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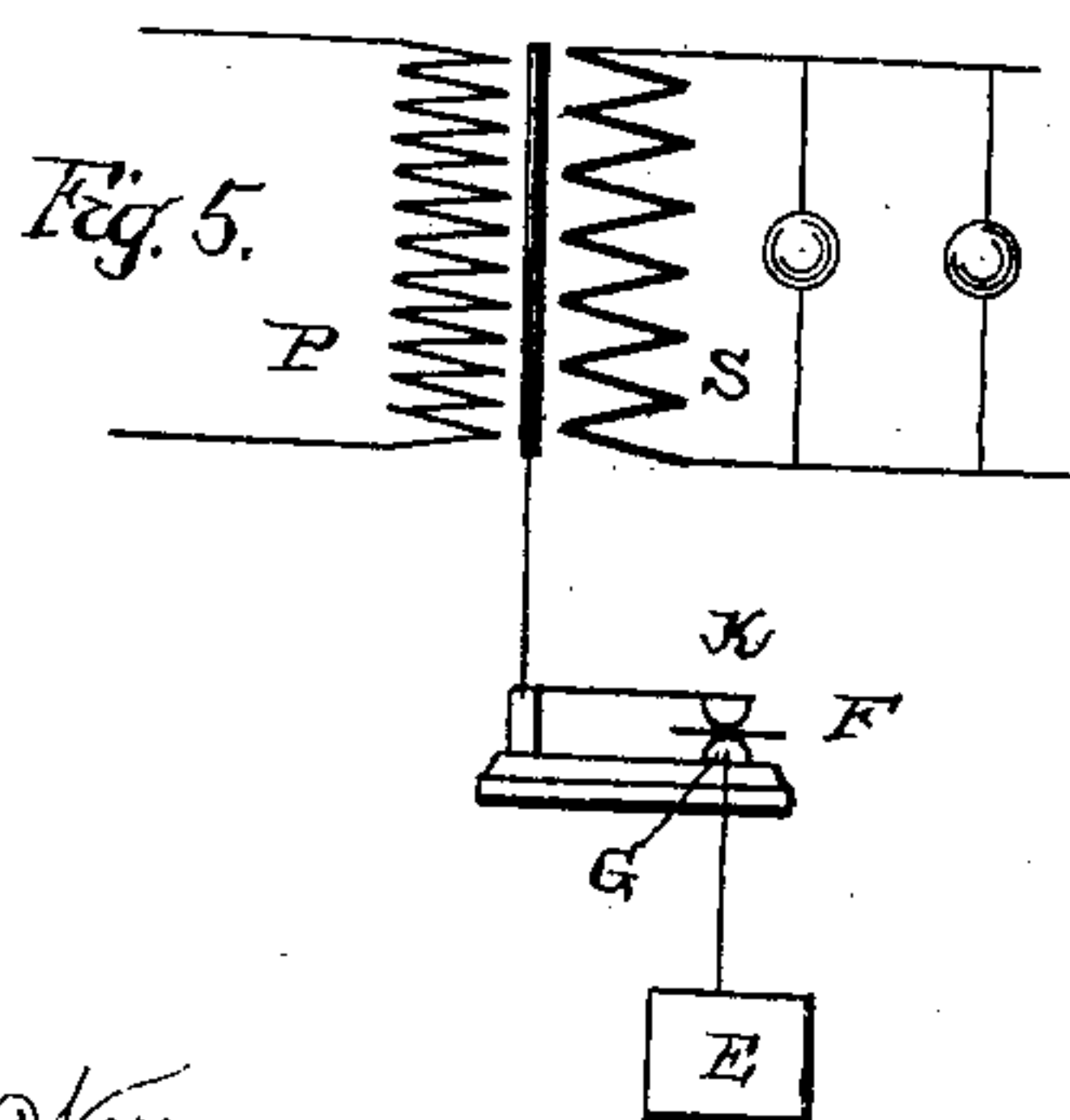
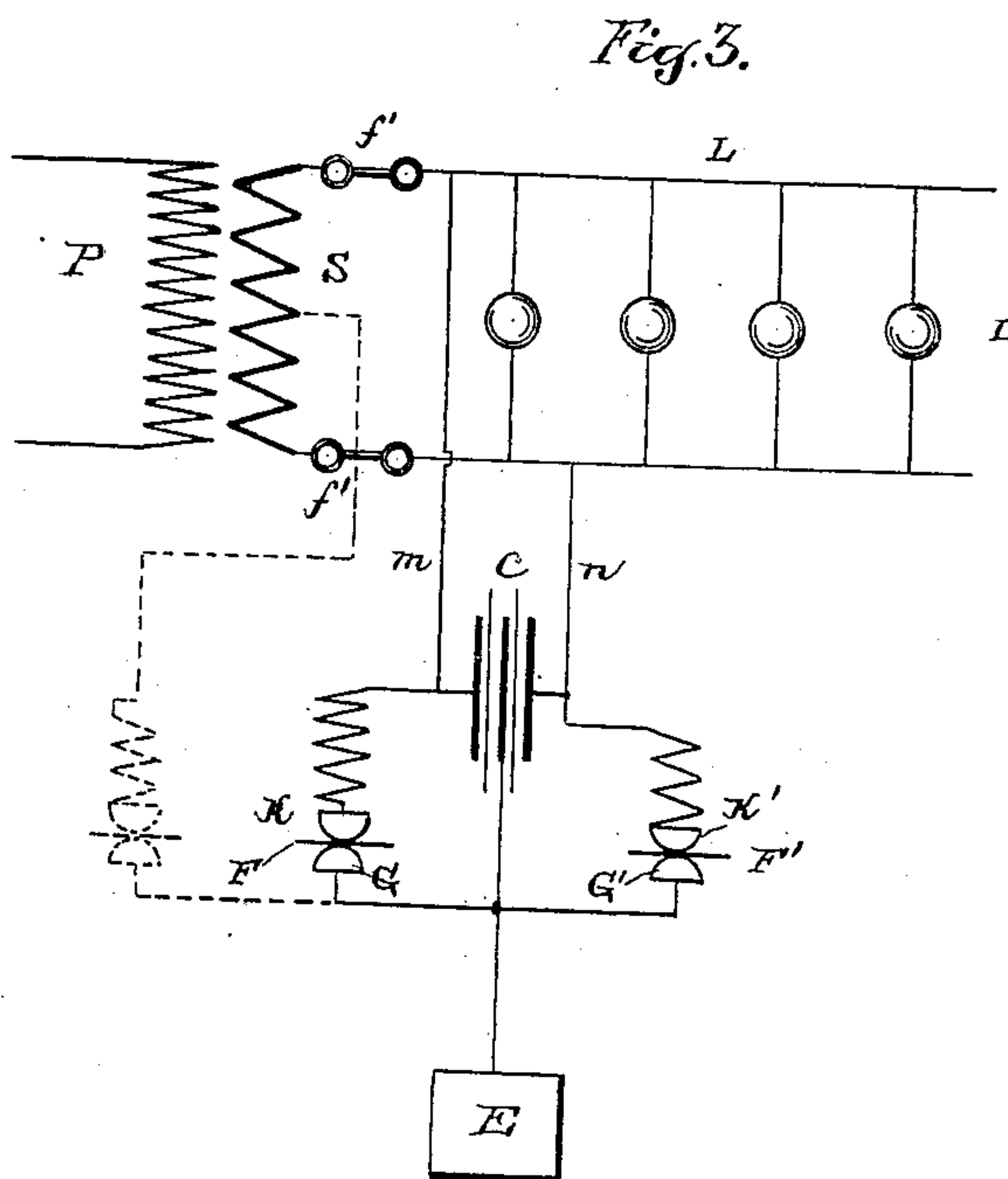
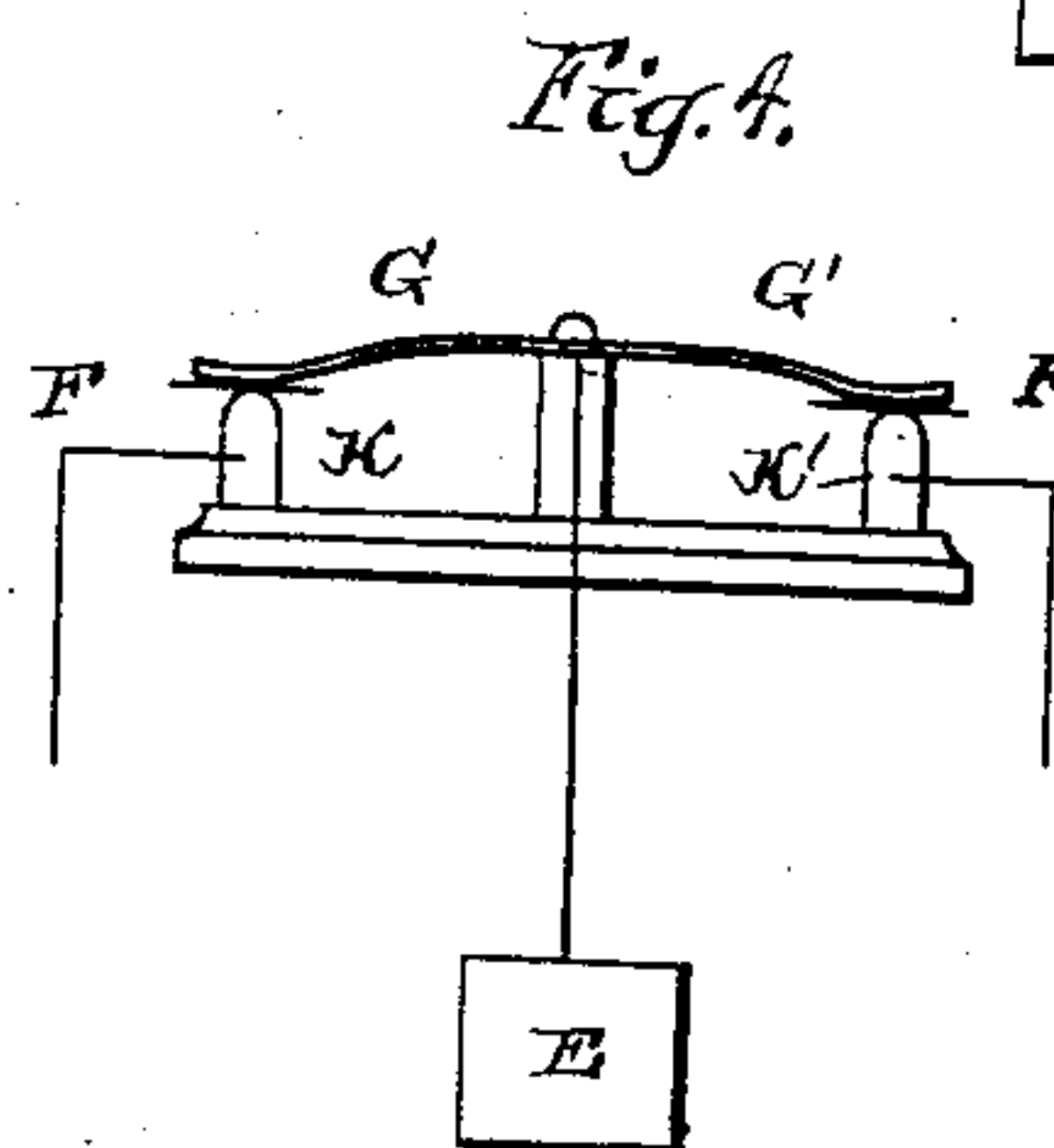
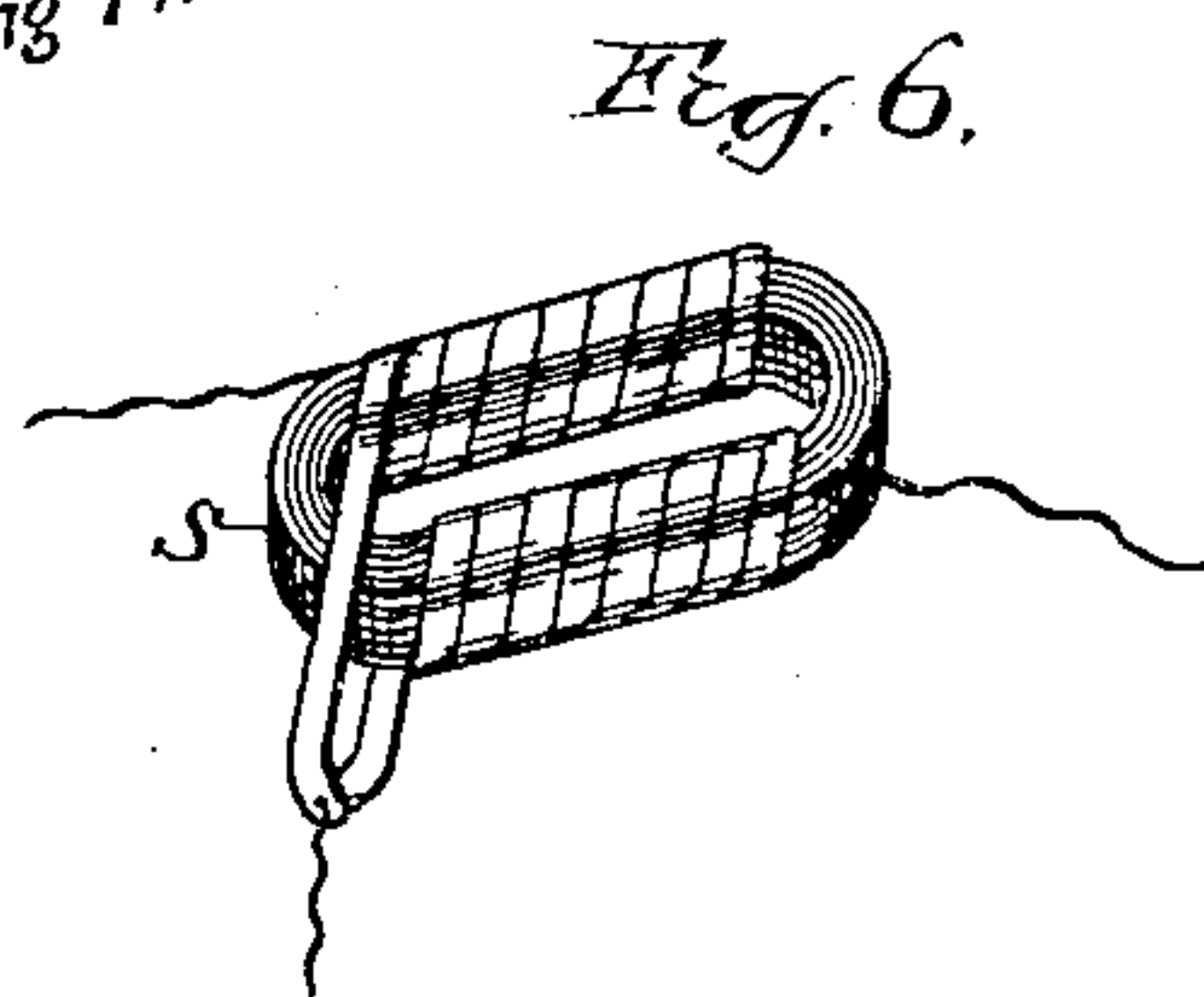
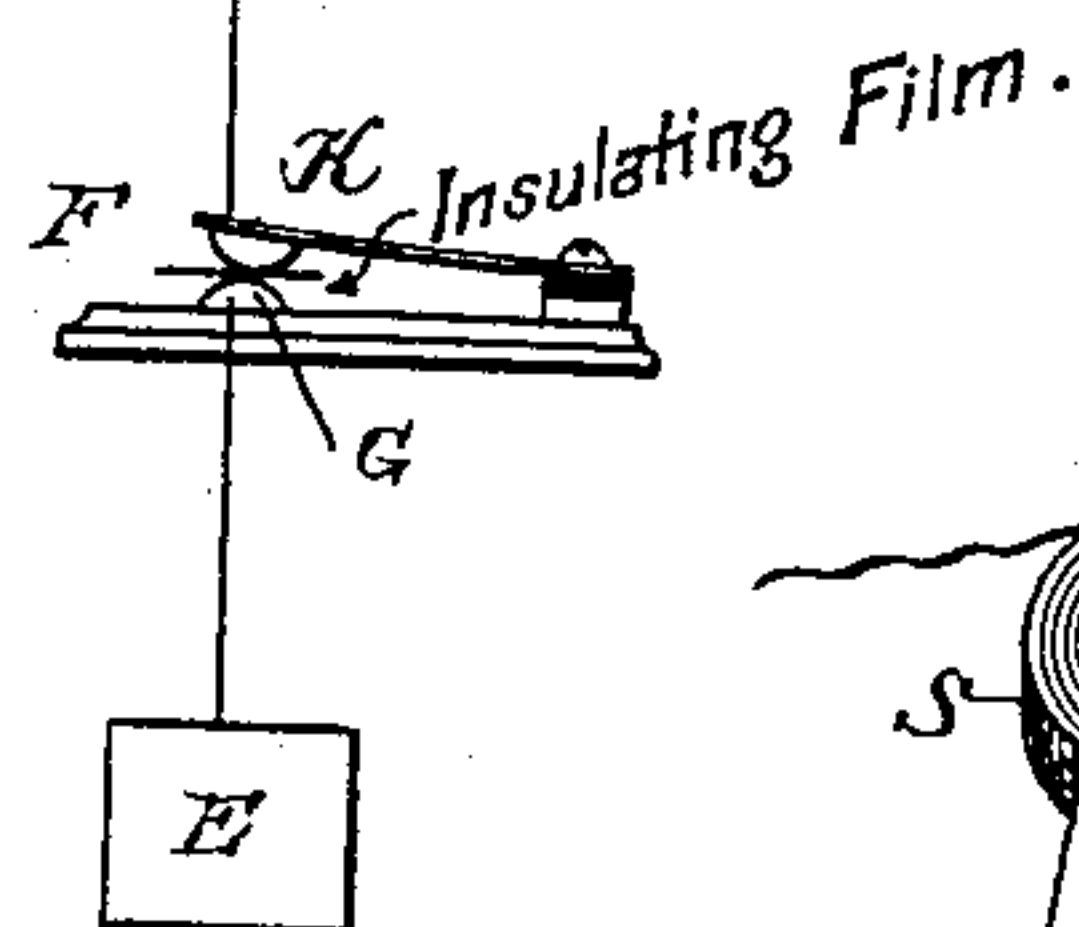
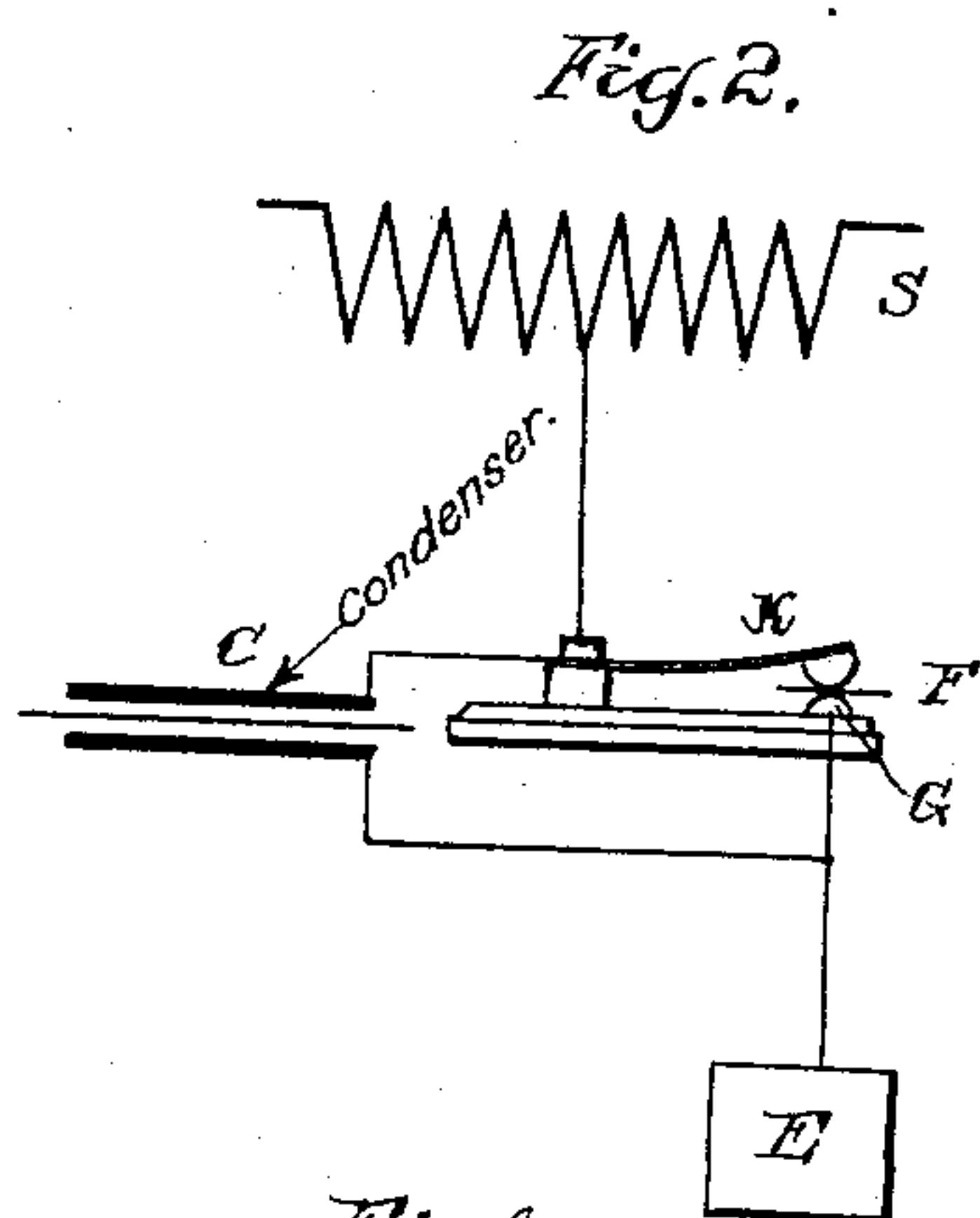
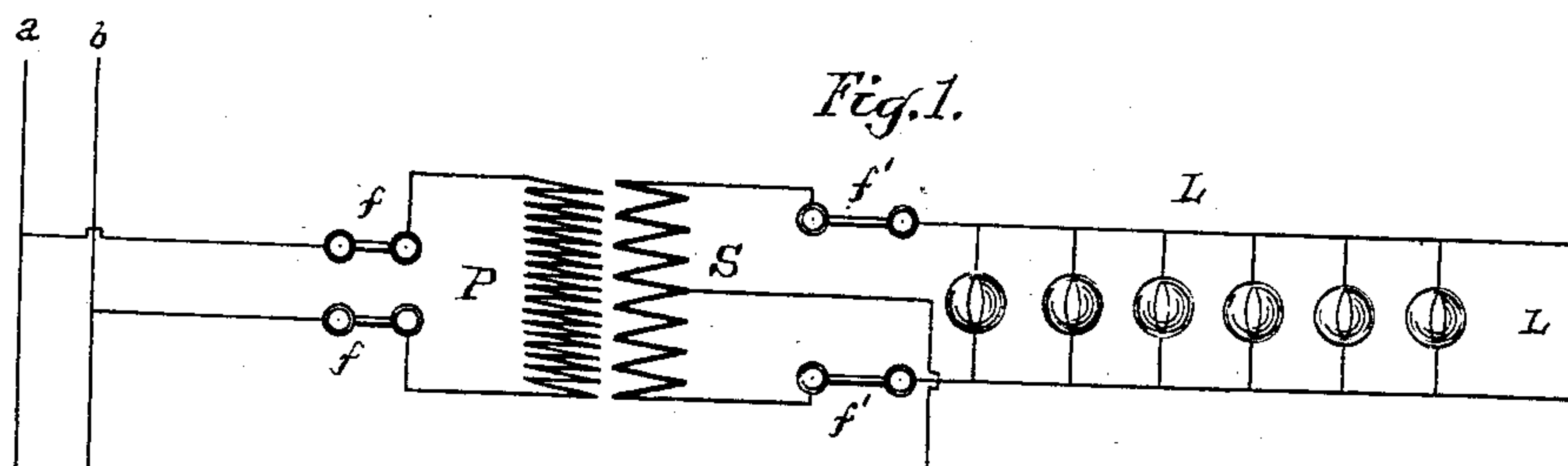
E. THOMSON.

2 Sheets—Sheet 1.

SAFETY CONNECTION FOR INDUCTION COIL SYSTEMS.

No. 496,918.

Patented May 9, 1893.



Witnesses:-
Ira R. Steward.
M^{rs} F. Cape

Inventor:-
Elihu Thomson.

by his Attorney.

H. L. Townsend

(No Model.)

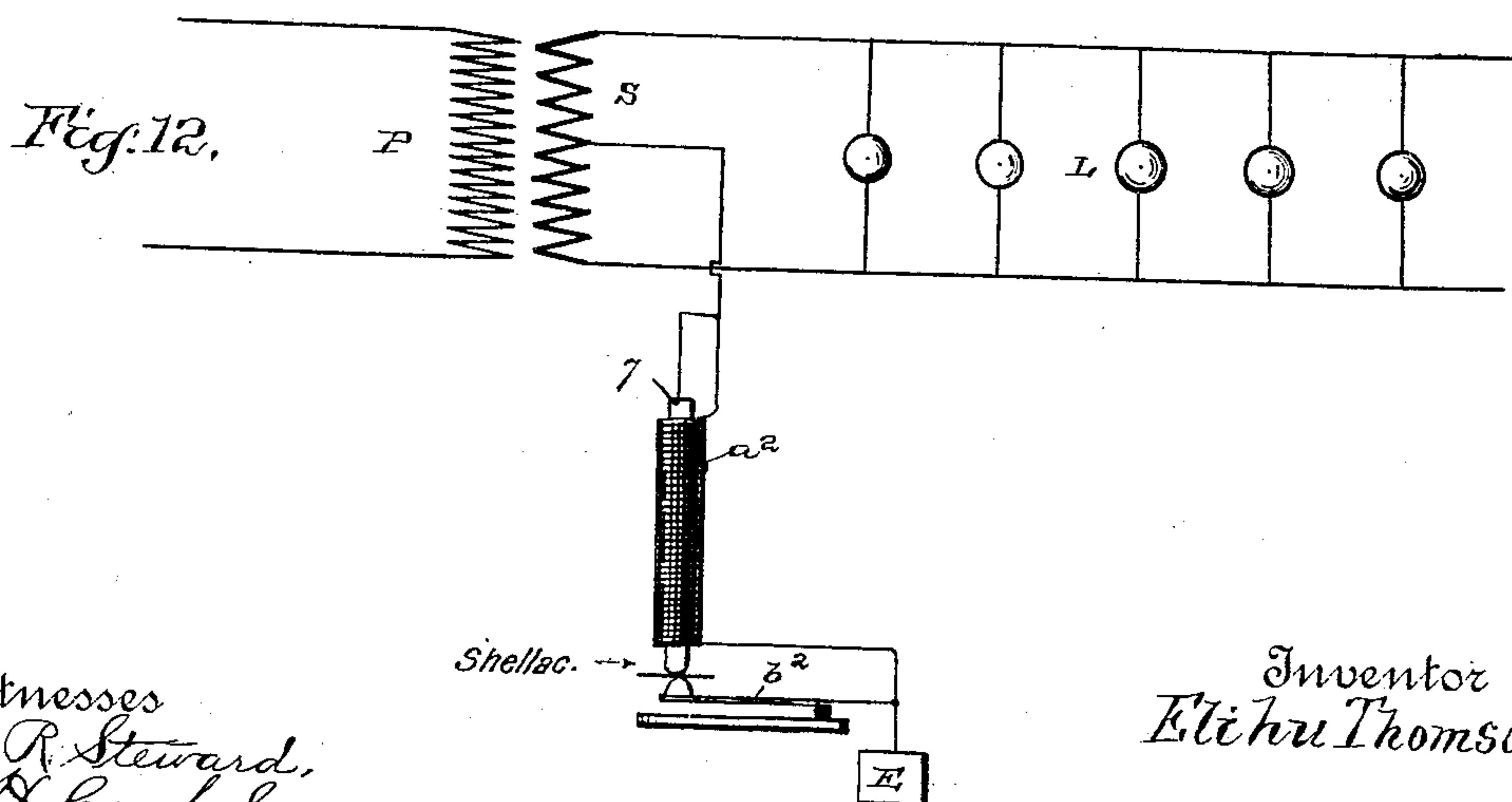
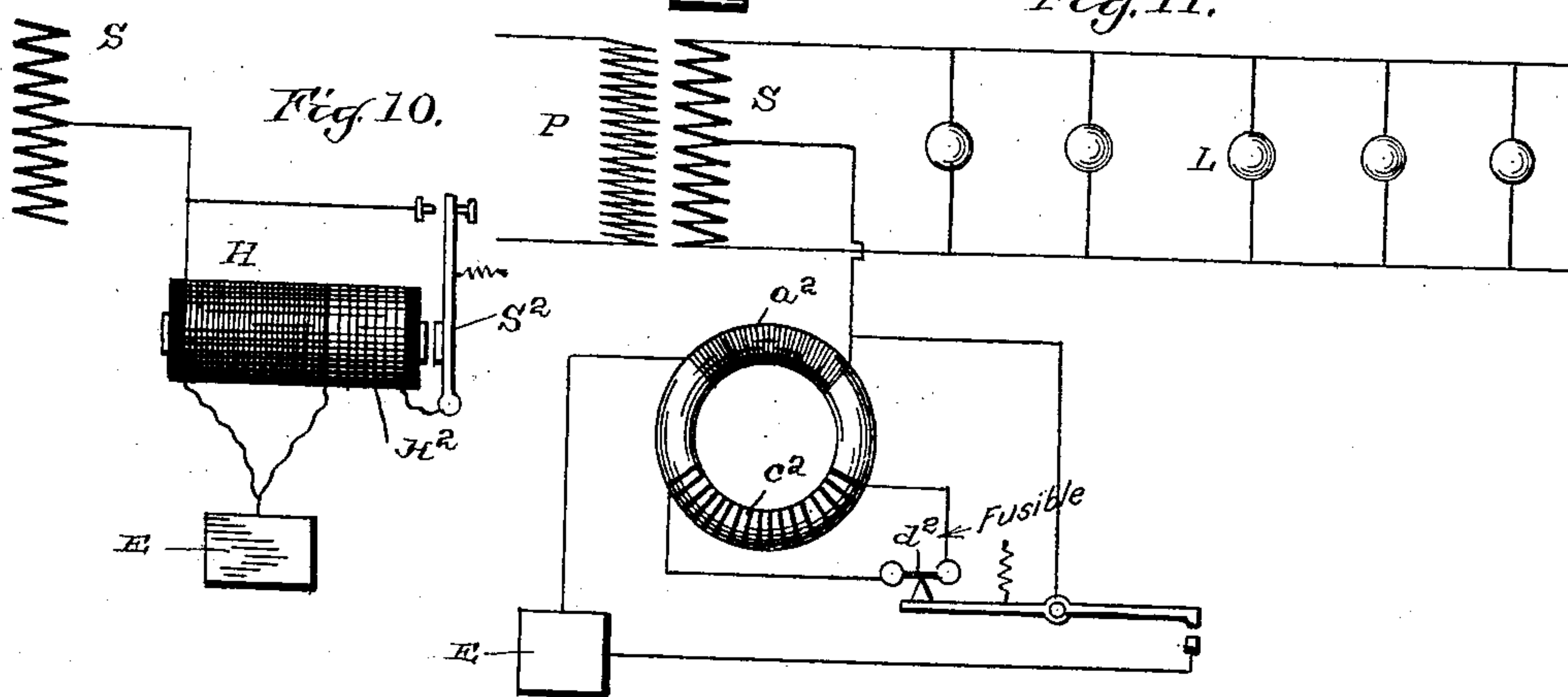
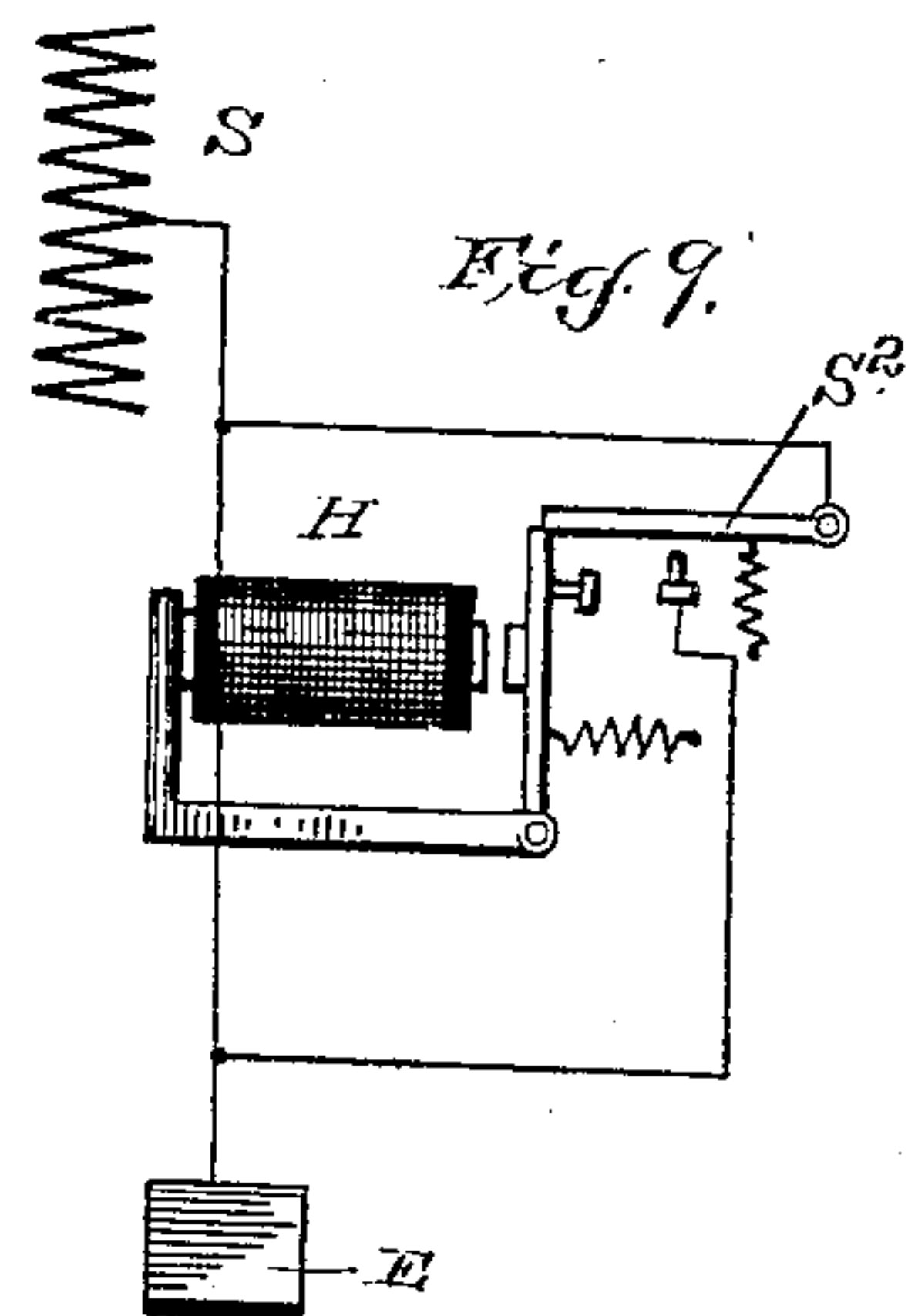
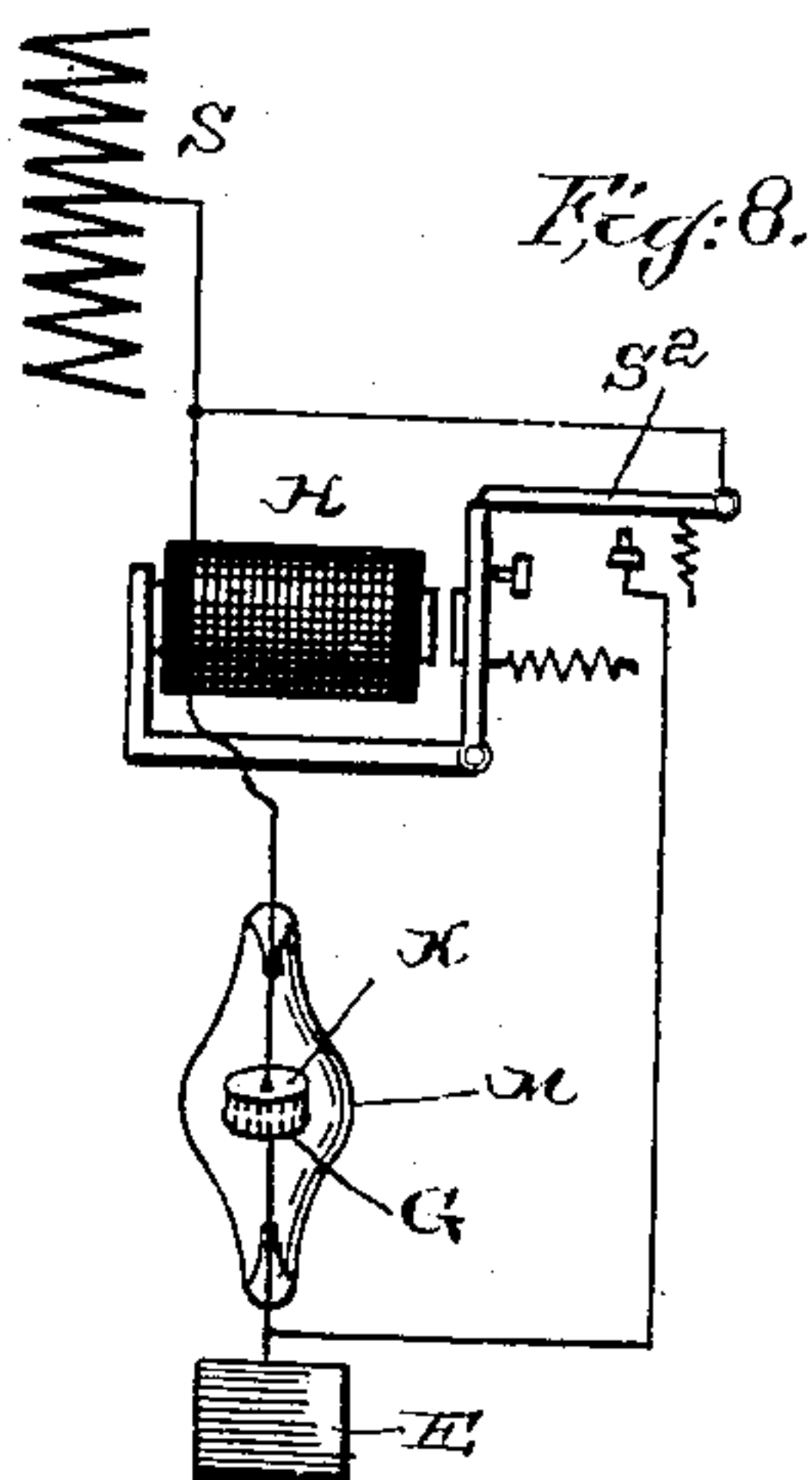
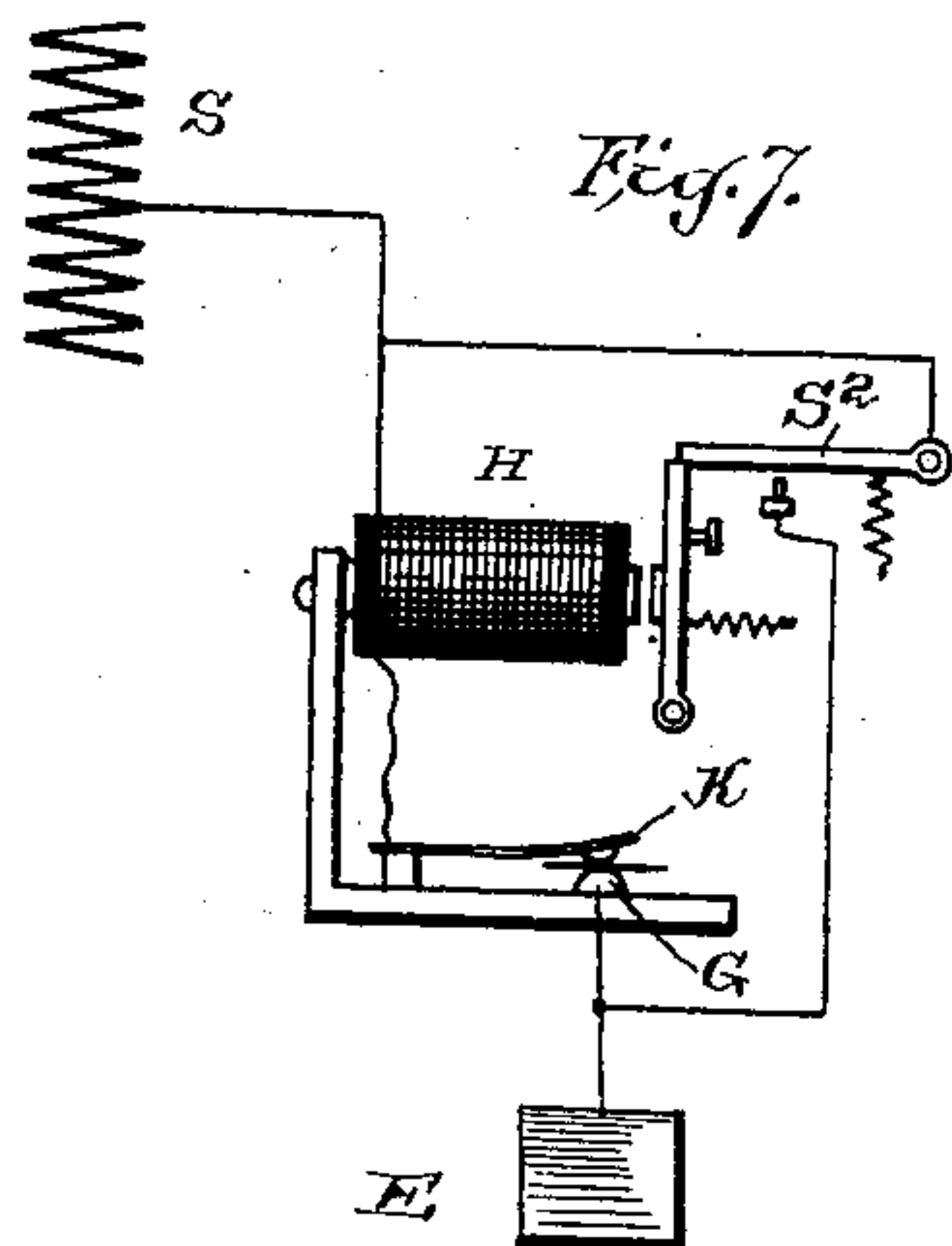
E. THOMSON.

2 Sheets—Sheet 2.

SAFETY CONNECTION FOR INDUCTION COIL SYSTEMS.

No. 496,918.

Patented May 9, 1893.



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UNITED STATES PATENT OFFICE.

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SAFETY CONNECTION FOR INDUCTION-COIL SYSTEMS.

SPECIFICATION forming part of Letters Patent No. 496,918, dated May 9, 1893.

Application filed October 8, 1888. Serial No. 287,564. (No model.)

To all whom it may concern:

Be it known that I, ELIHU THOMSON, a citizen of the United States, and a resident of Lynn, in the county of Essex and State of Massachusetts, have invented a certain new and useful Safety Connection for Induction-Coil Systems, of which the following is a specification.

In the operation of electric circuits carrying currents of high tension, a source of danger arises from the fact that a neighboring local circuit or conductor, or conducting material, may become accidentally connected with the high tension circuit. Under this condition a person whose body forms a ground connection from the local circuit or conductor may receive a dangerous shock if at the same time there be a distant ground upon the main or high tension circuit. This danger is present in greater or less degree whether the neighboring conductor be carrying an electric current or not, and it is the object of my invention to provide for any condition where from the location or nature of the neighboring conductor it may acquire accidentally, for the time being, the tension of a high tension circuit and so may become a source of danger to a person touching the same.

My invention while applicable to many cases is especially designed for application to systems of electric distribution in which the local or neighboring circuit is the path of currents derived, abstracted, or converted from the main but of lower tension, a well known example of such system being the alternating current system of distribution by induction coils or converters. Other systems are referred to in my prior patent No. 322,138.

In my present invention I aim, as in my prior patents, to protect a person touching a conducting medium, for the time being, in connection with the high tension circuit, by means of a low resistance ground or circuit from such conducting medium around his body, but my present invention differs from my prior invention in that in the former case there is always a low resistance safety ground wire or circuit from the local or secondary circuit or from the septum between the primary and secondary coils of the converter, while in the present instance the low resist-

ance ground circuit is not established until after the high potential of the primary or main is transmitted to the secondary or other conductor in proximity to such main.

My invention therefore furnishes all the protection afforded by the employment of the device forming the subject of my prior patent without, however, any of the objections which are incident to the use of a permanent low resistance ground connection from the secondary or local circuit or other conducting medium which is normally disconnected from the main line carrying the current of high tension but which, if permanently connected to earth by a low resistance, might invite the escape of the high tension currents from the main line.

My invention consists essentially in the combination of a main line circuit carrying currents of comparatively high potential, a local or separate circuit or conductor which is normally disconnected from said line but is liable to receive the high tension current escaping from the line to said separate conductor or circuit, and a ground circuit or connection taken from a part of the apparatus or circuits normally disconnected from the main line but containing a high resistance and means for establishing a substitute low resistance safety ground connection by the action of any high potential current which may escape from the line to the parts disconnected therefrom and pass over the high resistance to ground.

In carrying out my invention I may use as the means for establishing the substitute low resistance circuit, any devices known in the electric art whereby a current flowing on a circuit may establish another circuit or connection made up in whole or in part of the wires or circuit through which said current flows or consisting of wires or paths entirely independent or separate from the wires or paths which carry the initial current. Various devices are known to electricians for this purpose, the simplest being an electro magnet the armature of which shall close electric contacts when the magnet is excited to a sufficient degree. Other devices known as film and vacuum cut outs are also used for the same purpose, the only difference being

that in the case of a film cut out the path or circuit established by the action of the initial current is principally made up of the same wires or conductors through which the current first flows.

Other devices than those specifically described herein are known to electricians and will not be set forth in detail those described being sufficient to illustrate the principle of my invention which consists, as before stated, in the combination with the local or independent conductor normally disconnected from the main line carrying the current of high tension, of a high resistance ground connection applied as hereinafter set forth and combined with any suitable means for establishing a low resistance ground connection as a substitute circuit or shunting circuit.

The high potential current in passing over the high resistance circuit may establish the low resistance circuit for itself in any desired manner through heating, disruptive, electrolytic, magnetic or other effects of an electric current, thus giving rise to movement of contacts for establishing proper relations or conditions of an electric conductor or conductors suitable for forming an electric circuit or connection. Some of the expedients that may be employed will be presently described. The high resistance may be composed of any medium and may even consist of a rarefied gas or vapor, as will be described.

My invention consists further in certain details which will be described and then specifically claimed.

In the accompanying drawings:—Figures 1, 2, 3, 4, 5 and 6, illustrate various modified arrangements of one way of carrying out my invention. Figs. 7, 8, 9, 10, 11 and 12, show modifications in the manner of practicing my invention as will be more particularly stated in the detail description of these figures.

In the form of my invention illustrated in Figs. 1 to 6, the normal ground circuit is made of high resistance by the interposition of a thin layer or film of an insulating medium between two electrodes in the circuit. The high potential current punctures or pierces the film and by so doing establishes a direct connection between the electrodes thus forming the low resistance or safety circuit. Thus in Fig. 1, *a* and *b*, indicate a high potential primary line, a branch from which passes through a primary coil *P*, in the ordinary way, wound for high potential, and which is the primary of an induction coil. The secondary *S*, of the same coil, wound parallel to the coil *P*, is used to feed a consumption circuit of lights *L*, *L*, or other devices in the usual manner, suitable fuses being provided in both primary and secondary circuits *f*, *f*, *f'*, *f'*. From some point in the secondary circuit, preferably near the middle, a connection is taken to a contact piece *K*, bearing on a film or a thin layer of insulating material *F*, of oiled paper or of other material, and with an earth plate

or connection *G*, on the other side of the film, forming, as it were a film cut-out or weak spot in the insulation between the earth or ground and the secondary circuit. So long now, as no connection whatever exists between the primary coil or circuit *P*, receiving high potential discharges and the secondary coil or circuit *S*, in which low potential currents are induced there will be no discharge tending to puncture the film *F*. If, however, a connection, either temporary or permanent, is formed between the circuit *a*, *b*, or primary coil *P*, and the secondary coil *S*, or other conductor such that the potential of the primary line or other conductor is taken up by the secondary, the film *F*, is punctured by the endeavor of the high potential current to leak to ground, provided, of course, that anywhere on the primary circuit *a*, *b*, a sufficient leakage or static inductive capacity or tendency exists to give rise to the necessary discharge to earth in puncturing the film. It is needless to say that such leak or static inductive capacity is usually found in a circuit of considerable length. When the film *F*, has been punctured, the conductor or secondary coil *S*, is then connected solidly to earth by a circuit of low resistance and no danger can exist in touching the wires of the secondary circuit, even though connected with the primary circuit, when a person may be at the same time grounded, for he is already shunted by the connection through the electrodes *K*, *G*, to earth. After the film is punctured the device becomes the same in essence as that described in my former patent.

In my present invention the low resistance grounding of the secondary or other conductor to earth does not occur until the secondary has reached the same potential or a large part of the potential of the primary, when an instantaneous puncturing of the film *F*, takes place.

It may be well in some cases to shunt the film as it were, or rather to place around the film a condenser, as in Fig. 2, of small capacity, the condenser being represented at *C*, and consisting of plates separated by insulating material in the ordinary way, the plates opposed to each other being respectively connected one to the ground circuit and the other with the connection to the coil *S*, or septum near it. In this case a small amount of static induction or leakage may occur between the primary and secondary without forcing the puncturing of the film *F*, and the formation of a good connection between the metal pieces normally separated by said film, the condenser *C*, acting to prevent the ground which would reach the secondary by such small or slight induction or leakage; but if a solid connection between the primary coil *P*, and the secondary coil *S*, be formed, then the condenser *C*, is insufficient in capacity to condense or lower the potential of the alternating discharges which reach the secondary and the film is at once punctured, making the

connection to earth as before and shunting the condenser.

In Fig. 1, the connection has been shown as made to the secondary itself, but the line fed by it may also be in connection. Thus in Fig. 3, the dotted line from the secondary represents a connection similar to that of Fig. 1, but in place thereof, or in addition thereto there may be arranged connections m, n , one wire from each side of the local circuit, which wires m, n , terminating in spring contact pieces K, K' , bearing on films F, F' , or thin layers of insulating material, bear down on stationary blocks G, G' , which blocks are connected to the earth plate E . The condenser C , is in this case a double one, one pole or plate of which is connected to the earth plate and the other plates respectively connected with the wires m, n , or the pieces K, K' , as shown. In some cases this condenser might be dispensed with and the connections thereto removed leaving the double film arrangement intact. The breaking through of either one of these films F, F' will ground the secondary, and the breaking through of both simultaneously would not only ground the secondary but extinguish the lights L, L , by causing a short circuit of the secondary which would melt the fuses f, f' , in the secondary circuit, thus disconnecting the secondary or local wire from the line feeding the lights.

It is useful to combine the two film switches or connectors into a single compact device, such as is represented in Fig. 4. Here the earth connection is made to a spring strip or strips of metal G, G' , whose ends bear upon the films F, F' , placed on buttons K, K' , as shown, the buttons K, K' , being placed on a common base and connected as in Fig. 3, with the sides of the working circuit or with any other part of the secondary circuit. There is a tendency on account of the spring of the pieces G, G' , bearing upon the films to the formation of a connection between the opposing contact pieces should the films be punctured. The whole of the parts can be mounted upon a suitable insulating base. This device may be attached to any circuit in existence in which a high potential current is converted by induction or otherwise into a low potential current on a local and separate circuit and forms an efficient safe-guard when the films F, F' , are not of too great thickness or too difficult to puncture.

In my former patent I have shown the safety ground wire or circuit as leading from a conducting septum interposed between the primary or main and the secondary or local circuit and which septum assumes or partakes of the dangerous potential of the secondary or local whenever the latter becomes connected with the main or principal circuit carrying the current of high tension by any discharge tending to pass from the high potential primary to the secondary. This sheath or septum is placed between the primary and the secondary coils wherever they are opposed,

or wherever they are capable of having a connection formed between them, either directly or through the iron core itself of the induction coil, &c. Thus I wrap either the primary or the secondary coil with a ribbon of thin copper, connecting the ribbon either to ground as in my former invention or connecting it with the film switch F , as in Fig. 5, I , representing the interposed conductor between the primary coil P , and the secondary coil S , and T , the earth plate.

The interposed sheath may, as in Fig. 6, be formed by wrapping a copper sheet over the secondary coil S , so as to either cover it in part or entirely, but so that no closed circuits may be set up in the copper sheet itself. This interposed sheath is applicable to any form of induction coil, all that is necessary being to so dispose the sheath that it shall inclose so much of either the primary or secondary or both as may be subject to the possibility of interchange of current or electric action between them.

In Fig. 7, I have shown how the high tension current when it forces itself over the high resistance ground circuit may establish its low resistance circuit by means of a magnet. The low resistance circuit is through the contacts of a spring or otherwise actuated switch S^2 , that is normally held open by the armature of a magnet H , in the high resistance circuit formed as before. When at the first passage of the high tension current the magnet is energized its armature is attracted and the low resistance or safety circuit established through S^2 , in obvious manner.

It is obvious that, as shown in Fig. 9, the electrodes K and G , and interposed film might be omitted and the high resistance obtained in other ways as by winding the magnet with very fine wire or by interposing in the circuit an artificial resistance of other character in addition to the resistance of the magnet.

By a well known device indicated in Fig. 10, the switch of the low resistance circuit may be held closed by the current of such circuit instead of by a released spring as in Fig. 7. This is effected by providing the magnet H , with a coil H^2 , in the low resistance circuit as indicated. When the low resistance circuit is established otherwise than by the disruptive action of the high tension upon a material normally holding electrodes apart, as in Figs. 1-5, the high resistance path may be formed through electrodes separated by an insulating medium, such as rarefied air or gas. In this case it is desirable, and ordinarily necessary, that the high resistance circuit should include some device such as an electro magnet by acting upon which the initial discharge to earth may operate or bring about the operation of electrodes or contacts which shall close the low resistance circuit. Such a form of my invention is indicated in Fig. 8, where the electrodes K, G , are shown held in close proximity in a globe or receiver M , of glass or other material partially ex-

hausted of air. The high tension current in forcing its way across from one electrode to another operates upon the magnet in the high resistance circuit with such electrodes and so establishes the low resistance circuit for itself by means of the switch or contact lever S^2 .

Fig. 11, illustrates one of the ways in which the heating effect of the current of high tension upon the high resistance circuit may be employed to bring about the establishment of the low resistance path. The high resistance path consists of a heating coil a^2 , connected to earth and wound around a bar of iron, copper, or other conducting material to which the heat produced by the high tension current in the coil may be imparted. The copper bar forms a part of the low resistance path being attached to the normal high resistance circuit at the point 7, as indicated, and having at its end a fusible or destructible film of shellac or pyroxyline, or other suitable material which normally holds a contact device b^2 , out of electrical connection with the bar. The contact b^2 , is connected directly to earth, and when the film is destroyed or removed, owing to the large heating effects produced by the high tension current, the contact b^2 , establishes connection with the end of the copper bar thus establishing the low resistance circuit in obvious manner.

In Fig. 12, the normal high resistance path is shown as including a fine wire coil a^2 , of an induction coil or transformer T. The secondary c^2 , of said transformer is of coarse wire and includes in its circuit a fusible strip d^2 that serves to hold the low resistance circuit closer S^2 open. The current normally leaking to earth through the coil a^2 , is not sufficient to produce fusion of the strip d^2 , but, when through connection of the local circuit or coil with the high tension circuit, a current of large volume forces its way over the normal high resistance so that the heating current is increased in the secondary c^2 , the device or stop d^2 , melts and permits the switch S, to close the low resistance path.

It is of course understood that the arrangement shown in Fig. 12, is especially designed for use with systems using alternating or varying high tension currents upon the main. The special devices shown in Fig. 12, forms the subject of another application for Patent filed by me. (D. 489.)

Other means will readily occur to electricians whereby the current in a high resistance circuit may bring about the establishment of a circuit of low resistance formed in greater or less degree of the original path or entirely independent thereof. I wish it to be understood that my invention is not limited to any special devices but consists in the application of such devices in a ground connection or connections from a conductor apparatus or conducting object normally separated from but liable to accidental connection with a circuit carrying current of high tension, the purpose being to provide for the establish-

ment of a low resistance ground connection as a measure of safety when dangerous or other abnormal condition arises, but at all other times to leave such circuit conductor, septum, or object in its normal or practically ungrounded electrical condition.

The use of the two electrodes connected in the safety ground circuit but normally insulated from one another by a thin film or layer of some insulating material and the application to such device of a condenser in a shunt around the electrodes as hereinbefore described, I do not claim specifically in this application as these devices form the subject of specific claims in another application for patent filed by me August 5, 1889, Serial No. 319,834. Nor do I claim herein the use of a condenser in a branch around the electrodes, as this is also the subject of claims in the application named.

What I claim as my invention is—

1. The combination, substantially as described, of a main line circuit, a local or separate circuit or conductors disconnected from said line but liable to accidental connection therewith, a ground circuit or connection taken from a part of the apparatus or circuits normally disconnected from the main line and of sufficient high resistance not to interfere with the normal operation of such circuit, and means for establishing a substitute low resistance ground connection by the action of high tension current accidentally escaping from the line to the parts normally disconnected therefrom and passing over the high resistance to ground.

2. The combination, substantially as described, of a main line, a local or independent circuit or conductor normally out of connection with said main line, connections to earth from a part of the apparatus disconnected from the line and adapted to receive any high tension current accidentally escaping from the line but having an interposed high resistance placed in the connections leading to earth, and means for establishing a substitute low resistance circuit or connection by the action of the electric energy normally supplied to said line but escaping therefrom and passing to ground through such high resistance.

3. The combination, substantially as described, of a high tension main line, a low tension local line, an interposed converting appliance, a ground connection from the local circuit or conductors containing an interposed high resistance, and means for establishing a substitute low resistance safety connection by normally supplied high tension current of said main line escaping therefrom to the local circuit and thence to ground through the high resistance.

4. The combination, substantially as described, of a high tension main line, a converter, a low tension local, a normal ground connection from the latter of considerable resistance, and means in the ground wire or connection for establishing a substitute low

resistance safety path or connection by the action of the normal high tension main line current accidentally escaping therefrom to the local and thence over said ground connection.

5 5. The combination with a main line, of a local or independent line, an interposed converter, a high resistance ground connection from each side of the local line adapted to
10 form a path for the high tension current flowing from the main line, and a fuse between the converter and the local circuit whereby, in case of the establishment of both grounds and consequent short circuiting of the local
15 side of the converter, the fuse may operate to disconnect the local wire or circuit from said converter.

6. The combination, substantially as described, of a main line carrying alternating

currents, a transformer, a local circuit supplied with currents of lower potential from the secondary of said transformer, a ground connection from each side of the secondary wire or circuit to earth containing a high resistance with means for substituting a low resistance path or connection, and a fuse between each terminal of the secondary and the local wire or circuit whereby said wire or circuit may be disconnected from the secondary in case both low resistance grounds should
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30 be established.

Signed at Lynn, in the county of Essex and State of Massachusetts, this 26th day of September, A. D. 1888.

ELIHU THOMSON.

Witnesses:

J. W. GIBBONEY,
GEO. E. EMMONS.