No. 727,713. PATENTED MAY 12, 1903.

E. THOMSON.

MEANS FOR ACCENTUATING ELECTRICAL CONTACTS.

APPLICATION FILED SEPT. 29, 1900.

NO MODEL. 3 SHEETS—SHEET 1.

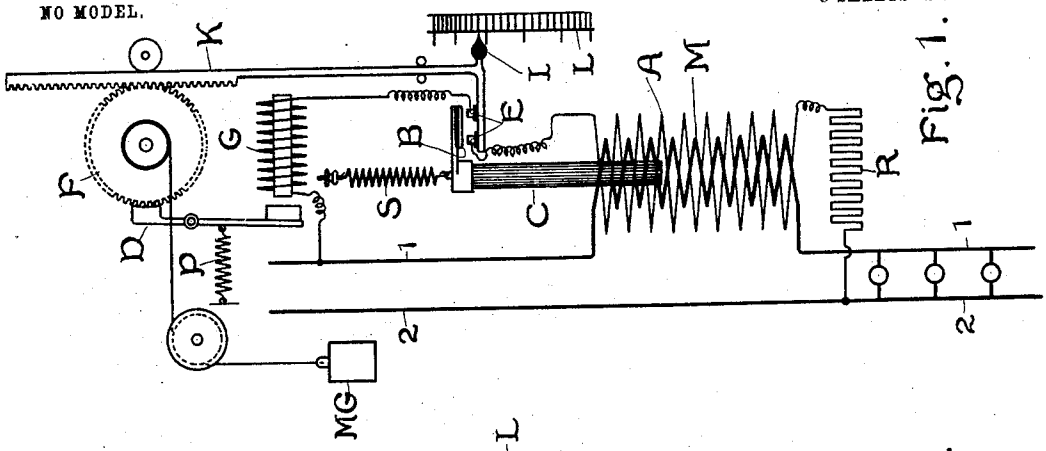

Fig. 1.

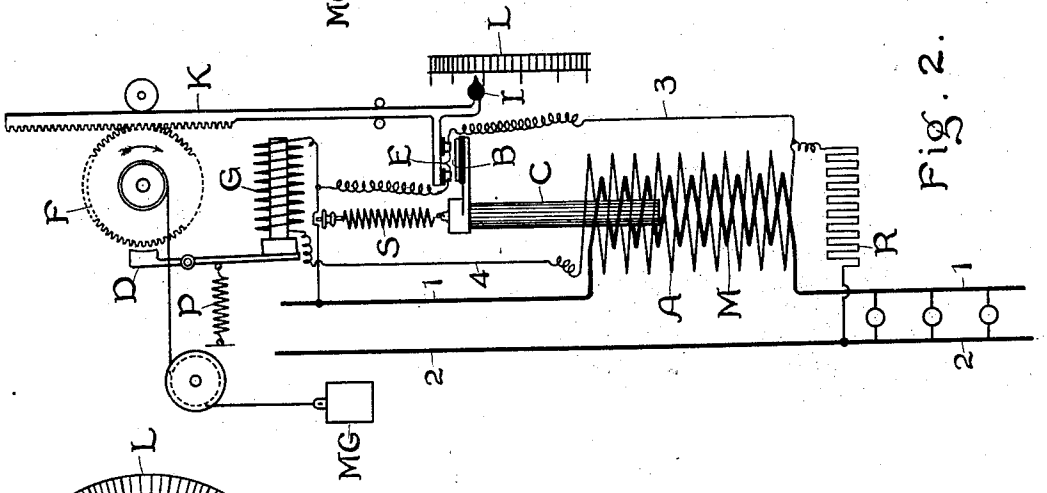

Fig. 2.

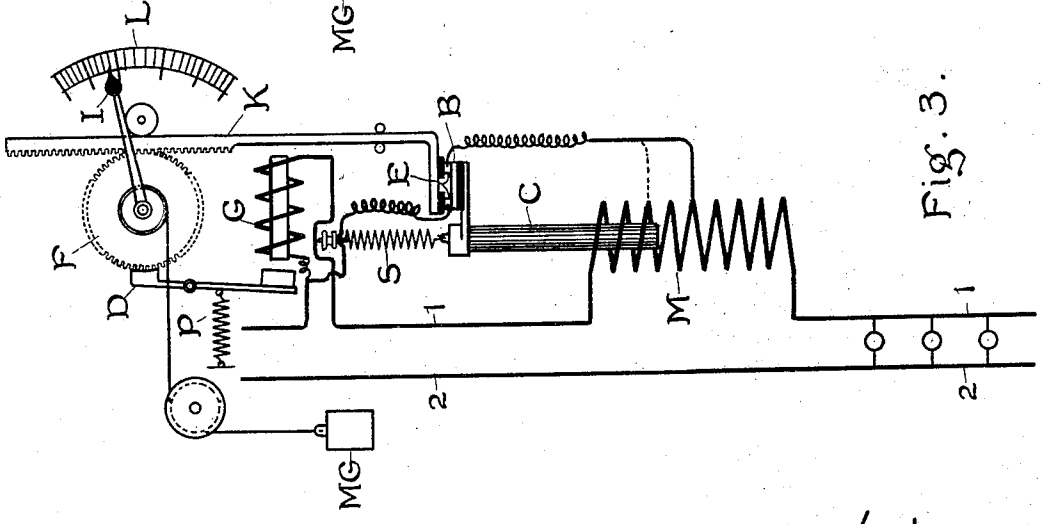

Fig. 3.

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NO MODEL. 3 SHEETS—SHEET 2.

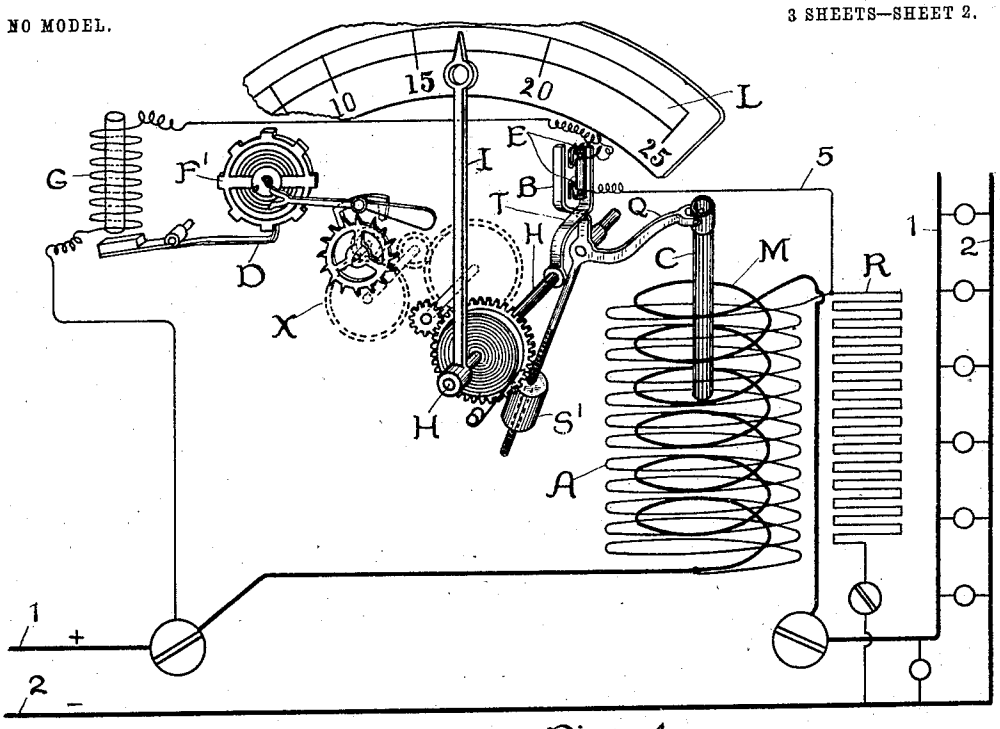

Fig. 4.

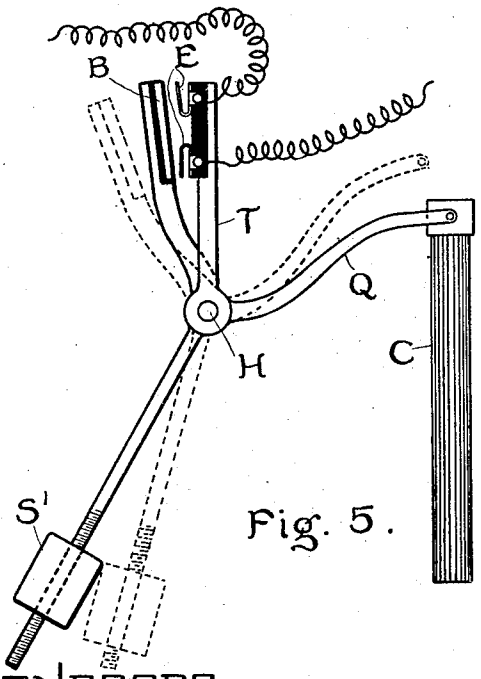

Fig. 5.

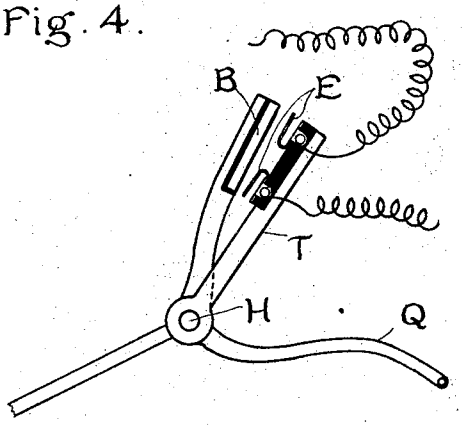

Fig. 6.

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No. 727,713. PATENTED MAY 12, 1903.

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MEANS FOR ACCENTUATING ELECTRICAL CONTACTS.

APPLICATION FILED SEPT. 29, 1900.

NO MODEL. 3 SHEETS—SHEET 3.

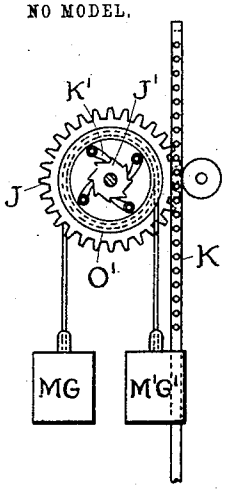

Fig. 8.

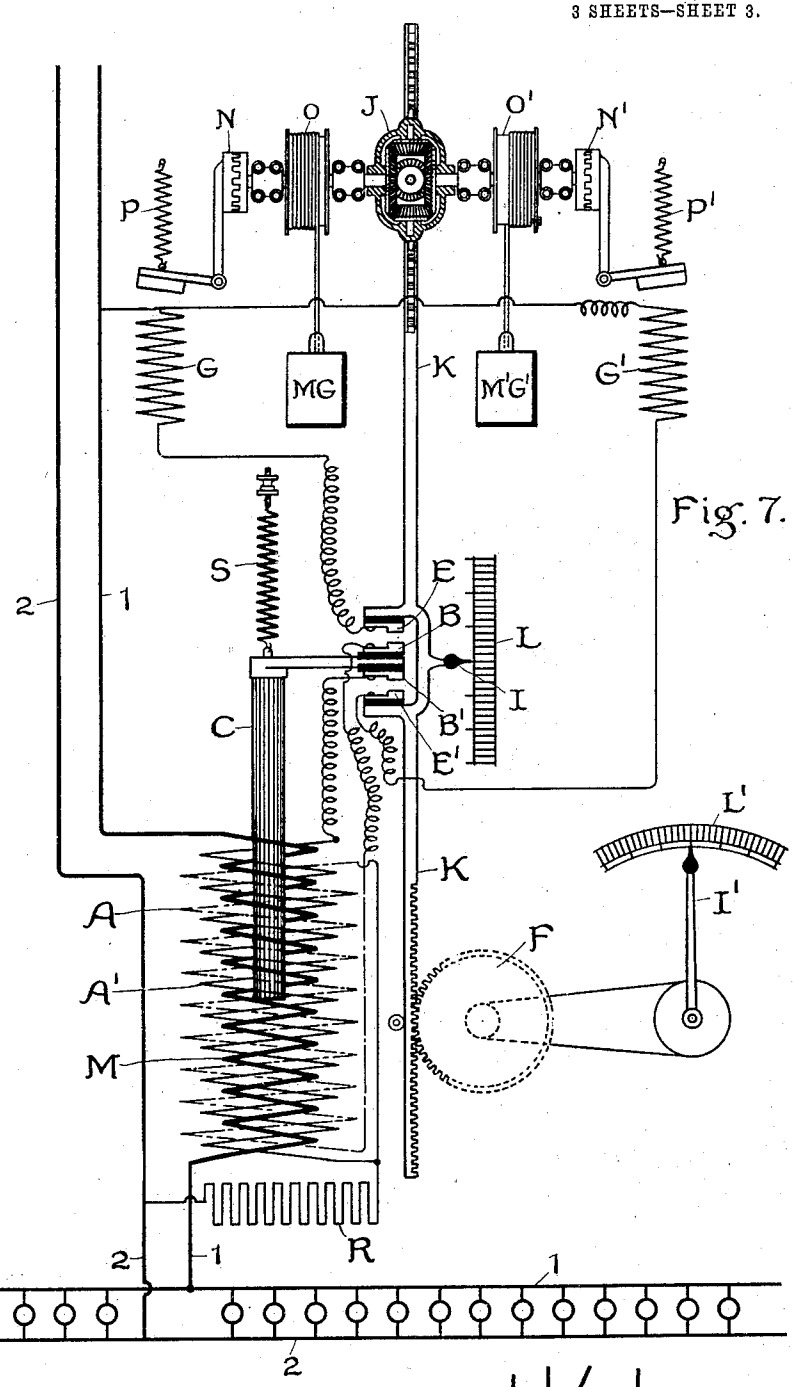

Fig. 7.

WITNESSES.

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No. 727,713. Patented May 12, 1903.

UNITED STATES PATENT OFFICE.

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

MEANS FOR ACCENTUATING ELECTRICAL CONTACTS.

SPECIFICATION forming part of Letters Patent No. 727,713, dated May 12, 1903.

Application filed September 29, 1900. Serial No. 31,493. (No model.)

To all whom it may concern:

Be it known that I, ELIHU THOMSON, a citizen of the United States, residing at Swampscott, county of Essex, State of Massachusetts, have invented certain new and useful Improvements in Means for Accentuating Electrical Contacts, of which the following is a specification.

This invention relates to means for insuring the positive and certain engagement and disengagement of electric contacts which are controlled by an electroresponsive coil which is so arranged as to cause a loose and uncertain or trembling engagement of the contacts. This may result from the structure of the coil or from the variation of the flow of current therethrough; but in any case arcing at the contacts results, with all the familiar attendant disadvantages.

The invention is applicable to many different purposes and is capable of being carried out in many different ways. It is especially adapted to be applied to instruments for measuring electricity in which the coil which causes the indication may necessarily be delicate and have a variable current flowing through it, but which may be required to close a circuit which may contain, for instance, means for recording the maximum flow of current through the coil. In an apparatus of this type the maximum-recording means might be constructed in a single apparatus, with an ordinary ammeter or other suitable measuring instrument, in which case the contacts which engage to complete the auxiliary circuit might be the recording-pointer of the maximum device and the indicating-pointer of the ammeter, or the maximum-recording device might be a separate and independent instrument having special contacts for completing the auxiliary circuit.

In general the invention is applicable in any case where it is desirable to have an instrument control a circuit in which are connected translating devices of any desired kind. In such cases it is essential that the contact should be made positively, and if the instrument is so delicate that it cannot fulfil this requirement there is need of this invention. It is also applicable to any case in which a contact must be made by a current which fluctuates in such a way as to cause arcing at the contact and to various other uses which will be evident to those skilled in the art.

The invention consists in means for varying the effect caused by the coil of the controlling instrument. In any case there is some force, such as gravity or a spring or weight, which normally acts in opposition to the coil. From this it follows that the invention may be carried out in many different ways. It makes no difference whatever in what manner the invention is embodied if only the variation of the effect caused by the actuating-coil serves to produce a positive and complete make-and-break action for the contacts. For example, in a case where the coil causes the contacts to be engaged and a spring or its equivalent tends to separate them the contacts when closed may complete a circuit, whereby additional ampere-turns are added to the effect of the coil and serve to accentuate the engagement of the contacts, which the coil itself, owing to its structure or the small flow of current through it, has uncertainly and partially accomplished. When now the current flowing through the coil decreases, so that the spring or its equivalent causes the contacts to be slightly separated, no trembling due to variation of the flow of the current in the coil is permitted, because instantly the additional ampere-turns coöperating with the coil to act on the contacts are eliminated, so that the spring is free to exert a force upon the contact which pulls it out of striking distance of the other contact before any arcing can occur, the spring being opposed only by the normal action of the coil. In any case it is clear that the invention can be carried out and the effect of the coil be varied either by the use of an auxiliary coil or by taps from portions of the coil itself. As another illustration, take the case where the spring or weight tends to separate the contacts. In this case the coil, together with the additional turns, may close the contacts, which when closed short-circuit the auxiliary turns and permit the spring to force the contacts widely apart as soon as the coil weakens sufficiently to break contact and before the auxiliary turns, which are then cut

in circuit, can affect the movable contact. In case the spring tends to hold the contacts in engagement and the ampere-turns are relied upon to keep them separated, the contacts when caused to engage by a decrease in current flow may close a shunt which short-circuits the auxiliary turns, so that the spring acting in opposition to the coil alone forces the contacts securely together. In opening, as soon as sufficient current flows through the coil to overcome the spring and separate the contacts the shunt is opened, the auxiliary turns are cut in circuit with the coil, and the contact is pulled against the effect of the spring sufficiently far from the other contact to prevent arcing. Again, in case the spring causes the contacts to engage and the coil alone tends to separate them the contacts may close a circuit which includes ampere-turns in opposition to the coil, whereby as soon as the contacts are caused by the spring to engage the magnetic effect on the movable contact is decreased and the spring is free to act with increased energy to hold the contacts firmly together. As soon as the coil has developed sufficient energy to overcome the spring the opposing turns are cut out and the increased magnetic effect quickly separates the contacts before any slight decrease of the flow of current through the coil can permit the spring to again cause the contacts to be engaged.

The invention can also be further utilized to great advantage in cases where it is desired to have a delicate coil-control apparatus or indicating instruments having greater inertia and in which the movement may be in two directions.

Of the drawings, Figures 1, 2, and 3 are diagrammatic illustrations of the different ways in which the invention might be applied to a simple form of maximum-recording instrument. Fig. 4 is a perspective and diagrammatic view showing the application of a form of the invention to a maximum-recording instrument of which the actuating means consists of a clock mechanism. Figs. 5 and 6 are detail views of the contacts and their associated parts. Fig. 7 is a diagrammatic illustration of the application of the invention to an apparatus in which a sensitive galvanometer or other coil controls the actuating means of an indicating instrument, and Fig. 8 is a detail view of a portion of the actuating means of the apparatus shown in Fig. 7.

In Fig. 1 the contacts B and E are typical of any circuit-closing means which is required to so act that a positive action of engagement and disengagement will be obtained.

M is a coil which has so few or variable ampere-turns that it opposes the spring S only to such extent as to barely cause the contacts B and E to engage with each other, or makes and breaks contact according to the slight variations in the flow of current. At such a contact trembling and arcing will occur, and to obviate this difficulty an auxiliary coil A is connected in the circuit which is closed by the contacts B and E. Thus as soon as the coil M has caused the contacts to engage loosely and uncertainly, but thereby cutting in the coil A, the latter will coöperate with it to pull down the core C with increased energy and hold the contacts positively together in close and intimate contact, so that no arcing can occur. Thus the contact is positively maintained even with slight variations in the flow of current through the coil M. Also even if the coil M alone can maintain a positive contact with a certain current flow the coil A will coöperate with it to maintain the positive contact when the current flow in the coil M varies between narrow limits. As soon as the current flowing through the coil M decreases to such extent that the spring S moves the contact B a slight distance away from the contacts E the coil A will be cut out of circuit and the spring be suddenly released, so that it pulls the contact B quickly and positively away from the contacts E before any trembling and arcing can occur.

The coils A and M may receive current from any suitable source; but in this illustration the coil M is connected in series with the main 1 of the distribution system 1 2, so that it responds to the load, and the coil A is a potential-coil connected across the mains. A suitable resistance R may be connected in series with the coil A.

The circuit closed by the contacts B and E may contain suitable translating devices for any desired purpose; but in this case the circuit is shown as controlling the actuating means for a maximum-demand-measuring instrument for which it is particularly adapted. A magnet-coil G is connected in series in the circuit of the coil A across the mains, and when the circuit is closed the armature of the magnet G is moved in opposition to the spring P. The armature is connected to the pivoted lever carrying the detent D at its opposite end, which engages in a gear F, operated by any suitable means, as a weight MG. When the magnet G has caused the detent D to be disengaged from the gear F, the weight MG causes the gear F to rotate and force downward the rack K. On the lower end of the rack are mounted the contacts E and an indicating-pointer I, which is shifted progressively by the rack over the scale L. As the flow of current increases in the coil M the contact B engages loosely with the contacts E, cutting in the coil A, and thereby causing a firm engagement of the contacts. Then, as described, the closing of the circuit through the coil G causes the contacts E and the pointer I to be moved downwardly to the lowest position of the pointer, thus recording the maximum flow of current in the system. The contacts B and E move downward together until the opposing forces controlling the core C are balanced, when the contacts E are moved a slight distance farther and away from the

contact B. The coil A is thus cut out, and the spring S instantly pulls the contact B up farther from the contact E, the movement of which has already ceased.

In Fig. 2 is shown an application of the same principle of positive actuation of the contacts in a slightly-different manner to the same distribution system and indicating device as that shown in Fig. 1. In this case, however, the spring S tends to cause the contacts E and B to engage and the delicate coil M opposes the spring. The auxiliary coil A is connected in an independent circuit across the mains 1 and 2, and the circuit closed by the contacts E and B constitutes a shunt for the coil A. The contacts E and B are normally held closed by the spring S, and when the flow of current through the coil M increases the contact B will be drawn a slight distance downward, whereat the shunt will be open, and the effect of the coil A will be added to that of the coil M to pull the contact B quickly down away from the contact E. As soon as the flow of current in the coil M decreases the spring S will raise the contact B against the combined action of the coils M and A until said contact engages with the contact E, whereat the shunt around the coil A will be closed and the spring S will pull the contact B firmly against the contact E. With respect to the indicating mechanism in this case, as soon as the contacts are separated and the coil A is cut in circuit the coil G in series therewith will pull the detent D from engagement with the gear F and the pointer I will be forced down by the rack K to give the maximum indication and record. As the pointer I is moved progressively under successive increments of current the spring S will be extended more and more, so that the engagement of the contacts becomes more positive as the pointer I moves over the scale L.

In Fig. 3 is shown a similar application of the same principle, in which taps are taken out from the series coil M instead of employing an auxiliary coil, as in Figs. 1 and 2. A spring S normally maintains the contacts E and B in engagement, thereby closing a shunt around a few turns of the upper part of coil M. When the flow of current increases in the coil M, the contact B is pulled down a trifle, whereat the shunt is broken at the contacts and the entire coil M serves to quickly pull the contact B a substantial distance away from the contact E. When the current flow in the coil M decreases, the spring S pulls up the contact B into engagement with the contact E, whereat the shunt around the upper portion of the coil M is closed and the spring exerts a greater effort to maintain the contacts B and E in close and intimate contact. In this case the detent-coil G is connected in series with the coil M. The pointer I is mounted to rotate with the gear F instead of being carried by the lower end of the rack K. An instrument having these electrical connections is not so well suited as a load-indicator where the currents in the coil M vary between wide limits.

In Fig. 4 is shown an application of the invention to a maximum-demand instrument provided with actuating mechanism which introduces a time element into the movement of the recording means. The coil M, having few ampere-turns, is connected as above in series with the conductor 1. Connected across the mains through a suitable resistance R is the auxiliary or accentuating coil A. Pivoted to the core C is an arm Q, which operates a suitably-pivoted structure embodying a contact B and an adjustable weight S'. Mounted on the shaft H is an arm T, carrying the contact E, which coöperates with the contact B to close the shunt around the coil A. Also mounted on the shaft H is a recording-pointer I, which is moved progressively over the scale L. Coil G, which is in series in the shunt closed by the contacts B and E, actuates its pivoted armature to withdraw the detent D from the escapement-wheel F' of the clock mechanism X, which operates the shaft H with a time lag. When the flow of current in the coils M and A increases, the core C is pulled quickly downward, raising the weight S' and causing the contact B to engage positively with the contacts E to close the shunt around the coil A, which shunt includes the coil G. Thereupon the coil G withdraws the detent from the escapement-wheel and the clock mechanism actuates the train to move the maximum-recording pointer I. The arm T, on which the contacts E are mounted, is moved in the same direction as the pointer I by the shaft H, on which they are both mounted, and thus the contacts B and E move together clockwise. The weight S' is raised continually until the maximum flow is recorded or until the flow of current in the coil M decreases. Then the contact B is moved slightly from the contact E and the coil G locks the clock mechanism, thus causing the contact E to remain stationary, and the weight S', which has been raised to a considerable extent, pulls the contact B away from the contact E before the contact B can be checked by the coils.

In Fig. 5 are shown the contacts in their relative positions before the operation of the instrument, and in Fig. 6 they are shown in their relative positions after the instrument has been operated, the final position of the contact B being dependent upon the reduction of the flow of current in the coil M.

In Fig. 7 is shown the application of the invention to an apparatus wherein the coil M represents a delicate galvanometer or other coil which controls an indicator, I movable in two directions. When the flow of current through the coil M increases, the core C, carrying the contact B', is pulled down to cause the engagement of contact B' with the contact E'. A circuit is then established from the main 2 through the resistance R and coil

A', contacts B' E', and the coil G' to the main 1. The armature of the coil G' is pulled down against the opposing spring P' to open the clutch N', whereat the weight M'G' forces the rack K down to move the pointer I over the scale L. The coil A' in the circuit thus completed coöperates with the coil M to cause the contacts to engage positively to prevent arcing. When now the flow of current in the coil M decreases, the spring S moves the contact B' slightly upward away from the contact E' and the coil A' is cut out, so that the spring pulls the contact B' sufficiently away from the contact E' to prevent arcing. When the flow of current in the coil M is still further reduced, the spring S pulls up the core C, which also carries the contact B, until the latter engages with slight pressure against the contact E. The circuit is thus closed from the main 2 through the resistance R, through the coil A in the opposite direction to the coil M, through the contacts B and E and the coil G to the main 1. The coil G pulls down its armature against the opposing spring P and releases the clutch N, whereat the weight MG moves the rack K up to move the pointer I in a corresponding direction. The coil A in the circuit thus completed thus serves to diminish the effect of the coil M, so that the spring S holds the contact B with increased pressure against the contact E. When the current through the coil M again increases, the contact B will be drawn down a trifle from the contact E against the opposition of the spring S and the coil A will be immediately cut out of circuit, so that the full effect of the coil M is utilized to move the contact B quickly to a sufficient distance to prevent arcing between the contacts. Any other suitable arrangement of indicating means may be utilized—as, for example, the gear F, which is operated by the rack K to transmit motion to the pointer I', which is reciprocated over the scale L'.

The actuating mechanism shown in the upper portion of Fig. 7 will be readily understood by reference to Fig. 8. The drums O O', from which the weights are suspended, have internal pawls and ratchets J' and K' oppositely arranged, so that the pawl and ratchet of the drum which is being moved by a weight are inoperative. The gear J is hollow and contains suitably-mounted differential gearing.

While I have described in the foregoing portions of the specification the accentuating turns as wound on the same core with the main turns, it will be understood that in certain cases this may not be necessary or desirable and a departure from this arrangement will not be beyond the limits of my invention.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent of the United States, is—

1. The combination of coöperating electric contacts, mechanical means for urging them together, magnetic means for urging them apart, and means for decreasing the opposing force of said magnetic means when the contacts come together and for increasing it when they separate.

2. The combination of coöperating electric contacts, mechanical means for urging them together, electric means for urging them apart, and means for automatically increasing the force urging the contacts together when they once make contact and decreasing it when they separate.

3. The combination with two coöperating contacts, one of which has a normal tendency to move in a certain direction with respect to the other, of an electromotive device in the circuit controlled by the positions of said contacts, and indicating means controlled by said electromotive device, the second of said contacts being moved with said indicating device, an electroresponsive coil which of itself tends to move only feebly or uncertainly in another direction the contact which has such normal tendency, and means which varies the effect caused by said coil.

4. The combination with two coöperating contacts, one of which has a normal tendency to move in a certain direction with respect to the other, of an electromagnet in the circuit which is controlled by the positions of said contacts, an indicating device, a clock mechanism which is released by said magnet and moves said indicating device and the second contact synchronously, an electroresponsive coil which of itself tends to move but feebly or uncertainly in another direction the contact which has such normal tendency, and means which varies the effect caused by said coil.

5. The combination with two coöperating contacts, one of which has a normal tendency to move in a certain direction with respect to the other, of indicating means, means in the circuit controlled by the positions of the said contacts, which actuates both said indicating means and the second contact, a load-coil which of itself tends to move but feebly or uncertainly in another direction the contact which has such normal tendency, and a potential-coil which varies the effect of said load-coil.

6. The combination with two coöperating contacts, of an electromotive device in the circuit which is controlled by the positions of said contacts, the mains of a distributing system, a normally energized series load-coil which of itself exerts but a slight effect upon said contacts, and a potential-coil connected across the mains for accentuating the effect of the series coil, to prevent trembling and arcing at the contacts.

7. The combination with two coöperating contacts, one of which has a normal tendency to move in a certain direction with respect to the other, of an electromagnet in the circuit, which is controlled by the positions of said contacts, an indicating device, a clock mechanism which is released by said magnet and moves both said indicating device, and the

second contact, mains of a distribution system, a coil in series in the mains, which of itself tends to move but feebly in another direction the contact which has such tendency, and a coil connected across the mains which accentuates the effect of the series coil.

8. The combination with two movable contacts, of an electroresponsive coil controlling one contact, indicating means, means for moving the indicating means and the second contact and controlled by the contacts, and means controlled by the contacts for accentuating the effect of the coil.

9. The combination with a movable contact, of an electroresponsive coil for actuating said contact and having limited ampere-turns, a second movable contact which is engaged by the first, indicating means movable with the second contact, a clock mechanism for actuating said indicating means, a detent for the clock-escapement, a coil in the circuit which is controlled by the positions of the contacts, which coil controls said detent, and means for increasing the effect of said electroresponsive coil.

In witness whereof I have hereunto set my hand this 25th day of September, 1900.

ELIHU THOMSON.

Witnesses:
DUGALD MCKILLOP,
HENRY O. WESTENDARP.