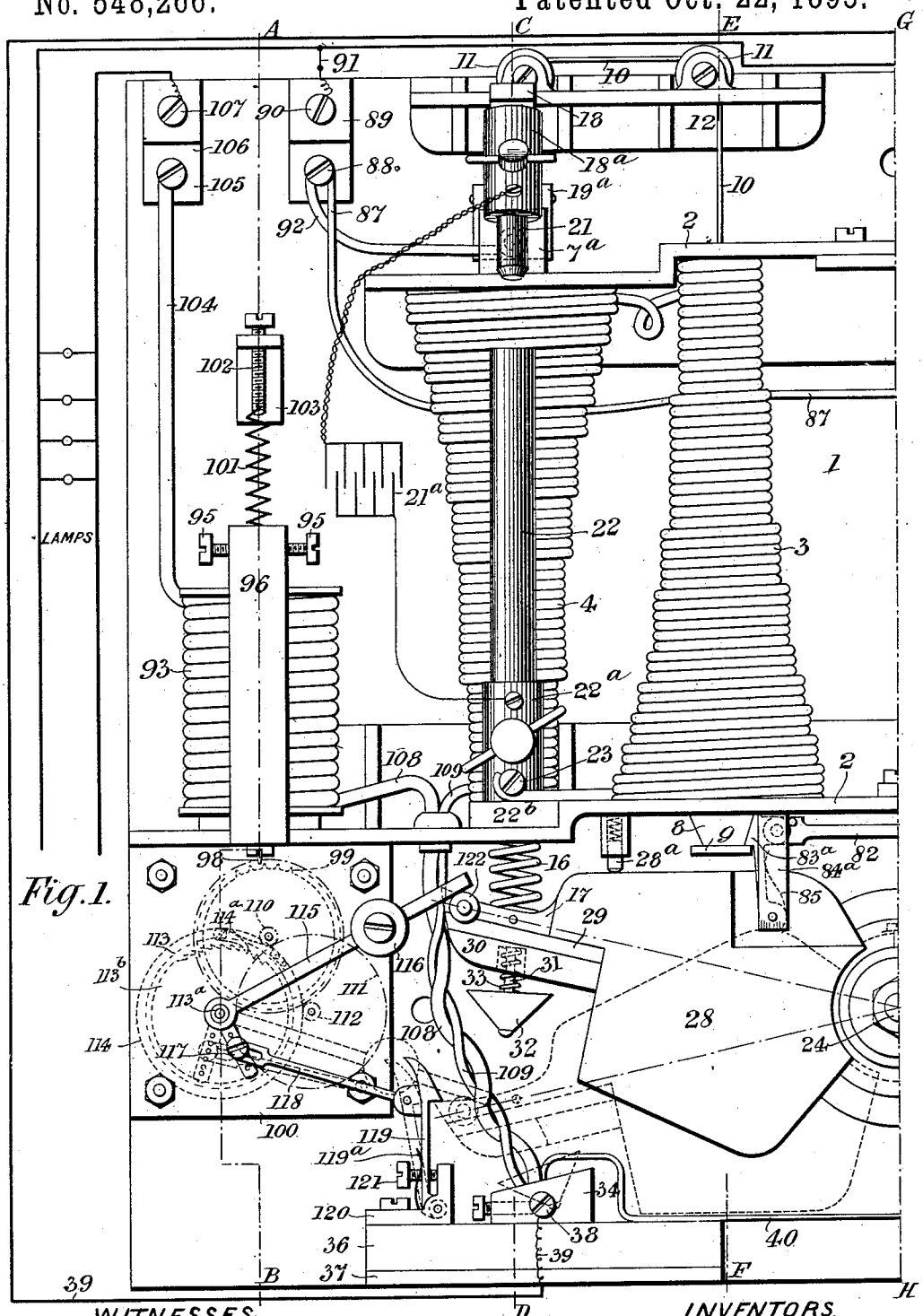

Fig. 1.

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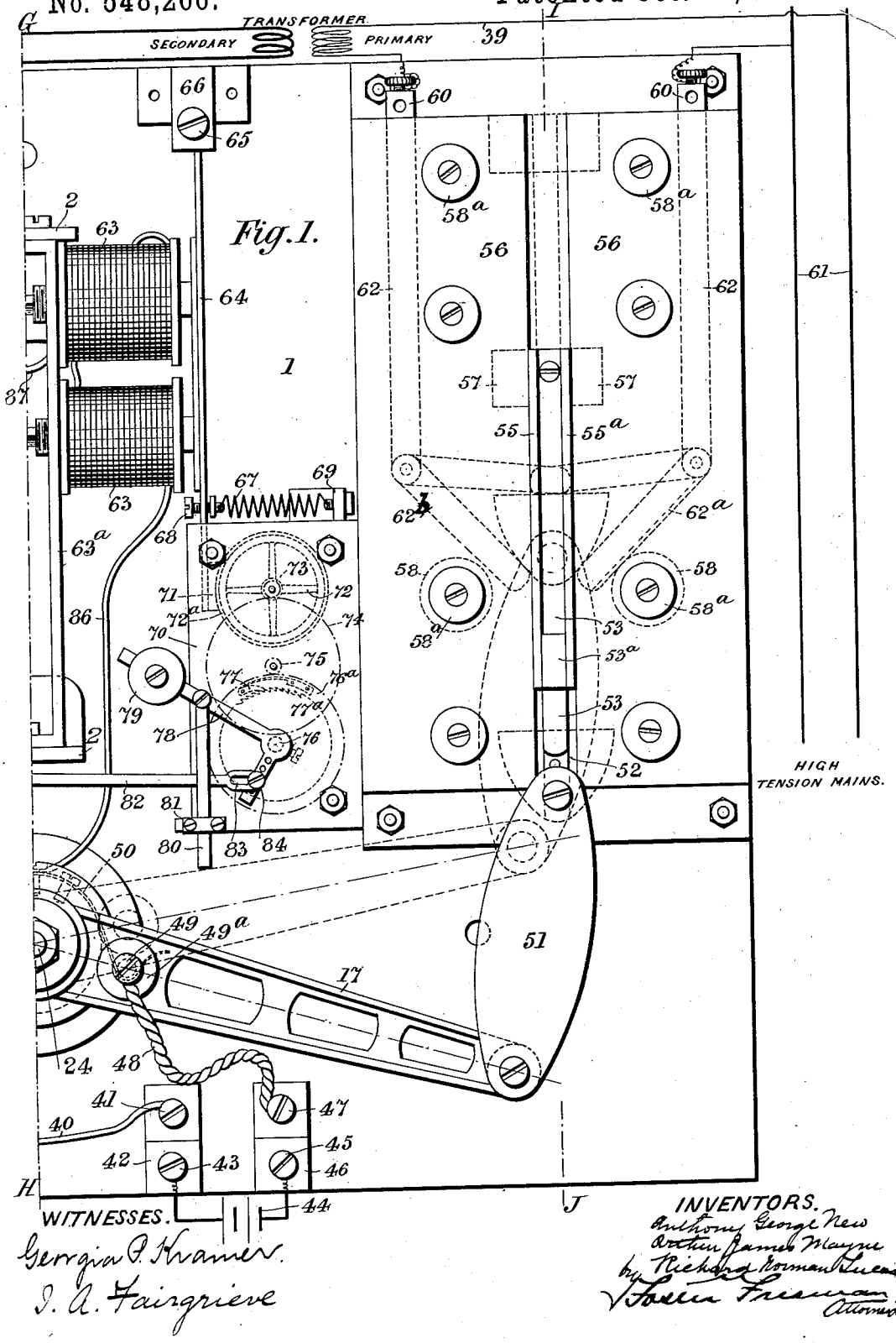

Fig. 1.

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(No Model.) 6 Sheets—Sheet 3.

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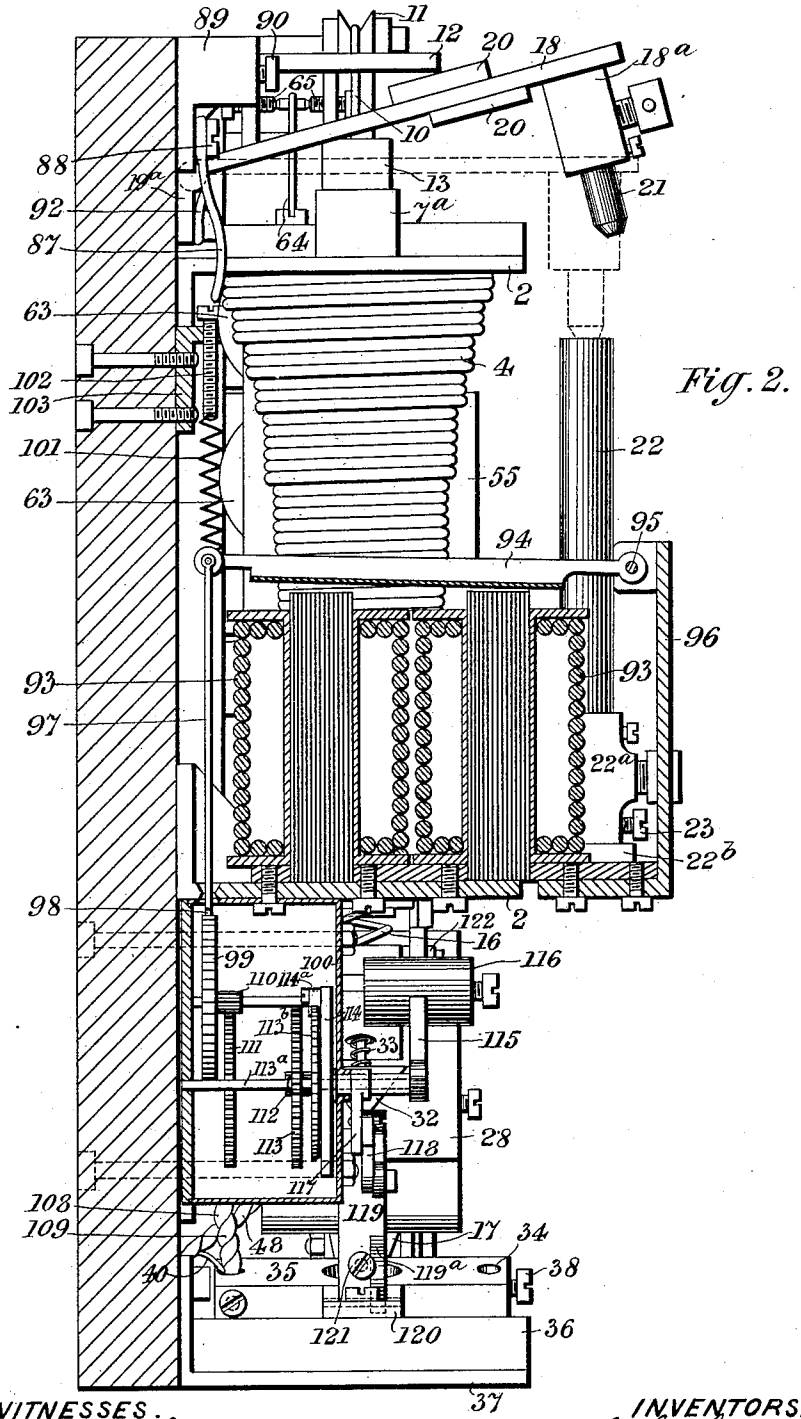

Fig. 2.

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(No Model.) 6 Sheets—Sheet 4.

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AUTOMATIC SWITCH FOR ELECTRIC TRANSFORMERS.

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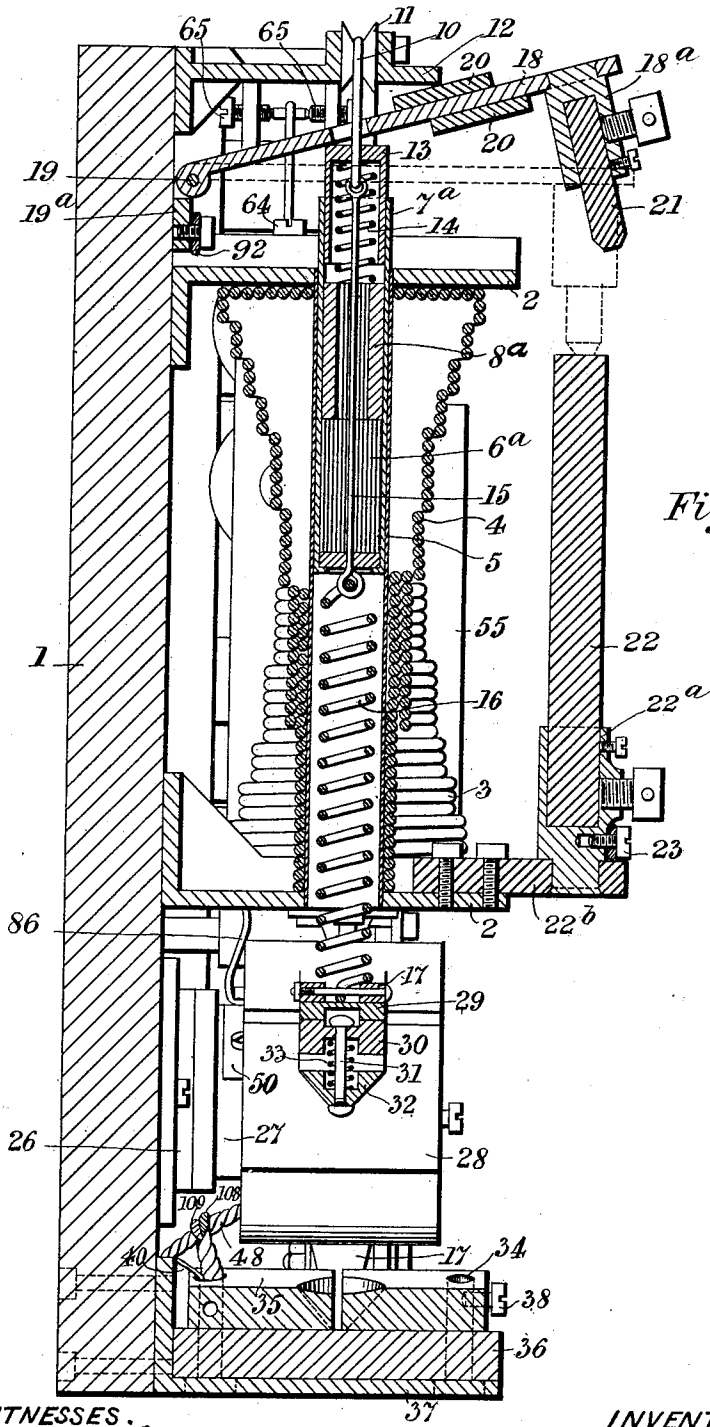

Fig. 3.

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AUTOMATIC SWITCH FOR ELECTRIC TRANSFORMERS.

No. 548,266. Patented Oct. 22, 1895.

Fig. 4.

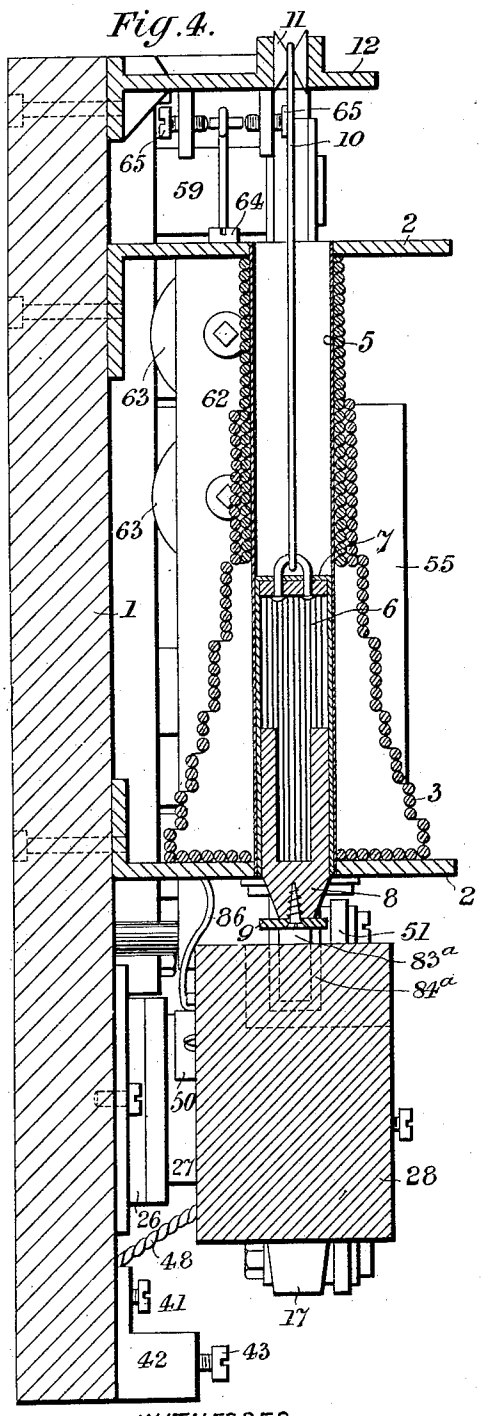
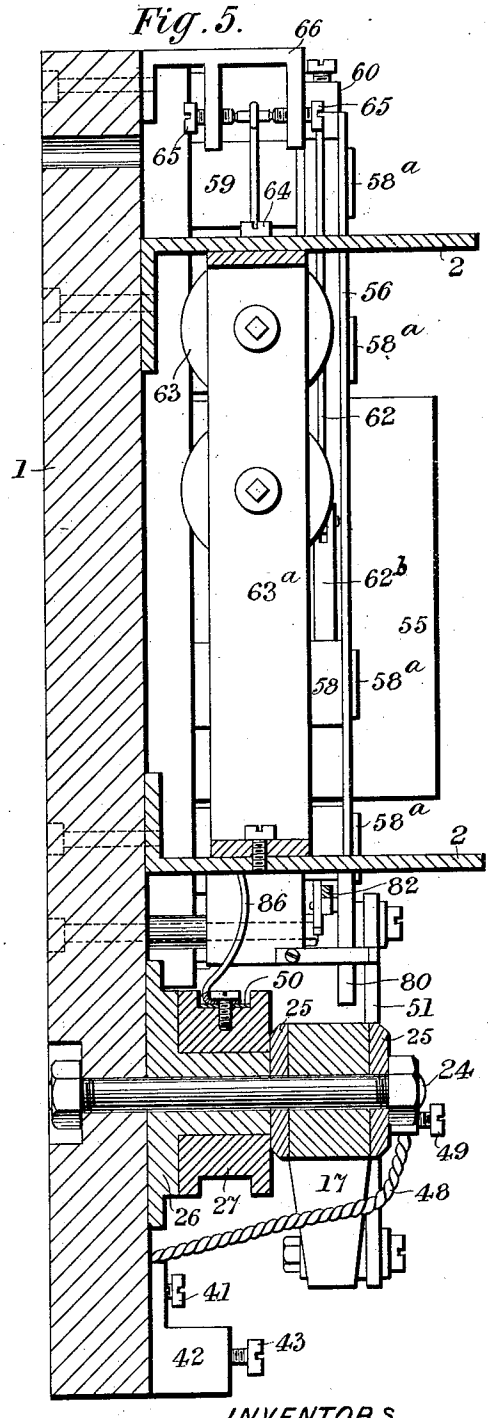


Fig. 5.



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AUTOMATIC SWITCH FOR ELECTRIC TRANSFORMERS.

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Fig. 6.

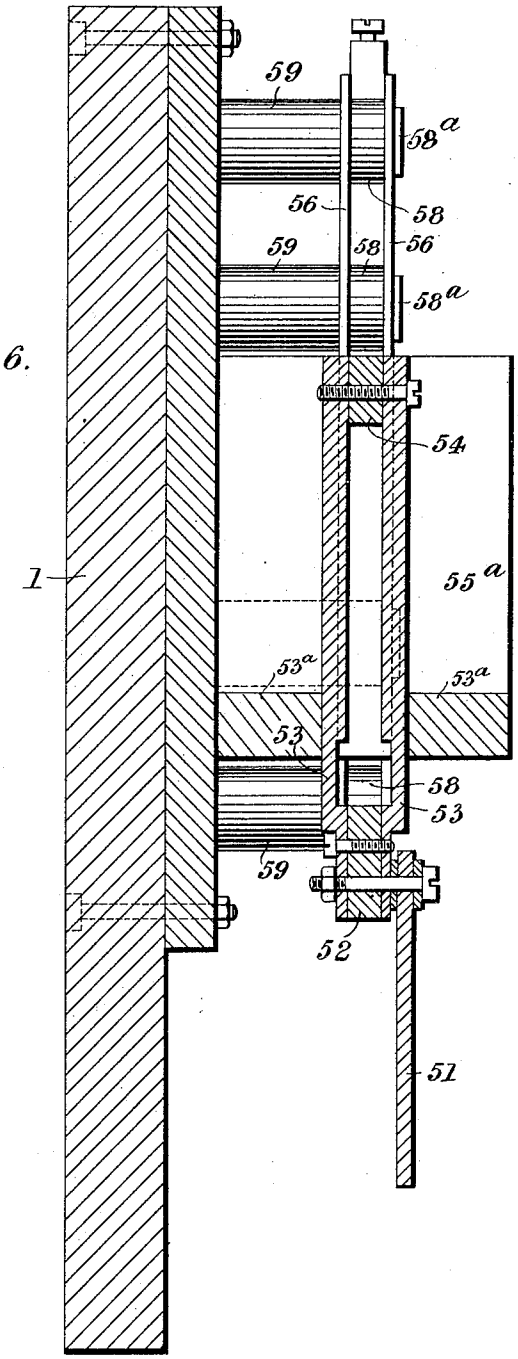
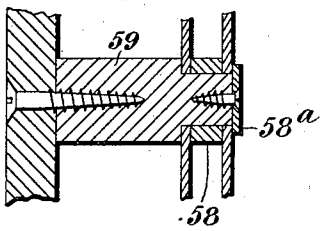


Fig. 7.



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UNITED STATES PATENT OFFICE.

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AUTOMATIC SWITCH FOR ELECTRIC TRANSFORMERS.

SPECIFICATION forming part of Letters Patent No. 548,266, dated October 22, 1895.

Application filed June 25, 1894. Serial No. 515,703. (No model.) Patented in England June 1, 1892, No. 10,451; in France March 13, 1893, No. 223,532, and in Germany April 19, 1893, No. 74,411.

To all whom it may concern:

Be it known that we, ANTHONY GEORGE NEW, residing at London, and ARTHUR JAMES MAYNE, residing at Woking, in the county of Surrey, England, and RICHARD NORMAN LUCAS, residing at Galway, in the county of Galway, Ireland, subjects of Her Majesty the Queen of Great Britain, have invented a certain new and useful Improved Automatic Switch for Electric-Current Transformers, (in part patented to us in Great Britain, dated June 1, 1892, No. 10,451; in France, dated March 13, 1893, No. 228,582, and in Germany under date of April 19, 1893, No. 74,411,) of which the following is a specification.

Our invention relates to an improved automatic switch for electric-current transformers, the object of the invention being to provide means for causing the primary or high-tension circuit in alternating-current transformers to be cut out automatically when the secondary or low-tension circuit is broken and to cause it to become connected again with the high-tension mains, also automatically, when the secondary circuit is closed, say, by switching on a lamp, and in this way to avoid the leakage or loss of electrical energy which under existing circumstances results from leaving the primary coil of the transformer permanently in circuit when no current is being used on the low-tension circuit. We attain this object by means of an apparatus or arrangement of parts whereby whenever the secondary circuit is made the primary coil of the transformer is switched on, and whenever the secondary circuit is broken the primary coil is switched off or put out of connection with the mains. The secondary current or a part of the secondary current is caused to store up during the time it is flowing a certain amount of its energy, or, in other words, to convert a certain portion of its actual energy into potential energy. Part of the energy thus stored up we make use of (at the moment when it is desired to close the secondary circuit—*e. g.*, by turning on a lamp) to actuate a mechanism for establishing connection between the primary coil of the transformer and the mains, and we make use of another portion of the stored-up energy to actuate a similar mechanism for cutting out the primary coil when the secondary circuit is broken—*e. g.*, by turning out the last light.

Such an apparatus is illustrated in the accompanying drawings, in which—

Figure 1 is an elevation of same, the figure being divided and placed on two sheets in order that it may be represented on a sufficiently-large scale. Fig. 2 is a section on line A B, Fig. 1. Fig. 3 is a section on line C D, Fig. 1. Fig. 4 is a section on line E F, Fig. 1. Fig. 5 is a section on line G H, Fig. 1. Fig. 6 is a section on line I J, Fig. 1; and Fig. 7 is a sectional elevation of a post, shown in Fig. 6.

The apparatus consists of a supporting-plate 1, of slate or other insulating material, between brackets 2, secured to which are held two solenoids 3 4, wound with insulated wire arranged in a tapered form and in connection with each other at their upper ends. These solenoids have for their interior linings split brass tubes 5, running their entire length, and inside each is a core which is able to move freely therein. The core in the solenoid 3 consists of a number of straight iron wires 6, contained in a case 7, the mass of wire being tapered or arranged as shown in Fig. 4, where the center wires are longer than the outside wires, the lower portion 8 of the core being of brass or other suitable material and having an annular groove around its end and a plate 9 secured thereto, or such plate may be formed out of the metal of the part 8. The core has a cord or chain 10 attached to it, which passes over pulleys 11 11 in a bracket 12, such cord passing to the core in the solenoid 4. This core consists of a case 7^a, containing wires 6^a and a metal block 8^a, but reversely arranged to the core in the solenoid 3. In the top of the case 7^a is inserted a loosely-fitting cap 13, through which the cord 10 passes, and in such cap is a spring 14, while through the spring and core passes a rod 15, attached at the bottom to a spring 16, connected to one end of a switch-lever 17, which is shown in its "on"

position, its "off" position being that shown in dotted lines.

The cord 10, before being secured to the core of the solenoid 4, passes through an opening in an arm 18, pivoted at 19 to a plate 19^a, having a binding-screw, said arm carrying plates 20 20 of insulating material to prevent the arm making electrical contact with the brackets 2 or 12. This arm 18 carries a socket 18^a, in which is held by a set-screw a carbon rod 21, adapted to make contact with a similar rod 22, held in a socket 22^a by a set-screw. This socket, as shown in Fig. 3, is secured to a plate of insulating material 22^b, which is screwed to the lower bracket 2 and carries a binding-screw 23, to which one end of the coil of the solenoid 3 is secured.

It will be seen that the effect of the rising of the core of the solenoid 4 will be to bring the cap 13 into contact with the bar 18, and so to raise it, separating the carbon bars 21 22 when they are in contact. The spring 14 allows the cap 13 to exert a yielding pressure on the bar, so that a shock or blow is avoided.

For the purpose of minimizing the sparking which would otherwise take place between the carbon points 21 and 22 we may connect a condenser 21^a up to the two sockets 18^a and 21^a, as shown in Fig. 1; but it is not essential to the operation of our invention.

The switch-lever 17 is pivoted on a bolt 24 between two metal disks or washers 25, (see Fig. 5,) the inside washer abutting against a block 26 surrounding the bolt, on the reduced neck of which is secured an annular grooved ring 27, of vulcanized fiber or other insulating material.

One end of the lever has a weight 28 formed thereon, (or a spring may be employed in place of the weight,) and to this the spring 16 is attached, and beneath the point of attachment of this is a plate of insulating material 29, beneath same being a metal plate 30, having a beveled or rounded end. Through the plate passes a rod 31, the head of which is held in a recess (see Fig. 3) formed partly in the plate 29 and partly in the plate 30, and surrounding the rod and partly held in recesses in the plate 30 and in a metal plug 32, loosely carried by the rod, is a spring 33, the arrangement enabling the plug to be pressed toward the plate 30 and to adjust itself in its seat. This seat consists of two metal plates 34 35, separated as shown in Fig. 3, and secured to a slate or insulating-block 36, carried by a bracket 37. The front block 34 has a binding screw 38, which serves to secure in a hole in the block a wire 39, passing to the secondary or low tension coil of the transformer and out to the house-circuit, on which are the lamps. The rear block 35 is connected by a wire 40 with a binding-screw 41 of a block 42, a second binding-screw 43 of which forms one terminal of a circuit of a primary battery 44, the other pole being connected to a binding-screw 45 of a block 46, a second binding-screw 47, which has a flexible insulated wire 48 attached to it, said wire passing to a stud 49, carried by the lever 17, the stud 49 being insulated from the lever by a bushing 49^a of insulating material. This stud passes through the lever and projects on the inside of same, and is adapted to engage with a light flat metal contact-spring 50, secured to the vulcanized fiber ring 27 by a screw, as shown in Fig. 5, the other end of the spring being bent, as shown by dotted lines, Fig. 1, to make contact with the stud 49 when the lever is in the position shown in that figure. 28^a is a small spring-cushioned stop for the weight 28 to strike upon when it rises. The long end of the lever is arranged to operate a main switch, which may be of any approved construction, but the shutter-switch shown is the one we prefer to employ. This switch is connected to the arm 17 by means of a connecting-piece 51 of vulcanized fiber or insulating material. The switch itself consists of a block 52 of insulating material, to which the connecting-piece 51 is pivoted, as shown in Figs. 1 and 6. To this piece 52 are secured strips 53 53 of insulating material, said strips being secured to a block 54 of insulating material at their upper ends to space them apart. To the frame thus formed are secured plates of insulating material 55 55^a, the plates being stiffened by blocks 53^a placed between them and cemented or secured thereto. All these parts are adapted to move up and down in a groove formed by the opening left between four plates 56 of insulating material, ear-pieces 57 57, forming part of the block 54, running between the plates 56 and serving to keep the sliding frame in position. The plates 56 are spaced apart by insulating-rings 58, Figs. 6 and 7, the plates and rings being carried by posts 59 of insulating material, which are secured to the supporting-plate 1. A washer 58^a, held by a screw, holds the outer of the plates 56 in position. Between the plates 56 are secured the terminals 60 of the high-tension mains 61 and primary coil of the transformer. These terminals connect with metal strips 62, to which are pivoted metal arms 62^b 62^a, the arm 62^b being solid and the arm 62^a of channel shape, so that the two when in contact are adapted to slightly interlock.

In the position shown the plates 55 and 55^a of the sliding frame keep the arms 62^b 62^a apart; but upon the frame being moved up by the lever 17 and connecting-piece 51 the arms will come into contact through the opening left between the frame formed of the strips 53 53, the block 52 pushing them up, as it moves with the frame, into engagement with each other. The arms 62^b 62^a are prevented from falling down into a vertical position by the insulating rings 58 of two of the posts 59, as shown by dotted lines in Figs. 1 and 5.

To a plate 63^a, supported between the brackets 2 2, are secured electromagnets 63 63, and

in front of these is an armature 64, carrying a cross-bar, which is pivoted in the concave ends of screws 65, held in a bracket 66. At the lower end of this armature is a spring 67, attached to it by a regulating-screw 68, the other end of the spring being attached to a bracket 69, carried by the casing 70 of a clockwork-train. The extreme end of the armature has a brake-shoe 71, which engages with a rubber ring 72 around a balance-wheel 72^a, against which the shoe is normally held by the spring 67, such wheel being driven through its pinion 73 by a toothed wheel 74, which is in turn driven through its pinion 75 by a toothed wheel 76^a, carried loosely on a spindle 76. One face of this wheel carries near the edge a spring-controlled pawl 77, which bears on the teeth of a ratchet-disk 77^a, the arrangement enabling the ratchet-disk to be turned in one direction without moving the train of wheels. The spindle 76 has affixed upon it a bell-crank arm 78, on which is an adjustable weight 79, and about midway on said arm is attached a rod 80, carried in guides 81 and adapted to be struck by the arm 17 when it moves into its up position. The other end of the cranked lever 78 has adjustably attached to it a rod 82, the rod having a slotted head 83 at one end, which engages with a screw 84, affixed in a hole in the short end of the arm 78, there being several of these holes for the purpose of adjusting the parts. The object of the slot is to enable the rod 82 to move backward without operating the lever 78. At the other end of this lever is a catch 83^a, pivoted in a drop-bracket 84^a, a spring 85 keeping the catch normally pressed forward, so that it may engage with the groove around the core of the solenoid 3, a small stop limiting its forward movement. In order to clear the bracket 84^a, a portion is removed from the weight 28 of the lever 17.

One of the wires 86 from the coils of the electromagnets 63 passes to the spring 50 on the ring 27 and the other wire 87 passes to a binding-screw 88 on a block 89, in which is also a binding-screw 90, connected to a wire, in which is inserted a fuse 91 of some ordinary form, said wire being connected to the low-tension or secondary circuit. Another wire 92 passes from the binding-screw 88 to a binding-screw on the plate 19^a, which is in electrical connection with the arm 18.

Supported on the lower bracket 2 are a pair of electromagnets 93 93, composed of a few turns of wire only, (or a solenoid might be employed,) the armature 94 of which is pivoted on screws 95 to an upright 96. The other end of the armature has a rod 97 hung to it, such rod having a tooth 98, which engages with an escapement-wheel 99 of a train of clockwork contained in a case 100. The rod 97 is normally kept out of engagement with the wheel by means of a light spring 101, attached to an adjusting-screw 102, carried by a bracket 103. A wire 104, forming one end of the coil of one of the magnets, passes up to a binding-screw 105 in a block 106, said block carrying a second binding-screw 107, which is in connection with the lamp or low-tension circuit. A wire 108 from the other end of the magnet-coil passes to the rear block 35, a second wire 109 also coming down with it from the coil of the solenoid 4 to the block 35.

The escapement-wheel 99 is driven through its pinion 110 by a wheel 111, which in turn is driven through its pinion 112 by a wheel 113. This latter is carried on the hub of a ratchet-wheel 113^b, carried in turn by a spindle 113^a, the ratchet being loose on same, and said spindle also carries a disk 114. On the inner face of this disk is a spring-controlled pawl 114^a, which acts on the teeth of the ratchet 113^b, the arrangement permitting the disk 114 to turn the ratchet 113^b and wheel 113 in one direction only.

The spindle has a bell-crank arm 115 affixed to it, the long end of the arm carrying an adjustable weight 116, the short end being provided with a number of holes for the reception of a screw 117, with which screw engages the slotted head of an arm 118, the other end of which is attached to a catch-arm 119, pivoted to a bracket 120, carried by the insulating-block 36 and having an adjusting-screw 121. The slot in the head of the arm 118 enables it to be pushed back without moving the short end of the crank-arm, and a spring 119^a serves to keep the arm 119 in its operative position. It will be seen that the long end of the bell-crank arm 115 is adapted to be raised by the end of the pivoted lever 17, which for this purpose carries an antifriction-roller 122.

The operation is as follows: The apparatus is shown in its off position—that is to say, the transformer is cut out, and no current of course is passing through the low-tension or house circuit. By turning on the first light a current is caused to flow from the primary battery 44 (or a condenser may be employed in place of the battery) through wire 48, stud 49 on lever 17, spring 50, wire 86, electromagnets 63, wire 87 to binding-screw 88, from binding-screw 90 through fuse 91, through lamps back to binding-screw 107, from binding-screw 105 by wire 104 through electromagnets 93 without attracting the armature 94, as the current is too weak, by wire 108 to block 35, from latter by wire 40 to binding-screw 41, and from binding-screw 43 back to the primary battery. The passage of the current through the magnets 63 causes the armature 64 to be attracted, thus withdrawing the brake 71 from the balance-wheel 72 and liberating the clockwork-train, so that the weighted bell-crank arm 78 is enabled to fall, causing rod 82 to withdraw the catch 83^a from the groove in the portion 8 of the core of the solenoid 3, the rod 80 falling at the same time. The core 8 being released, the lever 17 then of

its own weight falls, and in so doing, by means of the spring 16, draws down the core of the solenoid 4, which through the cord 10 is connected to the core of the solenoid 3, this operation allowing the arm 18 to fall, making contact between the carbon bars 21 22, the end of the lever 17 also passing under and being held by the catch 119, which is pushed back against its spring 119ª without moving the bell-crank arm 115. The falling of the plug 32 into its seat in the blocks 34 35 completes a circuit between these two, which circuit passes through the electromagnets 93, as will be seen hereinafter, and causes the latter to draw down its armature, so that the arm 115 is prevented from falling with the lever 17. The movement of the lever 17 further breaks connection between stud 49 and spring 50, thus breaking the primary-battery circuit, and by raising the rod 80 resets the weighted arm 78 of the clockwork in the case 70 by raising said arm and by the same movement of the bell-crank arm 78 replaces the catch 83ª through the rod 82 with the assistance of spring 85. As the primary-battery circuit is now broken, the spring 67 causes the brake 71 to hold the balance-wheel 72. The movement of the lever farther through the connecting-piece 51 raises the sliding plates 55 55ª of the switch and causes the block 52 to bring the arms 62ᵇ 62ª into contact, thus completing the high-tension circuit through that switch. Both high-tension and secondary circuits are now made, the latter through the electromagnets 93, which thus hold down the armature 94, so that the tooth 98 of the rod 97 is in engagement with the escapement-wheel 99, and the arm 115 remains in its raised position. Another circuit in parallel with the house or secondary circuit is also made as follows: from block 35, by wire 109, through solenoid 4 and solenoid 3, to binding-screw 23, carbon bars 22 and 21, (which have been brought into contact as described,) by wire 92, through fuse 91, to other pole of secondary. This circuit causes the solenoids 4 and 3 to move their cores back to their original positions, thus storing up energy by stretching the spring 16, as the lever 17 is still held by the catch 119, so that the lever will be lifted as soon as the catch is released, while the rising of the core in the solenoid 4 also raises the arm 18 and breaks the circuit between 21 and 22. The apparatus is now set to cut out the transformer as soon as the house-lights are turned off, and when the last one of these is put out, the secondary circuit being broken, the electromagnet 93 ceases to act on its armature, so that the spring 101 raises same and removes the tooth 98 from the escapement-wheel 99, the result of which is that the clockwork-train is operated by the weighted bell-crank arm 115, which falls and withdraws the rod 118 and catch 119, which releases the lever 17 and allows it to be drawn up smartly by the spring, thus breaking the circuit between blocks 34 and 35 and resetting all the parts which are not already so set, this including the raising of the bell-crank lever 115, which it meets in the act of falling after having withdrawn the catch 119 and immediately carries it back to its original position, which is that shown in Fig. 1.

We have described the above form of our apparatus as being actuated by and storing up energy from a secondary circuit only; but we may without altering the nature of our invention, though with less practical advantage, store up the said energy by means of the same appliances from the primary circuit of the transformer or from the high-tension mains (through a resistance choking coil or condenser) or from a separate battery, which may thus also replace the primary battery for performing the operations above assigned thereto, provided that the other actions of liberating the stored-up energy actuating the switch take place as described above.

We may also employ our apparatus for making and breaking a resistance-switch instead of a simple make-and-break switch—that is to say, we arrange the main switch so that in its descent it establishes connection between the primary circuit of the transformer and the mains, first, through a high resistance, (induction or other,) then through a lesser or a number of lesser resistances, and finally effects full and complete connection, while the reverse order of events takes place on breaking the secondary circuit.

Our invention may also be carried into effect by connecting the primary battery or other source of electric current employed to switches adjacent to or forming part of the lamp-switches instead of employing it as described above. One of these switches must then be turned on before turning on a light, when the current from the cell actuates the freeing appliance which throws in the main switch, while when the last light is turned out another switch or push is used to cause the primary battery-current to flow through the appliance which liberates the switch and causes it to break circuit.

We are aware that switches are in existence for severing the connection between the primary coil of transformers and the mains when the lights in the secondary circuit are turned out without, however, re-establishing that connection when the secondary circuit is again closed, (*i. e.*, a light turned on,) and likewise that there exist arrangements by which the current from a small transformer (left permanently in circuit) is employed when the load upon it rises to a certain point to switch in a larger transformer; but our invention differs from these both by reason of its greater utility, since it acts to switch in the transformer when even a single light is turned on, and also its greater economy, as

when the lights are turned off it severs connection with the mains completely and avoids the loss due to leaving a small transformer in circuit.

What we claim is—

1. In an automatic switch for electric current transformers, and in combination a switch for severing the connection between the primary coil of the transformer and the main, when the secondary or low tension circuit is broken, and for re-establishing the connection when the secondary circuit is again closed, and an external source of energy such as a primary battery and electro-magnetic means operated by said primary battery for releasing energy stored up from the supply mains, and which energy actuates the switch, substantially as described.

2. In an automatic switch for electric current transformers, and in combination a switch interposed between the primary coil of the transformer and the main, a solenoid and a relay mechanism in the secondary circuit, a spring connected to the core of the solenoid and the switch, and an external source of energy such as a primary battery, the current from the latter when a lamp is switched on in the secondary circuit energizing the relay mechanism and completing a second circuit, means operated by said second circuit releasing the switch to make connection between the primary coil of the transformer and the main, while at the same moment tension is put upon the spring by the action of the solenoid which for a short interval forms part of the secondary circuit, and means for holding and releasing the switch so that upon the breaking of the secondary circuit by the extinction of the lamps, said switch is liberated and breaks the connection between the primary coil of the transformer and the main, substantially as described.

3. In an automatic switch for electric current transformers, the combination with a weighted or spring controlled lever operating a main switch in the high tension circuit, of solenoids in the secondary circuit, a spring connected to the core of one of the solenoids, said spring operating to store up energy for imparting movement to the lever, means for holding the lever in one position, consisting of a catch engaging the core of one of the solenoids, a primary battery circuit, an electro magnet in same, and means controlled by the latter for operating the catch, a further electro magnet or a solenoid in the secondary circuit, and means controlled by the magnet for holding and releasing the lever when in another position, substantially as described.

4. An automatic switch for electric current transformers, comprising a weighted or spring controlled lever, operating a main switch in the high tension circuit, solenoids in the secondary circuit, a primary battery circuit, an electro magnet in same, a weighted arm controlled by the magnet, a catch controlled by the arm, engaging the core of one of the solenoids, a further electro magnet or solenoid in the secondary circuit, a weighted arm controlled by same, a catch operated by the arm adapted to hold the end of the lever, a contact arm adapted to be raised by the core of one of the solenoids to break the solenoid circuit, a contact making plug carried by the lever, and blocks adapted to be electrically connected by said plug, and a contact operated by the lever for making and breaking the primary battery circuit, substantially as described.

5. The combination with the weighted or spring controlled lever operating the main switch, of a pair of solenoids, a core in one of same, adapted to engage with a catch, means for withdrawing the catch, a connection between the cores of both solenoids, a spring carried by the second core, said spring being attached to one end of the pivoted lever, a contact arm operated by the second core, and means for holding the lever against the action of the spring, and releasing same, substantially as described.

6. In combination the weighted or spring controlled lever operating the main switch, a pair of solenoids operating to store up energy for imparting movement to the lever, a primary circuit, an electro magnet in same, a spring controlled armature, a weighted lever controlled by a train of clockwork, governed in turn by the armature, a catch operated by said lever, engaging the cores of one of the solenoids, a rod carried by the weighted arm for resetting same, a second electro magnet, a train of clockwork controlled by same, a weighted arm controlled by the clockwork, and a catch operated by said arm to engage the main switch lever, substantially as described.

7. In combination the weighted or spring controlled lever, a frame secured thereto carrying a block and plates of insulating material, plates 56 of insulating material, between which the frame and block slide, and contact arms 62 62^a, adapted to be separated by the frame, and forced into contact by the block, substantially as described.

8. In combination a base plate, solenoids 3, 4, a pivoted weighted lever, a contact device operated by same, a main switch connected to one end of the lever, an electro magnet, a spring controlled armature for same, a clockwork train controlled by the latter, a weighted cranked arm adapted to be released by the clockwork train, a catch operated by said arm, means for resetting the arm, a core in the solenoid 3 adapted to be held by the catch, a core in the solenoid 4, a spring attached to same, and to the end of the pivoted lever, a

cord connecting the two cores, pulleys over which the cord passes, an arm adapted to be lifted by the core of solenoid 4, carbon rods adapted to be put in and out of contact by said arm, a plug carried by the lever, contact blocks adapted to be connected by the plug, a spring catch for holding the end of the lever, a weighted cranked arm connected to the catch adapted to be raised by the end of the lever, a clockwork train controlling the arm, an electro magnet, and an armature normally held up by a spring, and adapted to control the clockwork, substantially as described.

In testimony whereof we have hereunto set our hands in the presence of two subscribing witnesses.

ANTHONY GEORGE NEW.
ARTHUR JAMES MAYNE.
RICHARD NORMAN LUCAS.

Witnesses to signatures of Anthony George New and Arthur James Mayne:
ALLEN PARRY JONES,
JAMES BOLES.

Witnesses to signature of Richard Norman Lucas:
THOMAS B. LAWLOR,
M. CLAYTON.