Private Property of

Edison, Thomas Alva.

United States patents issued to Thomas A. Edison from 1883-1888.

(No Model.)

T. A. EDISON.

MANUFACTURE OF INCANDESCING ELECTRIC LAMPS.

No. 271,613. Patented Feb. 6, 1883.

Fig.1.

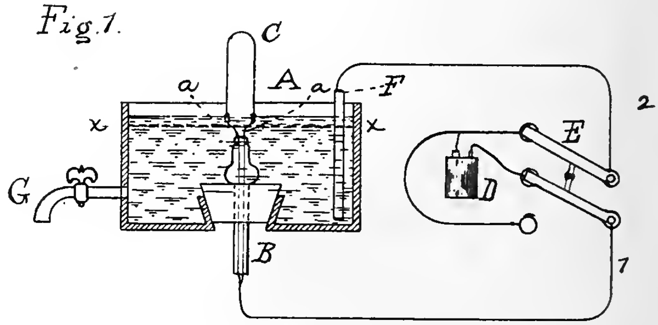


Fig.2.

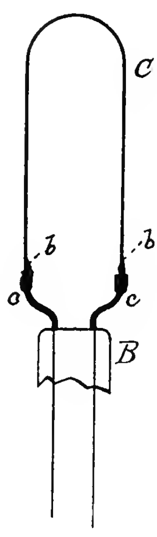
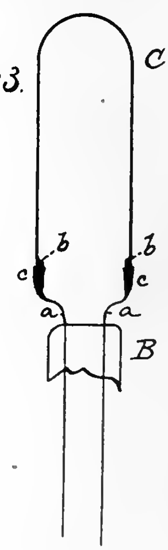


Fig.3.



WITNESSES:

Edw. C. Rowland

H. W. Seely

INVENTOR:

Thomas A. Edison

By Richd. N. Dyer

Atty.

UNITED STATES PATENT OFFICE.

United States patents issued to Thomas A. Edison from 1883-68 /

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

MANUFACTURE OF INCANDESCING ELECTRIC LAMPS.

SPECIFICATION forming part of Letters Patent No. 271,613, dated February 6, 1883.

Application filed September 13, 1882. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in the Manufacture of Incandescing Lamps, (Case No. 478,) of which the following is a specification.

In my incandescing electric lamps the carbon incandescing conductor is attached to the wires which convey the current thereto by the electro-deposition of metal at the points of union.

In carrying out this process the interior stem or tube of the lamp having the wires sealed in it and the carbon temporarily attached by any ordinary mechanical means to said wires is placed in an electro-depositing cell, together with a copper plate forming the anode, and copper is deposited on such wires and the ends of the carbon, forming a secure joint.

Heretofore I have placed the tube in the lamp with the wires covered with copper over the entire length above the glass. I have, however, found it desirable to have as little metal as possible inside the lamp, so that the gases and vapors occluded in such metal may be more readily and completely removed during the process of exhaustion.

The object of this invention, therefore, is to produce a lamp which shall have only a small amount of electro-deposited metal, just enough to complete the joint, placed only upon the ends of the leading-in wires. I accomplish this by placing the glass wire-support in the electro-depositing cell upright, and with the top of the liquid in the cell a little below the upper edges of the enlarged ends of the carbon. A suitable copper anode is provided, the wires and carbon forming the cathode. Copper is deposited as usual over the entire length of the wires above the glass. After this a portion of the solution is removed from the vessel by means of a faucet provided for that purpose until the liquid falls to a little below the enlarged ends. The current through the cell is then reversed, the wires becoming the anode and the copper plate the cathode, when the metal is removed from said wires and deposited on said plate, leaving only that which forms the union between the carbon and wires. Instead of removing a portion of the liquid from the cell, the stopper in the bottom of the cell which holds the glass-support (as described in my Patent No. 248,436) may be pushed up farther, so as to raise the proper portion of the wires out of the liquid.

In the drawings, Figure 1 is a view of the apparatus employed in my invention; Fig. 2, a view of the carbon and wires as they appear after the first stage of the process, and Fig. 3 a view of the same when completed and ready to be placed in the lamp.

A is the electro-depositing cell; B, the glass wire-support; *a a*, the leading-in wires, and C the carbon, having enlarged ends *b b*. D is a battery, and E a circuit-reverser, from which wires 1 2 run respectively to the leading-in wires *a a* and to the anode F of the cell. The liquid is originally of the height shown, but is afterward removed by the faucet G, as set forth, to the level of the dotted line *x x*. In Fig. 2 the wires *a a* are entirely covered with electro-deposited copper *c*, while in Fig. 3 there is only enough copper, *c*, left on the wires and carbon to make a proper joint.

What I claim is—

1. The method of forming an electroplated joint between the wires and carbon in an incandescing electric lamp, consisting in first depositing metal upon the ends of the carbon and the entire length of the wires above the glass, and then removing said metal from the lower parts of said wires, substantially as set forth.

2. The method of forming an electroplated joint between the wires and carbon in an incandescing electric lamp, consisting in first depositing metal upon the ends of the carbon and the entire length of the wires above the glass, then changing the relative level of the electrolytic liquid, so as to leave a small portion of the wires above said liquid, and then reversing the current through the cell, substantially as set forth.

3. The method of forming an electroplated joint between the wires and carbon in an incandescing electric lamp, consisting in first depositing metal upon the ends of the carbon and the entire length of the wires above the glass, then removing a portion of the liquid from the electro-depositing cell, and then re-

versing the current through the cell, substantially as set forth.

4. The combination of an electro-depositing cell, a copper plate, and the carbon and leading-in wires of an incandescing lamp, forming the electrodes of the cell, means for changing the level of the liquid in the cell relative to such wires and carbon, and means for changing the direction of the current through the cell, substantially as set forth.

This specification signed and witnessed this 25th day of August, 1882.

THOS. A. EDISON.

Witnesses:

H. W. SEELY,

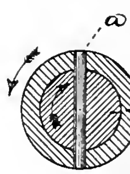
EDWARD H. PYATT.

(No Model.)

T. A. EDISON.

SHAFTING.

No. 271,614. Patented Feb. 6, 1883.



ATTEST:
Edw. C. Rowland
H. W. Seely

INVENTOR:
Thomas A. Edison
By Richd. N. Dyer.
Atty.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

SHAFTING.

SPECIFICATION forming part of Letters Patent No. 271,614, dated February 6, 1883.

Application filed October 20, 1882. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Shafting, (Case No. 502,) of which the following is a specification.

The object I have in view is to produce shafting in which the torsional elasticity will be reduced to the minimum or destroyed altogether. This I accomplish by constructing a shaft in two parts, one being placed within the other. These parts are proportioned to have the desired strength, and relatively to have the same or nearly the same torsional elasticity. After being placed one within the other the two parts of the shaft are twisted in opposite directions, being strained up to the limits of their torsional elasticity, when they are secured together in any suitable way, so that they will react upon each other and balance the torsional elasticity, producing a rigid shaft. This may be done by drilling holes through the two parts of the shaft and driving pins through them, or by coupling the two parts of the shaft together at their ends. Both of these methods of securing the two parts together may, however, be combined.

In the accompanying drawing a cross-section of the non-torsional shafting is shown.

A and B are the two parts of the shaft, placed one within the other, the inner part, B, being either solid or of tubular form. The parts are twisted in opposite directions, as shown by the arrows, and strained to the limits of their torsional elasticity, when they are fastened together by pins *a*, or by other suitable means. The shaft may be constructed of iron, steel, or other suitable material. I have found this character of shafting exceedingly efficient for use in connecting the governors of several engines together, so as to force the engines to act in unison; but I do not wish to limit myself to any particular use, since it is applicable to all uses where non-torsional shafting would be advantageous.

What I claim is—

A non-torsional shaft constructed in two parts, strained torsionally in opposite directions and connected together permanently while under such torsional strain, substantially as set forth.

This specification signed and witnessed this 19th day of October, 1882.

THOS. A. EDISON.

Witnesses:
RICHD. N. DYER,
H. W. SEELY.

(No Model.)

T. A. EDISON.

GOVERNOR FOR DYNAMO ELECTRIC MACHINES.

No. 271,615. Patented Feb. 6, 1883.

Fig. 1.

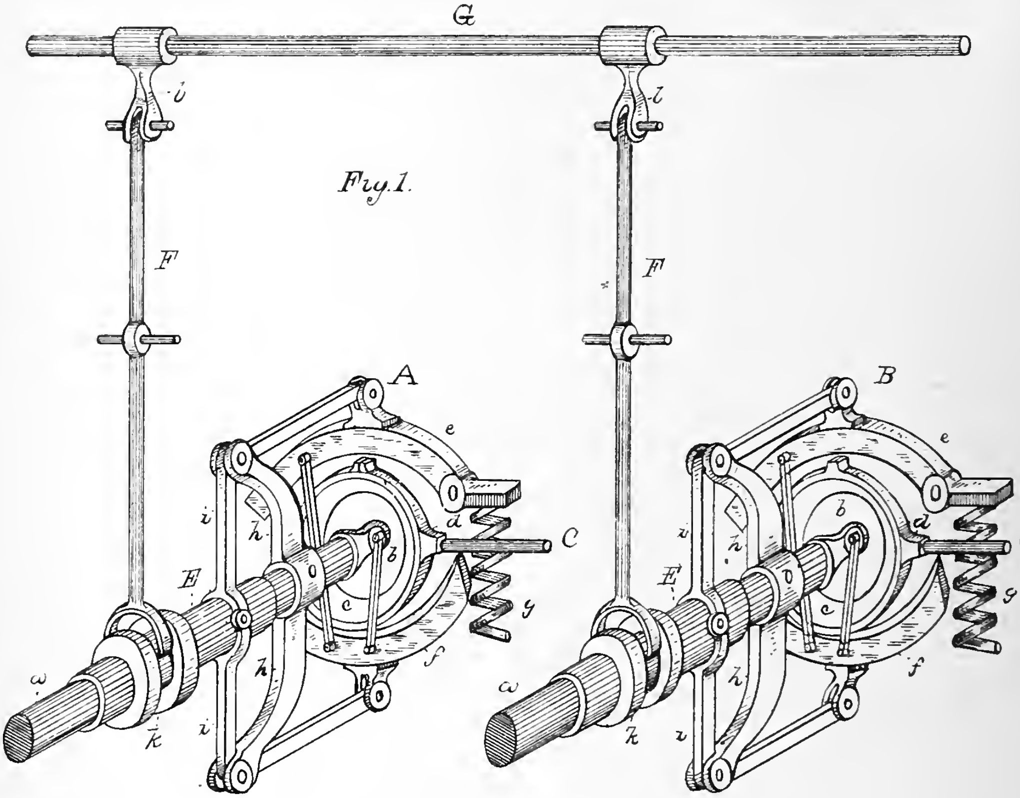
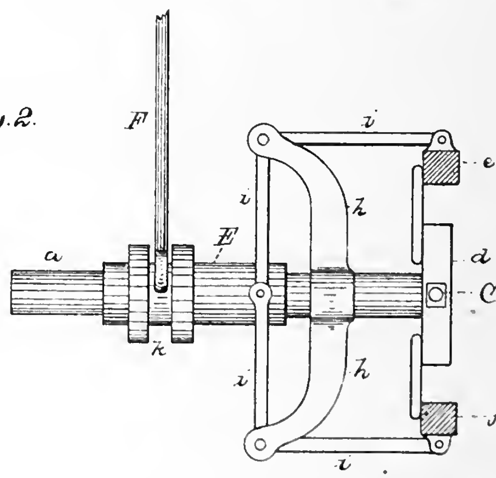


Fig. 2.



ATTEST:
E. C. Rowland
H. W. Seely

INVENTOR:
Thomas A. Edison,
By Richd. N. Dyer,
Atty.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

GOVERNOR FOR DYNAMO-ELECTRIC MACHINES.

SPECIFICATION forming part of Letters Patent No. 271,615, dated February 6, 1883.

Application filed November 9, 1882. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Governors for Dynamo-Electric Machines, (Case No. 501,) of which the following is a specification.

The object I have in view is to produce simple and efficient means for connecting together, so that they will work in unison, the automatic cut-off mechanisms of a number of engines, such cut-off mechanisms being composed of loose valve-eccentrics and wheel-governors adjusting such eccentrics. The invention is especially applicable to such engines when they are used to run dynamo or magneto electric machines feeding into the same conductors or system of conductors.

In my application No. 500 (Serial No. 75,203) I have shown and described means for connecting the cut-off mechanisms of engines of this character, my present invention relating to other means for accomplishing the same purpose.

In carrying out my invention I mount a sliding sleeve upon the shaft of each engine, and connect it by bell-cranks with the weights of the wheel-governor, so that the movement of such weights will give the sleeve a longitudinal sliding movement upon the engine-shaft. The sliding sleeves of the several engines being connected together, the cut-off mechanisms will be forced to work in unison. To make this connection each sleeve is provided with a grooved collar engaging the forked end of a pivoted lever, the pivoted levers of the several engines being removably connected with arms from a common shaft. This shaft moves only as the cut-off mechanisms are varied in unison by the combined action of the wheel-governors.

In the accompanying drawings, Figure 1 is a perspective view of the cut-off mechanisms of two engines, with connections embodying my invention; and Fig. 2, a vertical section of one of the wheel-governors and the loose eccentric.

A and B represent the cut-off mechanisms of two engines, which run dynamo or magneto electric machines feeding into the same conductors, and having means for regulating them, as required, by the addition or removal of translating devices, as described and shown in my application before referred to. The shaft *a* of each engine has a loose eccentric, which may be in one part, but is preferably in two parts, *b c*, as shown. The eccentric-sleeve *d* is connected with the valve-rod C. The fly-wheel of each engine (not shown) has weights *e f* pivoted thereto, and thrown inwardly toward the shaft by springs *g*. Secured to shaft *a*, near the weight *e f*, are arms *h*, in which are pivoted bell-cranks *i*, connected with the weights and with a sleeve, E, feathered upon the shaft *a*. This sleeve has a grooved collar, *k*, with which engages the forked end of a pivoted lever, F. At its other end the lever F is connected removably with an arm, *l*, projecting from a shaft, G. The cut-off mechanisms of all the engines are connected with the shaft G in a similar manner, and the engines forced to work in unison.

What I claim is—

1. The combination, with two or more separate engines having automatic cut-off mechanisms composed of loose eccentrics and wheel-governors adjusting such eccentrics, of a sliding sleeve feathered on the shaft of each engine, means connecting such sleeve to the governor-weights so as to be moved thereby, and means connecting the sliding sleeves of all the engines together, substantially as set forth.

2. The combination, with two or more separate engines having automatic cut-off mechanisms composed of loose eccentrics and wheel-governors adjusting such eccentrics, of a sliding sleeve feathered on the shaft of each engine, means for connecting such sleeve to the governor-weights so as to be moved thereby, a pivoted lever engaging a collar on such sleeve, and means connecting the levers of all the engines together, substantially as set forth.

3. The combination, with two or more separate engines having automatic cut-off mechanisms composed of loose eccentrics and wheel-governors adjusting such eccentrics, of a sliding sleeve feathered on the shaft of each engine, bell-cranks connecting the sleeve and governor-weights, a pivoted lever engaging a collar on the sleeve, and a shaft connecting the levers of all the engines together, substantially as set forth.

This specification signed and witnessed this 19th day of October, 1882.

THOS. A. EDISON.

Witnesses:

H. W. SEELY,

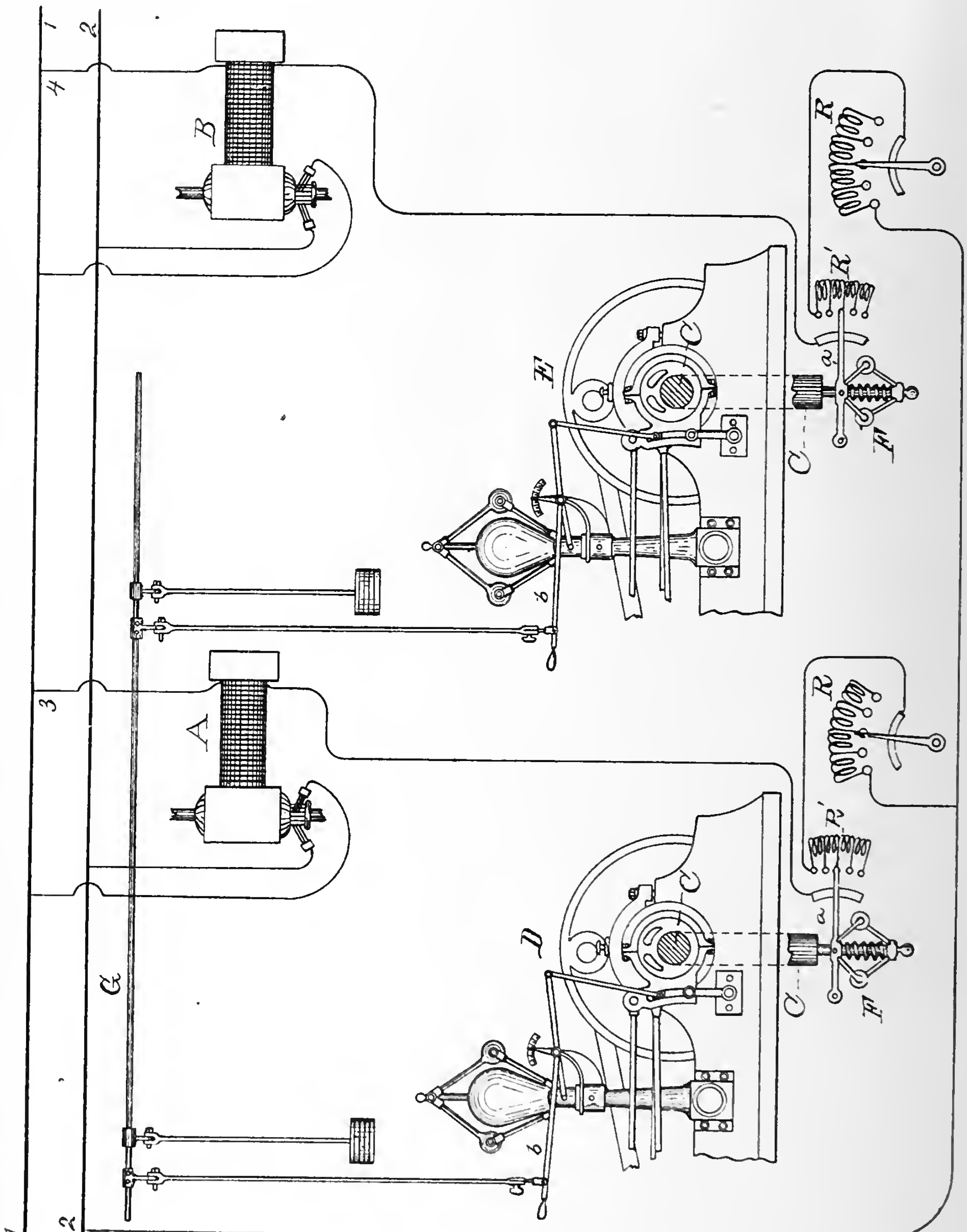
EDWARD H. PYATT.

(No Model.)

T. A. EDISON.

REGULATOR FOR DYNAMO ELECTRIC MACHINES.

No. 271,616. Patented Feb. 6, 1883.



ATTEST:

E. C. Rowland

H. W. Seely

INVENTOR:

Thomas A. Edison,

By Richd N. Dyer, Atty.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

REGULATOR FOR DYNAMO-ELECTRIC MACHINES.

SPECIFICATION forming part of Letters Patent No. 271,616, dated February 6, 1883.

Application filed October 20, 1882. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Means for Operating Electrical Generators, (Case No. 497,) of which the following is a specification.

The object I have in view is to maintain a uniform electro-motive force in all of a number of dynamo or magneto electric machines operated by two or more separate engines or motors and feeding into the same conductors or system of conductors, in order to avoid the racing of the engines and the loss of power caused by conversion of part of the generators into electromotors by reason of variations in the speed of the engines. This I accomplish by the use, in connection with each engine, of a mechanism controlled preferably by the speed of the engine, and arranged to regulate the electro-motive force of the generator or generators driven by it, so as to counteract the effect of the variations in the speed of the engine and maintain a uniform electro-motive force. This mechanism is employed in addition to the devices for varying the electro-motive force of the generator or generators as required by the addition or removal of translating devices, its office being simply to maintain the electro-motive force for which the machines are adjusted. I also prefer to employ means for causing all the engines to run in unison, as described in my application No. 488, (Serial No. 74,096;) but such means may be dispensed with.

The invention is illustrated in the accompanying drawing, which is a view of the principal parts of the cut-off mechanisms of two steam-engines, the generators driven thereby, but shown separated for clearness, and the regulating devices.

A B represent dynamo or magneto electric machines, which are of any suitable pattern and have their commutators connected with the same conductors, 1 2, or the same system of conductors. There may be any desired number of these generators connected in multiple arc, as shown, or in series or multiple series. Each generator is preferably coupled directly with the engine-shaft C, there being two engines, D E, shown, one for each generator; but it is evident that the generator can be connected with the engine-shaft by an endless belt, or by gearing, or that two or more generators (a battery) can be run by one engine, or that two or more engines can be used to operate each battery of generators. In short, the invention is applicable to any arrangement wherein dynamo or magneto electric machines are operated by separate sources of motive power, without regard to whether the electrical generators are divided into lots of one or more, or to whether each source of motive power is composed of one or more engines or motors. The arrangement shown is that preferred by me, each generator being run by a separate steam-engine. The field-circuits 3 5 and 4 5 of the generators are preferably separate multiple-arc circuits from 1 2, although they may be from another source of electrical energy. Each generator is provided with means for regulating its electro-motive force, as required by the addition or removal of translating devices, such means being preferably an adjustable resistance, R′, in its field-circuit. The means preferred for maintaining a constant electro-motive force of each generator controlled by the speed of the engine is a spring-governor, F, located directly upon the engine-shaft, or upon a spindle run from the engine-shaft. The pivoted lever *a* of the governor forms the contact-arm of an adjustable resistance, R′, located directly in the field-circuit of the generator. At a mean speed the lever *a* will be in contact with the central point of the resistance R′. Any increase of speed of one engine independent of the others would ordinarily increase the electro-motive force of the particular machine beyond that of the others. This increase of speed, however, throws a further part of the resistance R′ into the field-circuit of the machine, increasing the resistance of the field-circuit and counteracting the effect of the increase in speed. A decrease of speed has the contrary effect, throwing resistance out of the field-circuit. Thus it will be seen that the machines will always have the same electro-motive force notwithstanding variations in the speed of the engines.

Instead of having the extra resistance worked by a spring-governor, it may be adjusted by hand, which would enable the engineer to compensate for differences in speed between the engines, due to differences in friction or other causes.

The means described for maintaining uniform electro-motive force independent of variations in speed of the engines may be employed when a mechanical or electrical mechanism is used connecting the engines, so that they will work in unison, as described in my application before referred to.

On account of differences in friction, or from other causes, the mechanism for producing unison in speed may not, under all conditions, have the required efficiency. Hence the mechanism for maintaining uniform electro-motive force independent of variations in speed is useful in connection with it, although either mechanism may be used without the other.

Automatic cut-off engines of the Porter and Allen type are shown for illustration. The governor-arms *b* of these engines are connected removably and adjustably with the common shaft G, whereby any variation of the cut-off mechanism of one engine will produce a corresponding and simultaneous variation of the cut-off mechanisms of the other engines.

What I claim is—

1. The combination, with two or more independent engines and dynamo or magneto electric machines operated thereby and feeding into the same conductors, of means controlled by the speed of each engine for maintaining a constant electro-motive force of the generator or generators operated by it by compensating for variations in speed, whereby the electro-motive force of all the generators will be uniform, substantially as set forth.

2. The combination, with two or more independent engines and dynamo or magneto electric machines operated thereby and feeding into the same conductors, of means for varying the electro-motive force of the machines as required by the addition and removal of translating devices, and means for regulating each generator to compensate for differences in the speed of the engines, substantially as set forth.

3. The combination, with two or more independent engines and dynamo or magneto electric machines operated thereby and feeding into the same conductors, of means connecting the throttle-valve or cut-off mechanisms of the engines, and producing simultaneous and corresponding movements of such parts, and means controlled by the speed of each engine for maintaining a constant electro-motive force of the generator or generators operated by it, substantially as set forth.

4. The combination, with two or more independent engines and dynamo or magneto electric machines operated thereby and feeding into the same conductors, of means connecting the throttle-valve or cut-off mechanisms of the engines, and producing simultaneous and corresponding movements of such parts, means for regulating each generator to compensate for differences in the speed of the engines, and means for varying the electro-motive force of the generators as required by the addition or removal of translating devices, substantially as set forth.

This specification signed and witnessed this 16th day of October, 1882.

THOS. A. EDISON.

Witnesses:

RICHD. N. DYER,

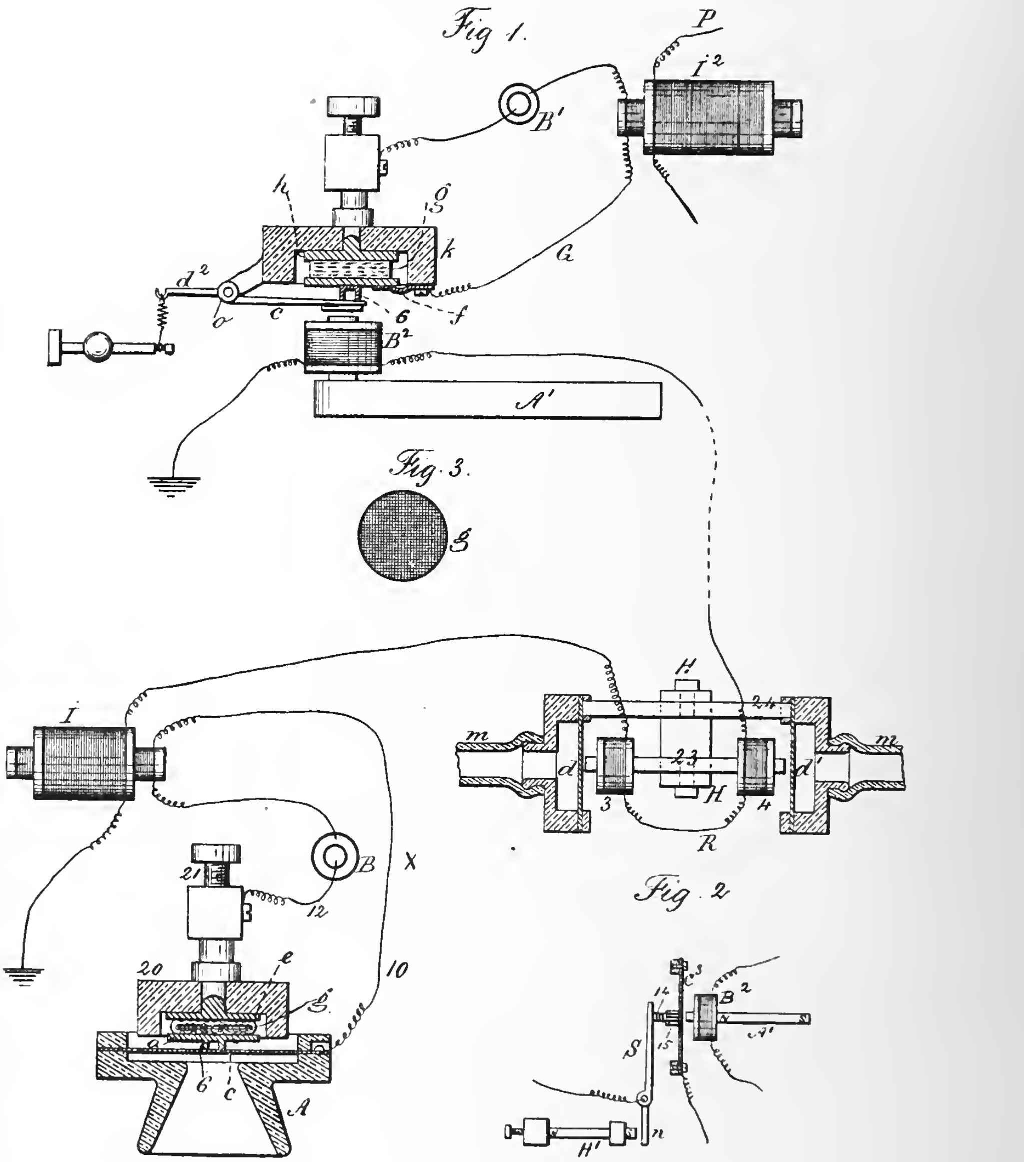
H. W. SEELY.

(No Model.)

T. A. EDISON.

TELEPHONE.

No. 272,034. Patented Feb. 13, 1883.



Witnesses
J. Staub
Chas H. Smith

Inventor
Thomas A. Edison
per Lemuel W. Serrell atty

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

TELEPHONE.

SPECIFICATION forming part of Letters Patent No. 272,034, dated February 13, 1883.

Application filed October 6, 1882. (No model.)

To all whom it may concern:

Be it known that I, THOMAS ALVA EDISON, of Menlo Park, in the State of New Jersey, have invented an Improvement in Telephones, of which the following is a specification.

This application is a division of my application filed November 18, 1878, No. 159, and said division is made for the purpose of separating from the said original application the different features of invention into three additional applications. The present I term "Case No. 159A."

In my application No. 130, heretofore filed, the circuit passes through plumbago or similar material, and the diaphragm that is acted upon by the sound-waves serves to vary the electric tension by the extent of surface-contact.

In my case No. 151, patented April 30, 1878, No. 203,016, I have shown an induction-coil with primary and secondary circuits and receiving and transmitting telephones. A carbon button in a circuit, and acted upon by the diaphragm, is shown in my said case 151, and also in case 141. These are not therefore claimed herein.

In my present improvement I make use of a surface or surfaces having numerous points produced by scores or fine lines across the surface, preferably about at right angles to each other, and this surface or surfaces are in the electric circuit, and combined with the diaphragm, so that the movement given to the diaphragm by the sound-waves will produce greater or less intimacy of contact at the scored surface, and a consequent rise and fall of electric tension. I also combine with a button of carbon or equivalent material in one circuit an electro-magnet in another circuit, the armature of which varies the pressure upon such carbon or other finely-divided material, and by this means repeats the telephonic pulsations. I also construct the telephonic receiver in a peculiar manner to prevent injury by undue currents—such as from lightning—and so that the diaphragms and cores will be polarized by induction and the line-current will act in two helices to vary the magnetism.

In the drawings, the diagram Figure 1 represents the transmitting, receiving, and repeating instruments, the instruments at X being at one station, and the instruments at G being at the repeating-station. Fig. 2 is a detached view of a modification of the repeating-instrument, and Fig. 3 is a face view of the tension-regulator formed by a surface scored with numerous lines.

The telephonic transmitter A is made with a case containing the diaphragm or plate c, against which the sound acts to vibrate the same. The plate e is in the bottom of a vulcanite cup or holder, 20, and can be adjusted nearer to or farther from the diaphragm c by the screw 21. The tension-regulating device g is between the plate e and the second plate, a, the wires 10 and 12 of the circuit to the battery B connecting, so that the circuit passes through these plates and the intervening tension-regulator. The tension-regulating device is composed of two contiguous surfaces, one or both of which is scored with numerous fine lines, so as to produce a great number of contact-points. By adjusting the screw 21 the initial pressure can be regulated, and the vibrations of the diaphragm, due to the action of sounds, will vary the pressure and the extent of surface-contact, so as to produce rise and fall of tension in the circuit, by bringing more or less of the points on the surface or surfaces into contact. In Fig. 3 I have shown the surface scored as aforesaid, and it is to be understood that the scoring is to be of the requisite fineness, preferably several thousand to the inch.

In the instrument A, Fig. 1, the tension-regulator is composed of a strip of platina scored by lines of ruling at right angles, and folded with a piece of felt, rubber, or similar material within the fold, and the scored surfaces in contact with the plates a and e, respectively. Several layers of foil, ruled as aforesaid, may be placed together, if desired, to obtain great resistance and variation in the electric tension of the circuit. The foil, ruled as aforesaid, is believed to operate in the circuit in a similar manner to a carbon button. Between the diaphragm c and plate a there is a short section of a tube, 6, to form a central bearing.

The inductorium I has its primary included in the circuit to the battery B and tension-regulator, and its secondary to the line and ground.

The receiving-telephone R is placed in the line-circuit passing through the secondary of the inductorium, so that it is always in position to receive a message sent over the line without the change of any switches or connections.

At the receiving-instrument R there is a permanent magnet, H, and upon one pole there is a bar, 23, forming at its ends the cores for the helices 3 and 4, that are in the line-circuit, and upon the other pole of the magnet H there is a bar, 24, that is connected at its ends to the diaphragms *d d'*. These diaphragms hence are polarized by induction, and are of one polarity—say south—while the cores of 3 and 4 are polarized north by induction. Flexible tubes *m*, with ear-pieces, are connected to the chambers or cases holding the diaphragms *d d'*, so that the sound is conveyed to the ears.

This apparatus is not liable to become demagnetized, because any current which passes through the helices 3 and 4 acts to increase the induced magnetism at one end of the bar 23 in proportion as it tends to decrease the induced magnetism in the other end. Thus there will be no tendency to injure the permanent magnet H; but the telephonic current will cause the diaphragms to respond by the change of magnetism in the cores adjacent to the diaphragms.

The repeating-instrument at the station G contains an electro-magnet, B^2, the helix of which is in the main-line circuit. Its core is adjacent to an iron plate or armature, and the variation of the magnetism resulting from rise and fall of electric tension in the main line increases and decreases the pressure upon a button of carbon, *g*, or similar material forming the tension-regulator in a second electric circuit. I have shown the local circuit from the battery B' as passing to the plate *f* at one side of the circuit regulator *g*, and to the adjusting device of the plate *h* at the other side of the carbon or similar material, and in this local circuit is the primary of the inductorium I^2, the secondary of which is in the line P to the distant receiving-instrument.

I prefer to connect the core of the electro-magnet B^2 to one pole of the permanent magnet A', so that it may be polarized by induction, and hence the line-circuit will increase or decrease the magnetism of the core of B^2. The armature-plate of the magnet B^2 is shown upon a lever, *e*, having a fulcrum at *o*, and the spring at d^2, which should be adjustable, serves to apply an initial pressure to the tension-regulator *g*, and I prefer to use a short cylinder, 6, between the armature-plate and the disk *f* to insure a central bearing on the tension-regulator. When an electric wave from the distant station varies the power of the magnet B^2, the pressure upon the tension-regulator *g* is decreased or increased, and the primary current from B' acts in the inductorium to translate or reproduce on the second line, P, currents corresponding or proportionate to those sent from the instrument A.

The instrument shown in Fig. 2 is a very delicate translator, acting similarly to that in Fig. 1. The electro-magnet B^2 has a helix in the line-circuit, as before, and A' is its polarized core. C^3 is a diaphragm, and S is a lever, the short end *n* of which is attracted by an adjustable magnet, H'. Between the lever S and diaphragm C^3 there are the pieces 14 and 15 of carbon or other finely-divided material, that act as a tension-regulator for the translating or repeating circuit that passes through the lever S and diaphragm C^3. Hence the rise and fall of electric tension in the repeating-circuit will result from the vibrations of the diaphragm, producing more or less pressure and intimacy of contact in the tension-regulator at 14 15, the initial pressure being determined by the proximity of the magnet H' to the lever S.

It will be observed that in my telephone-instruments I provide an electric tension-regulator having an extended surface, in contradistinction to a point or small bearing, such as shown in my application No. 141, and instead of the electric tension-regulator coming directly into contact with the diaphragm, as in my application No. 130, I combine with the electric tension-regulating device an intermediate bearing, having a small contact with the diaphragm and the required extent of surface against the tension-regulator. This bearing is non-elastic, to transfer more positively to the tension-regulator the tremulous movements of the diaphragm as distinguished from the yielding material—such as cork or rubber—as shown in my Patent No. 203,016. If the current passes through this non-elastic bearing-piece, as at A, the same is to be of metal or other good conductor.

Certain of the devices shown herein are not claimed, as they form the subject of other applications.

I claim as my invention—

In a telephonic receiving-instrument, two helices, 3 and 4, and the core 23, that is magnetized by induction, in combination with a permanent magnet, H, and two diaphragms that are connected to the magnet H, so as to be magnetized by induction, substantially as set forth.

Signed by me this 30th day of March, A. D. 1882.

THOMAS A. EDISON.

Witnesses:

GEO. T. PINCKNEY,

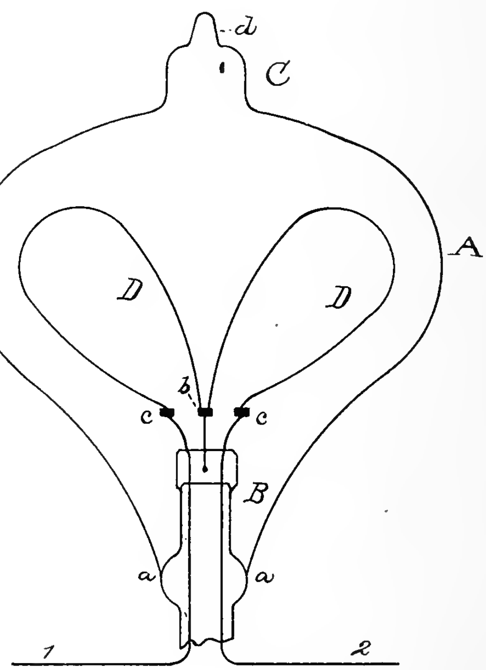
HAROLD SERRELL.

(No Model.)

T. A. EDISON.

INCANDESCING ELECTRIC LAMP.

No. 273,485. Patented Mar. 6, 1883.



ATTEST:
E. C. Rowland
W. W. Seely

INVENTOR:
Thomas A. Edison
By Rich'd N. Dyer
Atty

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

INCANDESCING ELECTRIC LAMP.

SPECIFICATION forming part of Letters Patent No. 273,485, dated March 6, 1883.

Application filed November 9, 1882. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Incandescing Electric Lamps, (Case No. 508,) of which the following is a specification.

In the use of incandescing electric lamps it may sometimes be desired that the light-giving body shall be of a broad, flat shape similar to that of a gas-flame. My object is to provide a lamp of this character.

In the lamp which I have devised the incandescing conductor consists of two flexible "horseshoe-shaped" filaments of carbon, connected together within the globe in series, and diverging or spreading out from each other, so that the effect of a broad, flat flame is produced, the conductor being supported in the middle from the glass inner stem of the lamp. Such filaments are attached to the inner stem by means of the leading-in wires and a central wire-support sealed therein, and are placed in the lamp together, they being first folded or bent together, so that they may pass through the opening at the bottom of the globe. The stem is sealed, as usual, in the bottom of the globe. The top of the globe is provided with an opening of sufficient size to admit a suitable tool, which is put through this opening and used to bend the filaments apart and into the desired form. By using this process the opening at the bottom of the tube and the stem which is sealed within such opening may be made of the usual small diameter, whereas if the filaments were spread out before being placed in position a very large opening would be required to allow of their entrance, and a correspondingly large stem would of course be required to fit closely and be sealed within said opening. After the filaments are placed in position an exhaust-tube is sealed to the top of the globe, through which the air is exhausted, the carbon being heated to incandescence during the exhausting process, and the exhaust-tube is then sealed off close to the top of the globe.

By the use of the devices and process described I produce a lamp of very high resistance, and of an ornamental and desirable construction.

My invention is illustrated in the annexed drawing, which is a view in elevation of a lamp embodying said invention.

A is the inclosing-globe, and B the inner glass stem or wire-support through which the leading-in wires 1 2 pass. Such stem is sealed in the bottom of the globe at *a a*. The globe is provided with a projection, C, at its top, which originally is left open.

D D are the two carbon filaments, electroplated or otherwise attached together at *b*, and to a supporting-wire sealed into the stem, and attached to the leading-in wires 1 2 at *c c*, so that they are connected in series. The filaments are folded together, so that they may be passed through the opening *a a*, and after the stem B is sealed within said opening a tool is introduced through C, and the filament bent apart, as shown. The globe is exhausted through a tube attached at C, and such tube is then sealed off at *d*.

The form of the incandescing conductor and of the globe will be made the subject of an application for Design Patent.

What I claim is—

1. The method of manufacturing electric lamps consisting in attaching two flexible filaments connected and folded together to the inner stem or wire-support, sealing such stem within the bottom of the globe, and then bending said filaments apart and into the shape shown, substantially as set forth.

2. An incandescing electric lamp composed of the globe A, provided with enlargement C, the wire-support B, the diverging filaments D D, the leading-in wires, and the central wire-support, substantially as set forth.

This specification signed and witnessed this 26th day of October, 1882.

THOS. A. EDISON.

Witnesses:

WM. H. MEADOWCROFT,
H. W. SEELY.

(No Model.)

T. A. EDISON.

INCANDESCING ELECTRIC LAMP.

No. 273,486. Patented Mar. 6, 1883.

Fig.1.

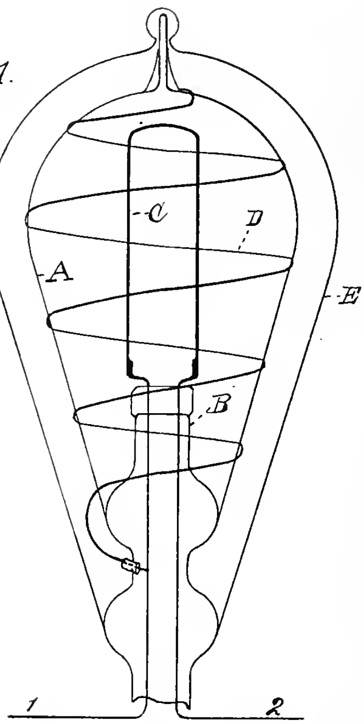


Fig.2.

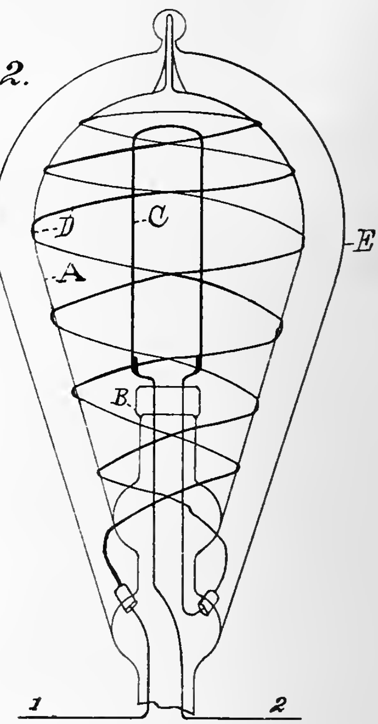


Fig.3.

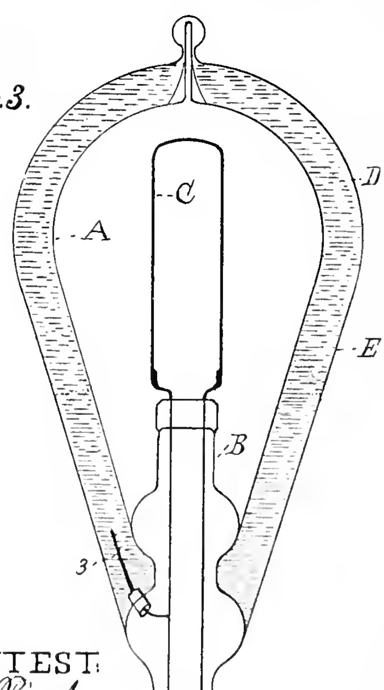
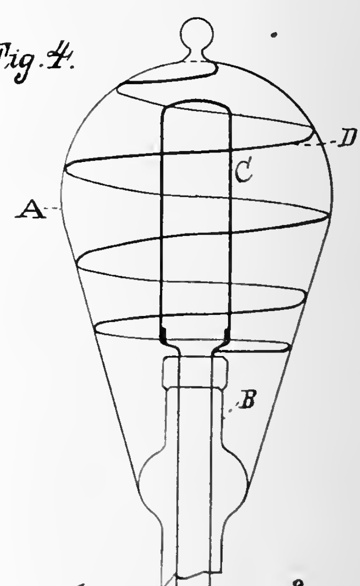


Fig.4.



ATTEST:
E. C. Rowland
H. W. Seely

INVENTOR.
Thomas A. Edison,
By Rich^d N. Dyer,
Atty.

N. PETERS, Photo-Lithographer, Washington, D. C.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

INCANDESCING ELECTRIC LAMP.

SPECIFICATION forming part of Letters Patent No. 273,486, dated March 6, 1883.

Application filed October 20, 1882. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Methods of and Means for Preventing Electrical Carrying in Incandescing Electric Lamps, (Case No. 493,) of which the following is a specification.

In the use of incandescing electric lamps particles are thrown off from the carbon filament and deposited upon the glass inclosing-globe, resulting in the gradual destruction of the filament and the blackening of the globe, obscuring the light. This, I think, is due to the static attraction between the glass globe and the heated electrified particles, the globe having a lower potential than the filament. In my application No. 479 (Serial No. 74,095) is shown and described means for neutralizing this static attraction.

The object of my present invention is more especially to produce more efficient means for the purpose. This I accomplish by bringing the conductor connected with one of the leading-in wires of the lamp directly into contact with the glass globe, which has the effect of raising the globe to the same or nearly the same potential as the filament. When the conductor for neutralizing the static attraction is attached to the outside of the inclosing-globe, to prevent the discharge of the electricity I provide an external protecting-globe, which protects the neutralizing-conductor from the effects of the surrounding atmosphere. If the neutralizing-conductor is a solid material—such as a wire or strip of metal, carbon, or other suitable material—the external globe will be exhausted and sealed with or after the main lamp or globe; but if this neutralizing-conductor is a transparent or semi-transparent liquid or other mass the space between the main and protecting globes may be filled with the liquid or mass and sealed before or after the lamp-globe is exhausted. A heavy oil or substance, like Canada balsam or olive oil or water, may be used for the purpose, and a metal wire attached to one of the leading-in wires of the lamp is immersed in the liquid, so that the same will be electrically charged. If platinum is used for the neutralizing-conductor, it may be fused to the glass of the globe or not, as desired. When the neutralizing-conductor is placed within the lamp-globe the external protecting-globe is dispensed with. The internally-arranged conductor may be sustained in position against the globe by its own resiliency; or if platinum is used it can be attached to the globe by a fusion of the glass. When the neutralizing-conductor is located within the lamp-globe I prefer to connect it with the negative wire of the lamp, and when such neutralizing-conductor is external to the lamp-globe I prefer to connect it with the positive wire of the lamp. The neutralizing-conductor may be placed directly in the circuit of the filament, it being of low resistance, so as not to be heated by the passage of the current therethrough.

In the accompanying drawings, forming a part hereof, Figure 1 is a view of a lamp with an external neutralizing-conductor connected to one leading-in wire; Fig. 2, a similar view when the neutralizing-conductor is in circuit with the filament; Fig. 3, a view of a lamp with a protecting-globe and a liquid neutralizing-conductor, and Fig. 4 a view of a lamp having an internal neutralizing-conductor.

Like letters denote corresponding parts in all four figures.

A is the exhausted and sealed glass globe of the lamp; B, the tube supporting the carbon filament C and the leading-in wires 1 2.

D is the neutralizing-conductor, bearing directly upon the globe A and in contact therewith, either upon the outside or inside of the globe. The neutralizing-conductor may be connected with one of the leading-in wires 1 2, its other end being free, as shown in Figs. 1, 3, and 4; or the neutralizing-conductor may be in circuit with the filament, as shown in Fig. 2.

E is the outer protecting-globe, which is used when the neutralizing-conductor is located on the outside of the lamp-globe A. This protecting-globe is exhausted and sealed with or after the lamp-globe; but where a liquid is used, as in Fig. 3, the space within the protecting-globe is filled with the liquid. This liquid is connected with one of the leading-in wires by a wire, 3, sealed into the glass and immersed in the liquid.

I do not wish to express a preference for any one of the arrangements described and shown, since, although I have tried them all, I cannot immediately determine the best form, on account of the long time required to make a comparative test of the life of the lamps.

What I claim is—

1. The method of preventing electrical carrying in incandescing electric lamps, consisting in raising the globe to the same or nearly the same potential as the filament, substantially as set forth.

2. In incandescing electric lamps, the combination, with the filament and the inclosing-globe, of a neutralizing-conductor connected with the lamp-circuit and located in contact with the lamp-globe, substantially as set forth.

3. In incandescing electric lamps, the combination, with the lamp-globe and the neutralizing-conductor external thereto, of the outer protecting-globe, substantially as set forth.

4. In incandescing electric lamps, the combination, with the lamp-globe and the neutralizing-conductor of solid material external thereto, of the outer exhausted protecting-globe, substantially as set forth.

This specification signed and witnessed this 12th day of October, 1882.

THOS. A. EDISON.

Witnesses:

H. W. SEELY,

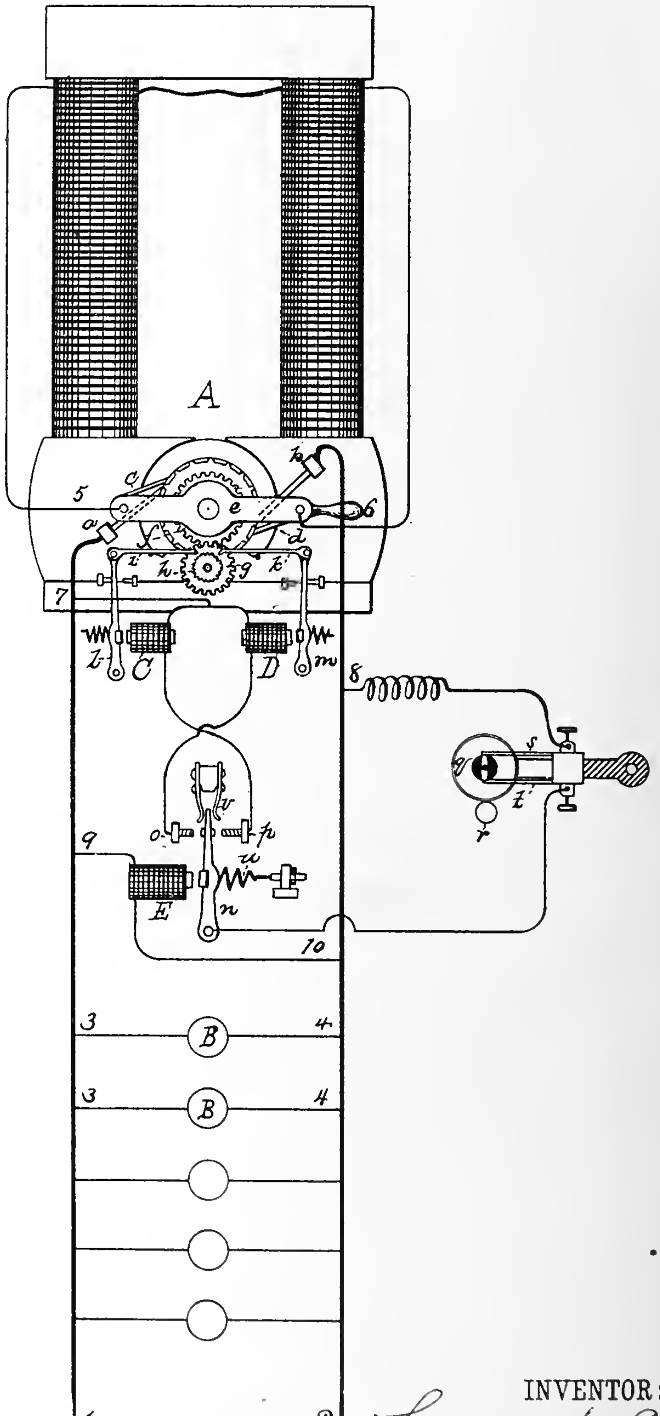
RICHD. N. DYER.

(No Model.)

T. A. EDISON.

REGULATOR FOR DYNAMO ELECTRIC MACHINES.

No. 273,487. Patented Mar. 6, 1883.



WITNESSES:

E. C. Rowland

H. W. Seely

INVENTOR:

Thomas A. Edison

By Rich^d N. Dyer.

Atty.

United States Patent Office.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

REGULATOR FOR DYNAMO-ELECTRIC MACHINES.

SPECIFICATION forming part of Letters Patent No. 273,487, dated March 6, 1883.

Application filed September 22, 1882. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Means for Regulating Electric Generators, (Case No. 443;) and I do hereby declare that the following is a full and exact description of the same, reference being had to the accompanying drawing, and to the letters of reference marked thereon.

The object I have in view is to produce simple and efficient means for automatically regulating the generative capacity of a dynamo or magneto electric machine which will regulate both for changes in the number of translating devices and in the speed of the engine. This I accomplish by taking from the commutator-cylinder of the machine a separate current for the field-of-force circuit by means of one or more extra commutator-brushes adjusted by mechanism operated or controlled by an electro-magnet placed in a multiple-arc circuit from the main conductors, so as to be affected exactly as are the lamps.

The arrangement for obtaining the separate current at the commutator-cylinder may be any one of those described in a previous application for patent filed by me, (Serial No. 68,626,) the extra brush or brushes being adjusted by a double pawl-and-ratchet vibrating mechanism controlled by the electro-magnet in multiple arc.

The foregoing will be better understood from the drawing, which is a view, partly diagrammatic, of apparatus embodying the invention.

A is a dynamo or magneto electric machine, from the main commutator-brushes *a b* of which run the main conductors 1 2. These main brushes are supported in any usual or suitable way, the drawing showing them diagrammatically for clearness of illustration.

The lamps or other translating devices B are located in multiple-arc circuits 3 4 from 1 2.

Two extra brushes, *c d*, bearing on the commutator-cylinder, are mounted upon a yoke, *e*, pivoted on the armature-shaft. The field-of-force circuit 5 6 of the machine is taken from these brushes *c d*. The yoke *e* has secured to it a cog-wheel, *f*, with which meshes a cog-wheel, *g*, keyed to the same spindle, with two oppositely-turned ratchet-wheels, one of which is shown at *h*. With these ratchet-wheels engage two pawls, *i k*, carried by the armature-levers *l m* of electro-magnets C D, the levers being retracted by springs. The circuit of these electro magnets may be a circuit derived in any suitable way from the conductors supplied by the machine. It is shown as a multiple-arc circuit, 7 8, from the main conductors 1 2. This circuit passes through the armature-lever *n* of an electro-magnet, E, the circuit being divided at the front and back contacts, *o p*, of this lever, and the magnets C D being located in the separate divisions of the circuit. The circuit 7 8 also passes through a circuit-breaker, which may be a circuit-breaking wheel, *q*, driven by the armature-shaft *r*, or any other moving part. The spring-fingers *s t* rest on the breaking-hub of this wheel, and the circuit-connections are made with these spring-fingers. The electro-magnet E is located in a multiple-arc circuit, 9 10, from 1 2. Its armature-lever *n* is retracted by an adjustable spring, *u*, and is held at a central point intermediate between its contact-points by spring-fingers *v*. When the current increases to a definite extent the lever of E will make its front contact, completing circuit through D, and causing its lever to vibrate with the assistance of the circuit-breaker. This movement will turn the yoke *e* and throw the brushes *c d* on the commutator-cylinder away from the line of greatest generation. When the candle-power of the lamps becomes normal the lever *n* will resume a central position, breaking the circuit 7 8. Upon a definite decrease of current the lever *n* will make its back contact, energizing C and throwing the brushes *c d* toward the line of greatest generation. The brushes *c d* may work upon a different portion of the commutator-cylinder from the main brushes, so that they will not interfere with each other. The extra brushes may therefore be adjusted to the points of greatest generation, or away from it, and the field-circuit may have the same electro-motive force as the main circuit, or a lower electro-motive force.

Instead of using two extra brushes to which the ends of the field-wire run, one extra brush may be used, connected with one end of the field-wire, while the other end of the field-wire will be connected with a main brush; or two extra brushes forming one pole may be used, a main brush forming the other pole, as described in my application Serial No. 68,626. The adjustment of the extra brush or brushes by the mechanism before described will effect the regulation of the machine.

What I claim is—

1. The combination, with a dynamo or magneto electric machine having the current for its field-circuit taken from its commutator-cylinder by means of an extra brush or brushes, of means for automatically adjusting said extra brush or brushes to effect the regulation of the machine, substantially as set forth.

2. The combination, with a dynamo or magneto electric machine supplying translating devices in multiple arc, and having the current for its field-of-force circuit taken from the commutator-cylinder by means of an extra brush or brushes, of mechanism for adjusting such extra brush or brushes, and an electro-magnet located in a multiple-arc circuit and operating or controlling the operation of said adjusting mechanism, substantially as set forth.

3. The combination, with a dynamo or magneto electric machine supplying translating devices in multiple arc, and having the current for its field-circuit taken from its commutator-cylinder by an extra brush or brushes, of mechanism for adjusting such extra brush or brushes, and an electro-magnet located in a multiple-arc circuit, the armature-lever of which completes at its front and back contacts separate circuits through the adjusting mechanism, causing it to move in opposite directions, substantially as set forth.

4. The combination, with a dynamo or magneto electric machine supplying translating devices in multiple arc, and having the current for its field-circuit taken from its commutator-cylinder by an extra brush or brushes, of two electro-magnets working oppositely, moving pawls and ratchets, a circuit-breaker in the circuit of said magnets, and an electro-magnet in multiple arc completing the circuits of said first magnets at its contacts, substantially as set forth.

This specification signed and witnessed this 12th day of September, 1882.

THOS. A. EDISON.

Witnesses:

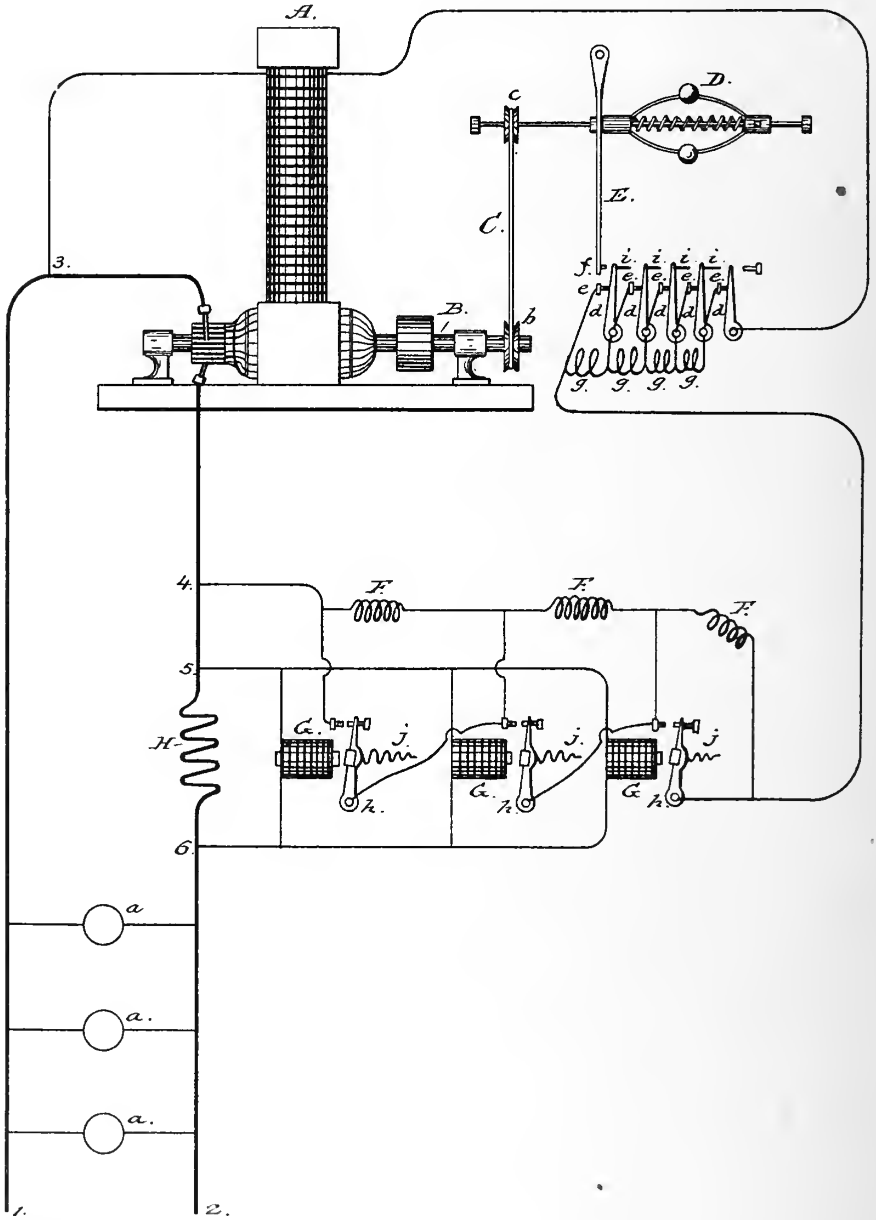
WM. A. STERN,
H. W. SEELY.

(No Model.)

T. A. EDISON.

REGULATOR FOR DYNAMO ELECTRIC MACHINES.

No. 273,488. Patented Mar. 6, 1883.



WITNESSES:

E. C. Rowland

F. W. Howard

INVENTOR:

T. A. Edison

BY Richd. N. Dyer

ATTORNEY.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

REGULATOR FOR DYNAMO-ELECTRIC MACHINES.

SPECIFICATION forming part of Letters Patent No. 273,488, dated March 6, 1883.

Application filed August 7, 1882. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in the Regulation of Dynamo or Magneto Electric Machines, (Case No. 413;) and I do hereby declare that the following is a full and exact description of the same, reference being had to the accompanying drawing, and to the letters of reference marked thereon.

The object of this invention is to produce a system of regulation for dynamo or magneto electric machines, which system shall consist of means for regulating the current both for an increase or decrease in the speed of the engine actuating the armature, and for variations in the number of translating devices in circuit.

The speed-regulator consists of a centrifugal governor connected to the armature or engine shaft or other revolving portion of the generating apparatus, and also to a movable arm whose motion throws portions of a resistance into or out of the field-circuit of the machine, an increase in the speed of the engine thus causing a movement of the governor and of the movable arm, which causes the immediate throwing in of resistance, and a decrease in speed causing a corresponding throwing out of resistance.

For regulating the machine according to variations in the number of translating devices in circuit, I use, preferably, a series of electro-magnets and movable armatures, the former placed in multiple arc to each other across a shunt around a resistance in the main line, and the latter each forming a part of a shunt around a resistance in the field-circuit. These armatures and electro-magnets are so arranged relatively to each other that different amounts of currents are required to cause each magnet to attract its armature, this being accomplished by making the retracting springs or weights of the armatures of different degrees of strength by placing the armatures at different distances from the magnets, or in any other suitable manner. Therefore as more translating devices are placed in circuit the successive increases of the current in the shunt which contains the electro-magnets cause the successive drawing forward of the pivoted armature, and the shunts around the field-circuit resistance are closed one after another, the resistances thus being successively removed from circuit and the energy of the field-magnets increased. Various other arrangements of magnets and armatures may be used for this purpose, if desired, many such being described in former applications made by me for Letters Patent.

The foregoing may be better understood by reference to the annexed drawing, which represents my invention diagrammatically.

A is a dynamo-electric machine, shown in side elevation, and 1 2 are the main conductors leading therefrom, lamps or other translating devices *a a* being placed in multiple arc upon them.

3 4 is a multiple-arc circuit from the main line, which energizes the field-magnet of the machine; but a circuit supplied from any suitable external source may be used for this purpose.

B is the armature-shaft, on which is mounted a pulley, *b*, from which a belt, C, runs to another pulley, *c*, on the shaft of a centrifugal governor, D.

Attached to the governor D in such manner that it will be moved along the shaft by the backward and forward movements of the governor is an arm, E, the lower end, *f*, of which is opposite the free ends of the series of pivoted contact-arms *d d*. These arms normally make contact with points *e e*, the pins *i i* being of insulating material. In a shunt around each of said contacts is a resistance, *g*. A forward movement of the arm E forces the arms *d d* successively away from their contacts, and thus throws the resistances *g g* into the field-circuit 3 4. Such forward movement is produced by an increase of speed of the governor D, caused by an increase in the speed of the armature of the machine, and the increased and unnecessary generation of current produced by such an increase of speed is of course immediately counteracted by the throwing of one of the resistances *g* into the field-circuit.

In the field-circuit 3 4 are also placed resistances F F, and around each of such resistances is formed a shunt-circuit, which includes one of the pivoted armatures *h*. These armatures have springs j, of different degrees of strength. The magnets G G, which attract the armatures, are in multiple arc across the shunt 5 6, which is formed around a resistance, H, in the main conductor 2. As more translating devices are placed in circuit and the energy of the magnets G increases the armatures h are successively drawn forward and the shunts around the resistances F F are closed, such resistances thus being removed from the field-circuit. As the number of translating devices in circuit is reduced a reverse operation takes place and the resistances F are again included in the circuit.

By using the two arrangements described in connection with each other the machine is automatically regulated both for changes in the amount of current required in the system and for variations in the speed of the motor which drives the armature.

It is evident that the governor D could be run from the shaft of the engine or from any moving part of the apparatus.

It is also evident that other forms of adjustable resistance than that shown could be used in connection with the governor, and that various other arrangements of magnets, armatures, and resistances could be made for the other portion of the regulator.

What I claim is—

1. The combination, with a dynamo or magneto electric machine and translating devices arranged in multiple arc, of adjustable resistance in the field-circuit of the machine, mechanical means connected with and operated by some moving portion of the machine, or of the motor actuating it, for varying such resistance according to variations in the speed of said motor, and an electro magnet or magnets energized by the current generated for varying such resistance, according to variations in the number of translating devices in circuit, substantially as set forth.

2. The combination, with a dynamo or magneto electric machine and translating devices arranged in multiple arc, of an adjustable resistance in the field-circuit, a mechanically-operated device for varying such resistance, and a number of electro-magnets in a shunt from the main line, operating successively to vary such resistance, substantially as set forth.

This specification signed and witnessed this 1st day of May, 1882.

THOMAS A. EDISON.

Witnesses:

H. W. SEELY.

P. B. WILBER.

(No Model.)

T. A. EDISON.

TURN TABLE FOR ELECTRIC RAILWAYS.

No. 273,489. Patented Mar. 6, 1883.

Fig 1

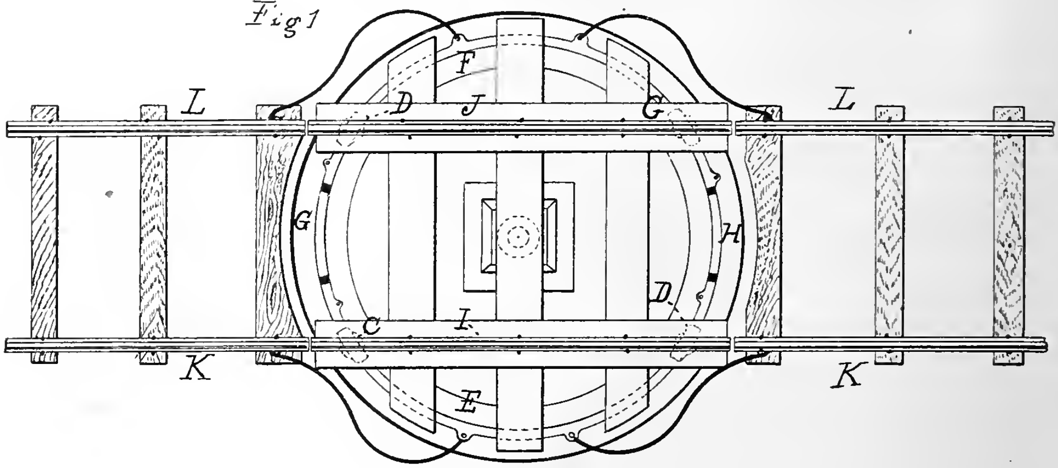
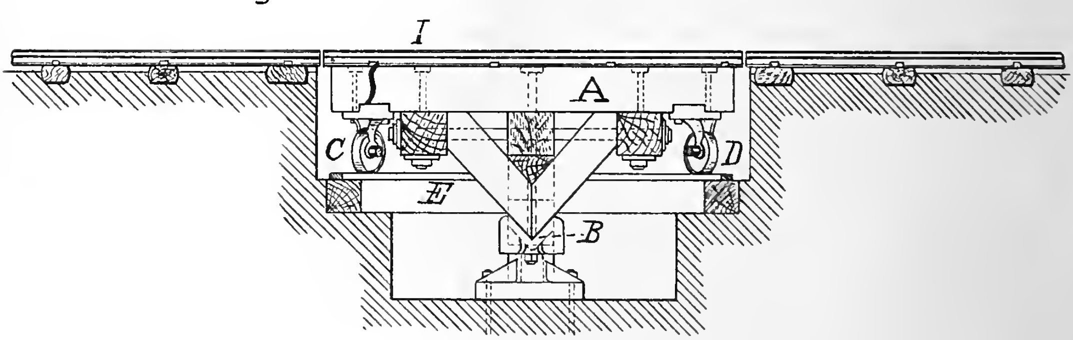


Fig 2.



WITNESSES:

E. C. Rowland

H. W. Seely

INVENTOR:

T. A. Edison

BY Richd. N. Dyer

ATTORNEY.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

TURN-TABLE FOR ELECTRIC RAILWAYS.

SPECIFICATION forming part of Letters Patent No. 273,489, dated March 6, 1883.

Application filed August 7, 1882. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Turn-Tables for Electric Railways, (Case No. 430;) and I do hereby declare that the following is a full and exact description of the same, reference being had to the accompanying drawings, and to the letters of reference marked thereon.

The object of this invention is to provide a turn-table suitable for use with an electric railway in which the current actuating the trains is conducted to them through the rails of the track, which turn-table shall be so connected that there will be no danger of a short circuit when it is moved, and so that a car can be run onto the table and, after being reversed, receive current to move it off again.

My invention is illustrated in the accompanying drawings, in which Figure 1 is a top view of the turn-table, and Fig. 2 a vertical section of the same.

The turn-table consists of a frame-work, A, pivoted at its center B, and supported on four rollers, C C and D D, which run on a circular metallic track composed of two sections, F F, electrically divided from each other by means of two short insulated sections, G H, which, however, must be long enough not to allow a short circuit between the parts E F when the rollers pass from one to the other. Opposite rollers C C are connected to the rails I J of the turn-table, respectively, and the stationary rail K is connected to the section E of the circular track, while stationary rail L is connected to the section F, such connections being made by wires, as shown, or in any other suitable manner. The rollers D D, however, are insulated from all the rails.

It will be seen that a car may be run onto the turn-table, and will receive current through the circular track and the rollers C C, and after such car is reversed, on the circuit being completed to the armature of the electric motor on the car, (such circuit being of course broken while the car is being turned around,) current will reach the car in the same way to remove it from the turn-table again.

What I claim is—

1. In electric railways, the combination, with the stationary rails acting as conductors, of a turn-table and electrical connections of the stationary rails around the turn-table, whereby the flow of current through the stationary rails is not affected by the movement of the turn-table, substantially as set forth.

2. In electric railways, the combination, with the stationary rails acting as conductors, of a turn-table, electrical connections of the stationary rails around the turn-table, and electrical connections with the rails of the turn-table for supplying the same with currents, substantially as set forth.

3. In a turn-table for electric railways, the combination of the circular track divided into two electrically-insulated sections, the rollers running on said track, and the turn-table rails carried by said rollers, one pair of diagonally-opposite rollers being electrically connected with such rails, as shown, substantially as set forth.

4. In an electric-railway turn-table, the circular metallic track divided into two electrically-insulated sections, each of such sections being electrically connected with one line of the stationary rails, in combination with electrical connections between such sections and the rails of the turn-table, substantially as set forth.

This specification signed and witnessed this 9th day of June, 1882.

THOS. A. EDISON.

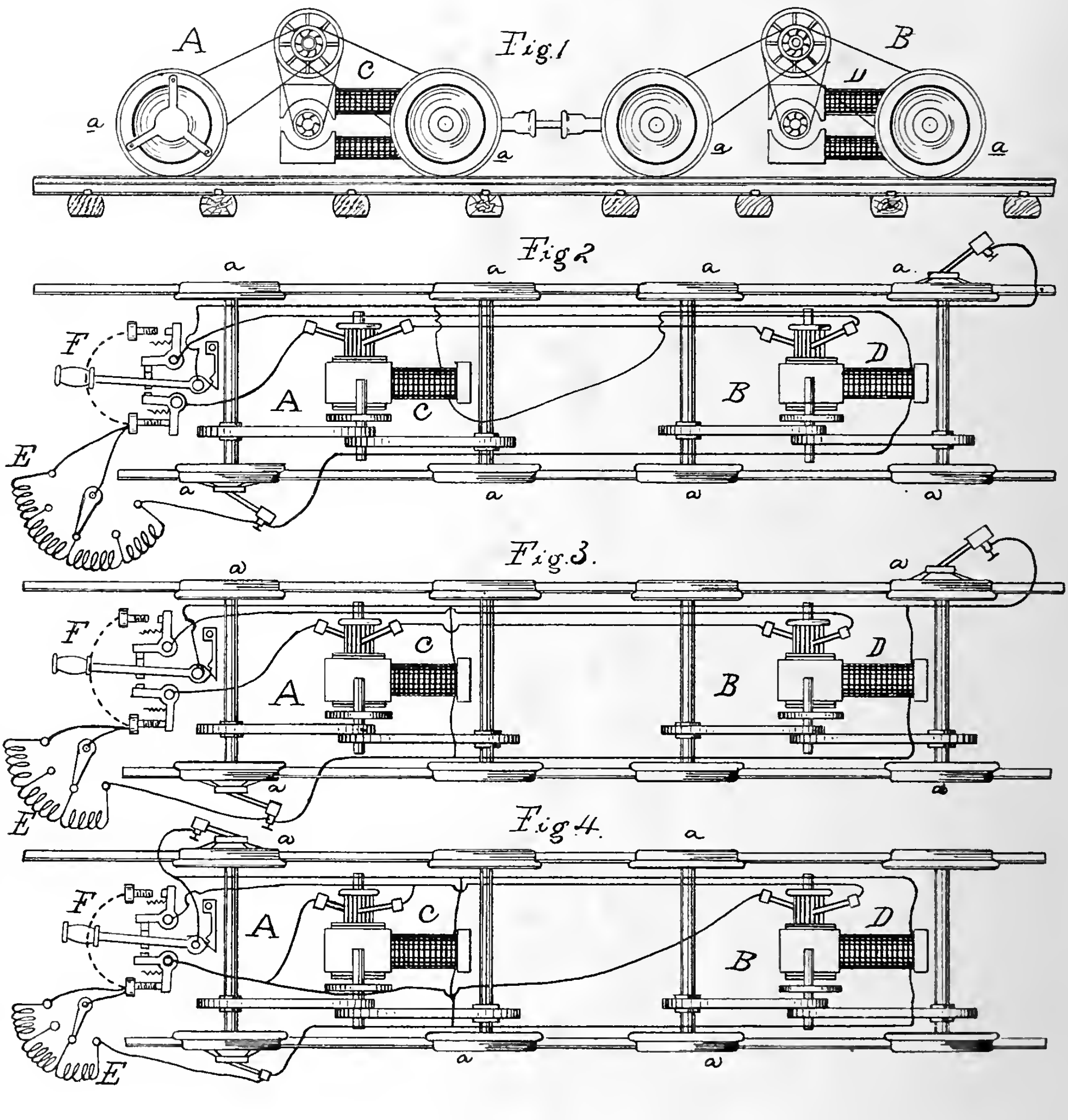
Witnesses:
RICHD. N. DYER,
EDWARD H. PYATT.

(No Model.)

T. A. EDISON.

ELECTRO MAGNETIC RAILWAY SYSTEM.

No. 273,490. Patented Mar. 6, 1883.



WITNESSES:

E. C. Rowland

H. W. Seely

INVENTOR:

T. A. Edison

BY Richd. N. Dyer

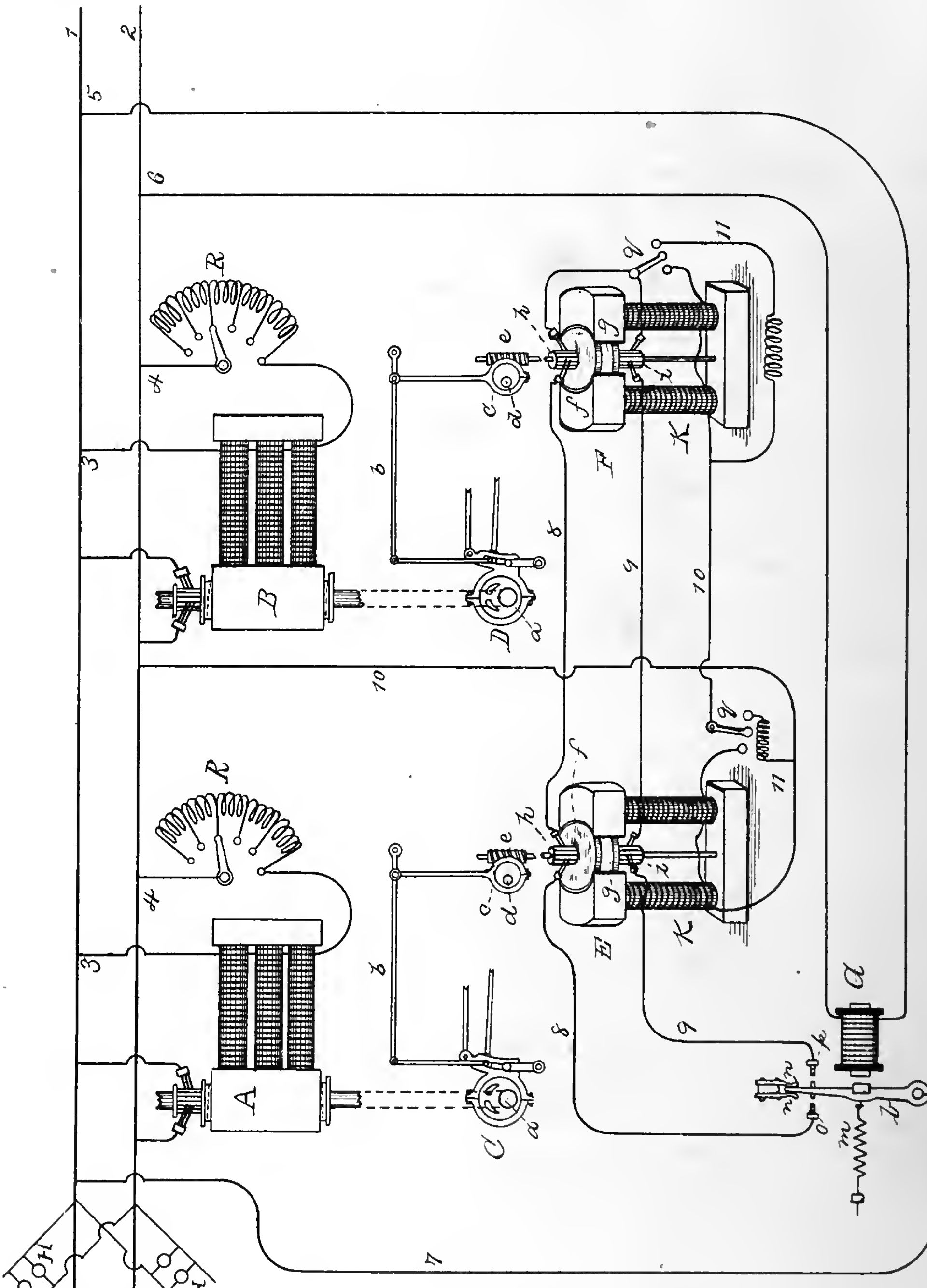
ATTORNEY.

(No Model.)

T. A. EDISON.

REGULATOR FOR DRIVING ENGINES OF ELECTRICAL GENERATORS.

No. 273,491. Patented Mar. 6, 1883.



ATTEST:

E. C. Rowland

H. W. Seely

INVENTOR:

Thomas A. Edison,

By Richd. N. Dyer,

Atty.

N. PETERS, Photo-Lithographer, Washington, D.C.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

REGULATOR FOR DRIVING ENGINES OF ELECTRICAL GENERATORS.

SPECIFICATION forming part of Letters Patent No. 273,491, dated March 6, 1883.

Application filed October 26, 1882. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Means for Operating Electrical Generators, (Case No. 490,) of which the following is a specification.

In any system of electric distribution wherein dynamo or magneto electric machines feed into the same conductors or system of conductors, and are operated by two or more separate steam-engines or other motors, difficulty is experienced on account of variations in the speed of the engines.

In my application No. 488, (Serial No. 74,096,) I have shown and particularly described means for mechanically connecting the governors controlling the throttle-valves or cut-offs of all the engines, so that such governors will work together and will not be allowed to jump or vibrate independently of each other, a uniform speed of all the engines being thereby preserved.

The object of the present invention is to accomplish this end by mechanism operated or controlled electrically.

In carrying out my invention I substitute for the centrifugal governors, which are affected indirectly by the load of the engines, electrical governors, which are controlled by the current generated, and hence are affected directly by the conditions of the circuit and the load of the engines. All the governors are controlled by the current of the circuit into which the generators feed, and hence move in unison. The electrical governors are also preferably operated by the current from this circuit, although they may be operated by current from any other source.

In the preferred form of the apparatus, I connect with the throttle-valve or cut-off mechanism of each engine (the latter preferably) the spindle of an electro-dynamic motor. The circuit of these motors is controlled by an electro-magnet located in a multiple-arc circuit from the conductors with which the generators are connected, such magnet being affected exactly as are the lamps, motors, or other translating devices, which are also arranged in multiple arc. The armature lever of this magnet is provided with an adjustable retractor, and it has its central position determined by means of springs between which it is balanced. In order to avoid the use of a current-reverser, each motor has two armatures, with reverse windings or connections, one armature of each motor being brought into circuit when the armature-lever of the controlling electro-magnet makes its front contact, adjusting the throttle-valves or cut-off mechanisms of all the engines simultaneously and to the same extent in one direction, and the other armature of each motor being brought into circuit when said lever makes its back contact, adjusting the throttle-valves or cut-off mechanisms of all the engines in the opposite direction. If electro-dynamic motors with one armature each are used, a current-reverser worked by the controlling electro-magnet will be employed.

The broad invention of the electro-dynamic motor having two armatures with reverse windings will be made the subject of another application for patent.

Means are employed for cutting each motor out of circuit when the engine it governs is not running. This can be done by a switch, breaking the field-circuit of the motor and closing another circuit having a resistance equal to that of the field-magnet coils; or, the motor may be disconnected mechanically from the engine and allowed to run with the other motors.

Each generator is provided with means for varying its electro-motive force, as required, by the addition and removal of translating devices, the electrically-controlled governers being employed to adjust the engines to meet the load and to secure uniformity of speed. The means for varying the electro-motive force of each generator, as required by the addition or removal of translating devices, may be an adjustable resistance in its field-circuit.

In the accompanying drawing is shown a view of part of the cut-off mechanisms of two steam-engines, the generators driven by such engines, and means for controlling the cut-off mechanisms electrically, embodying my invention, the parts being shown separated for clearness.

A and B are two dynamo or magneto electric machines, which are connected with and feed into the same conductors, 1 2, or system of conductors. These generators are preferably connected with the conductors 1 2 in multiple arc, although they may be arranged in series or multiple series. The field-circuit 3 4 of each generator is provided with an adjustable resistance, R, to vary the electro-motive force of the machine, as required by the addition or removal of translating devices.

C D represent portions of the cut-off mechanisms of two steam-engines. The shafts *a* of the engines are coupled directly or connected by belting with the shafts of the generators, or each engine may operate two or more generators. The lever *b*, which adjusts the cut-off, is connected by a rod with a crank-pin or eccentric sleeve, *c*, on a shaft, *d*, provided with a worm-wheel engaging a worm, *e*, on the spindle of an electro-dynamic motor. Two of these motors, E F, are shown, one for each engine. Each motor has two armatures, *f g*, with reverse windings or connections, and two commutators, *h i*, the two armatures having a common field-magnet, *k*.

G is a controlling electro-magnet, located in a multiple-arc circuit, 5 6, from 1 2, and affected the same as the lamps, motors, or other translating devices H, which are also arranged in multiple arc. The armature-lever *l* of this magnet is provided with an adjustable retractor, *m*, and is centered between two springs, *n*. The circuit of the motors is from conductor 1, by conductor 7, to the lever *l*. At the front and back contacts, *o p*, of this lever the circuit is divided, one branch, 8, passing through the armatures *f*, and the other branch, 9, through the armatures *g*. At the last machine the circuit is again through one conductor, 10, which returns through the field-magnets of all the motors, and is connected with the conductor 2. At each motor is a switch, *q*, which completes the field-magnet circuit in one position, and in its other position breaks such magnet-circuit and completes another circuit, 11, having a resistance equal to that of the field-magnet. When lever *l* makes contact *o* the armatures *f* will receive current; but when *l* makes contact *p* the armatures *g* receive the current. In a central position the lever *l* breaks both branches of the circuit through the motors. When any one of the engines is stopped, the switch *q* of the governor-motor of the engine is moved to break the field-circuit and complete circuit 11, or the motor may be disconnected mechanically from the engine.

These electrical governors, controlled from the same circuit, and that circuit the one into which all the generators feed, maintain a uniform speed of the engines, and prevent the racing of the engines, and the conversion of part of the generators into motors, which occur when the engines are controlled by separate and independent mechanisms.

What I claim is—

1. The combination, with two or more independent engines and dynamo or magneto electric machines operated thereby and feeding into the same conductors, of governors for such engines and means for electrically controlling said governors simultaneously, substantially as set forth.

2. The combination, with two or more independent engines and dynamo or magneto electric machines operated thereby and feeding into the same conductors, of governors for such engines and means connected with the circuit supplied by the generators for electrically controlling such governors simultaneously, substantially as set forth.

3. The combination, with two or more independent engines and dynamo or magneto electric machines operated thereby and feeding into the same conductors, of governors for such engines, means for operating such governors electrically, and means connected with the circuit supplied by the generators for electrically controlling such governors simultaneously, substantially as set forth.

4. The combination, with two or more independent engines and dynamo or magneto electric machines operated thereby and feeding into the same conductors, of governors for such engines, means for operating such governors electrically, energized from the same circuit, and means connected with the circuit supplied by the generators for closing reverse circuits through all of such governor-operating devices, whereby the electrical governors are caused to move in one or the other direction simultaneously, as required, substantially as set forth.

5. The combination, with the independent engines, of the motors with two armatures connected with the throttle-valves or cut-offs of the engines, and the electro-magnet controlling all of the motors, substantially as set forth.

6. The combination, with the independent engines, of the electrical governors, means for electrically controlling such governors simultaneously, and means for throwing any one of the governors out of operation without affecting the action of the other governors, substantially as set forth.

7. The combination, with two or more independent engines and dynamo or magneto electric machines operated thereby and feeding into the same conductors, of means for varying the electro-motive force of the generators, as required by the addition or removal of translating devices, and means for electrically controlling the throttle-valves or cut-off mechanisms of the engines simultaneously, substantially as set forth.

This specification signed and witnessed this 19th day of October, 1882.

THOS. A. EDISON.

Witnesses:
H. W. SEELY,
E. H. PYATT.

(No Model.)

T. A. EDISON.

SECONDARY BATTERY.

No. 273,492. Patented Mar. 6, 1883.

Fig. 1.

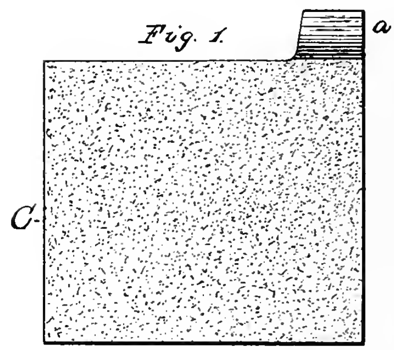


Fig. 2.

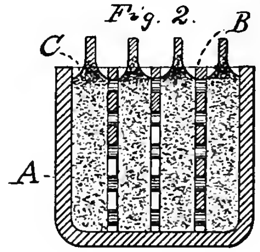
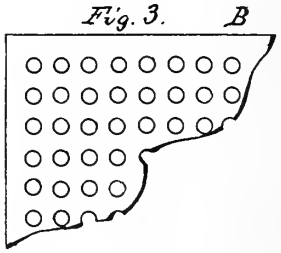


Fig. 3.



WITNESSES:

E. C. Rowland,

E. P. Mott

INVENTOR:

Thomas A. Edison

BY Z. F. Wilber

ATTORNEY

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

SECONDARY BATTERY.

SPECIFICATION forming part of Letters Patent No. 273,492, dated March 6, 1883.

Application filed June 26, 1882. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Secondary Batteries, (Case No. 419;) and I do hereby declare that the following is a full and exact description of the same, reference being had to the accompanying drawings, and to the letters of reference marked thereon.

The object I have in view is to produce a highly efficient form of secondary battery, employing electrodes of metallic lead of such peculiar construction that the battery will be ready for use with a far less extensive preparatory "forming" of the electrodes than is required with ordinary lead plates. This I accomplish by the employment of electrodes made entirely of finely-divided or spongy metallic lead, which is produced chemically or by electrolysis, portions of such electrodes being compressed to form connections.

In carrying out the invention the finely-divided metallic lead is packed in vertical compartments in a suitable vessel. These compartments are separated by perforated partitions, which are constructed of suitable insulating material—such as celluloid, hard rubber, cloth, mica, earthenware, or parchment paper. The finely-divided metallic lead is extended above the perforated insulating partitions at one end of each electrode, and is compressed into a solid mass for giving means for making the necessary connections. The dilute sulphuric acid is held by the perforations of the partitions and by the pores of the material of which the partitions are constructed, if a porous material is employed, and by perforating the material closely a large part of the surface of each electrode will be exposed to the action of the oxygen and hydrogen liberated in charging the battery. The spongy or finely-divided metallic lead may be obtained by any method, as by heating an organic salt of lead, or by precipitating finely-divided lead by immersing metallic iron or zinc in a solution containing a lead salt—such as the acetate of lead, or by depositing finely-divided metallic lead by the electrolysis of the acetate of lead, the deposited lead being removed and packed into the compartments as before explained.

In the accompanying drawings, forming a part hereof, Figure 1 is an elevation of one of the electrodes; Fig. 2, a vertical section of a battery constructed in accordance with my invention; and Fig. 3 a view of a portion of one of the perforated partitions.

A is a suitable vessel, which is divided into compartments by transverse partitions B. These partitions are made of a suitable insulating material, and are perforated as shown. The electrodes C are made of finely-divided metallic lead, packed into the compartments, as shown. The finely-divided metallic lead of each electrode is extended up at one end and is compressed to form the solid lug *a* to which connection is made. The electrodes of finely-divided metallic lead are retained in position and separated by the insulating partitions, in the perforations of which is held the dilute sulphuric acid.

What I claim is—

The electrodes for secondary batteries composed of finely-divided metallic lead having compressed portions for connections, substantially as set forth.

This specification signed and witnessed this 19th day of May, 1882.

THOMAS A. EDISON.

Witnesses:
EDW. C. ROWLAND,
C. P. MOTT.

(No Model.) 2 Sheets—Sheet 1.

T. A. EDISON.

VALVE GEAR FOR ELECTRICAL GENERATOR ENGINES.

No. 273,493. Patented Mar. 6, 1883.

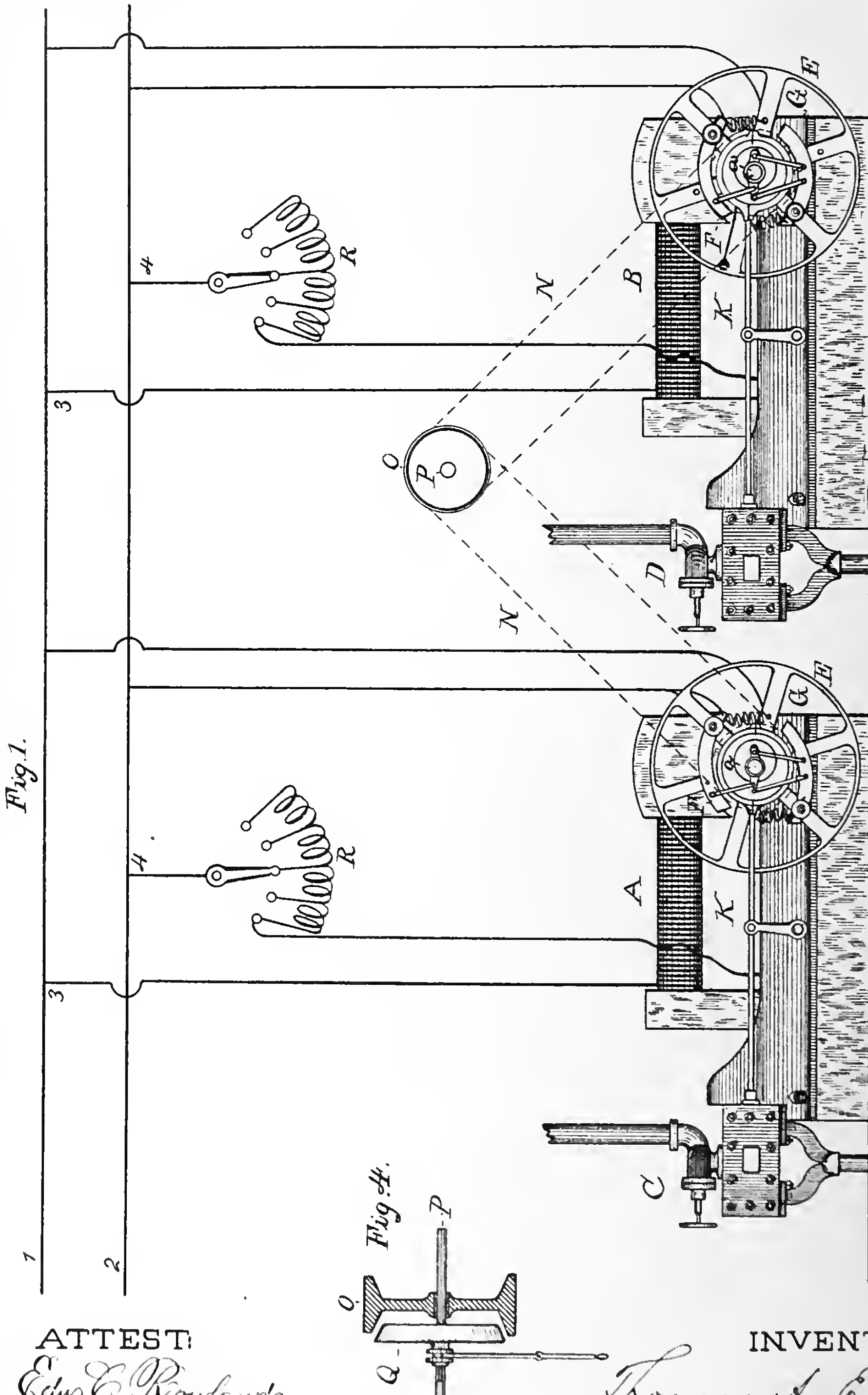


Fig. 1.

Fig. 4.

ATTEST:

Edw. C. Rowland

H. W. Seely

INVENTOR:

Thomas A. Edison,

By Richd. N. Dyer

Atty.

(No Model.) 2 Sheets—Sheet 2.

T. A. EDISON.

VALVE GEAR FOR ELECTRICAL GENERATOR ENGINES.

No. 273,493. Patented Mar. 6, 1883.

Fig. 2.

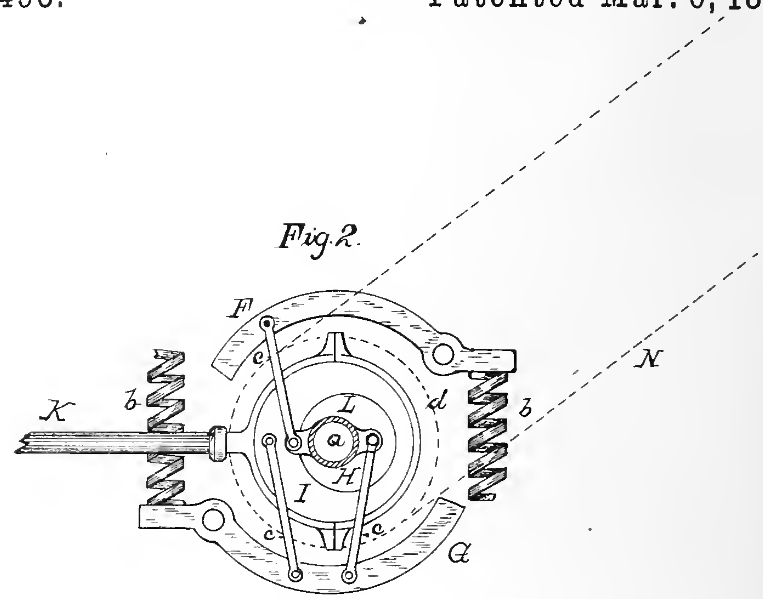
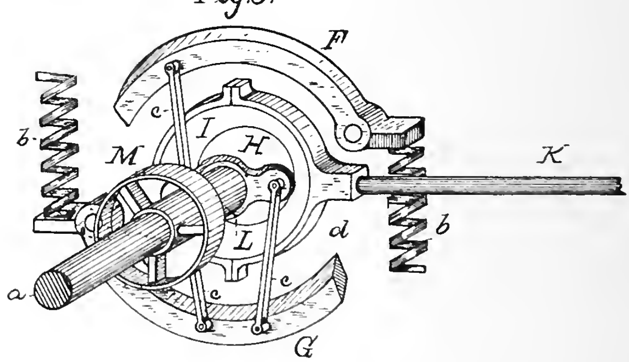


Fig. 3.



ATTEST:

Edw. C. Rowland.

W. W. Seely

INVENTOR:

Thomas A. Edison,

By Rich. N. Dyer.

Atty.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

VALVE-GEAR FOR ELECTRICAL GENERATOR-ENGINES.

SPECIFICATION forming part of Letters Patent No. 273,493, dated March 6, 1883.

Application filed October 26, 1882. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Valve-Gear for Electrical Generator-Engines, (Case No. 500,) of which the following is a specification.

As explained in my application No. 488, (Serial No. 74,096,) great difficulty is experienced in operating two or more independent steam-engines, or other motors, running dynamo or magneto electric machines which feed into the same conductors or system of conductors, on account of the racing of the engines and the conversion of part of the generators into motors. In said application means are particularly shown and described for connecting together mechanically the governors of one type of engines. In that type the governors are mounted on spindles run from the engine-shaft and operate an arm which shifts the position of a slide-block working in a slot in a pivoted eccentric sleeve. The governor-arms being connected to a common shaft, the engines are forced to run in unison.

The object of my present invention is to produce simple and efficient means for connecting the governors of another type of engines, wherein pivoted centrifugal spring-weights are carried by the fly-wheel of each engine, and are connected with a double or single eccentric mounted loosely upon the engine-shaft. The sleeve surrounding the double or single eccentric is connected directly with the valve-rod, and the adjustment of such eccentric by the weights varies the point at which the steam is cut off. When the eccentric is double there is an adjustment of the outer part upon the inner part of the eccentric, as well as an adjustment of the inner part upon the shaft, while if the eccentric is single there is an adjustment only of the eccentric upon the shaft. The object is accomplished by connecting the loose eccentrics of all the engines together, so that variations in the governor of one engine will cause corresponding variations in the governors of all the other engines, and a uniform speed of the engines will be maintained. The connections of the eccentrics is made by any suitable means, each connection being a removable one, so that more or less of the engines can be run, as desired.

In carrying out my invention, the loose eccentric (or the inner part thereof, if it is a double eccentric) is mounted upon a sleeve loose upon the engine-shaft, which sleeve carries a pulley connected by a belt with a pulley on a revolving shaft common to all the engines; or the sleeve of the eccentric may be connected with the common shaft by gearing or otherwise. The connection with the common shaft is made a removable one by the use of a clutch-pulley, or by other means. All the eccentrics being connected with the common regulating-shaft, this shaft will be revolved by the engine-shafts, and the adjustment of one eccentric by its governor will, through the medium of the common shaft, adjust the other eccentrics simultaneously and to the same extent.

In the accompanying drawings, Figure 1 is an elevation of two engines with the governor-eccentrics connected with a common shaft, a diagram of connections being shown; Fig. 2, an elevation of one of the governors; Fig. 3, a perspective view of the same; and Fig. 4, a sectional view of a clutch forming the removable connection with the common shaft.

A and B represent dynamo or magneto electric machines which have their armatures connected to the same conductors, 1 2, or to the same system of conductors. The field-circuits 3 4 of the machines are provided with adjustable resistances R to regulate the machines, as required, by the addition and removal of translating devices.

C and D represent steam-engines, the shafts *a* of which are coupled directly with the shafts of the generators.

Upon each engine-shaft *a* is a wheel, E, which carries two pivoted weights, F G. These weights are thrown inwardly toward the shaft by springs *b*, and are connected by links *c* with the inner and outer parts, H I, of the loose eccentric. If a single eccentric is used, the links *c* will be connected with the one movable part. The eccentric sleeve *d* is connected with the valve-rod K. The eccentric, or the inner part, H, thereof, is mounted on a sleeve, L, sleeved upon the shaft *a*, and carrying a pulley, M. This pulley is connected by a belt, N, with a loose pulley, O, on the revolving shaft P. The loose pulley O is connected with the shaft P, when desired, by a friction-clutch, Q, Fig. 4. All the engines (two or more) have their governors connected in this way with the revolving shaft P, and are thus forced to work in unison.

What I claim is—

1. The combination, with two or more separate engines having automatic cut-off mechanisms composed of loose eccentrics, and wheel-governors adjusting such eccentrics, of means for connecting such cut-off mechanisms together, so that they will work in unison, substantially as set forth.

2. The combination, with dynamo or magneto electric machines feeding into the same conductors, and two or more separate engines having automatic cut-off mechanisms composed of loose eccentrics, and wheel-governors adjusting such eccentrics, of means for connecting such cut-off mechanisms together, so that they will work in unison, substantially as set forth.

3. The combination, with two or more separate engines having automatic cut-off mechanisms composed of loose eccentrics, and wheel-governors adjusting such eccentrics, of a revolving shaft, and means connecting such shaft with the loose eccentrics of all the engines, substantially as set forth.

4. The combination, with two or more separate engines having automatic cut-off mechanisms composed of loose eccentrics, and wheel-governors adjusting such eccentrics, of a revolving shaft, means connecting such shaft with the loose eccentrics of all the engines, and means for disconnecting the engines as desired, substantially as set forth.

5. The combination, with two or more separate engines having automatic cut-off mechanisms composed of loose eccentrics, and wheel-governors adjusting such eccentrics, of sleeves upon which the eccentrics are mounted, a common revolving shaft, and pulleys and belts connecting the sleeves with said shaft, substantially as set forth.

This specification signed and witnessed this 19th day of October, 1882.

THOS. A. EDISON.

Witnesses:
H. W. SEELY,
E. H. PYATT.

(No Model.)

T. A. EDISON.

ELECTRICAL RAILROAD.

No. 273,494. Patented Mar. 6, 1883.

Fig. 1.

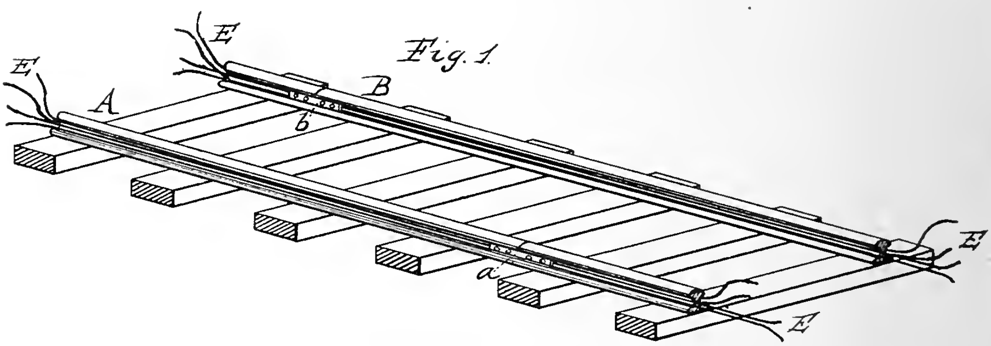
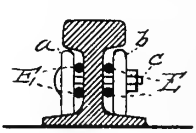


Fig. 2.



WITNESSES:

E. C. Rowland.

W. W. Seely

INVENTOR:

Thomas A. Edison,

By Richd. N. Dyer,

Atty.

N. PETERS, Photo-Lithographer, Washington, D. C.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

ELECTRICAL RAILROAD.

SPECIFICATION forming part of Letters Patent No. 273,494, dated March 6, 1883.

Application filed August 14, 1882. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Electrical Railroads, (Case No. 467;) and I do hereby declare that the following is a full and exact description of the same, reference being had to the accompanying drawings, and to the letters of reference marked thereon.

Heretofore in electrical railroads wherein the two lines of traffic-rails have been used as part or all of the conductors for carrying the current to and from the motor, or wherein a third or central line of rails has been used for one-half of the circuit, it has been attempted to lessen the resistance and secure good conductivity by perfecting as far as possible the joints between the ends of the rails; but this has been only partially successful, from the fact that loose joints have to be provided at the ends of the rails to permit of expansion and contraction, and the surfaces of the parts in contact becoming oxidized the contact becomes bad, making the combined resistance of the large number of joints in any section of the railroad considerable.

The object of the present invention is to reduce the resistance of the circuit to the minimum. This is accomplished by providing each line of rails used as a conductor with two or more continuous conducting-wires on one or on each side of the line of rails, which continuous wires pass beneath the fish-plates at the joints of the rails, and are clamped by such fish-plates against the rails. These wires may be bare copper wires, or they can be insulated between the fish-plates and left bare where they pass under such fish-plates. The insulation is scraped from the web of the rails at the ends, and the surfaces so scraped are cleaned, and may be electroplated with nickel or silver or other metal not easily oxidized by exposure to air and moisture, in order to make good contact with the continuous wires. One of the conductors from the electrical generators is connected with the continuous wires of the line of rails and with the rails directly or with the wires only. It will be seen that the resistance of the lines of rails provided with the continuous conducting-wires will be greatly reduced thereby, since the wires will form a continuous metallic circuit to and from the rails over which the motor is passing, no matter where the motor may be on the track, more or less of the current being conducted through the lines of rails according to the resistance at the joints.

In the drawings, Figure 1 is a perspective view of a portion of two lines of rails having the continuous conducting-wires; and Fig. 2, a cross-section of a rail near the end of the same, showing the fish-plates in elevation.

A and B represent two lines of T-rails. The rails of each line are connected together by fish-plates *a b* and bolts *c*, passing through the fish-plates and rails, as usual. The rails are used as conductors of the current, and are insulated as described in my application No. 466.

E represents continuous conducting-wires, which are placed on one or on each side of the rails of each line, and are clamped by the fish-plates against the ends of the rails. The continuous wire may be bare copper wire, or it can be insulated, except where it passes beneath the fish-plates. The webs of the rails at their ends have the insulation removed therefrom, and are cleaned and preferably electroplated with nickel, silver, or other metal not easily oxidized by exposure to air and moisture, in order to make as good contact as possible with the continuous wires. The conductors from the electrical generators are connected with the wires and also with the rails or with the wires alone. The current is conducted to and from the motor through wheels resting on the rails, and a continuous metallic circuit will be formed to and from the rails over which the motor is passing by the conducting-wires, while part of the current will pass through the rails themselves.

What I claim is—

1. In an electrical railroad, a line of connected rails having its conductivity increased by means of one or more continuous conductors attached thereto, substantially as set forth.

2. In an electrical railroad, the combination, with a line of connected rails, of one or more

continuous conductors attached to such rails and making contact therewith at the joints of the rails, substantially as set forth.

3. In an electrical railroad, the combination, with a line of connected rails, of one or more continuous conductors extending on one or on each side of the rails and clamped by means of the fish-plates against the ends of the rails with which they make electrical contact, substantially as set forth.

This specification signed and witnessed this 7th day of July, 1882.

THOMAS A. EDISON.

Witnesses:

RICHD. N. DYER,

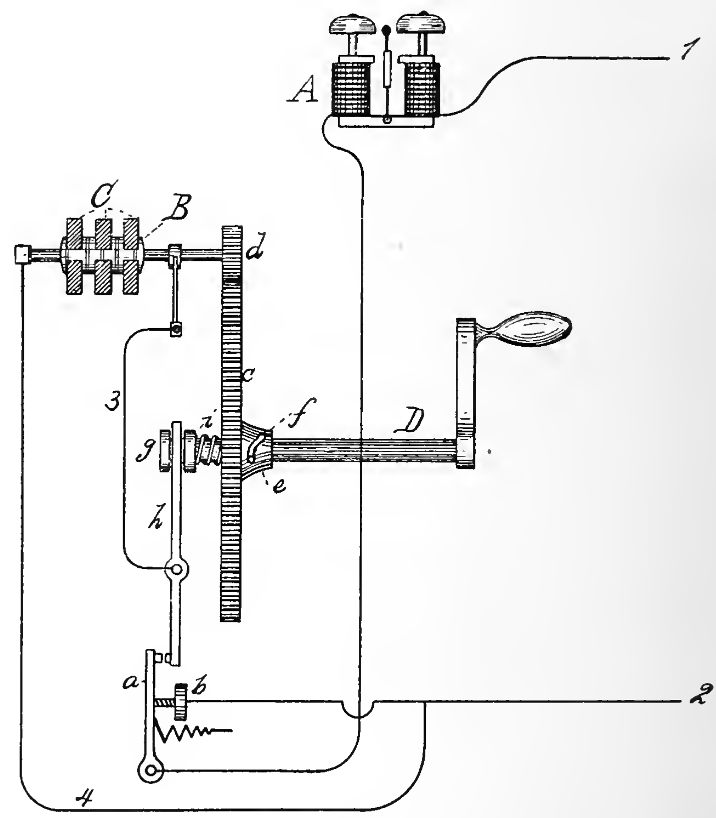
EDWARD H. PYATT.

(No Model.)

T. A. EDISON.

MAGNETO ELECTRIC SIGNALING APPARATUS.

No. 273,714. Patented Mar. 13, 1883.



WITNESSES:

E. C. Rowland,

H. W. Seely.

INVENTOR:

Thomas A. Edison,

By Richd. N. Dyer

Atty.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

MAGNETO-ELECTRIC SIGNALING APPARATUS.

SPECIFICATION forming part of Letters Patent No. 273,714, dated March 13, 1883.

Application filed August 7, 1882. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Magneto-Electric Signaling Apparatus, (Case No. 469,) of which the following is a specification.

Heretofore in magneto-electric signaling apparatus it has been usual to provide means for normally closing a short or shunt circuit around the dynamo or magneto electric machine, and for automatically breaking such shunt-circuit immediately upon and continuously during the operation of the machine, the generator-circuit being kept permanently closed, as described in my application filed September 19, 1881, the purpose being to cut out of circuit the resistance of the generator when not in use by providing a circuit of practically no resistance around it, and to throw the generator into circuit when in use by breaking this shunt-circuit, the whole being done automatically by utilizing the mechanical movement necessary to work the generator.

The object of the present invention is to provide simple and efficient means for automatically throwing the generator into and out of circuit, not dependent upon the making and breaking of a shunt-circuit while the generator-circuit is kept closed. This is accomplished by providing means for automatically closing the main line and opening the generator-circuit when the generator is not in use, and for automatically opening the main line and closing the generator-circuit when the generator is in use.

In carrying out the invention the movement of the crank or wheel in working the generator is utilized to move a lever in one direction, such lever being moved in the other direction by a spring. This lever, when moved by the working of the generator, makes contact with a spring-lever, and separates the same from a contact-point. The main line passes through the latter lever and its contact-point, and hence their separation opens the main line. The first lever is connected with one end of the generator-circuit, while its other end is connected with the main line at or beyond the contact-point of the second lever. When the first lever pushes the second lever from its contact-point the generator-circuit is completed by the contact of the levers, and the generator will throw electric impulses upon the main line, the two levers forming a switch which is worked by the movement required to operate the generator.

In utilizing the movement of the crank-shaft a sleeve may be moved longitudinally on the shaft by the force of turning the crank; but I prefer to move the shaft itself, it being connected with the cog or belt wheel, through which it passes loosely by a pin working in an oblique or triangular slot in the hub of such wheel. The shaft is provided with a grooved collar to work the lever, and is moved longitudinally in one direction by a spring.

The foregoing will be better understood from the accompanying drawing, which illustrates, partly diagrammatically, apparatus embodying the invention.

1 2 represent the main line passing through the coils of the bell-magnet A, and through the spring-lever a and contact-point b, the conductor 1 being connected with the lever a, while the conductor 2 is connected with the contact-point b.

B is the revolving armature of a dynamo or magneto electric machine, the field-magnets C of which are shown in horizontal section. The armature is revolved by crank-shaft D through cog-wheels c d, or two grooved wheels connected by an endless belt. The shaft D passes loosely through the hub of wheel c, and is connected therewith by a pin, e, entering an oblique slot, f, in the hub of said wheel. Shaft D has a grooved collar, g, at its inner end, which receives the end of a pivoted lever, h. A spiral spring, i, moves the shaft D in one direction longitudinally, while it is moved in the opposite direction by the traveling of the pin e in the oblique slot f. The generator-circuit 3 4 is connected with the lever h and with the contact-point b or the conductor 2 beyond said contact-point. Normally when the generator is not in use the main line will be closed at b, and the generator-circuit will be open, levers a and h not being in contact. When the crank-shaft D is turned the shaft will move longitudinally, and lever h will strike lever a, forcing it from contact b and keeping it separated therefrom until the movement is stopped, when it will make contact again with *b*. This movement of lever *h*, forcing *a* from *b*, completes the generator-circuit at the same time that it opens the main line.

What I claim is—

1. In magneto-electric signaling apparatus, the combination, with a dynamo or magneto electric machine, of means for automatically opening the main line and closing the generator-circuit when the generator is in use, and for automatically closing the main line and opening the generator-circuit when the generator is not in use, substantially as set forth.

2. In magneto-electric signaling apparatus, the combination, with a dynamo or magneto electric machine, of a switch operated automatically by the movement required to work the generator, and the main line and generator circuits made and broken alternately by the switch, one circuit being open when the other is closed, substantially as set forth.

3. In magneto-electric signaling apparatus, the combination, with a dynamo or magneto electric machine, of the lever *a* and contact *b*, connected with the main line 1 2, the lever *h*, worked by the movement required to operate the generator, and the generator-circuit 3 4, connected with *h* and with 2, the main line being normally closed at *b*, and the generator-circuit being normally open by the separation of *a* and *h*, substantially as set forth.

4. In magneto-electric signaling apparatus, the combination, with the dynamo or magneto electric machine, of a longitudinally-moving driving-shaft, and means operated by the movement for throwing the generator into and out of circuit, substantially as set forth.

This specification signed and witnessed this 5th day of August, 1882.

THOS. A. EDISON.

Witnesses:
H. W. SEELY,
EDWARD H. PYATT.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

ART OF MALLEABLEIZING IRON.

SPECIFICATION forming part of Letters Patent No. 273,715, dated March 13, 1883.

Application filed August 7, 1882. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in the Art of Malleableizing Cast-Iron; and I do hereby declare that the following is a full and exact description of the same.

My invention relates to the art of rendering cast-iron malleable; and it consists in a new and improved process or method of decarbonizing articles made of cast-iron to the extent necessary to give to the iron the desired degree of malleability.

This improved process or method may be stated in general terms as consisting in removing from the iron by exhaustion and while at a high heat as large a per cent. as possible of the air or gases occluded within its pores, and then replacing such air or gases with an active carbon-reducing agent, to the end that the carbon be speedily eliminated, it uniting with the reducing agent to form a gaseous compound.

In carrying this process into practice I prefer to proceed as follows: The iron article or articles to be rendered malleable are placed in a pot or flask capable of standing a high degree of heat and provided with a connection to an air-pump, so that the air may be exhausted therefrom, and also provided with a connection to a source of supply of a reducing-gas. The pot or flask is also so constructed that it may be closed air-tight. The article or articles are placed in the pot or flask, which is then closed air-tight and subjected to heat sufficient to bring the articles to a white or nearly white heat, whereupon the air is exhausted by the pump from the pot or flask to as great a degree as is readily attainable, the same degree of vacuum of course existing within the pores of the iron. A charge of the active reducing agent chosen in a gaseous state is then admitted to the pot or flask, replacing the extracted gas or air in the pores of the iron, thereby being brought into intimate contact with the carbon and eliminating it by combustion in whole or in part. With very small articles the one exhaustion and one charging so far described might suffice. In practice, however, it is preferable to again exhaust the pot or flask and again charge with the reducing agent and to repeat this sequence of operations until proper malleableization is attained, the heat being kept up constantly during the operations. Good and speedy results are had by using as the carbon-reducing agent oxygen or an oxidizing-gas, which under some conditions may be common air.

The operation of the process may be stated as follows, supposing for the sake of illustrating that an oxidizing agent be employed: The heating opens more freely the physical and mechanical pores of the cast-iron, exposing more fully the carbon in the iron for the action of the agent, while at the same time it tends to expel therefrom a part of the air or other occluded gas, if such there be, by rarefying it. The exhaustion almost completely empties these pores, leaving them in condition to be filled by any gaseous matter presented. On the charge being admitted, it fills them, the oxygen unites with the carbon immediately, in view to form carbonic oxide or acid, which tends to remain in the pores. If the process stopped here, it would so remain, except as displaced by the further diffusion of the oxidizing agent—a slow process. Therefore the pot or flask is again exhausted, and a fresh charge admitted. The results are that cast-iron is rendered malleable in a very short time, the time of treatment being at the most only hours where days are required with the old processes, the malleableization being more thorough and at less cost. After the proper degree of malleability has been attained it is preferable that the articles should for a few minutes be raised to a higher degree of heat than that used during the process.

What I claim is—

1. The improvement in the art of rendering solid cast-iron malleable, which consists in heating the iron to a high heat, then exhausting mechanically any air or occluded gas therefrom, and then charging the iron with an active carbon-reducing agent in gaseous form, substantially as set forth.

2. The improved process of treating solid cast-iron to render it malleable, consisting in inclosing it in an air-tight pot or flask, heating the cast-iron therein, exhausting the air therefrom, and then charging the same with

an active carbon-reducing agent in gaseous form, substantially as set forth.

3. The improved process of treating solid cast-iron to render it malleable, consisting in inclosing it in an air-tight pot or flask, heating the cast-iron therein, exhausting the flask and then charging the same with an active carbon-reducing agent in gaseous form, again exhausting and charging, the two latter operations being repeated as often as necessary, the cast-iron being meanwhile maintained at a high heat, substantially as set forth.

This specification signed and witnessed this 4th day of October, 1881.

THOS. A. EDISON.

Witnesses:

H. W. SEELY,

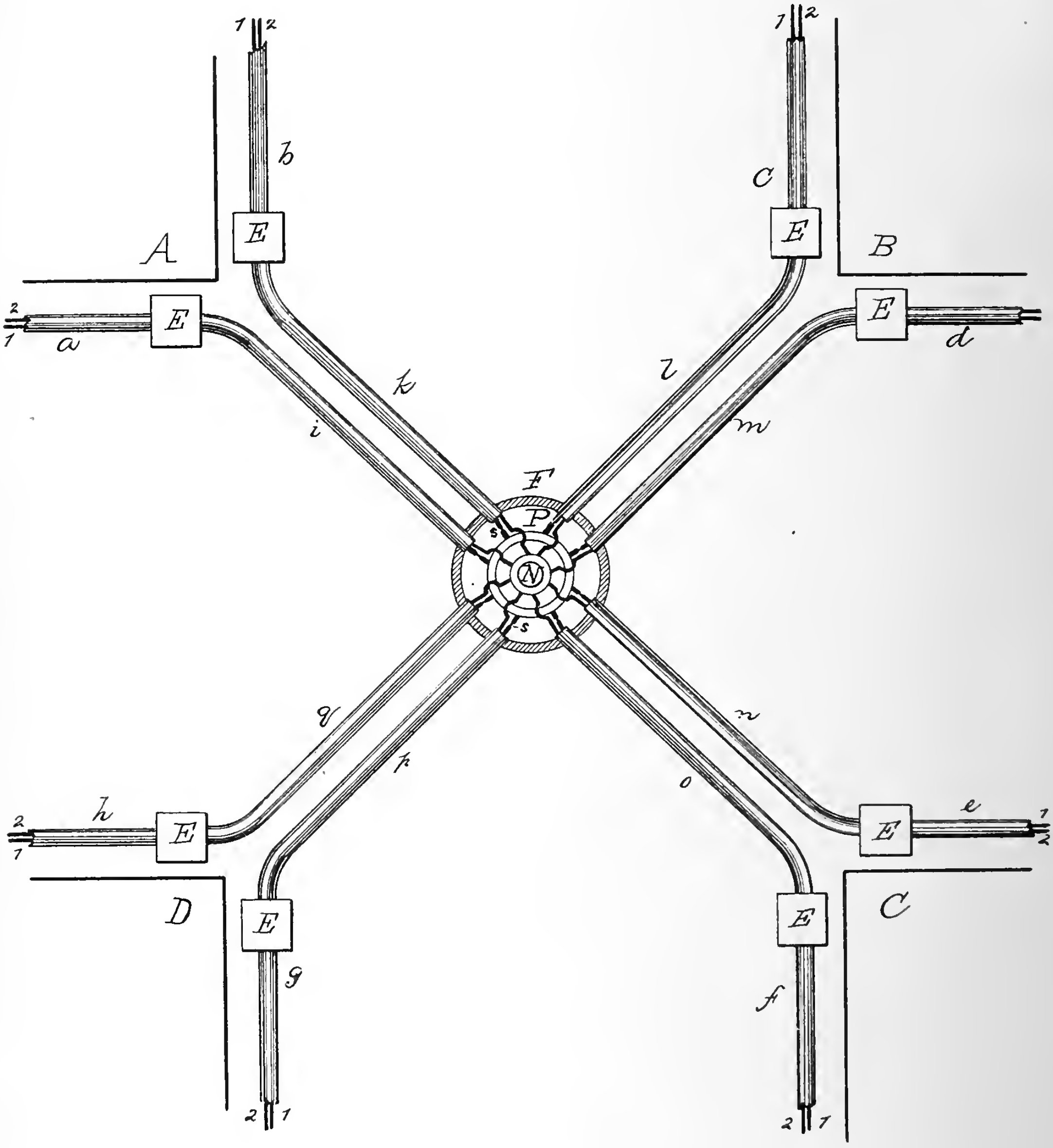
RICHD. A. DYER.

(No Model.)

T. A. EDISON.

SYSTEM OF UNDERGROUND CONDUCTORS FOR ELECTRICAL DISTRIBUTION.

No. 273,828. Patented Mar. 13, 1883.



WITNESSES:
E. C. Rowland
H. W. Seely

INVENTOR:
T. A. Edison
BY Richd. N. Dyer.
ATTORNEY.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

SYSTEM OF UNDERGROUND CONDUCTORS FOR ELECTRICAL DISTRIBUTION.

SPECIFICATION forming part of Letters Patent No. 273,828, dated March 13, 1883.

Application filed August 7, 1882. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Systems of Underground Conductors for Electrical Distribution, (Case No. 421;) and I do hereby declare that the following is a full and exact description of the same, reference being had to the accompanying drawing, and to the letters of reference marked thereon.

I have proposed heretofore, in laying the conductors for my multiple-arc system of electrical distribution, to connect the intersecting conductors at each crossing of two streets at four points by running them into four junction-boxes located at the corners of the blocks or squares, the positive conductors being in this way all connected together, and likewise all the negative conductors, the whole forming a double net-work of intersecting and connected conductors. Each tube was run into a separate box near each corner, and a fusible conductor or "safety-catch" placed in the line of one or each conductor. This plan is set forth in application for patent filed by me October 4, 1881, (Serial No. 43,162.)

The object of the present arrangement is to produce a more convenient manner of arranging and connecting the conductors at the intersection of two streets, making them more accessible for repairs of connections, replacement of safety-catches, or for testing purposes. This I accomplish by connecting the conductors of the eight pairs of conductors at each street intersection and locating the safety-catches at one point. For this purpose the eight tubes carrying the conductors are run to the center of the street intersection, and there enter a single box in which the positive conductors are connected together, as well as the negative conductors, and in which a fusible conductor or safety-catch is placed in the line of each of the positive or negative conductors, or both. This box is provided with a hand-hole and cover at the surface of the pavement for giving easy access to the connections. A similar method of connecting the conductors may, if desired, be employed where one street runs into another without crossing, in which case only six tubes instead of eight would enter the box.

The foregoing will be better understood from the drawing, which is a top view of the parts, the junction-box being in horizontal section.

A B C D are four blocks or squares, along the sides of which run the tubes *a b c d e f g h*, each carrying a pair of conductors, 1 2. From coupling or service boxes E, near corners of the blocks or squares, tubes *i k l m n o p q* run to a box, F, at the center of the intersection of the streets, such tubes being bent to the proper curve for the purpose, which bending does not affect the insulation of the inclosed conductors. The tubes enter the sides of the box F, and the conductors projecting from such tubes are connected to rings or plates P N. Safety-catches or sections of fusible conductor *s* are connected in the line of the positive or negative conductors, or both, within the box F, which safety-catches melt and break the circuit when the flow of current becomes abnormal and before damage is done. The junction-box F has a hand-hole and cover at the surface of the pavement, to give access to the connections.

What I claim is—

1. In a system of underground conductors for electrical distribution, the combination of positive and negative conductors forming complete metallic circuits, laid on opposite sides of intersecting streets, with connections between all the positive conductors and connections between all the negative conductors of the two streets, said connections being made at one point, to which all the conductors run, substantially as set forth.

2. In a system of underground conductors for electrical distribution, the combination of positive and negative conductors, laid in intersecting streets and forming complete metallic circuits, with connections between all of the positive conductors and connections between all the negative conductors of the two streets, said connections being made at one

point, to which all the conductors run, and fusible safety-catches in the several circuits at such point, substantially as set forth.

3. The combination, with the tubes laid on each side of intersecting streets and the pairs of conductors inclosed therein, of a single central box, into which all of such tubes run, and two pole-plates within such central box, to which all the conductors are connected, substantially as set forth.

This specification signed and witnessed this 22d day of May, 1882.

THOMAS A. EDISON.

Witnesses:

EDWARD C. ROWLAND,
C. P. MOTT.

(No Model.) 3 Sheets—Sheet 1.

T. A. EDISON.

SYSTEM OF ELECTRICAL DISTRIBUTION.

No. 274,290. Patented Mar. 20, 1883.

Fig. 1.

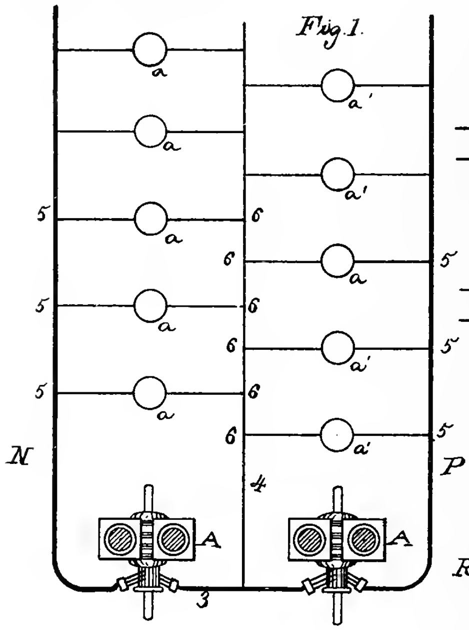


Fig. 2.

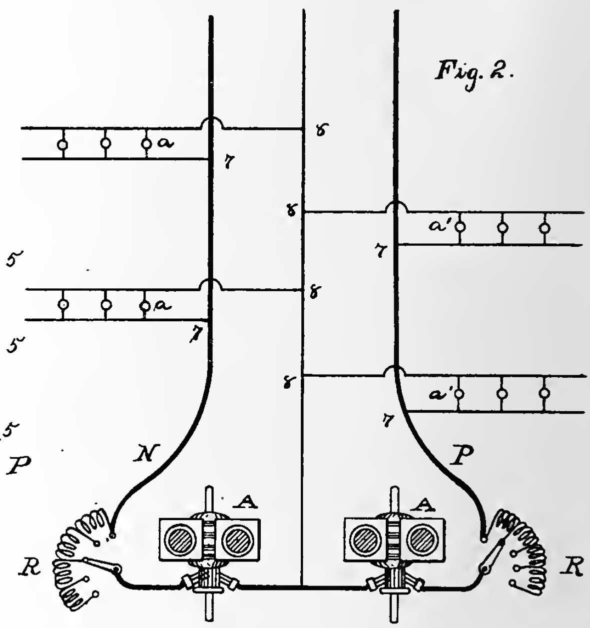


Fig. 3.

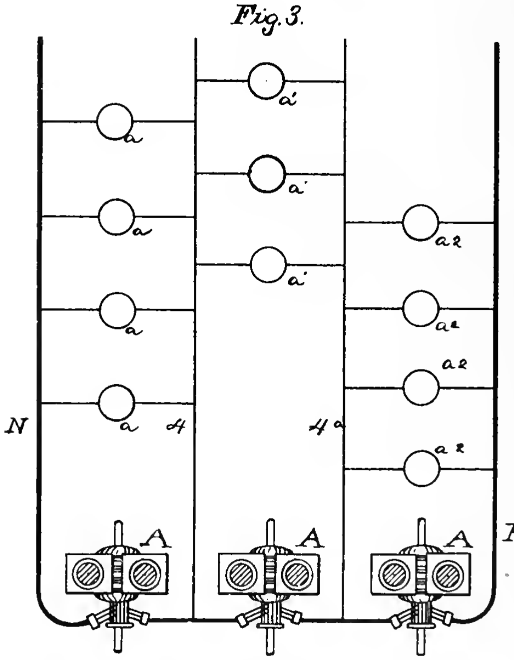
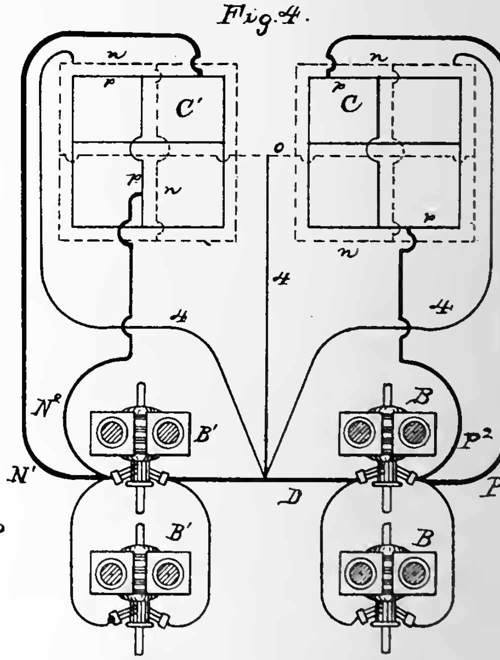


Fig. 4.



ATTEST:

E. C. Rowland

H. W. Seely

INVENTOR:

Thomas A. Edison

By Richd. N. Dyer

Atty

(No Model.) 3 Sheets—Sheet 2.

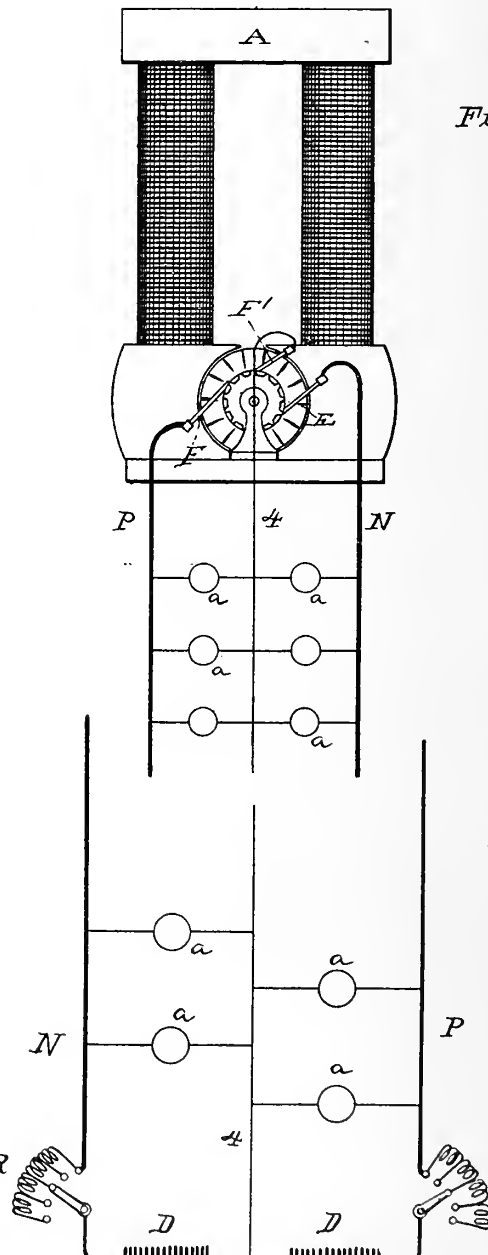
T. A. EDISON.

SYSTEM OF ELECTRICAL DISTRIBUTION.

No. 274,290. Patented Mar. 20, 1883.

Fig 5.

Fig 6



WITNESSES:

E. C. Rowland,
Wm. Seely

INVENTOR:

Thomas A. Edison,
By Richd. N. Dyer,
Atty.

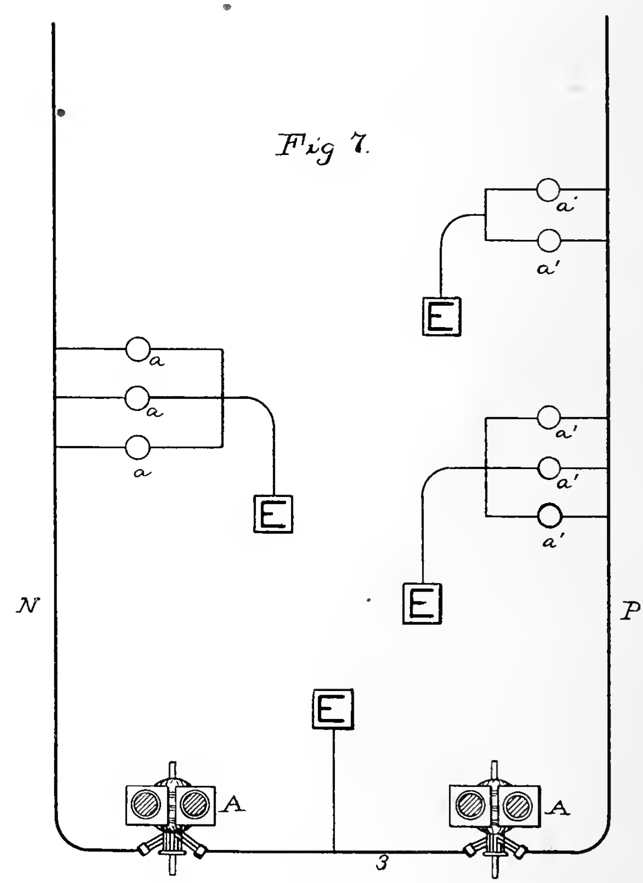
N. PETERS, Photo-Lithographer, Washington, D.C.

(No Model.) 3 Sheets—Sheet 3.

T. A. EDISON.

SYSTEM OF ELECTRICAL DISTRIBUTION.

No. 274,290. Patented Mar. 20, 1883.



WITNESSES:
E. C. Rowland,
W. W. Seely

INVENTOR:
Thomas A. Edison,
By Richd. N. Dyer
Atty.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

SYSTEM OF ELECTRICAL DISTRIBUTION.

SPECIFICATION forming part of Letters Patent No. 274,290, dated March 20, 1883.

Application filed November 27, 1882. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Systems of Electrical Distribution, (Case No. 520,) of which the following is a specification.

In multiple-arc systems of lighting by electrical incandescence in which complete or round metallic circuits are used it may sometimes be desired to employ electric currents of unusually high electro-motive force, so that the size of the conductors which convey said current may be diminished, thus economizing in metal, and allowing the conductors to be placed overhead instead of laid under ground in places where the former arrangement is more convenient. It is also generally desirable in such systems that the incandescing electric lamps or other translating devices should be independent of each other—that is, that such devices shall be independently controllable, so that each lamp can be lighted and extinguished separately and without affecting any others.

To provide a system in which currents of high tension can be used, while at the same time each lamp is entirely independent of all the others, the lamps being also each of the standard or usual resistance, is the object of my invention; and I accomplish this by employing a source of energy of high electro-motive force, arranging the translating devices in multiple series, dividing said source into as many parts as there are translating devices in series in any circuit, and correspondingly dividing each series of lamps, such division being made by means of a central compensating conductor or conductors connected between the divisions of the source of energy, and also between the translating devices, so that when all the devices in any multiple-arc circuit are in use current will pass through all such devices, the current passing across from the positive to the negative main conductor; but if one or more translating devices are removed from any series circuit the excess of current which would otherwise affect the other lamps in the circuit is taken by the compensating central conductor, so that the other lamps remain unchanged. The compensating-conductor is preferably a metallic wire, though the earth might be used for the purpose, if it is so desired.

In carrying out my invention the central station or source of electrical supply for the system may contain one, two, or any desired number of generators, according to the number of translating devices to be supplied with current, such generators developing a high electro-motive force. Such generators are preferably dynamo or magneto electric machines; but secondary batteries may be employed, if desired, and the generators may be connected in any desired manner. If two generators, placed in series, are employed, the compensating-conductor is connected between the two to the wire connecting their armatures, such compensating-conductor extending out between the two main conductors leading from the generators. The multiple-arc circuits which contain the lamps or other translating devices extend across from each main conductor to the compensating-conductor. When equal numbers of lamps are in circuit on opposite sides of the compensating-conductor, no current will traverse such compensating-conductor, the whole amount generated passing out through the positive main conductor across both sets of multiple-arc circuits containing lamps, and back by the negative main conductor, as will be more fully hereinafter explained. Thus the same effect is produced as though two lamps were in series in each multiple-arc circuit, as the current must pass through two lamps to get from the positive to the negative conductor. At the same time, however, such two lamps are independently controllable.

In case lamps are removed from one side of the compensating-conductor, so that the numbers on opposite sides become unequal, a portion of current varying in amount according to the degree of inequality will pass through the compensating-conductor, the direction of such current varying according to whether the positive or the negative side contains the greater number of devices. The system should be so arranged by properly locating the lamps and conductors that at no time can there be a very great inequality between the two sets of lamps. Thus very little current will ever traverse the compensating-conductor, almost the whole passing out through the positive and returning by means of the negative main conductor. The compensating-conductor can therefore be of very small mass, it never being required to convey much current. An adjustable resistance is preferably placed in each main conductor, so that in case the drop in electro-motive force is greater on one main conductor than on the other the resistance may be adjusted to compensate for such inequality. In systems of general distribution such resistances would be placed in the conductors of the feeding-circuits.

It is evident that two or more generators may be placed on each side of the central conductor in series or in multiple arc, if desired.

If currents are to be employed of such high tension that three or more lamps must be placed in each cross-circuit between the positive and negative sides of the main circuit, three or more generators or series of generators may be placed in series, with two or more compensating-conductors extending between the main conductors, such compensating-conductors being connected between the generators or series of generators, the source of energy being thus divided into as many parts as there are lamps in series.

By the use of my invention lamps in different districts connected with separate central stations may be connected in series with each other, the generators of the two stations being connected by a conductor, and compensating-conductors running from convenient parts of the district.

If desired, one generator only might be placed at the central station, having its commutator provided with an extra brush or brushes, placed between the main brushes, from which the compensating conductor or conductors run, such conductors being connected with the multiple-arc circuits between the lamps.

My invention is illustrated in the annexed drawings, in which Figure 1 is a diagram showing an arrangement of two generators in series. Fig. 2 represents a similar arrangement of generators, but a different one of the translating devices. Fig. 3 shows the arrangement of three generators in series. Fig. 4 shows an arrangement whereby lamps in different districts, supplied from separate stations, may be placed in series. Fig. 5 shows the arrangement where one generator is used. Fig. 6 illustrates the use of secondary batteries, and Fig. 7 shows the use of the earth as a compensating-conductor.

In Fig. 1, A A represent dynamo or magneto electric machines connected in series by conductor 3, and having positive and negative main conductors P N extending from them. Midway between the generators the compensating-conductor 4 is attached to conductor 3. Multiple-arc circuits 5 6 extend from the compensating-conductor to each of the main conductors, and each of such multiple-arc circuits contains a lamp or other translating device, those on one side of the compensating-conductor being designated by a, and those on the other by a'. When, as shown, the number of lamps a is equal to that of lamps a', any current which may tend to return through conductor 4 will be neutralized by the current which will meet it from wire 3, so that no current will pass in either direction in said conductor 4; but if a lamp, a', is removed from circuit, so that less current will pass from conductor P to conductor 4, the tendency from wire 3 to wire 4 will be correspondingly greater than the return-tendency, and current due to the inequality will flow in wire 4, which will pass through the lamps a and return through conductor N, while if a lamp or lamps, a, be removed, so that less current will pass from 4 to N, the difference of current will return through conductor 4. Thus the conductor 4 compensates for differences in either side; and while the lamps are independently controllable and any lamp can be removed from circuit without varying the current flowing to the lamps on the opposite side, yet it is evident that currents may be employed of as high tension as though the lamps were arranged in multiple series in the ordinary way.

The arrangement shown in Fig. 2 is similar to that just described, except that here the lamps a and a' are placed across multiple-arc circuits 7 8, derived from the main conductor P N. The same effect is of course produced as just described. The adjustable resistances R R are shown in this figure, which are used to compensate for differences in the drop in electro-motive force of the two conductors.

In Fig. 3 three generators, A A A, are shown in series, there being two compensating-conductors, 4 and 4^a, and three sets of lamps, a a' a^2, the main portion of the current passing entirely across from conductor P to conductor N, and an amount due to differences in the number of translating devices will return through the central conductors. The number of lamps a^2 being greater than a', a portion of current due to the difference will return through conductor 4^a, the remainder passing through lamps a' to conductor 4. The number of lamps a being greater than a', current will flow from the generators through conductors 4 to supply lamps a, which current will return through main conductor N.

In Fig. 4, C and C′ each represent a district to be supplied with electric energy, a central station or source of supply being provided for each district. At one central station generators B B are placed in multiple arc, and at the other generators B′ B′ are similarly arranged. It is desired to connect lamps in district C in series with lamps in district C′. To accomplish this a conductor, D, is run from one station to the other, connecting one pole of each battery of generators together. From the other poles run the feeding-circuits P′ N′ and P^2 N^2, such feeding-circuits being connected with the main conductors of the system. Compensating-conductors 4 are connected at convenient points to said main conductors, all such compensating-conductors being connected at the same point to the wire D between the stations, so that a divided source of electric energy is formed, as in the previous cases. Current flows through feeding-conductors P′ P^2 to main conductors *p p*, thence through cross-circuits containing translating devices to main conductors *n n*, by a conductor, *o*, to district C′, through translating devices to main conductors *p*, and back to the generators by feeders N′ N^2. It is evident that each translating device in district C is in series with one in district C′, though all such devices are independently controllable, the conductors 4 acting to compensate for the removal of any device on either side. It is evident that any desired number of districts might be connected in this manner by proportionately dividing the source of energy, so that currents of very high electro-motive force may be employed. Fig. 5 illustrates the application of my invention to a single generator, A, of high electro-motive force.

The main current is taken from the machine by the commutator-brushes F F, to which are connected the main conductors P N, and an extra brush, F′, is provided between the main brushes, from which runs the compensating-conductor 4. Lamps *a* are arranged as in Fig. 1. The current taken by the extra brush neutralizes the tendency for current to return on the compensating-wire, so that no current traverses that wire so long as the number of translating devices remains the same on each side of the same, while as the numbers vary, current traverses such conductors in one or the other direction, as previously explained.

It is evident that the generator may be still further divided by the use of a greater number of extra brushes and compensating-conductors.

In Fig. 6, D D are secondary batteries, P N being the main conductors, and 4 the central conductor. R R are the adjustable resistances, for the purpose before described. It is evident that with either of the forms described the adjustable resistances R R may or may not be used, as found necessary.

Fig. 7 illustrates the use of the earth as a compensating-conductor, which arrangement may be convenient in some cases, though I usually prefer to use a metallic conductor.

The generators A A are connected by wire 3 in series, and conductors P N extend from them. Translating devices *a′* are connected with conductor P, and also to earth E, and translating devices *a*, connected to conductor N, are also connected to earth. Between the generators A A wire 3 is connected to earth, as shown. It will readily be seen that current will pass through the earth from P to N, and thus through both sets of translating devices in multiple series. An amount of current due to the inequality between the devices *a* and *a′* will, it is evident, pass between wire 3 and the translating devices through the earth in the same manner as explained with reference to the metallic conductor 4 of Fig. 1.

What I claim is—

1. In a system of electrical distribution having translating devices arranged in multiple series, the compensating conductor or conductors connecting the translation-circuits with the source of energy, substantially as and for the purpose set forth.

2. A system of electrical distribution having in combination the following elements, viz: a divided source of electrical energy, main conductors extending therefrom, translating devices arranged in multiple series, and a compensating conductor or conductors connecting the translation-circuits with the source of energy at the points of division, substantially as and for the purpose set forth.

3. In a system of electrical distribution, the combination, with translating devices arranged in series across main conductors, of a source of electric energy divided into as many parts as there are lamps in series, and a compensating conductor or conductors connected between the divisions of the source of energy and between the lamps in series, substantially as set forth.

4. The combination, with a source of electrical energy, of main conductors leading therefrom, translating devices in circuit from said main conductors, a compensating-conductor, and an adjustable resistance in each of said main conductors, substantially as set forth.

This specification signed and witnessed this 20th day of November, 1882.

THOS. A. EDISON.

Witnesses:

H. W. SEELY,

EDWARD H. PYATT.

(No Model.)

T. A. EDISON.

MOLD FOR CARBONIZING.

No. 274,291. Patented Mar. 20, 1883.

Fig. 1.

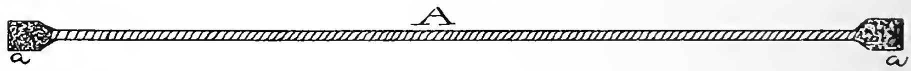


Fig. 2.

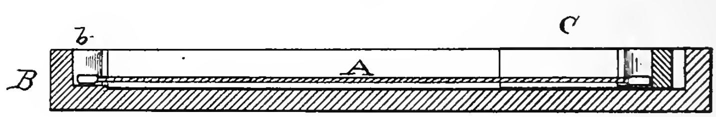
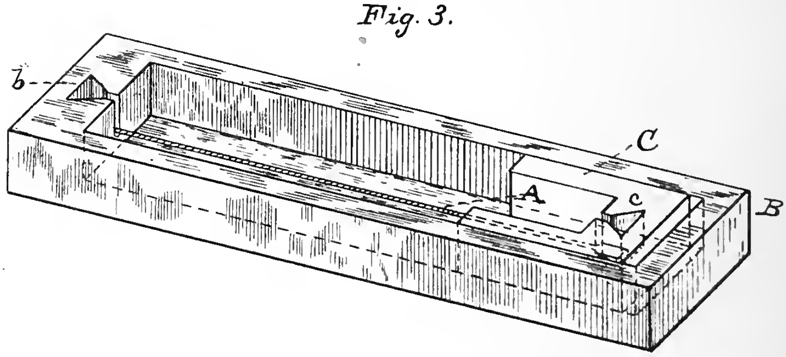


Fig. 3.



ATTEST:

Edw. C. Rowland

H. W. Seely

INVENTOR:

Thomas A. Edison,

By Rich^d. N. Dyer

Atty.

N. PETERS. Photo-Lithographer. Washington, D. C.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

MOLD FOR CARBONIZING.

SPECIFICATION forming part of Letters Patent No. 274,291, dated March 20, 1883.

Application filed December 8, 1882. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Molds for Carbonizing, (Case No. 528,) of which the following is a specification.

In my application No. 515 (Serial No. 77,525) is described an incandescing conductor for electric lamps, formed of a number of fine filaments twisted or otherwise massed together, and having their ends secured by a carbonizable substance.

My present invention relates to the manufacture of such conductors, my object being to provide a mold for holding them during carbonization, which will keep them straight, allow contraction, and prevent the filaments, from untwisting.

While my invention is adapted for use with the twisted filaments described, it may also be employed in carbonizing any straight filaments for the purpose mentioned.

My invention is illustrated in the annexed drawings, in which Figure 1 is an enlarged view of a twisted conductor; Fig. 2, a sectional view of the carbonizing-mold, and Fig. 3 a perspective view of the same.

The conductor A is formed of a number of fine continuous filaments massed together. Such filaments are preferably natural vegetable fibers; but they may be formed of cellulose, paper, parchment, or of fibrous material treated with hydrofluoric acid, or of any desirable carbonizable substance. The ends are secured and enlarged by the addition of a plastic carbonizable material, *a a*.

The carbonizing-mold consists of a box, B, formed of carbon, nickel, or other material capable of withstanding high temperatures. In one end is formed a slot, *b*, of such size and shape as to receive the enlarged end of the filament. At the other end of the mold is set a movable block, C, provided with a slot, *c*, similar to slot *b*. The block C may be of carbon or of nickel, or of nickel covered with carbon. It must, however, have sufficient weight to keep the filament stretched. The slots *b c* do not extend quite to the bottom of the mold, and the filament for carbonization is placed in the mold from above, with the ends resting in the bottoms of the slots and its body kept out of contact with the mold. The filament is kept taut in the mold, which is placed in the carbonizing-furnace, a suitable cover being provided. As the filament contracts the movable block C slides toward the center of the mold, keeping the filament still slightly stretched and preventing the fibers from untwisting.

It is evident that two movable blocks, instead of one, might be employed, which would slide toward each other as the carbon contracts.

It is evident that the mold described can be used for any straight filaments to allow contraction during the carbonization. Filaments formed in this manner are preferably bent into a loop before being placed in the lamp.

Any desired number of filaments may of course be placed one above another in the carbonizing-mold.

In my Patents Nos. 263,139 and 263,144 I have shown and described means for holding a filament in a doubled or looped form, under strain, during carbonization and permitting contraction, the invention herein being limited to the carbonization of straight filaments.

What I claim is—

1. The combination, with a mold for carbonizing filaments, of means for keeping such filaments straight and under strain, and at the same time allowing contraction during carbonization, substantially as set forth.

2. The combination, with a mold for carbonizing straight filaments, of means for holding both ends of a filament fixed, but allowing contraction of the filament, substantially as set forth.

3. The combination, with a mold for carbonizing straight filaments, of one or two movable blocks for holding one or both ends of the filament movably to allow contraction, substantially as set forth.

4. A mold for carbonizing straight filaments, provided with a slot for holding an end of the filament, and a movable block having a similar slot for the other end of the filament, substantially as set forth.

5. The method of manufacturing incandescing conductors for electric lamps, consisting in twisting together a number of fine filaments of carbonizable material, securing their ends, and then carbonizing the whole while under tensile strain, substantially as set forth.

This specification signed and witnessed this 28th day of November, 1882.

THOS. A. EDISON.

Witnesses:

H. W. SEELY,

E. H. PYATT.

(No Model.)

T. A. EDISON.

SECONDARY BATTERY.

No. 274,292. Patented Mar. 20, 1883.

Fig 1.

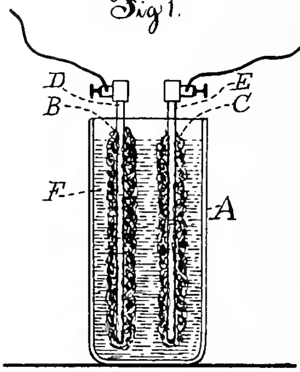
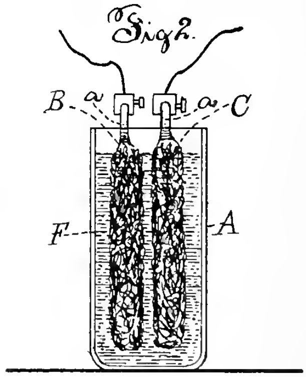


Fig 2.



WITNESSES:

E. C. Rowland

H. W. Seely

INVENTOR:

T. A. Edison by Rich^d N. Dyer Atty

N. PETERS, Photo-Lithographer, Washington, D. C.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

SECONDARY BATTERY.

SPECIFICATION forming part of Letters Patent No. 274,292, dated March 20, 1883.

Application filed August 7, 1882. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Secondary Batteries, (Case No. 439;) and I do hereby declare that the following is a full and exact description of the same, reference being had to the accompanying drawings, and to the letters of reference marked thereon.

Heretofore in secondary batteries the electrodes have been formed of lead plates, or lead plates having oxide of lead secured thereto, or of lead plates carrying chemically-precipitated metallic lead; but all these constructions have defects which detract greatly from their efficiency. The simple lead plates present a very small surface, and hence have a low efficiency, and, in addition, it becomes necessary, for that reason, to reduce the surface of the plates to oxide to a considerable depth. This thick coat of oxide cracks off and separates at points from the plates, producing bad contact and high resistance, and making portions of the oxide inert and reducing greatly the efficiency of the battery. With the second construction—that of the oxide secured to lead plates—the oxide also becomes separated from the lead plates, resulting in bad contact, high resistance, inert portions, and loss of energy. The spongy or chemically-precipitated lead carried by lead plates is also open to the same objection, the precipitated lead not being integral with the plates which carry it or the particles of the lead with one another, and becoming detached from such plates in use.

The object, therefore, that I have in view is to produce electrodes of metallic lead for secondary batteries without the use of chemically-precipitated lead or salts or compounds of lead, which electrodes will be integral throughout and will present an exceedingly large surface, producing a highly efficient battery by a small reduction of the surface of the lead, and not having the defects before stated. This I accomplish by constructing each electrode, or the exposed surface thereof, of integral arborescent metallic lead. This form of lead is obtained by pouring molten lead from a height into water or into powdered material—such as powdered chalk or lime—or by blowing air through molten lead. The crystallization of the lead being disturbed at the moment of setting, the lead assumes an arborescent form, presenting a large surface and being integral throughout its mass. This integral arborescent lead may be fused to lead plates by fusing the surfaces of the plates and pressing the arborescent lead upon them. The arborescent lead is thus made integral with the plates which carry it, the plates forming means for making connection; or molten lead may be blown onto lead plates in dropping from a height, and will be fused with the plates and assume upon them the arborescent form. The electrodes are, however, preferably made entirely of arborescent metallic lead, and they may be so constructed by pouring molten lead into suitably-shaped troughs or receptacles containing water. The arborescent lead will take the shape of the troughs, and lugs for making connections may be formed by pinching or fusing the arborescent lead together. This form of electrodes has openings entirely through it, and has the advantage, in a battery, of bringing the back sides of the outer electrodes into action, increasing the efficiency of the battery.

In the drawings, Figure 1 is a vertical section of a secondary cell having the electrodes made partly of integral arborescent metallic lead; Fig. 2, a similar view of a secondary cell having the electrodes made entirely of such lead.

A is the containing-vessel. B C are the electrodes, made entirely of integral arborescent metallic lead, formed as before explained, with lugs *a* for connections, Fig. 2; or these electrodes may be lead plates D E, having exposed surfaces of integral arborescent metallic lead fused to said plates, Fig. 1. F represents the dilute sulphuric acid of the cell.

What I claim is—

1. An electrode for secondary batteries, formed partly or entirely of arborescent metallic lead and made integral throughout its mass, substantially as set forth.

2. An electrode for secondary batteries, composed of arborescent metallic lead and made integral throughout its mass, substantially as set forth.

This specification signed and witnessed this 3d day of June, 1882.

THOS. A. EDISON.

Witnesses:

RICHD. N. DYER,
EDWARD C. ROWLAND.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

ELECTRIC LAMP.

SPECIFICATION forming part of Letters Patent No. 274,293, dated March 20, 1883.

Application filed October 20, 1882. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Electric Lamps and the Manufacture Thereof, (Case No. 494,) of which the following is a specification.

The object I have in view is to increase the durability in use of the flexible carbon filaments of incandescing electric lamps by reducing as much as possible the "electrical carrying" or attraction of carbon particles from one side of the filament to the other, and from the filament to the glass of the inclosing-globe, which usually occurs in these lamps.

In incandescing electric lamps there is always a small amount of residual gas remaining in the globe after the latter is exhausted, it being of course impossible to produce a complete vacuum. I have found that when such residuum consists entirely or almost entirely of hydrochloric-acid gas the electrical carrying is greatly reduced, and consequently the life of the carbon filament is lengthened.

My invention therefore consists in providing an incandescing electric lamp with a residual atmosphere of hydrochloric-acid gas.

I prefer to accomplish my invention by first exhausting the air from the globe to as great an extent as this can be done with an ordinary air-pump, and then allowing the hydrochloric-acid gas (generated in any suitable manner) to flow into the globe to replace such air. I then re-exhaust the globe and repeat the operation of refilling and re-exhausting several times until the small residue which remains consists almost entirely of hydrochloric-acid gas. The final exhaustion should be done by means of a Sprengel pump, so that as little gas as possible will remain in the globe; or all the operations of exhausting and re-exhausting might be done by means of the Sprengel pump, means being connected with the pump for filling the globe with the hydrochloric-acid gas.

What I claim is—

An incandescing electric lamp whose residual atmosphere consists almost entirely of hydrochloric-acid gas, substantially as set forth.

This specification signed and witnessed this 14th day of October, 1882.

THOS. A. EDISON.

Witnesses:

H. W. SEELY,

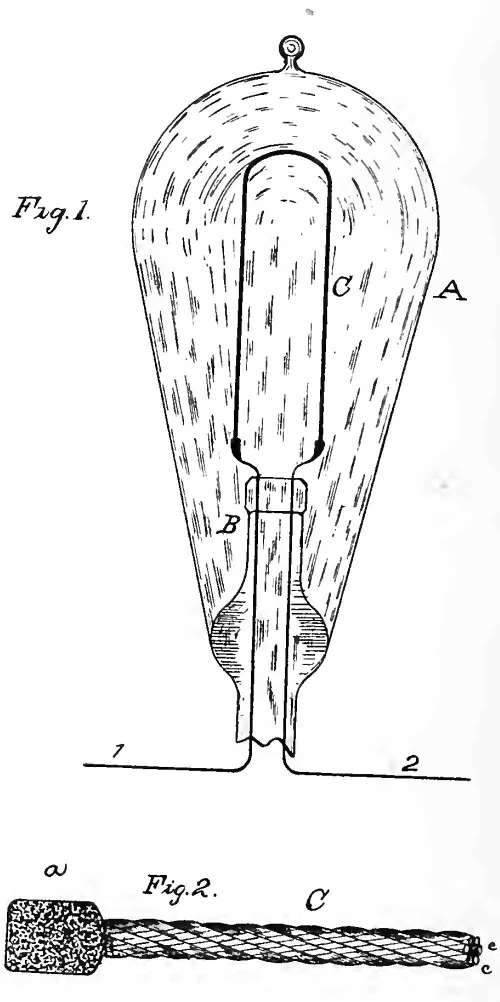
RICHD. N. DYER.

(No Model.)

T. A. EDISON.

INCANDESCING ELECTRIC LAMP.

No. 274,294. Patented Mar. 20, 1883.



ATTEST:

E. C. Rowland

H. W. Seely

INVENTOR:

Thomas A. Edison

By Rich^d N. Dyer

Att'y.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

INCANDESCING ELECTRIC LAMP.

SPECIFICATION forming part of Letters Patent No. 274,294, dated March 20, 1883.

Application filed November 23, 1882. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Incandescing Electric Lamps, (Case No. 515,) of which the following is a specification.

The object I have in view is to produce flexible carbon filaments for the incandescing conductors of electric lamps which shall be of high resistance and of even resistance throughout their length, and shall have great flexibility and toughness, so that they will not be liable to be fractured by the expansion and contraction, more or less unequal, which take place from the lighting and extinguishing of the lamp.

To this end my invention consists in an incandescing conductor for an electric lamp, formed of a number of fine continuous filaments massed together, so as to be in close contact throughout the whole length, and having their ends secured, the said individual filaments being capable of independent expansion and contraction throughout the length of their bodies, between the ends, where they are brought together into solid and homogeneous masses.

In carrying out my invention I preferably take several long and very fine fibers of the same or almost the same length — such as those of ramee, flax, and similar vegetable substances—and twist them tightly together, so as to form a fibrous thread. The ends are secured preferably by a plastic carbonizable substance attached to them, such as a compound of carbon and sugar. The filament thus formed is carbonized under strain or pressure, or both, and may be bent, either before or after carbonization, into the desired form. The plastic compound upon the ends of the filament may form enlarged ends for clamping. The separate filaments are not secured together by carbonization, but remain free, except at their ends, where they become solid homogeneous masses of carbon. The ends of the twisted filament are then attached to the leading-in wires sealed in the stem or tube of a lamp, and are preferably electroplated to such wires, the fibers, before electroplating, being again twisted tightly, so as to bring them all in contact with each other through their entire length. Instead of the process described, the fibers may be carbonized straight and separately, and such carbonized fibers then twisted tightly together. The ends are then attached to the leading-in wires, preferably by electroplating, the fibers being kept tightly twisted during this process. The filament formed in either of the above ways and attached to the leading-in wires is placed in the globe of a lamp in the usual manner, and is ready for the exhausting process.

While, as stated, I prefer to use natural vegetable fibers, it is evident that a conductor of the kind described may be formed of other substances—such as cellulose, paper, parchment, fine thread treated with hydrofluoric acid, &c.—fine filaments of such substances being twisted together, as described. It will be understood that the fiber is reduced to cellulose before the separate filaments are massed together, in order to maintain the individuality of the separate filaments after carbonization. Filaments may, it is evident, be braided or intertwined instead of twisted together.

Filaments formed as described are of unusually even resistance and incandescence, as each of the fibers is continuous, extending the whole length of the filament. The filament is also exceedingly flexible and elastic, and therefore well adapted for the purpose for which it is to be used. The expansion and contraction of the solid carbon filament which take place during the use of the lamp are more or less unequal, and for this reason it is liable to be fractured; but by the use of a carbon filament made up of a number of separate filaments capable of independent expansion and contraction this danger is greatly diminished.

In the accompanying drawings, Figure 1 is a view of an incandescing electric lamp embodying my invention; and Fig. 2 represents a portion of the twisted filament, the size thereof being of course greatly exaggerated.

A is the inclosing globe, and B the inner stem, through which pass the leading-in wires 1 2, to which are attached the ends of the carbon filament C, which is formed of a number of individual fibers, *c c*, twisted together, and secured together at their ends by a plastic substance, *a*.

What I claim is—

1. A flexible carbon filament for the incan-

descing conductor of an electric lamp, formed of a number of separate continuous flexible carbon filaments massed together, substantially as set forth.

2. A flexible carbon filament for the incandescing conductor of an electric lamp, formed of a number of continuous individual carbonized natural fibers massed together, substantially as set forth.

3. A filament for forming, on carbonization, the incandescing conductor of an electric lamp, consisting of a number of separate filaments, of carbonizable material, massed together, and secured at their ends by a plastic carbonizable compound, substantially as set forth.

4. A flexible carbon filament for incandescing electric lamps, formed of a number of separate flexible carbon filaments with their ends connected in solid homogeneous masses, substantially as set forth.

5. The combination, in an incandescing electric lamp, of a chamber made entirely of glass, leading-in wires passing through and sealed in the glass of said chamber, and a flexible carbon incandescing conductor formed of a number of separate filaments massed together and secured to said leading-in wires, substantially as set forth.

This specification signed and witnessed this 13th day of November, 1882.

THOS. A. EDISON.

Witnesses:

H. W. SEELY,

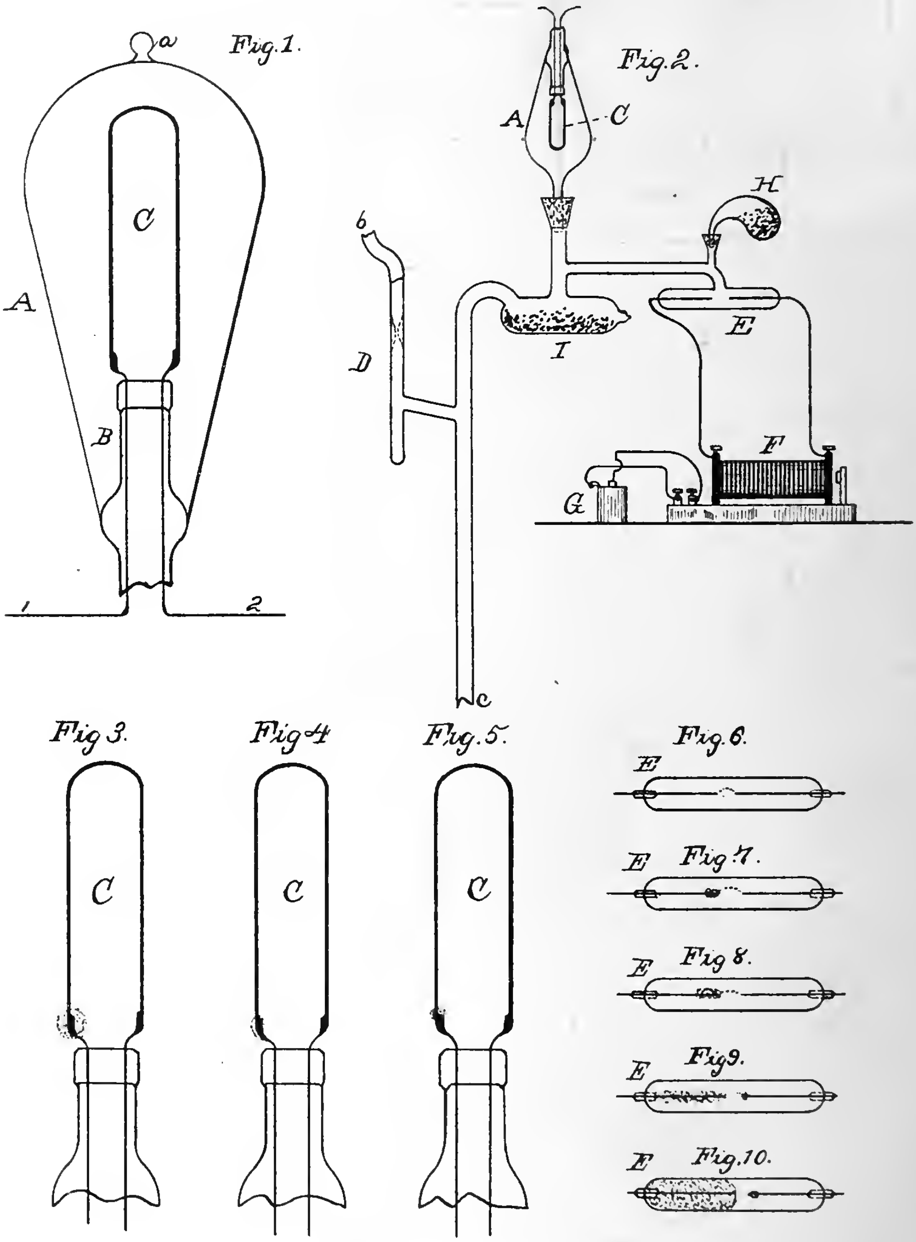
EDWARD H. PYATT.

(No Model.)

T. A. EDISON.

INCANDESCENT ELECTRIC LAMP.

No. 274,295. Patented Mar. 20, 1883.



ATTEST:

E. C. Rowlands

H. W. Seely

INVENTOR:

Thomas A. Edison

By Richd N. Dyer, Atty.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

INCANDESCENT ELECTRIC LAMP.

SPECIFICATION forming part of Letters Patent No. 274,295, dated March 20, 1883.

Application filed November 23, 1882. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Incandescing Electric Lamps, (Case No. 516,) of which the following is a specification.

This invention relates to incandescing electric lamps, wherein flexible filaments of carbon are inclosed in hermetically-sealed chambers made entirely of glass, with leading-in wires passing through and sealed into the glass; and the object of the invention is principally to lengthen the life of electric lamps of this character by diminishing the electrical carrying between the flexible carbon filament and the inclosing-chamber, or the metallic terminals of the filament within the lamp, and incidentally to increase the resistance of the lamp, so as to reduce the investment required for conductors.

Heretofore in electric lamps of this character it has been the general practice to produce high vacua in the glass globes previous to hermetically sealing the same, in order to preserve the carbon filaments from oxidation and to prevent the loss caused by convection of heat which takes place when the globes are filled with an inert gas.

The improvements made by me in the past upon my standard incandescing electric lamps have been principally by increasing the resistance of the flexible carbon filaments without a corresponding increase of the radiating-surface and without diminishing in the least the degree of vacuum; but I find that advance in this direction is limited by reason of the increased deposit of the carbon upon the walls of the glass chamber, obscuring the light and diminishing considerably the exterior candle-power of the lamp, and also consuming and destroying the fine filament, reducing materially the length of life of the lamp.

I have found that the amount of deposit in any given period depends generally upon the degree of incandescence per unit surface to which the carbon filament is raised, the higher the degree of incandescence the more rapid being the deposit. It also depends upon the state of the vacuum, the higher the vacuum the greater being the deposit. This deposit I have discovered is due to electrical carrying of the carbon of the filament, the phenomenon being similar to that which takes place in the well-known Geissler tubes, wherein at certain stages of the vacuum or pressure electrical carrying of the platina forming the terminals takes place, blackening the walls of the glass vacuum-chamber, notwithstanding the platina is scarcely above the temperature of the atmosphere, while at other stages of the vacuum or pressure this blackening does not take place.

I have also discovered that the economy of the carbon-filament lamp (the number of standard lamps per horse-power) increases as the pressure within the globe diminishes, up to a certain stage of the vacuum, when any higher exhaustion does not practically increase the economy. If the vacuum is diminished below this point of greatest economy to prevent electrical carrying, the economy of the lamp is diminished, since the residual air acts as a carrier of heat to the walls of the chamber, where it is rapidly dissipated; but, owing to the greatly diminished electrical carrying of the carbon from the filament when the vacuum is low, I am enabled to diminish the radiating-surface, so as to raise each unit of surface to a higher degree of incandescence than would be practicable were the vacuum higher and the electrical carrying at its maximum; and as an increase in the degree of incandescence is an advance in the direction of economy, I am enabled to regain, by the economy of higher incandescence, the energy lost by the increased convection of heat from the filament to the glass walls of the lamp, caused by the greater density of the residual gas due to a low vacuum; hence a carbon-filament lamp embodying these conditions of low vacuum and high incandescence and resistance will have a longer life than if the vacuum were higher, and its candle-power will not be diminished by the obscuration of the globe by a deposit of carbon. It will also permit of a reduction in the size of conductors for carrying the current to and from the lamps by reason of its increased resistance, and the filament itself will be more flexible and less liable to break.

In carrying out the invention the flexible carbon filament is produced by the carbonization, under strain or pressure, of any suitable organic or inorganic material, reduced or not reduced to an amorphous or semi-amorphous condition in the way now well understood. The filament before carbonization, however, may be reduced to a smaller cross-section than usual heretofore, in order to produce the reduction of radiating-surface and increase of resistance per unit of radiating-surface necessary to compensate for the loss caused by the reduced vacuum. For illustration, it may be stated that the radiating-surface can be reduced in size two-tenths; but the sizes of filaments used by me at present may be retained, the loss in economy being more than counterbalanced by the increased length of life. The flexible carbon filament is secured to the leading-in wires, which are sealed in one glass part of the lamp, and this part is fused to the glass globe of the lamp in the usual or any suitable way. The lamp is then connected with a Sprengel pump, and the globe exhausted until a high vacuum is obtained, so as to remove all oxygen from the globe. During the latter part of the operation of exhausting the lamp the flexible carbon filament may be gradually raised to an incandescence higher than that at which it is intended afterward to be used; but this heating of the filament may be omitted. After the exhaustion of the lamp-globe is completed an inert gas is allowed to pass into the globe, gradually reducing the vacuum and increasing the pressure within the globe. This is preferably done by providing the pump with a tube containing a solid substance, which, when heated, will evolve an inert gas. The heat is applied at the proper time to the exterior of the tube containing the substance. The flexible carbon filament is raised to incandescence during the time that the inert gas is being admitted into the lamp-globe and certain phenomena will be noticed during this period. As the pressure gradually increases a light-blue halo very much spread out will appear upon the positive clamp of the filament. As more gas passes in, the halo will increase in density and hug the clamp. At this pressure carbon from the filament is deposited on the clamp in considerable quantity, which is due to the increase of the electrical resistance of the vacuum and the consequent prevention of deposit upon the globe. If, now, the pressure be further increased, the blue halo leaves the metallic portions of the clamp and appears on the carbon at the juncture of the latter and the metal of the clamp. If, now, the pressure is carried beyond this point, the blue halo will disappear entirely, and the resistance of the residual gas will be so great as to nearly or quite extinguish the electrical carrying. The proper stage being reached, the lamp is sealed off from the pump while incandescent.

The particular pressure at which the lamp should be sealed off is dependent upon the nature of the residual gas. With nitrogen for the inert gas this pressure may be when a mercurial column connected with the lamp stands at a height of about twenty inches; but with hydrochloric-acid gas, on account of its greater electrical resistance, the pressure may be somewhat reduced. At twenty-nine inches with nitrogen and equivalent pressure with other gasses the electrical carrying is greatly diminished. This vacuum of twenty-nine inches or below that height for nitrogen and equivalent pressures with other gases is what I hereinafter term a "low vacuum."

Since the blue halo in the lamp disappears altogether to the eye when a certain pressure is reached, on account of the incandescence of the filament, and since the operation should be carried beyond this point, a Geissler spark-gage may be used to determine the exact point to seal off the lamp, the terminals of the Geissler spark-gage being connected to an induction-coil worked by a constant battery. A mercurial column may be used for the purpose; but the Geissler spark-gage is preferred, for the reason that the electrical carrying depends, where the vacuum is low, both upon the nature of the residual gas and the pressure, which conditions will also affect the Geissler spark-gage, in which the phenomena due to electrical carrying can be observed after their disappearance to the eye in the lamp, while the mercurial column is only affected by the pressure.

The different degrees of exhaustion at which certain phenomena will appear in the spark-gage depend upon the size and distance apart of the electrodes, as well as on the chamber of the gage and on the electro-motive force of the coil; hence it is necessary to determine, in the first instance, by the disappearance of the blue halo from the clamps of the filament, due to increased pressure, the appearance of the spark-gage at the exact moment when the lamp is to be sealed off, which is an increased pressure of several inches of a column of mercury after the disappearance of the halo from the metallic terminals of the filament. The residual gas might be allowed to flow in until the gas within the globe is at atmospheric pressure, and good results would be obtained as far as the electrical carrying is concerned; but the economy would be considerably diminished without a corresponding increase of the life of the filament; hence it is best to diminish the pressure for the sake of economy, but not to the point where the blue halo begins to appear on the metallic terminals of the filament.

Instead of exhausting to a high vacuum with a mercury-pump, and then gradually reducing the vacuum to the proper point by means of an inert gas, the lamp is first exhausted to a high vacuum, and the inert gas is then allowed to flow into the lamp until the vacuum is reduced to atmospheric pressure, when the inert gas may be pumped out until the desired pressure is obtained; or any other way of displacing the oxygen by an inert gas and obtaining the desired pressure may be employed.

The making of the inclosing-chamber entirely of glass, through which the leading-in wires are passed and in which they are sealed, and the hermetical closing of such glass inclosing-chamber, assure the retention of the same conditions of pressure that it is found desirable to give the lamp when manufactured, which is a feature of essential importance in lamps with a low vacuum, as well as with lamps having a high vacuum. Since electrical carrying takes place also with incandescing conductors made of other material than carbon, I do not wish to limit myself to carbon, but intend to include all flexible filamentary incandescing conductors having, like carbon, a high specific resistance.

In the accompanying drawings, Figure 1 is a view of the lamp; Fig. 2, an elevation showing the principal parts of the pump and the devices connected therewith. Figs. 3, 4, and 5 illustrate the phenomena that appear at the positive clamp of the filament, and Figs. 6, 7, 8, 9, and 10 illustrate the phenomena that appear in the Geissler spark-gage.

A is the glass lamp-globe, fused to the inside glass part, B, through which pass the leading-in wires 1 2, such wires being sealed into the upper end of B by the fusion of the glass around and upon them.

C is the flexible carbon filament, secured to the leading-in wires in any suitable way. The globe A is provided with an inert gas at a low vacuum or atmospheric pressure, as before described, and is sealed at *a*.

D is the Sprengel pump, the mercury entering at *b* and passing out at *c*.

E is a Geissler spark-gage, connected with the exhaust-tube of the pump. Its terminals are connected with an induction-coil, F, worked by a constant battery, G.

H is a chamber or tube, also connected with the exhaust-tube of the pump. The tube H contains the solid material for producing the inert gas when the tube is heated. This material may be, for illustration, solid cyanide of mercury, which evolves cyanogen when heated. Other inert gases may, however, be used, being evolved from the decomposition of different salts by heat. The exhaust-tube may be connected with a reservoir of pure inert gas which can be allowed to pass, as desired, into the vacuum by means of a stop-cock; but the method first described is preferred, since it is quite impracticable to manipulate the gas or make it free from oxygen. This difficulty is not met with when the gas is evolved from a solid in a tube by the application of heat to the exterior of the tube, and the heat can be so applied as to set free the exact quantity of gas desired, the quantity being regulated with a nicety and exactness which cannot be obtained with a stop-cock.

I is a chamber or tube containing a drying agent.

Figs. 3, 4, and 5 represent the appearance of the blue halo on the positive clamp at three stages; Fig. 3, when it first appears, which corresponds with nitrogen for the inert gas, to a pressure shown in the mercury column of thirty and three-sixteenths inches; Fig. 4, when it becomes dense and hugs the clamp, which occurs at a pressure of twenty-nine and nine-sixteenths inches; and Fig. 5, when it is about to disappear, which occurs at a pressure of twenty-eight and fifteen-sixteenths inches. Figs. 6, 7, 8, 9, and 10 represent the phenomena of the spark-gage. Fig. 6 shows the spark between the terminals at the atmospheric pressure. Fig. 7 shows a halo on the end of the positive pole, which occurs at twenty inches. Figs. 8 and 9 show it extending along the wire, which occurs at about twenty-nine and five-eighths inches; and Fig. 10 shows the halo spread out so as to touch the walls of the tube, which occurs at thirty and one-fourth inches of the mercury column.

What I claim is—

1. An incandescing electric lamp having, in combination, the following three elements, viz: a flexible carbon filament, an inclosing-chamber, and an inert gas having the definite high pressure described, whereby electrical carrying of the carbon to the walls of the inclosing-chamber or the metallic terminals of the filament within the lamp is prevented, substantially as set forth.

2. An incandescing electric lamp having, in combination, a flexible carbon filament, a hermetically-sealed inclosing-chamber made entirely of glass, leading-in wires passing through and sealed into the glass, and an inert gas having the definite high pressure described, for the purpose set forth.

3. The method of completing incandescing electric lamps having flexible carbon filaments and inclosing-chambers entirely of glass, consisting in exhausting the inclosing-chambers until a high vacuum is obtained for removing the oxygen, then filling the chambers with an inert gas at a pressure sufficiently high to cause the disappearance of the blue halo from the positive clamp of the filament, and then hermetically sealing the chambers by a fusion of the glass, substantially as set forth.

4. The method of completing incandescing electric lamps having flexible carbon filaments and inclosing-chambers entirely of glass, consisting in exhausting the inclosing-chambers until a high vacuum is obtained for removing the oxygen, then raising the filaments to incandescence, then filling the chambers with an inert gas at a pressure sufficiently high to cause the disappearance of the blue halo from the positive clamp of the filament, and then hermetically sealing the chambers by a fusion of the glass while the filaments are incandescent, substantially as set forth.

5. The method of completing incandescing electric lamps, consisting in exhausting the lamp, and at the same time exhausting a chamber connected with said lamp, and containing a material evolving an inert gas when heated, then heating such chamber externally to evolve the gas, then filling the lamp with the inert gas at a pressure sufficiently high to cause the disappearance of the blue halo from the positive clamp of the filament, and then sealing off said lamp from connection with said chamber and the exhausting apparatus, substantially as set forth.

This specification signed and witnessed this 14th day of November, 1882.

THOS. A. EDISON.

Witnesses:
WM. H. MEADOWCROFT,
EDWARD H. PYATT.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

MANUFACTURE OF INCANDESCENTS.

SPECIFICATION forming part of Letters Patent No. 274,296, dated March 20, 1883.

Application filed August 14, 1882. (No specimens.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in the Manufacture of Incandescing Conductors for Electric Lamps, (Case No. 456;) and I do hereby declare that the following is a full and exact description of the same.

The object I have in view is to provide a cheap and efficient material and method for producing flexible carbon filaments for use as the incandescing conductors of electric lamps. This I accomplish by the use of gluten, or a mixture thereof with starch or other material. The gluten is obtained by removing the starch from the flour of cereals; but a part or all of the starch may be allowed to remain mixed with the gluten. A dough or paste is formed of the gluten or gluten and starch with the minimum amount of water, and the dough is then pressed out on polished surfaces into sheets of uniform thickness. Filaments of the desired shape with enlarged ends are punched from the dough and are dried, after which they are carbonized by heat under strain and pressure; or the dough is forced by pressure from a chamber through an orifice in the shape of a long filament, and is cut into proper lengths. Extra pieces of dough are put on the ends of the cut filaments to form the enlarged clamping ends, when the filaments are bent into proper shape and dried, after which they are carbonized by heat under strain and pressure. The filaments made in either way described may be dried under strain or strain and pressure to preserve their shape.

What I claim is—

A flexible carbon filament for incandescing electric lamps, formed of carbonized gluten, or a mixture thereof with other materials, substantially as set forth.

This specification signed and witnessed this 5th day of July, 1882.

THOMAS A. EDISON.

Witnesses:

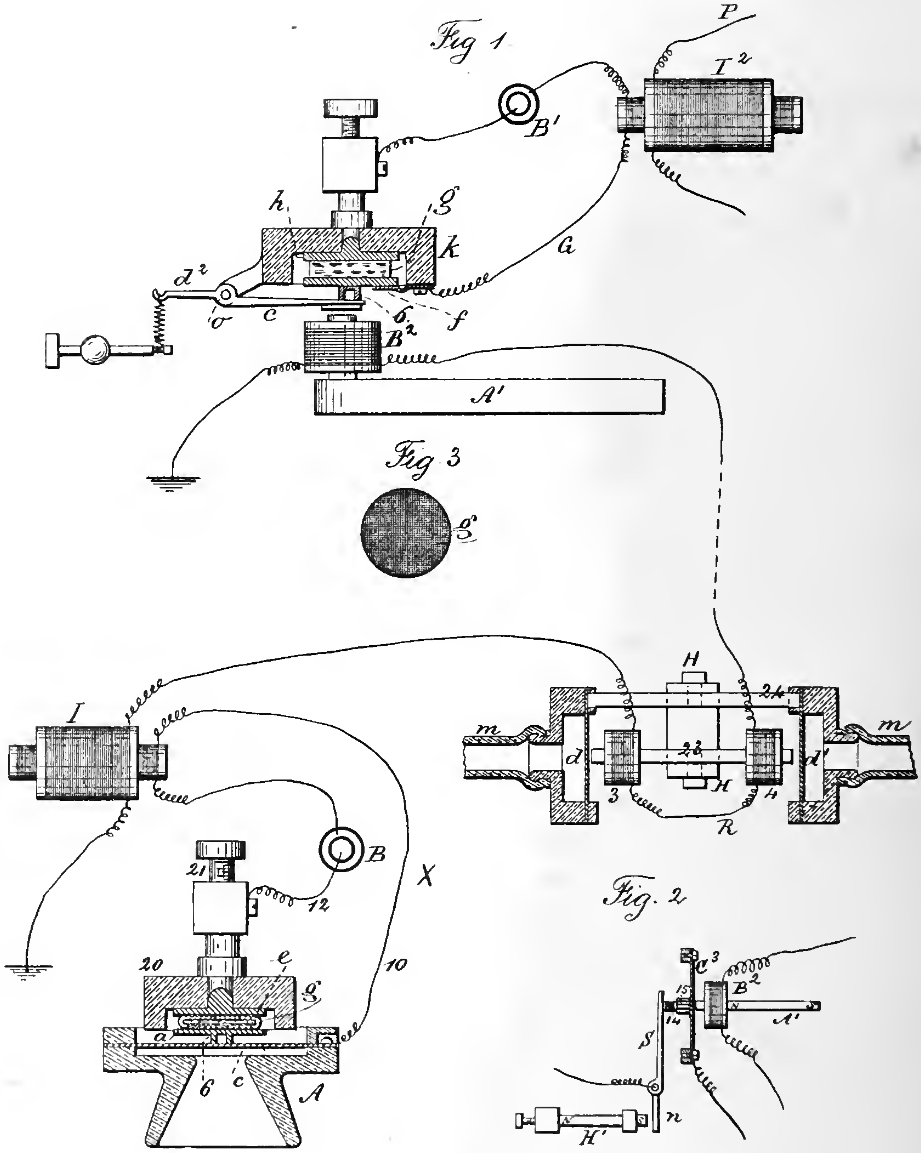
C. P. MOTT,
RICHD. N. DYER.

(No Model.)

T. A. EDISON.

TRANSMITTING TELEPHONE.

No. 274,576. Patented Mar. 27, 1883.



Witnesses
J. Hail.
Chs. H. Smith

Inventor
Thomas A. Edison
per Lemuel W. Serrell atty

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

TRANSMITTING-TELEPHONE.

SPECIFICATION forming part of Letters Patent No. 274,576, dated March 27, 1883.

Application filed October 6, 1882. (No model.)

To all whom it may concern:

Be it known that I, THOMAS ALVA EDISON, of Menlo Park, in the State of New Jersey, have invented an Improvement in Transmitting-Telephones, (Case No. 159[B],) of which the following is a specification.

This application is a division of my application filed November 18, 1878, No. 159, and said division is made for the purpose of separating from the said original application the different features of invention into three additional applications. The present I term "Case No. 159[B]."

In my application No. 130, heretofore filed, the circuit passes through plumbago or similar material, and the diaphragm that is acted upon by the sound-waves serves to vary the electric tension by the extent of surface contact.

In my Case No. 151, patented April 30, 1878, No. 203,016, I have shown an induction-coil with primary and secondary circuits and receiving and transmitting telephones. A carbon button in a circuit and acted upon by the diaphragm is shown in my said Case 151 and also in Case 141. These are not therefore claimed herein.

In my present improvement I make use of a surface or surfaces having numerous points produced by scores or fine lines across the surface, preferably about at right angles to each other, and this surface or surfaces are in the electric circuit and combined with the diaphragm, so that the movement given to the diaphragm by the sound-waves will produce greater or less intimacy of contact at the scored surface and a consequent rise and fall of electric tension. I also combine with a button of carbon or equivalent material in one circuit an electro-magnet in another circuit, the armature of which varies the pressure upon such carbon or other finely-divided material, and by this means repeats the telephonic pulsations. I also construct the telephonic receiver in a peculiar manner to prevent injury by undue currents, such as from lightning, and so that the diaphragms and cores will be polarized by induction, and the line-current will act in two helices to vary the magnetism.

In the drawings, the diagram Figure 1 represents the transmitting, receiving, and repeating instruments, the instruments at X being at one station and the instruments at G being at the repeating-station. Fig. 2 is a detached view of a modification of the repeating-instrument, and Fig. 3 is a face view of the tension-regulator formed by a surface scored with numerous lines.

The telephonic transmitter A is made with a case containing the diaphragm or plate *c*, against which the sound acts to vibrate the same.

The plate *e* is in the bottom of a vulcanite cup or holder, 20, and can be adjusted nearer to or farther from the diaphragm *c* by the screw 21.

The tension-regulating device *g* is between the plate *e* and the second plate, *a*, the wires 10 and 12 of the circuit to the battery B connecting, so that the circuit passes through these plates and the intervening tension-regulator. The tension-regulating device is composed of two contiguous surfaces, one or both of which are scored with numerous fine lines, so as to produce a great number of contact-points. By adjusting the screw 21 the initial pressure can be regulated, and the vibrations of the diaphragm due to the action of sounds will vary the pressure and the extent of surface contact, so as to produce rise and fall of tension in the circuit by bringing more or less of the points on the surface or surfaces into contact.

In Fig. 3 I have shown the surface scored as aforesaid, and it is to be understood that the scoring is to be of the requisite fineness, preferably several thousand to the inch.

In the instrument A, Fig. 1, the tension-regulator is composed of a strip of platina scored by lines of ruling at right angles, and folded, with a piece of felt, rubber, or similar material within the fold, and the scored surfaces in contact with the plates *a* and *e*, respectively. Several layers of foil ruled as aforesaid may be placed together, if desired, to obtain great resistance and variation in the electric tension of the circuit. The foil ruled as aforesaid is believed to operate in the circuit in a similar manner to a carbon button. Between the diaphragm *c* and plate *a* there is a short section of a tube, 6, to form a central bearing.

The inductorium I has its primary included in the circuit to the battery B and tension-regulator and its secondary to the line and ground. The receiving-telephone R is placed in the line-circuit passing through the secondary of the inductorium. At the receiving-instrument R there is a permanent magnet, H, and upon one pole there is a bar, 23, forming at its ends the cores for the helices 3 and 4, that are in the line-circuit; and upon the other pole of the magnet H there is a bar, 24, that is connected at its ends to the diaphragms *d d*. These diaphragms hence are polarized by induction, and are of one polarity—say south—while the cores 3 and 4 are polarized north by induction. Flexible tubes *m*, with ear-pieces, are connected to the chambers or cases holding the diaphragms *d d'*, so that the sound is conveyed to the ears. This apparatus is not liable to become demagnetized, because any current which passes through the helices 3 and 4 acts to increase the induced magnetism at one end of the bar 23 in proportion as it tends to decrease the induced magnetism in the other end. Thus there will be no tendency to injure the permanent magnet H; but the telephonic current will cause the diaphragms to respond by the change of magnetism in the cores adjacent to the diaphragms.

The repeating-instrument at the station G contains an electro-magnet, B^2, the helix of which is in the main-line circuit. Its core is adjacent to an iron plate or armature, and the variation of the magnetism resulting from the action of the current in the main line increases and decreases the pressure upon a button of carbon, *g*, or similar material forming the tension-regulator in a second electric circuit. I have shown the local circuit from the battery B' as passing to the plate *f* at one side of the circuit-regulator *g* and to the adjusting device of the plate *h* at the other side of the carbon or similar material; and in this local circuit is the primary of the inductorium I^2, the secondary of which is in the line P, to the distant receiving-instrument. I prefer to connect the core of the electro-magnet B^2 to one pole of the permanent magnet A', so that it may be polarized by induction, and hence the line-current will increase or decrease the magnetism of the core of B^2. The armature-plate of the magnet B^2 is shown upon a lever, *e*, having a fulcrum at *o*, and the spring at d^2, which should be adjustable, serves to apply an initial pressure to the tension-regulator *g*, and I prefer to use a short cylinder, 6, between the armature-plate and the disk *f*, to insure a central bearing on the tension-regulator. When an electric wave from the distant station varies the power of the magnet B^2 the pressure upon the tension-regulator *g* is decreased or increased, and the primary current from B' acts in the inductorium to translate or reproduce on the second line, P, currents corresponding or proportionate to those sent from the instrument A. The receiving-telephone, being in the main line, responds to the electric waves transmitted by the inductorium as the resistance in the primary of the inductorium is varied by the transmitting-instrument.

The instrument shown in Fig. 2 is a very delicate translator, acting similarly to that in Fig. 1. The electro-magnet B^2 has a helix in the line-circuit, as before, and A' is its polarized core. C^3 is a diaphragm, and S is a lever, the short end *n* of which is attached by an adjustable magnet, H'. Between the lever S and diaphragm C^3 there are the pieces 14 and 15, of carbon or other finely-divided material, that act as a tension-regulator for the translating or repeating circuit that passes through the lever S and diaphragm C^3; hence the rise and fall of electric tension in the repeating-circuit will result from the vibrations of the diaphragm, producing more or less pressure and intimacy of contact in the tension-regulator at 14 15, the initial pressure being determined by the proximity of the magnet H' to the lever S.

It will be observed that in my telephone-instruments I provide an electric tension-regulator having an extended surface, in contradistinction to a point or small bearing such as shown in my application No. 141, and instead of the electric tension-regulator coming directly into contact with the diaphragm, as in my application No. 130, I combine with the electric tension-regulating device an intermediate bearing having a small contact with the diaphragm and the required extent of surface against the tension-regulator. This bearing is non-elastic to transfer more positively to the tension-regulator the tremulous movements of the diaphragm, as distinguished from the yielding material, such as cork or rubber, as shown in my Patent No. 203,016. If the current passes through this non-elastic bearing-piece, as at A, the same is to be of metal or other good conductor.

Certain of the devices shown herein are not claimed, as they form the subject of other applications.

I claim as my invention—

1. In a telephonic transmitter, the combination, with the diaphragm, of one or more metallic plates the surface or surfaces of which are scored with numerous fine lines to form a tension-regulator in an electric circuit, substantially as set forth.

2. In a telephonic transmitter, the combination, with the diaphragm and the electric circuit, of two contiguous surfaces, one of which is scored with numerous fine lines to form a tension-regulator, substantially as set forth.

3. The combination, with the diaphragm in a telephonic transmitter, of a tension-regulator, a metallic surface at each side of the same, and a central bearing between the diaphragm and one of the metallic surfaces that inclose the tension-regulator, substantially as set forth.

4. In a speaking-telephone, the combination, with the diaphragm and the tension-regulator,

of an intermediate bearing of non-elastic material having a small surface in contact with the diaphragm, substantially as set forth.

5. In a speaking-telephone, the combination, with the diaphragm, of two plates or rigid surfaces, an elastic circuit-regulator between the said rigid surfaces, and a non-elastic bearing of small area between one of the rigid plates and the diaphragm, substantially as set forth.

6. In a speaking-telephone, the combination, with the diaphragm and tension-regulator, of two rigid plates or surfaces, one at each side of the tension-regulator, and an adjusting device to regulate the initial pressure upon the tension-regulator and against the diaphragm, substantially as set forth.

7. The combination, in a telephone-instrument, of a diaphragm the edges of which are clamped in a case and a mouth-piece, a tension-regulator, a cup or recess for the same, a non-elastic plate between the tension-regulator and the diaphragm, and a non-elastic bearing against said diaphragm, substantially as set forth.

Signed by me this 30th day of March, A. D. 1882.

THOMAS A. EDISON.

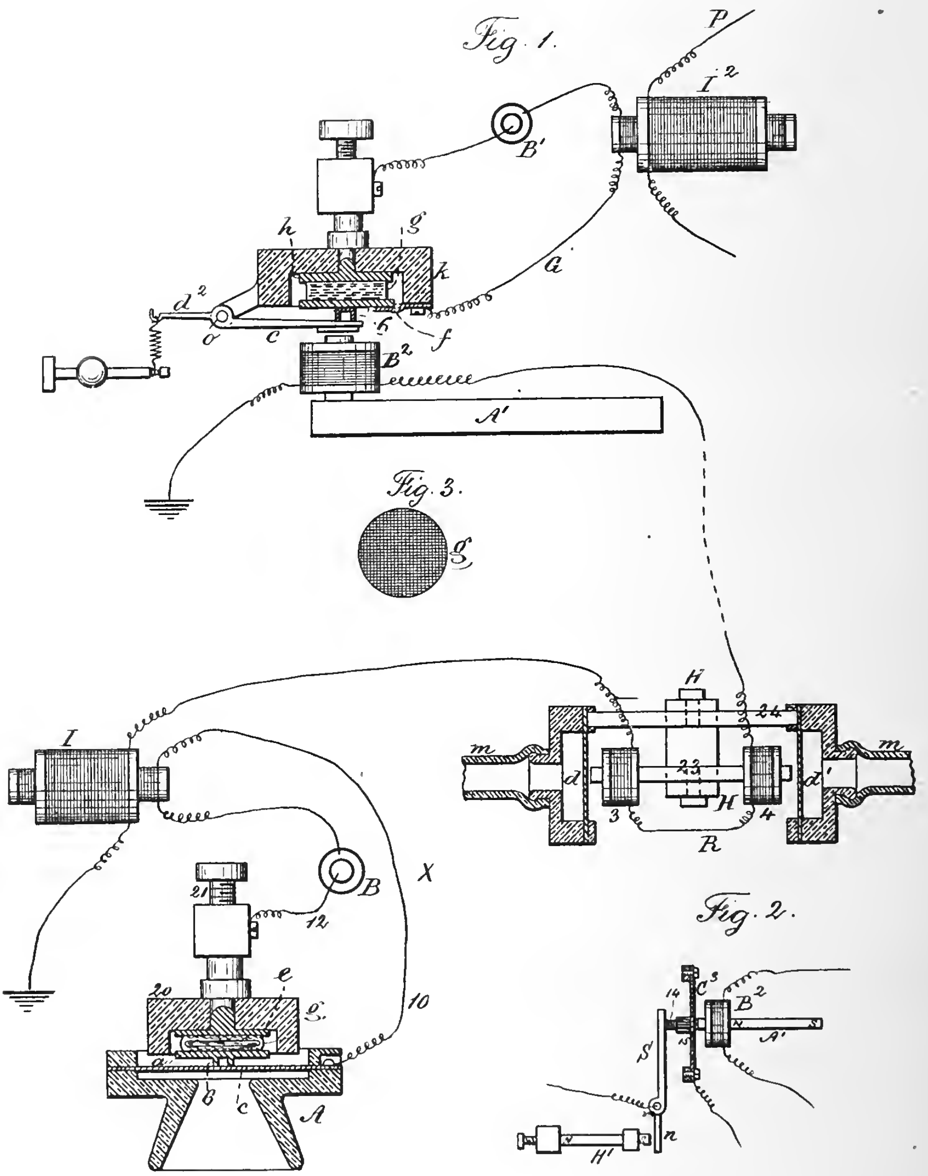
Witnesses:
GEO. T. PINCKNEY,
HAROLD SERRELL.

(No Model.)

T. A. EDISON.

TELEPHONE.

No. 274,577. Patented Mar. 27, 1883.



Witnesses

J. Staib

Chas. A. Smith

Inventor

Thomas A. Edison

per Lemuel W. Serrell atty

N. PETERS. Photo-Lithographer, Washington, D.C.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

TELEPHONE.

SPECIFICATION forming part of Letters Patent No. 274,577, dated March 27, 1883.

Application filed October 6, 1882. (No model.)

To all whom it may concern:

Be it known that I, THOMAS ALVA EDISON, of Menlo Park, in the State of New Jersey, have invented an Improvement in Telephones, (Case No. 159^C,) of which the following is a specification.

This application is a division of my application filed November 18, 1878, No. 159, and said division is made for the purpose of separating from the said original application the different features of invention into three additional applications. The present I term "Case No. 159^C."

In my application No. 130, heretofore filed, the circuit passes through plumbago or similar material, and the diaphragm that is acted upon by the sound-waves serves to vary the electric tension by the extent of surface contact.

In my Case No. 151, patented April 30, 1878, No. 203,016, I have shown an induction-coil with primary and secondary circuits and receiving and transmitting telephones. A carbon button in a circuit and acted upon by the diaphragm is shown in my said Case 151 and also in Case 141. These are not therefore claimed herein.

In my present improvement I make use of a surface or surfaces having numerous points produced by scores or fine lines across the surface, preferably about at right angles to each other, and this surface or surfaces are in the electric circuit and combined with the diaphragm, so that the movement given to the diaphragm by the sound-waves will produce greater or less intimacy of contact at the scored surface and a consequent rise and fall of electric tension. I also combine with a button of carbon or equivalent material in one circuit an electro-magnet in another circuit, the armature of which varies the pressure upon such carbon or other finely-divided material, and by this means repeats the telephonic pulsations. I also construct the telephonic receiver in a peculiar manner to prevent injury by undue currents, such as from lightning, and so that the diaphragms and cores will be polarized by induction, and the line-current will act in two helices to vary the magnetism.

In the drawings, the diagram Figure 1 represents the transmitting, receiving, and repeating instruments, the instruments at X being at one station and the instruments at G being at the repeating-station. Fig. 2 is a detached view of a modification of the repeating-instrument, and Fig. 3 is a face view of the tension-regulator formed by a surface scored with numerous lines.

The telephonic transmitter A is made with a case containing the diaphragm or plate *c*, against which the sound acts to vibrate the same.

The plate *e* is in the bottom of a vulcanite cup or holder, 20, and can be adjusted nearer to or farther from the diaphragm *c* by the screw 21.

The tension-regulating device *g* is between the plate *e* and the second plate, *a*, the wires 10 and 12 of the circuit to the battery B connecting, so that the circuit passes through these plates and the intervening tension-regulator.

The tension-regulating device is composed of two contiguous surfaces, one or both of which are scored with numerous fine lines, so as to produce a great number of contact-points. By adjusting the screw 21 the initial pressure can be regulated, and the vibrations of the diaphragm due to the action of sounds will vary the pressure and the extent of surface contact, so as to produce rise and fall of tension in the circuit by bringing more or less of the points on the surface or surfaces into contact.

In Fig. 3 I have shown the surface scored as aforesaid, and it is to be understood that the scoring is to be of the requisite fineness, preferably several thousand to the inch.

In the instrument A, Fig. 1, the tension-regulator is composed of a strip of platina scored by lines of ruling at right angles, and folded, with a piece of felt, rubber, or similar material within the fold, and the scored surfaces in contact with the plates *a* and *e*, respectively. Several layers of foil ruled as aforesaid may be placed together, if desired, to obtain great resistance and variation in the electric tension of the circuit. The foil ruled as aforesaid is believed to operate in the circuit in a similar manner to a carbon button. Between the diaphragm *c* and plate *a* there is a short section of a tube, 6, to form a central bearing.

The inductorium I has its primary included in the circuit to the battery B and tension-regulator and its secondary to the line and ground. The receiving-telephone R is placed in the line-circuit passing through the secondary of the inductorium. At the receiving-instrument R there is a permanent magnet, H, and upon one pole there is a bar, 23, forming at its ends the cores for the helices 3 and 4, that are in the line-circuit, and upon the other pole of the magnet H there is a bar, 24, that is connected at its ends to the diaphragms d d. These diaphragms hence are polarized by induction, and are of one polarity—say south—while the cores of 3 and 4 are polarized north by induction. Flexible tubes m, with ear-pieces, are connected to the chambers or cases holding the diaphragms d d', so that the sound is conveyed to the ears. This apparatus is not liable to become demagnetized, because any current which passes through the helices 3 and 4 acts to increase the induced magnetism at one end of the bar 23 in proportion as it tends to decrease the induced magnetism in the other end. Thus there will be no tendency to injure the permanent magnet H; but the telephonic current will cause the diaphragms to respond by the change of magnetism in the cores adjacent to the diaphragms.

The repeating-instrument at the station G contains an electro-magnet, D^2, the helix of which is in the main-line circuit. Its core is adjacent to an iron plate or armature, and the variation of the magnetism resulting from the action of the current in the main line increases and decreases the pressure upon a button of carbon, g, or similar material, forming the tension-regulator in a second electric circuit. I have shown the local circuit from the battery B' as passing to the plate f at one side of the circuit-regulator g, and to the adjusting device of the plate h at the other side of the carbon or similar material, and in this local circuit is the primary of the inductorium I^2, the secondary of which is in the line P to the distant receiving-instrument. I prefer to connect the core of the electro-magnet B^2 to one pole of the permanent magnet A', so that it may be polarized by induction, and hence the line-current will increase or decrease the magnetism of the core of B^2. The armature-plate of the magnet B^2 is shown upon a lever, e, having a fulcrum at o, and the spring at d^2, which should be adjustable, serves to apply an initial pressure to the tension-regulator g, and I prefer to use a short cylinder, 6, between the armature-plate and the disk f, to insure a central bearing on the tension-regulator. When an electric wave from the distant station varies the power of the magnet B^2 the pressure upon the tension-regulator g is decreased or increased, and the primary current from B' acts in the inductorium to translate or reproduce on the second line, P, currents corresponding or proportionate to those sent from the instrument A.

The instrument shown in Fig. 2 is a very delicate translator, acting similarly to that in Fig. 1. The electro-magnet B^2 has a helix in the line-circuit, as before, and A' is its polarized core. C^3 is a diaphragm, and S is a lever, the short end, n, of which is attracted by an adjustable magnet, H'. Between the lever S and diaphragm C^3 there are the pieces 14 and 15, of carbon or other finely-divided material, that act as a tension-regulator for the translating or repeating circuit that passes through the lever S and diaphragm C^3; hence the rise and fall of electric tension in the repeating-circuit will result from the vibrations of the diaphragm, producing more or less pressure and intimacy of contact in the tension-regulator at 14 15, the initial pressure being determined by the proximity of the magnet H' to the lever S.

It will be observed that the vibrations of the diaphragm act upon the carbons 14 and 15 to vary the electric tension in the circuit passing through them, and that the magnet H' and lever S form the resistance behind the carbons.

It will be observed that in my telephone instruments I provide an electric tension-regulator having an extended surface, in contradistinction to a point or small bearing such as shown in my application No. 141, and instead of the electric-tension regulator coming directly into contact with the diaphragm, as in my application No. 130, I combine with the electric tension-regulating device an intermediate bearing having a small contact with the diaphragm and the required extent of surface against the tension-regulator. This bearing is non-elastic to transfer more positively to the tension-regulator the tremulous movements of the diaphragm, as distinguished from the yielding material—such as cork or rubber—as shown in my Patent No. 203,016. If the current passes through this non-elastic bearing piece, as at A, the same is to be of metal or other good conductor.

Certain of the devices shown herein are not claimed, as they form the subject of other applications.

I claim as my invention—

1. In a telephone, the combination, with the diaphragm and the tension-regulating device, of a magnet to secure the desired initial pressure upon the tension-regulator, substantially as set forth.

2. The combination, in a telephone, of two electrodes, one of which is connected with the diaphragm, a lever carrying the other electrode, and a magnet acting to secure the desired initial pressure of the electrodes, substantially as set forth.

3. The combination, with a diaphragm, of an electro-magnet in one circuit acting to vibrate such diaphragm, a tension-regulator in an-

other circuit acted upon by such diaphragm, and a yielding-pressure device to apply an initial pressure to the tension-regulator, substantially as set forth.

4. The combination, in a telephone, of a diaphragm, a lever-arm, and two electrodes of carbon or similar material, one of which is connected with the diaphragm and the other with the said arm, substantially as set forth.

Signed by me this 30th day of March, A. D. 1882.

THOMAS A. EDISON.

Witnesses:
GEO. T. PINCKNEY,
HAROLD SERRELL.

United States Patent Office.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

MANUFACTURE OF INCANDESCING ELECTRIC LAMPS.

SPECIFICATION forming part of Letters Patent No. 275,612, dated April 10, 1883.

Application filed October 20, 1882. (No specimens.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in the Manufacture of Incandescing Electric Lamps, (Case No. 491,) of which the following is a specification.

In the manufacture of flexible carbon filaments for use as the incandescing conductors of electric lamps, it is usual to first carbonize the organic fibers from which such filaments are formed, and afterward place them within the lamp-globes, which are then exhausted and sealed off. In this process more or less time must elapse before a carbon filament is placed in its globe. During this time, as carbon is very susceptible to moisture, the filament may absorb a certain amount of moisture from the atmosphere, which may injure it to some extent.

The object I have in view is to remedy this difficulty, and I accomplish this by dipping the filament, after carbonization, in a strong solution of carbonizable material until it becomes coated and its pores become impregnated with such material. The filament is then dried and attached to the leading-in wires, when it is ready to be incorporated into the lamp. After the filament is placed in the lamp such lamp is exhausted of air, preferably by means of a Sprengel vacuum-pump, and during the latter portion of this process of exhaustion, after a nearly complete vacuum is attained, the filament is heated to incandescence by an electric current. This results in the carbonization of the deposited carbonizable material, and a homogeneous flexible carbon filament of high resistence is produced. After the lamp is exhausted to as nearly complete a vacuum as possible it is hermetically sealed by the fusion of the glass. During the time which intervenes between the preparation of a filament and its incorporation into the lamp its surface is covered with the carbonizable substance, and it therefore does not absorb the atmospheric moisture, as it otherwise might. By carbonizing this substance by the heat of an electric current in a vacuum where a minimum of oxygen is present such carbonization is more completely accomplished, the volatile portions being more readily driven off. I prefer to dip the carbonized filaments in a solution of sugar, though many other carbonizable materials may be employed, such as camphor, anthracine, shellac, or substances analogous to these. The substance used is dissolved in its proper solvent and the filament dipped in this solution.

What I claim is—

1. The process of preparing the incandescing conductors of electric lamps, consisting in first carbonizing filaments of the desired material, then soaking the same in a solution of carbonizable material, and then carbonizing the whole in a vacuum, substantially as set forth.

2. The process of manufacturing incandescing electric lamps, consisting in carbonizing a filament of proper material, soaking said filament in a solution of carbonizable material, placing said filament in the lamp-globe, exhausting the air from said globe, the filament being heated to incandescence during the latter portion of the exhausting process, and finally hermetically sealing the globe, substantially as set forth.

This specification signed and witnessed this 14th day of October, 1882.

THOS. A. EDISON.

Witnesses:

H. W. SEELY,

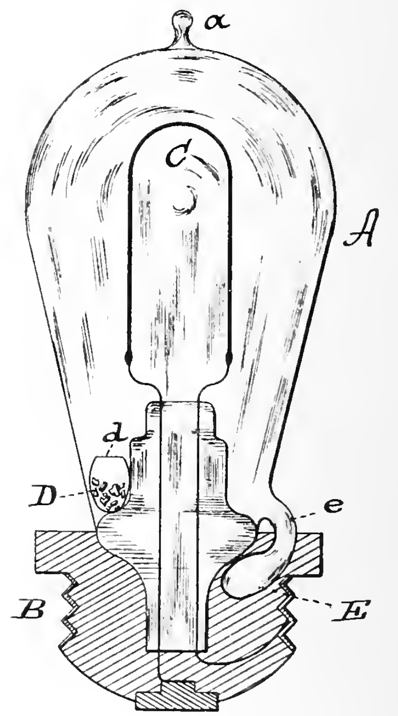
RICHD. N. DYER.

(No Model.)

T. A. EDISON.

INCANDESCING ELECTRIC LAMP.

No. 275,613. Patented Apr. 10, 1883.



WITNESSES:

Thomas E. Birch.

D. W. Mott

INVENTOR:

T. A. Edison

BY Richd. N. Dyer.

ATTORNEY

United States Patent Office.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

INCANDESCING ELECTRIC LAMP.

SPECIFICATION forming part of Letters Patent No. 275,613, dated April 10, 1883.

Application filed August 7, 1882. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Incandescing Electric Lamps, (Case 397;) and I do hereby declare that the following is a full and exact description of the same, reference being had to the accompanying drawings, and to the letters of reference marked thereon.

In my Patent No. 248,416 is described an incandescing electric lamp having crystals of naphthaline or other similar carbon compound placed in the globe for continuously supplying and repairing the waste of the more defective spots of the carbon filament. When the carbon is deposited, however, the hydrogen or other gas is set free and tends to impair the stability of the vacuum.

The object, therefore, that I have in view is to provide means for repairing continuously the waste of the carbon filament during the life of the lamp, and at the same time to maintain the stability of the vacuum. This I accomplish by providing the same lamp with tetrachloride or other chloride of carbon, or preferably with a mixture thereof, with naphthaline crystals or other similar compound of carbon volatilizable at low heat, and with a gas-absorbing heat. The mixture is decomposed into carbon and hydrochloric-acid gas, the carbon being deposited in the form of hard carbon on the defective spots of the carbon filament, and the hydrochloric-acid gas set free being absorbed by the gas-absorbing material, which is preferably charcoal, as such substance is capable of readily absorbing very many times its own bulk of the gas named without materially detracting from its capacity for the absorption of other gases, and will therefore take up, in addition to the hydrochloric-acid gas, all the hydrogen or other gas which may exude from the carbon or the clamps when they are heated. The crystals of chloride of carbon, or a mixture thereof with naphthaline, are preferably inclosed in a small spherical vessel of glass, perforated to permit the escape of the vapors therefrom, and secured by fusion or by a cement to the inside of the lamp, or they may be contained by a tube projecting from the globe. The gas-absorbing material is, as stated, preferably of charcoal, (a dense cocoa-nut charcoal being best for the purpose,) and is placed in a tube closed at its outer end and connected at its inner end with the lower part of the lamp-globe. This tube is heated to a high temperature when the lamp is exhausted, so as to drive the air out of the charcoal, and after the lamp is sealed the tube is bent down and inclosed partly or wholly by the molded base or collar of the lamp.

It is evident that this process of decomposing the vapor of a material containing carbon by the heat of the incandescing carbon filament of an electric lamp in the presence of a gas-absorbing material could be used for building up and equalizing the resistance of such filaments.

The foregoing will be better understood from the drawing, in which the lamp is represented in vertical section.

A is the globe of the lamp, exhausted and sealed off at *a*.

B is the molded base of the same.

C is the carbon filament within A, connected by leading-in wires passing through and sealed into the glass, with terminals on the base B.

D is the chloride of carbon, or mixture of that substance with naphthaline, inclosed in glass vessel *d*, secured by fusion to some point on the inside of the lamp.

E is the charcoal, inclosed in tube *e*, buried in the base B.

In my Patent No. 248,428 I have described a method of removing the gases occluded in the incandescing conductor, consisting in heating the conductor in a high vacuum in the presence of a material which will absorb the gases eliminated from such conductor, and I do not claim such invention herein.

What I claim is—

1. The within-described process of repairing the waste of or building up the incandescing carbon filament of an electric lamp, or equalizing the resistance of such filament, consisting in decomposing the vapor of a material containing carbon by the heat of the incandescing carbon filament in the presence of a material which will absorb the gas set free.

2. An incandescing electric lamp provided with a compound of carbon volatilizable at low

heat and a gas-absorbing material, substantially as and for the purpose set forth.

3. The within-described process of repairing the waste of or building up the incandescing carbon filament of an electric lamp, consisting in decomposing the vapor of a mixture of chloride of carbon and a hydrocarbon by the heat of the incandescing carbon filament in the presence of a substance which will readily absorb the gas set free.

4. An incandescing electric lamp provided with a chloride of carbon vapor for depositing carbon upon the carbon filament by decomposing such vapor by the heat of the filament, substantially as set forth.

This specification signed and witnessed this 10th day of February, 1882.

THOMAS A. EDISON.

Witnesses:
RICHD. N. DYER,
WM. H. MEADOWCROFT.

(No Model.)

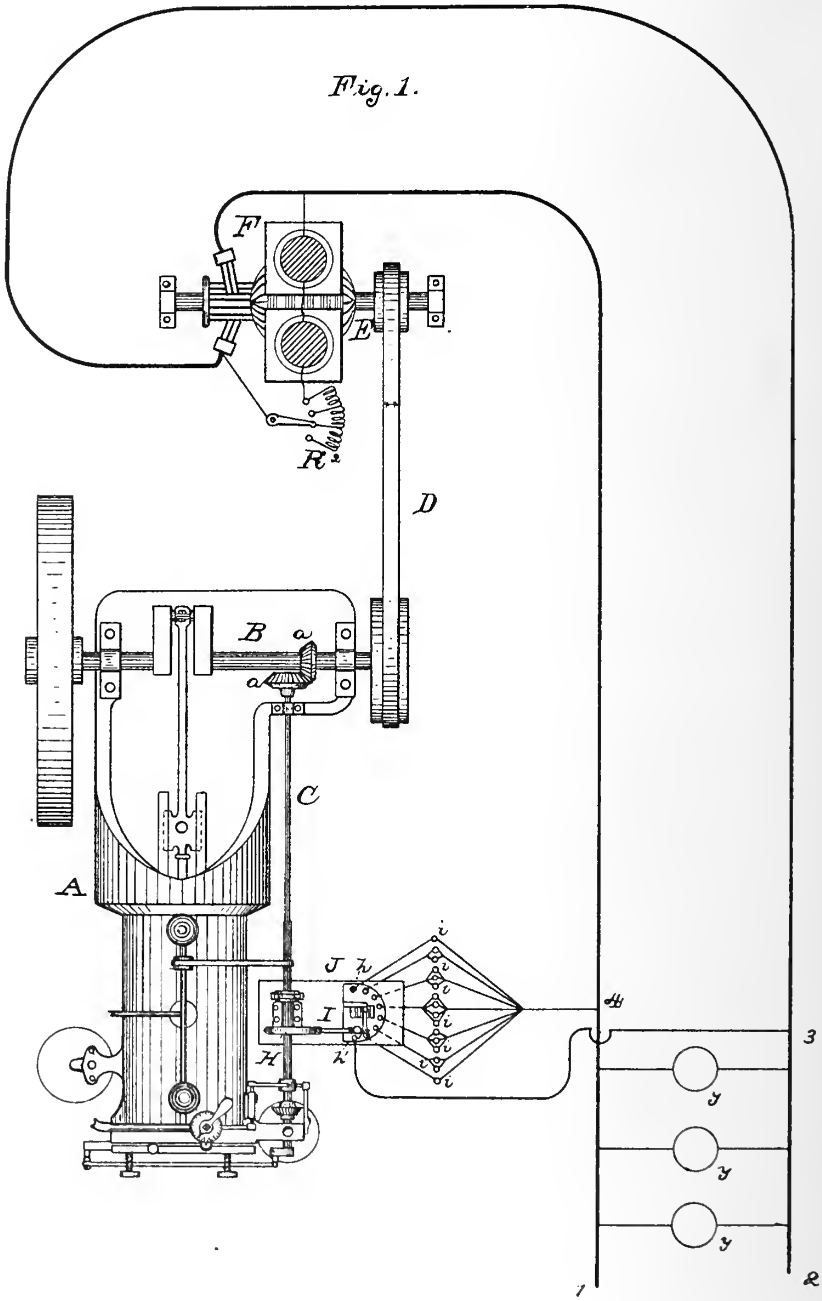
4 Sheets—Sheet 1.

T. A. EDISON.

MEANS FOR OPERATING AND REGULATING ELECTRICAL GENERATORS.

No. 276,232. Patented Apr. 24, 1883.

Fig. 1.



ATTEST:
Edward C. Rowland
Henry W. Seely

INVENTOR
Thomas A. Edison,
By Richd. N. Dyer,
Atty.

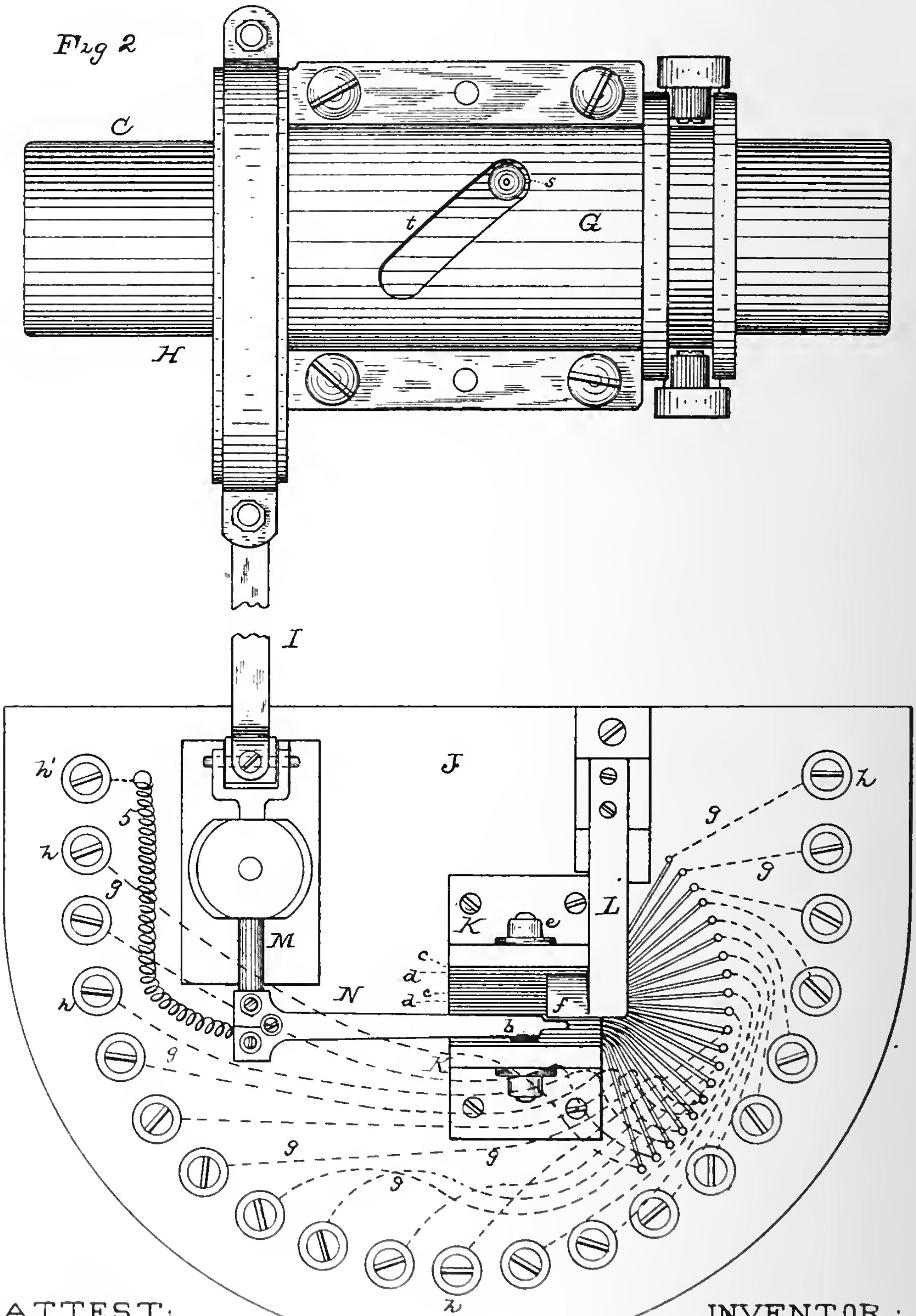
(No Model.) 4 Sheets—Sheet 2.

T. A. EDISON.

MEANS FOR OPERATING AND REGULATING ELECTRICAL GENERATORS.

No. 276,232. Patented Apr. 24, 1883.

Fig 2



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(No Model.)

4 Sheets—Sheet 3.

T. A. EDISON.

MEANS FOR OPERATING AND REGULATING ELECTRICAL GENERATORS.

No. 276,232. Patented Apr. 24, 1883.

Fig. 3.

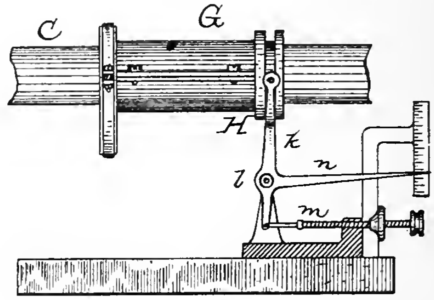


Fig. 4.

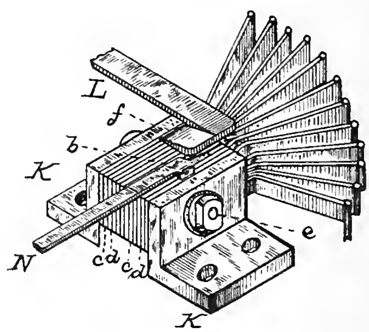
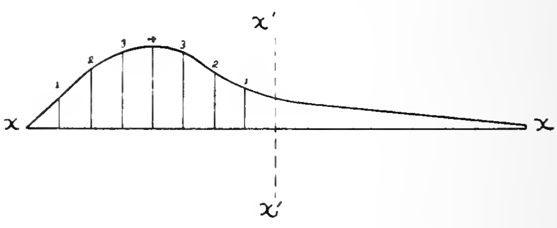


Fig. 5.



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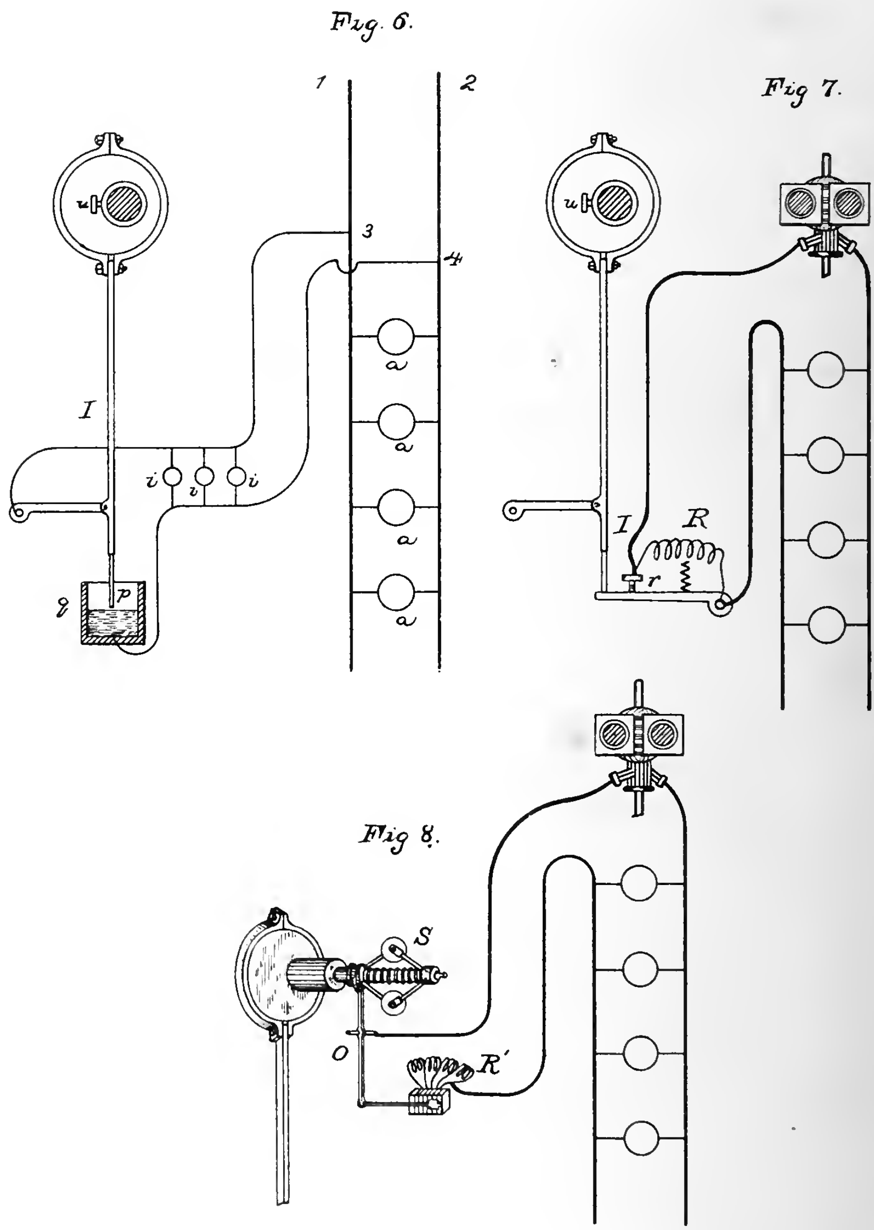
(No Model.) 4 Sheets—Sheet 4.

T. A. EDISON.

MEANS FOR OPERATING AND REGULATING ELECTRICAL GENERATORS.

No. 276,232. Patented Apr. 24, 1883.



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UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

MEANS FOR OPERATING AND REGULATING ELECTRICAL GENERATORS.

SPECIFICATION forming part of Letters Patent No. 276,232, dated April 24, 1883.

Application filed January 8, 1883. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Means for Operating Electrical Generators, (Case No. 532,) of which the following is a specification.

All attempts which have hitherto been made to produce electricity for illuminating and other purposes by employing engines actuated by explosions of gas to drive the rotating armatures of electrical generators have been practically unsuccessful, for the reason that when the explosion occurs the speed of the engine, and consequently that of the armature revolved thereby, is increased, causing an increase in the current generated, while between the explosions the speed gradually declines and the current is diminished. This variation in current of course produces improper effects in the translating devices supplied from the generator; and this is especially the case when the current is employed for incandescent electric lamps, the variations of current causing constant variations in the brilliancy of the lamps.

The object I have in view is to successfully employ gas-engines in operating electric generators which supply current to electric lamps, electro-motors, or other translating devices; and to this end my invention consists in employing, in connection with a gas-engine and the generator or generators driven thereby, means operated automatically by the movement of the apparatus, to compensate for the increase of speed by reducing the proportion of the entire current generated, which is transmitted to the translating devices, such means being caused to operate at the moment when the increase of speed commences, so that practically the same current is supplied to the translating devices as before.

I prefer to employ my invention in connection with a multiple-arc system of lighting by electrical incandescence, though it may be employed with a series system and with arc-lamps or any kind of translating devices.

The generator, which is preferably a dynamo-electric machine having its field and armature coils in multiple-arc relation to each other, but which may have its field energized from an external source, is connected preferably by a belt with the shaft of the gas-engine.

Lamps or other translating devices are placed in multiple arc across main conductors leading from the machine.

Where the "Otto" or other gas-engine is used, in which an explosion occurs at every second revolution of the fly-wheel, a cam or eccentric is placed on the shaft which operates the valves, which shaft revolves with one-half the speed of the main shaft, so that the explosion occurs once during each of its revolutions. This cam or eccentric works an arm whose movement causes a decrease in the proportion of the current generated, which is supplied to the translating devices at the moment of the explosion. Such diminution may be accomplished by throwing resistance into the main circuit; but it is preferable to diminish the proportion of current in the translating devices by closing other multiple-arc circuits, (through suitable resistance,) and thus providing new paths for the current. A number of such multiple-arc circuits, all of the same resistance, may be simultaneously thrown into circuit as soon as the increase of speed occurs; but in a gas-engine the speed gradually increases after the explosion up to a certain point, and then gradually declines. Therefore I prefer to close a circuit of high resistance at the beginning of the increase, and then successively close circuits of gradually-decreasing resistance in the proper proportion until the maximum speed is reached, when the resistances are gradually increased as the speed runs down. To accomplish this I prefer to employ as resistances a number of incandescing electric lamps. One terminal of the multiple-arc circuit from the main line is connected with the circuit-controlling arm worked by the eccentric, while the other terminal is divided into a number of branches, each running to a contact-point. In each of these branches is placed one or more of the resistance-lamps, they being, if more than one is used, in multiple-arc relation to each other, so that the branch containing most lamps is the one of least resistance. The lamps are so arranged that at the first slight increase of speed a circuit containing only one lamp will be closed by the movement of the circuit-controlling arm, while as the speed increases circuits containing two, three, or more lamps are successively closed. As the speed again declines circuits containing less numbers of lamps are closed until near the end of the first revolution. During the second revolution the decline in speed is so small and gradual that the generation of current is practically unaffected by it.

I prefer to use for opening and closing the multiple-arc branches a commutator, which consists of a number of thin metal plates set near together, but separated by plates of insulation. Each metal plate is extended out beyond the insulation and bent so that the plates diverge into a fan shape. Wires connected one to each plate run to binding-posts, from which the wires run which form the circuits including the resistance-lamps. A contact-point placed at the extremity of the circuit-controlling arm slides backward and forwark over the edges of the commutator-plates during each revolution of the valve-shaft; and a thin metal plate is so placed that it will lie between the contact-point and the commutator-plates during that half of the revolution of the valve-shaft during which no explosion occurs, while during the rest of the revolution the contact-point will pass under this plate and be in contact with the edges of the commutator-plates. Thus when the explosion occurs the contact-point, passing over the edges of the commutator-plates, will close the successive multiple-arc branches, while, when the eccentric draws such point back, it will be separated from the commutator-plates by the flat plate mentioned, and said branches are not affected.

As stated, it is preferable to vary the proportion of current supplied to the translating devices gradually. I may, however, accomplish such variation all at once, and this accomplishes the regulation in a very satisfactory manner, although not so perfectly as that just described. In this case the arm attached to the eccentric merely serves to close a circuit, which may be a multiple-arc circuit of the desired resistance, or may act as a shunt around a wire-resistance in the main line. The circuit-controller may be a point dipping into a mercury-cup, and withdrawn therefrom as the arm is moved back and forth; or the circuit may be made and broken at contact-points in any ordinary manner. With all these arrangements means are provided for adjusting the position of the eccentric so that it can be set to act at the proper point.

It is evident that the eccentric might be placed on the main shaft of the engine, on the shaft of the armature, or on any moving part of the apparatus, proper adjustment of the eccentric being made to insure its action at the proper point.

In some gas-engines the air and gas are admitted to the exploding-chamber at such times and in such proportions that the explosions occur irregularly instead of at every other revolution. With such engines an arrangement different from those described is necessary. Such arrangement consists of a spring-governor placed on the valve-shaft or any rotating portion of the engine or generator, and provided with an arm for varying a resistance placed preferably in one of the main conductors. I preferably employ the flat commutator-plates described, with wires running from them and including resistance-coils. As the speed of the engine increases upon the occurrence of an explosion, the movement of the governor throws the resistance-coils into circuit, while, as the speed declines, the contact-arm is drawn back and throws out resistance.

In the accompanying drawings, Figure 1 is a top view, representing a gas-engine, the generator driven thereby, and the compensating devices; Fig. 2, a top view of the eccentric on the valve-shaft and the resistance-commutator; Fig. 3, an elevation illustrating the devices for adjusting the eccentric; Fig. 4, a detail view, in perspective, of the resistance-commutator; Fig. 5, a diagram illustrating the variation in speed of the gas-engine and the times at which the resistance-lamps should be placed in circuit; and Figs. 6, 7, and 8 are diagrams illustrating other forms of the invention.

Referring to the first five figures of the drawings, A represents a gas-engine, B the main shaft of the same, and C the shaft which operates the valves, and is revolved from shaft B by gears *a a*, the shaft C making half as many revolutions as the shaft B. A belt, D, runs from shaft B to the armature-shaft E of a dynamo-electric machine, F. From the generator F main conductors 1 2 extend, across which translating devices *y y* are placed in multiple-arc circuits.

Upon a sleeve, G, on shaft C is mounted an eccentric, H. From the eccentric H runs a rod, I, which terminates in a contact-point, *b*.

Upon a suitable insulating-base, J, are supported edgewise and side by side the series of thin metal plates *c c*, separated by plates *d d*, of mica or other insulating material, the whole being supported and held together by an insulated bolt, *e*, passing through the plates and the standards K K. Supported also from the base J is the flat spring-piece L, which terminates in an inclined plane, *f*, located immediately above the edges of the commutator-plates *c c*.

The rod I, which is attached to the eccentric, is connected with rod M, and to rod M is attached at right angles the contact-arm N, which terminates in a point, *b*, resting on the commutator-plates *c c*. Each commutator-plate extends out beyond the insulating-plates and is bent out from the rest, the whole forming a fan shape, and to each is attached a wire, *g*, passing under the base J, each wire *g* being connected with one of the binding posts *h*. The wire 3 of a multiple-arc circuit, 3 4, from the main conductors 1 2 is connected to a binding-post, *h'*, on the base J, from which a wire, 5, runs to arm N. The wire 4 is divided into a number of branches, as seen in Fig. 1, each connected with one of the binding-posts h. Each of these branches contains one or more resistance-lamps, i, in multiple-arc relation to each other, as shown.

The operation of these devices is as follows: The explosion occuring, as stated, once during each revolution of the valve-shaft C, the eccentric is so adjusted that at the time of the explosion the contact b is in the position shown in Figs. 2 and 4. The motion of the eccentric draws the contact-point along the plates c c, under the piece f, making successive contacts and throwing into circuit first one, then two, three, and four lamps, as the speed increases, and then gradually reducing the number as the speed declines. This is clearly illustrated in Fig. 5, wherein the curve x x shows the increase and decrease of speed during two revolutions of the main shaft and fly-wheel, or one revolution of the valve-shaft, the dotted lines x' x' showing the end of the first revolution. The full vertical lines represent the points at which lamps are thrown in, the figures showing the number of lamps at each point. The decline in speed during the second revolution is so small and gradual that it is not necessary to compensate for it. It is evident that the circuit 34 may be divided into many more parts and lamps thrown in with much greater frequency; that more lamps may be used, if necessary, at points of greatest speed, and that at points of less speed, where a high compensating resistance is desired in the circuit, higher resistance lamps may be used, or two or more lamps in series may be thrown in. During the second half of the revolution of the valve-shaft the contact b slides forward, but now passes over the inclined plane f, and is thus kept from contact with the commutator-plates. It then drops into the position shown in Figs. 2 and 4 in time for the explosion.

The sleeve G, which carries the eccentric H, is made adjustable on shaft C by means of a forked arm, k, attached to said sleeve, pivoted at l, and moved by screwing in and out the rod m, a pin, s, on the shaft moving in a slot, t, so that the movement of the sleeve adjusts the eccentric. A pointer, n, is attached to arm k, moving on a scale, o, by which the position of the eccentric is determined. This adjustment is desirable in order that the eccentric may be made to act at precisely the proper points.

In Fig. 6, a number of resistance-lamps i are in multiple arc across the circuit 3 4. The arm I terminates in a contact-point, p, which enters a mercury-cup, q, and completes the circuit 3 4 at the moment when the explosion occurs, thus throwing the lamps i i into circuit and reducing the proportion of current supplied to the translating devices a a.

It is evident that the eccentric which moves the rod I may be attached to any revolving part of the apparatus. In Fig. 7 the motion of the arm I opens and closes circuit at r, thus throwing a resistance, R, into the main circuit when the speed increases, and closing a shunt around the resistance when the speed diminishes. In Figs. 6 and 7 the eccentric is adjusted by means of a set-screw, u.

The device illustrated in Fig. 8 is intended for use with gas-engines in which the explosive gaseous mixture is not regulated so as to explode at stated regular intervals, but explodes irregularly. A spring-governor, S, is placed on the main shaft or valve-shaft of the engine or on any other revolving part of the apparatus, and an arm, O, attached to the sleeve of said governor, acts to gradually throw the resistance R′ into the main line as the speed increases and to remove it as the speed diminishes.

With all these forms, an adjustable resistance, R^2, (shown in Fig. 1,) should be placed in the field-circuit of the generator to regulate the generation of current according to variations in the number of translating devices in circuit, or other suitable form of regulating device should be provided for this purpose.

What I claim is—

1. The combination, with a gas-engine, a dynamo or magneto electric machine driven thereby, and one or more translating devices supplied with current by said machine, of means for compensating for irregularities in the speed of said engine, whereby a practically constant electro-motive force will be maintained at the translating device or devices, substantially as set forth.

2. The combination, with a gas-engine, a dynamo or magneto electric machine driven thereby, and translating devices supplied with current by said machine, of means for controlling the supply of current to said translating devices to compensate for irregularities in the speed of said engine, so as to maintain a practically constant electro-motive force, substantially as set forth.

3. The combination, with a gas engine, a dynamo or magneto electric machine driven thereby, and translating devices supplied with current by said machine, of means actuated by a moving part of the apparatus controlling the supply of current to the translating devices to compensate for accelerations and retardations in the speed of said engine, substantially as set forth.

4. The combination, with a gas-engine, an electric generator driven thereby, and translating devices supplied by such generator, of means actuated by some moving portion of the apparatus for gradually varying the resistance of the circuit which contains the translating devices to compensate for the gradual accelerations and retardations of the speed of said engine, whereby a practically constant electro-motive force is maintained, substantially as set forth.

5. The combination, with a gas-engine, an electric generator driven thereby, and trans-

lating devices supplied by such generator, of a circuit-controlling device operated by the movement of said engine, and controlling a circuit or circuits whose opening or closure varies the resistance of the circuit containing the translating devices, to compensate for irregularities in the speed of said engine, substantially as set forth.

6. The combination, with a gas-engine, an electric generator driven thereby, and translating devices supplied by said generator, of an eccentric mounted on a revolving portion of the apparatus, and a circuit-controlling device operated by said eccentric and controlling the supply of current to the translating devices, to compensate for irregularities in the speed of the engine, substantially as set forth.

7. The combination, with the gas-engine, the generator, and the translating devices, the last being arranged in multiple arc, of means actuated by the movement of the engine for closing other multiple-arc circuits when the speed of the engine increases, and opening such circuits when the speed declines, substantially as set forth.

8. The combination, with the gas-engine, the generator, and translating devices in multiple arc, of a number of multiple-arc circuits of various resistances, and means actuated by the movement of the engine for successively closing such circuits to compensate for irregularities in speed of the engine, substantially as set forth.

9. The combination, with the circuit-controlling arm carried by the eccentric operated from the shaft of the gas-engine, and the contacts made successively by said arm, of means for keeping said arm from touching said contacts during the revolutions of the shaft in which no explosions occur, substantially as set forth.

10. The combination, with the arm operated by the eccentric and carrying a contact-point which slides on the edges of thin commutator-plates, of means for keeping said point from contact with said plates during one-half of the movement of the eccentric, substantially as set forth.

11. The combination, with the eccentric-operated arm provided with a contact-point and the edgewise commutator-plates, of the spring-plate, over which said contact-point passes in one direction, but under it in the other, substantially as set forth.

12. The combination, with a gas-engine, a dynamo or magneto electric machine driven thereby, and translating devices supplied with current by said machine, of adjustable means for compensating for irregularities in the speed of said engine, whereby a practically constant electro-motive force will be maintained at the translating devices, substantially as set forth.

13. The method of maintaining a constant electro-motive force at the translating devices in a system of electrical distribution whose generator is actuated by an intermittently-operating motor, consisting in varying the proportion of the entire current generated, which is supplied to said translating devices to a degree corresponding to the curve of acceleration and retardation of the speed of said motor, the proportion of current sent to the translating devices being diminished when the speed increases, and vice versa, substantially as set forth.

This specification signed and witnessed this 20th day of December, 1882.

THOS. A. EDISON.

Witnesses:

H. W. SEELY,

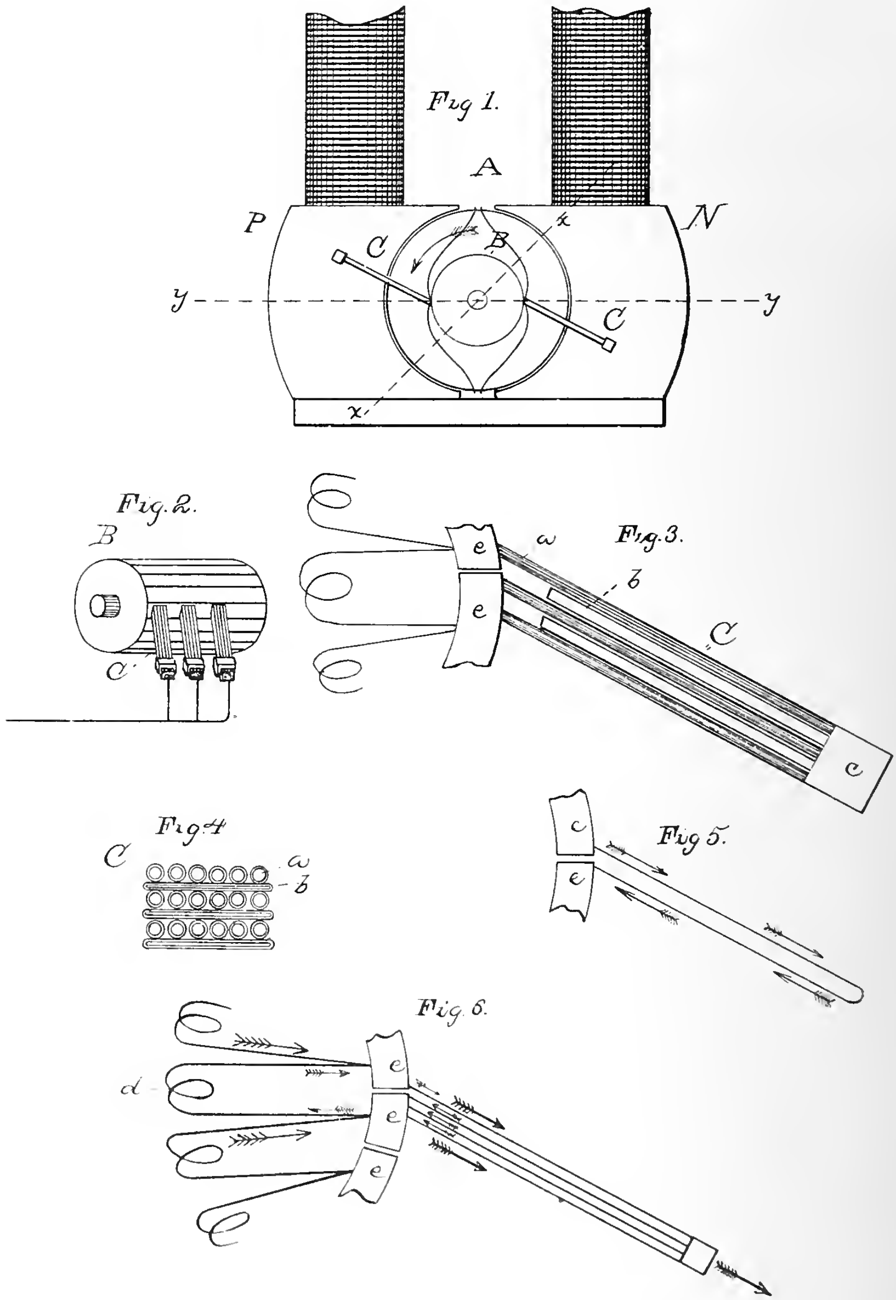
WM. H. MEADOWCROFT.

(No Model.)

T. A. EDISON.

ELECTRICAL GENERATOR AND MOTOR.

No. 276,233. Patented Apr. 24, 1883.



ATTEST:
E. C. Rowland,
H. W. Seely

INVENTOR:
Thomas A. Edison.
By Richd. N. Dyer
Atty.

UNITED STATES PATENT OFFICE

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

ELECTRICAL GENERATOR AND MOTOR.

SPECIFICATION forming part of Letters Patent No. 276,233, dated April 24, 18[illegible]

Application filed November 23, 1882. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Electrical Generators and Motors, (Case No. 517,) of which the following is a specification.

In the working of continuous-current dynamo-electric machines or electro-dynamic motors the increase of the load of such machines causes the neutral line, or the line where there is the least spark, to advance in the direction of rotation, (away from the line of maximum electro-motive force or work,) which I have found is always located on the armature centrally between the polar extensions of the field-magnet. It has been found necessary heretofore to shift the commutator-brushes or current-collectors forward to the neutral line in order to prevent destructive sparks, which are due to the cutting of lines of force produced by the polarity of the armature-core, caused by the current flowing through the armature-coils; but the removal of the brushes away from the line of maximum electro-motive force of the generator reduces the electro-motive force of the machine. With electro-dynamic motors the difficulties are greatly increased, since the load may vary frequently, and, if the brushes are adjusted for the average load, the shifting of the neutral line away from the brushes will be productive of undue sparking, destructive both of the commutator and the brushes.

The object, therefore, of this invention is to produce means whereby the current-collectors or commutator-brushes may be retained at the points of maximum electro-motive force or work of the generator or motor without undue or destructive sparking, the capacity of the machines being thereby largely increased.

It has been the universal practice heretofore to use for the commutator-brushes of machines of this character copper or other metal having good electrical conductivity and making good electrical contact. I have found that the copper brushes, by reason of their great conductivity and good contact, form circuits of very low resistance between the bars of the commutator as they pass over them, and hence short-circuit in succession the coils connecting the pairs of commutator-bars, such coils then forming a local dynamo and generating a powerful local current. The breaking of that short circuit, which takes place when the brushes leave a commutator-bar, causes the destructive spark. The generation of the powerful local currents also causes the heating of the machine and the loss of energy due to such heating.

I reverse the practice heretofore followed, and provide current-collectors of inferior electrical conductivity and contact, compared with copper, so that the bridge formed by each collector across the commutator-bars will have a large resistance compared with the local coils, the circuit of which is completed within the machine by the bridging of the commutator-bars; hence the local current will be very weak and the spark comparatively nothing. With current-collectors of this character I am enabled to keep the collectors at the points of maximum electro-motive force or work, notwithstanding these may not be the neutral points, and by providing a number of such collectors I can get the requisite total conductivity and contact to carry the main current without sparking. The current-collectors, whether in the form of wire brushes, plate-springs, or of other form, are made of some metal or alloy having inferior conductivity, and making inferior contact compared with copper, and preferably having a high melting-point. Nickel, iron, steel, cobalt, platinum, or palladium might be used, or alloys, such as phosphor-bronze or brass; but I prefer to use German silver for the purpose, for the reason that it offers very great resistance and does not lose its stiffness by heat, as most alloys do. The current-collectors, when made as brushes, are made up of layers of wires, which are preferably separated by metal plates, the whole being soldered together into a solid mass at one end. To increase the resistance of the bridge formed by the brush, the layers of wire are preferably insulated from each other. This may be done by japanning the separating metal plates. The wires themselves may also be japanned and the separating-plates omitted or not, as desired. The separating japanned metal plates may be replaced by strips of mica or other suitable insulating material; but the japanned metal is preferred.

The brush has its end bearing on the commutator-cylinder, the ends of all or nearly all the wires being in contact therewith. The current, in passing from one bar to another through the brush, is forced to travel up part of the wires to the solid end of the brush and then down other wires to the other bar, the resistance of the length of the wires being interposed in the local circuit. The high resistance is due not only to the resistance offered by the metal of the current-collectors, but largely to the inferior electrical contact of the collectors on the commutator-cylinder, which occurs when metals or alloys having a conductivity inferior to copper are used for the collectors. The contact-resistance may be further increased by constructing the commutator-bars or surfacing them with such a metal or alloy as has been described, making an inferior electrical contact compared with copper. In addition to the local sparking, there is the sparking due to the taking off of the main current. This latter sparking is of course increased by the inferior contact made by the current-collectors. The sparking due to the main current can be prevented by increasing the number of collectors or the component parts of the collectors to such an extent that the spark due to the main current will be reduced to the minimum by division.

In the accompanying drawings, Figure 1 illustrates a dynamo-electric machine or electro-dynamic motor with commutator-brushes arranged in accordance with my invention; Fig. 2, a view of the commutator, showing several brushes; Fig. 3, a view on a larger scale of two bars of a commutator and the improved brush; Fig. 4, a cross-section of the brush; Fig. 5, an illustration of the course taken by the local current through the electrically-divided brush, and Fig. 6 an illustration showing the course of the local and main currents.

P N, Fig. 1, are the polar extensions of the field-magnet of the generator or motor, A being the armature; B, the commutator-cylinder, and C C the commutator-brushes. The varying neutral line on the commutator-cylinder is represented by the dotted line x x and the line of maximum electro-motive force by the dotted line y y. The armature-coils are connected with the commutator-bars at intermediate points, as indicated by the lines in Fig. 1, bringing the points of maximum electro-motive force on the commutator opposite the center of the polar extensions of the field-magnet. The lines x x and y y correspond with the neutral line and the line of maximum electro-motive force on the commutator, and are perpendicular to corresponding lines on the armature.

Heretofore, in order to prevent sparking, it has been found necessary to shift the brushes onto the line x x; but I am enabled by the peculiar construction of my brushes and the commutator-bars (either or both) to keep them on line y y without sparking. Two or more commutator-brushes connected together are used on each side of the commutator-cylinder to carry the current, as shown in Fig. 2. Each brush may be constructed of layers of wires a, of German silver or other inferior conducting metal or alloy, the layers being divided by metal plates or strips b.

The wires a and plates b are formed into a solid mass by soldering at the outer end, c, of the brush. The plates b are japanned, as are also the wires a, so as to insure a good electrical division of the brush. The brush rests with the ends of all its wires bearing on the commutator-cylinder, as shown. The course of the local current is indicated by the small arrows in Figs. 5 and 6, while the course of the main current is indicated by the large arrows in Fig. 6.

The local coil d, Fig. 6, has its circuit closed at the commutator by the bridge formed by the brush. This bridge, however, is of high resistance compared with the coil d. It is made so by the inferior electrical contact of the brush on the commutator, by the inferior conductivity of the metal of which the brush is made, and also by the electrical division of the brush at its inner or bearing end.

It will be noticed that the local current, in addition to being forced to overcome the resistance offered by the length of the wires, has to overcome the main current in one side of the bridge formed by the brush.

The bars e of the commutator B may also be made of or surfaced with German silver or other suitable alloy or metal, making inferior electrical contact compared with copper. This increases the resistance of the contact and makes the bridges formed by the brushes of higher resistance.

What I claim is—

1. The combination, with an electrical generator or motor, of current-collectors, each forming a bridge of high resistance between the bars of the commutator, substantially as set forth.

2. The combination, with an electrical generator or motor, of current-collectors making inferior electrical contact at the commutator-cylinder of said generator or motor, substantially as set forth.

3. A current-collector for electrical generators or motors, made of inferior conducting material, substantially as set forth.

4. In an electrical generator or motor, the combination, with the commutator, of current-collectors divided electrically at their bearing ends in the direction of the motion of the commutator, whereby the collectors will form bridges of high resistance between the commutator-bars, substantially as set forth.

5. A current-collector for electrical generators or motors, made of inferior conducting material and divided electrically, substantially as set forth.

6. The combination, with an electrical generator or motor, of a commutator-cylinder having its bars made of or surfaced with a material making inferior electrical contact with the current-collectors, substantially as set forth.

7. In an electrical generator or motor, the combination, with the commutator-cylinder, of the current-collectors, the bars of said commutator-cylinder and said collectors being both constructed of or surfaced with a material making inferior electrical contact, substantially as set forth.

8. In an electrical generator or motor, the combination, with the commutator-cylinder, of a number of current-collectors, each offering a high resistance to the local current, and having a combined contact and conductivity sufficient to carry the main current, substantially as set forth.

9. A current-collector made of German silver, substantially as set forth.

10. A commutator having its bars made of or surfaced with German silver, substantially as set forth.

11. A commutator-brush constructed of wires arranged in layers, the several layers being insulated from each other at the bearing end of the brush, substantially as set forth.

12. A commutator-brush constructed of wires, the separate wires being all insulated from each other at the bearing end of the brush, substantially as set forth.

This specification signed and witnessed this 14th day of November, 1882.

THOS. A. EDISON.

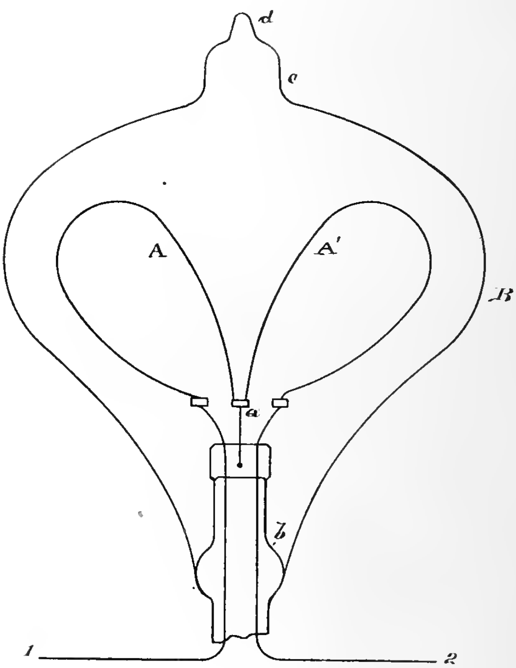
Witnesses:
WM. H. MEADOWCROFT,
EDWARD H. PYATT.

DESIGN.

T. A. EDISON.

INCANDESCING ELECTRIC LAMP.

No. 13,940. Patented May 29, 1883.



ATTEST:

E. C. Rowland,

H. W. Seely

INVENTOR:

Thomas A. Edison,

By Richd. N. Dyer,

Atty.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, ASSIGNOR TO THE EDISON ELECTRIC LIGHT COMPANY, OF NEW YORK, N. Y.

DESIGN FOR INCANDESCING ELECTRIC LAMP.

SPECIFICATION forming part of Design No. 13,940, dated May 29, 1883.

Application filed March 16, 1883. Term of patent 14 years.

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and original Design for Incandescing Electric Lamps, (Case No. 545,) of which the following is a specification.

The object I have in view in producing this design is to imitate in the carbon burner or incandescing conductor of an electric lamp the form of the flame of an ordinary gas-jet—that is, narrow at its lower portion, flaring outwardly toward the top, and depressed in the middle; and the leading feature of my design consists in an incandescing conductor formed in this shape. I prefer to employ also in connection with this conductor an inclosing-globe of substantially similar form.

My invention is illustrated in the annexed drawing, which represents in elevation an incandescing electric lamp formed according to my design.

In this lamp two carbon filaments, A and A′, are used, connected together electrically at *a*. Each filament is looped, as shown, and the two are bent out so as to diverge from each other and form the shape shown. The glass globe B, which incloses this conductor, is blown in a shape whose section is similar in shape to said conductor, it being narrow at the bottom where the supporting-tube *b* is sealed to it, and flaring outwardly to near the top. A projection, *c*, is formed at the top of the globe. The burner thus formed, when rendered incandescent by the electric current, presents an outline similar to that of a gas-flame.

What I claim is—

1. The incandescing conductor of an electric lamp, shaped substantially as shown and described.

2. In an electric lamp, the incandescing conductor, shaped substantially as shown, in combination with an inclosing-globe substantially of the form shown and described.

This specification signed and witnessed this 13th day of February, 1883.

THOS. A. EDISON.

Witnesses:

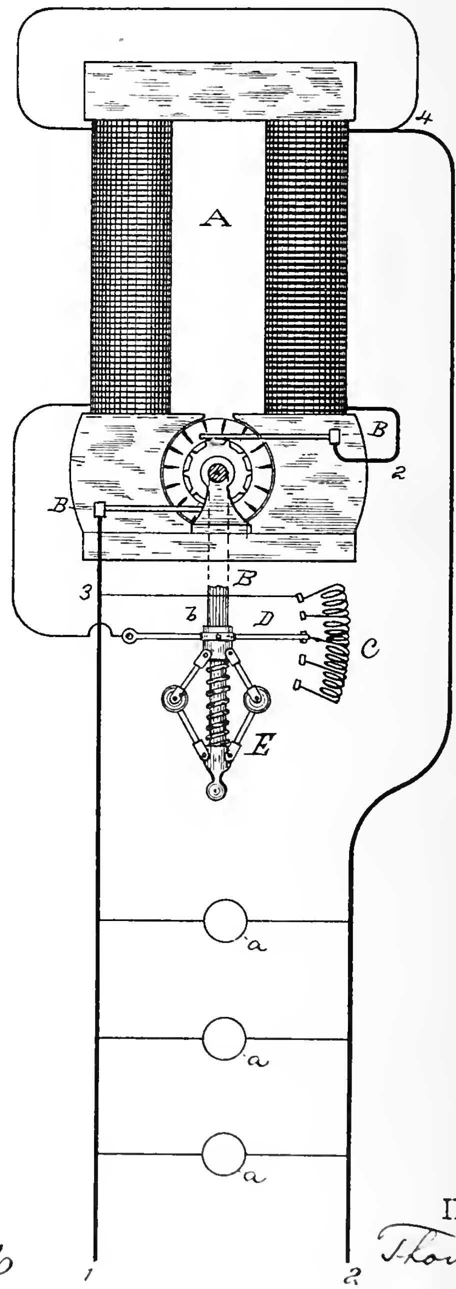
H. W. SEELY,
EDWARD H. PYATT.

(No Model.)

T. A. EDISON.

REGULATOR FOR DYNAMO ELECTRIC MACHINES.

No. 278,413. Patented May 29, 1883.



ATTEST:

E C Rowland

H W Seely

INVENTOR:

Thomas A. Edison

By Rich^d N Dyer
Atty.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, ASSIGNOR TO THE EDISON ELECTRIC LIGHT COMPANY, OF NEW YORK, N. Y.

REGULATOR FOR DYNAMO-ELECTRIC MACHINES

SPECIFICATION forming part of Letters Patent No. 278,413, dated May 29, 1883.

Application filed December 8, 1882. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Regulators for Dynamo-Electric Machines, (Case No. 521,) of which the following is a specification.

In my application No. 72,523 is set forth a method of regulating a dynamo-electric machine by placing a portion of its coils, formed of coarse wire, in the main circuit, and the remaining portion, composed of fine wire, in a multiple-arc circuit therefrom, whereby variations in the number of translating devices in circuit, by oppositely varying the current in the two portions in proper proportions, regulated the generation of current by the machine according to the requirements of the system.

My present invention relates to an improvement upon regulators of this kind, which regulate only for variations in number of translating devices, by which improvement I am enabled to regulate for variations in the speed of the armature, as well as for differences in the number of translating devices in circuit.

Such invention consists in combining with a dynamo-electric machine, having its field-magnet coils so connected that variations in current on the main line vary directly the energy of the magnet, mechanical means operated by variations in speed of the armature to regulate the current energizing the field-magnet, as required by such variations.

A simple and convenient manner of carrying out my invention consists in winding the field-magnet as above described, and placing in the multiple-arc circuit, which includes the fine-wire coils, a resistance adjustable by means of an arm carried by a spring-governor placed on the shaft of the armature, or attached to any other revolving portion of the apparatus. Such governor acts to throw out resistance when the speed of the armature is diminished, and to increase the resistance if the speed is too much increased.

My invention is illustrated in the accompanying drawing, which is a view partly in diagram of a dynamo-electric machine with the accompanying devices and circuits.

A is the field-magnet, and B B are the commutator-brushes, from which main conductors 1 2 lead in multiple-arc circuits, from which are placed lamps or other translating devices, *a a*. Conductor 2 is wound around one limb of magnet A, as shown, and a multiple-arc circuit, 3 4, of finer wire, includes the other limb; or the fine-wire circuit 3 4 could cover both limbs, and the coarse wire be wound above the whole, or a portion of it.

For convenience in drawing, a top view of the speed-regulating devices is shown, a portion of the armature-shaft B being shown in dotted lines.

C is an adjustable resistance in the circuit 3 4, and D an arm connected in said circuit for varying said resistance. The arm D is attached to the sleeve *b* of spring-governor E, attached to the armature-shaft B.

If the number of lamps or other translating devices in multiple arc in the system is increased, an increase of current is caused in the conductor 2 and a decrease in the fine-wire circuit 3 4, the excess of the increase over the decrease producing the proper increase in the energy of the field-magnet to meet the requirements of the additional number of translating devices. An opposite effect is produced by the removal of such devices. An increase in the speed of the motor which drives the armature of the machine would cause the generation of too much current for the system, and also would increase the current in both portions of the coils of the field-magnet, so that the generation of current would continue to increase. I therefore provide the governor E, which, when the speed of the armature increases, moves the arm D so as to increase the proportion of resistance C in the fine-wire circuit 3 4, thus decreasing the energy of the magnet and diminishing the generation of current to compensate for the increase caused by the increase of speed. An unusual decrease of speed causes the governor E to move the arm D in the other direction, so as to decrease the resistance C. The two regulators in combination, it will be seen, are sufficient to regulate for all the conditions of inequality of generation which can occur. It is evident that the same effect will be produced if the governor E is mounted on any other revolving portion of the apparatus and properly connected.

In my Patent No. 264,665 mechanical means actuated by variations in speed are shown in connection with an electro-magnet in the main line, both acting upon an adjustable resistance, in the field-circuit of a generator. In this case the addition or removal of translating devices by varying the energy of the magnet in the main line, and thus adjusting the resistance, causes variations in the current in the field-magnet of the machine. By my present invention, however, I dispense with the regulating electro-magnet and place part of the coils of the field-magnet in the main circuit, so that the energy of such field-magnet is directly influenced and varied by changes in the number of translating devices in circuit, and it is to connections producing such direct variations that this invention is limited.

What I claim is—

1. The combination, with a dynamo-electric machine, of connections with its field-magnet coils, whereby variations in current in the main line, caused by the addition and removal of translating devices, act directly upon said field-magnet to vary its energy, and mechanical means operated by variations in the speed of the armature for varying the current energizing said magnet, substantially as set forth.

2. The combination of a dynamo-electric machine having a portion of its field-magnet coils included in the main circuit, translating devices arranged in multiple arc from said main circuit, a multiple-arc circuit, including the remaining portion of such field-magnet coils, and mechanical means operated by variations in the speed of the armature, and varying the current in said multiple-arc circuit, substantially as set forth.

3. The combination of a dynamo-electric machine having a portion of its field-magnet coils so connected that variations in current in the main line, caused by the addition and removal of translating devices, vary directly the energy of the magnet, a centrifugal governor, and an adjustable resistance varied by said governor to regulate the current in the remaining portion of said field-magnet coils according to variations in the speed of the armature, substantially as set forth.

4. The combination, with a dynamo-electric machine having a portion of the coils of its field-magnet included directly in the main circuit and the remainder in a multiple-arc circuit therefrom, and translating devices arranged in multiple arc, of a centrifugal governor acting to vary the resistance of said multiple-arc circuit according to variations in the speed of said armature-shaft, substantially as set forth.

This specification signed and witnessed this 28th day of November, 1882.

THOS. A. EDISON.

Witnesses:

H. W. SEELY,
E. H. PYATT.

(No Model.)

T. A. EDISON.

REGULATOR FOR DYNAMO ELECTRIC MACHINES.

No. 278,414. Patented May 29, 1883.

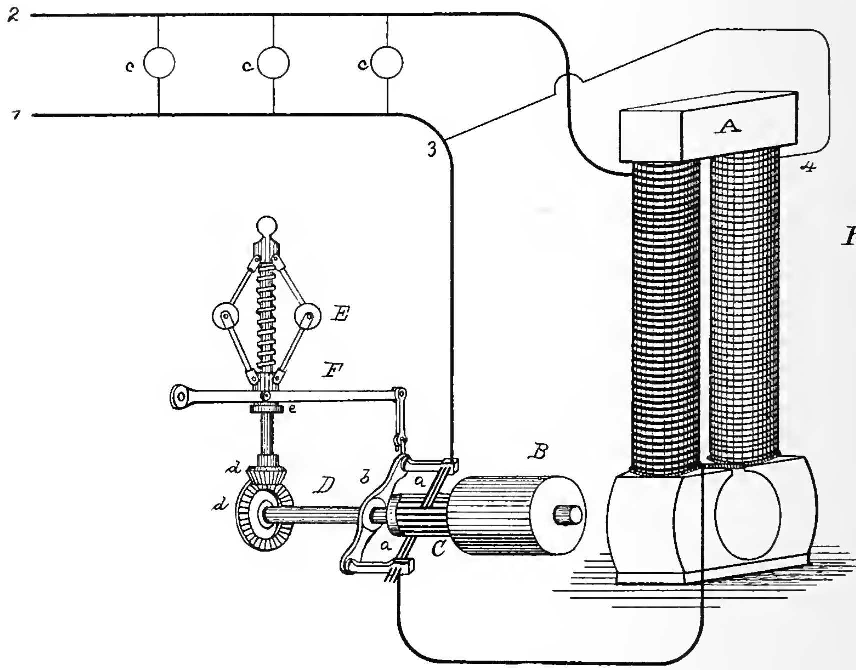


Fig. 1.

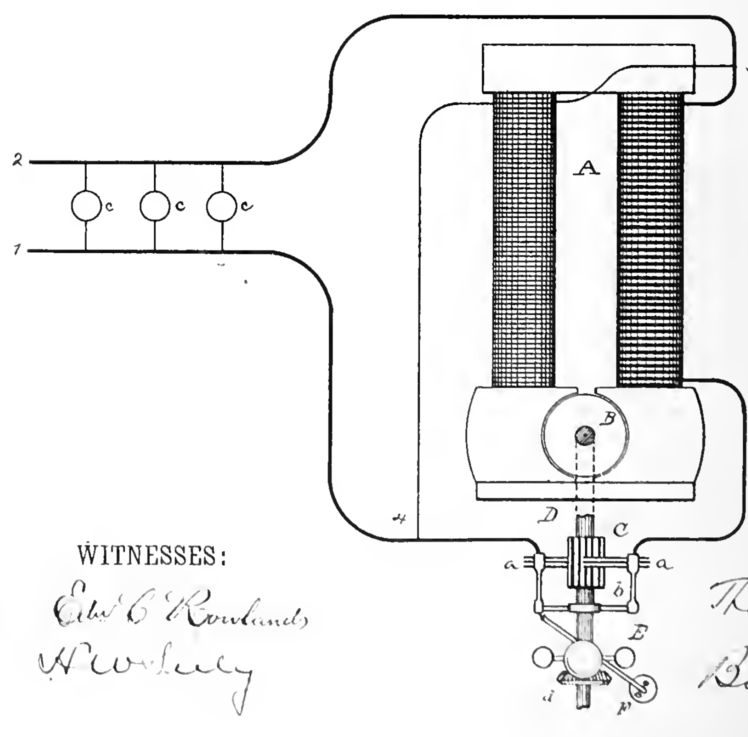


Fig. 2.

WITNESSES:

Edw C. Rowland
H. W. Seely

INVENTOR:

Thomas A. Edison
By Rich^d N. Dyer
Atty.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, ASSIGNOR TO THE EDISON ELECTRIC LIGHT COMPANY, OF NEW YORK, N. Y.

REGULATOR FOR DYNAMO-ELECTRIC MACHINES.

SPECIFICATION forming part of Letters Patent No. 278,414, dated May 29, 1883.

Application filed December 8, 1882. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Regulators for Dynamo-Electric Machines, (Case No. 522,) of which the following is a specification.

My invention relates to an improvement on the regulator described in my application No. 72,523, wherein a dynamo-electric machine is shown having a portion of the coils of its field-magnet included directly in the main circuit from the machine and the remaining portion in a multiple-arc circuit from said main circuit, differences in the number of translating devices connected in multiple arc with the machine by varying the current in the two sets of coils oppositely, but in different proportions, properly regulating the generation of current by the machine. Variations in speed of the armature are, however, not compensated for in a regulator of this kind; and my present invention consists in combining with such a regulator means actuated by variations in the speed of the armature for varying the position of the commutator-brushes, so as to regulate the generation of current according to such variations in speed.

My invention is illustrated in the accompanying drawings, wherein Figure 1 is a view in perspective of a dynamo-electric machine embodying my invention, the armature being, for convenience, shown apart from the field-magnets, and the circuits being shown diagrammatically; and Fig. 2 represents the machine in elevation, with a top view of the brush-adjusting devices.

A is the field-magnet, B the armature, and C the commutator-cylinder, of the machine. The commutator-brushes *a a* are attached to a yoke, *b*, pivoted on the shaft D. Main conductors 1 2 extend from the commutator-brushes, and translating devices *c c* are placed in multiple arc across said conductors. A part of the field-magnet coils are included in the main circuit 1 2, as shown, while the remainder are in a multiple-arc circuit, 3 4, of finer wire; and the generation of current is regulated according to variations in the number of translating devices by the effect produced in the field-coils by such variations, as explained in the application above referred to. A spring-governor, E, is revolved from the armature-shaft D through gears *d d*, though it may be connected with said shaft by other suitable means. The sleeve *c* on the governor-shaft is connected to arm F, which is attached to the pivoted yoke *b*, which holds the commutator-brushes. It is evident that an increase in the speed of the motor which drives the armature will cause the raising of the arm F, which moves the commutator-brushes *a a*, so as to decrease the current taken from the machine, while a decrease in speed will produce an opposite result.

What I claim is—

1. The combination, with a dynamo or magneto electric machine and translating devices arranged in multiple arc, of connections whereby variations in current caused by variations in the number of said translating devices in circuit act directly upon the field-magnet of the machine to vary its intensity, and means actuated by variations in speed of the armature for shifting the commutator-brushes of the machine to compensate for such variations, substantially as set forth.

2. The combination, with a dynamo-electric machine having a portion of its coils included in the main circuit and translating devices arranged in multiple arc, of means actuated by variations in the speed of the armature for shifting the commutator-brushes to compensate for such variations, substantially as set forth.

3. The combination, with a dynamo-electric machine having a portion of its coils included in the main circuit and translating devices arranged in multiple arc, of a governor revolved by the armature-shaft and connected to the commutator-brushes, substantially as set forth.

This specification signed and witnessed this 28th day of November, 1882.

THOS. A. EDISON.

Witnesses:
H. W. SEELY,
E. H. PYATT.

(No Model.)

T. A. EDISON.

MANUFACTURE OF INCANDESCING ELECTRIC LAMPS.

No. 278,415. Patented May 29, 1883.

Fig. 1.

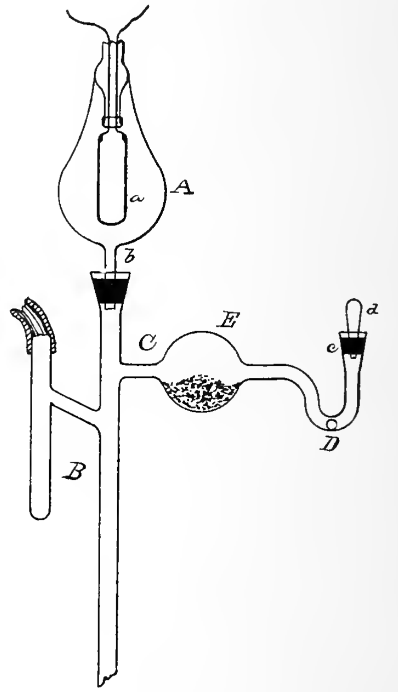


Fig. 2.

ATTEST:
E. C. Rowland,
H. W. Seely

INVENTOR:
Thomas A. Edison
By Richd N. Dyer
Atty.

N. PETERS, Photo-Lithographer, Washington, D. C.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, ASSIGNOR TO THE EDISON ELECTRIC LIGHT COMPANY, OF NEW YORK, N. Y.

MANUFACTURE OF INCANDESCING ELECTRIC LAMPS.

SPECIFICATION forming part of Letters Patent No. 278,415, dated May 29, 1883.

Application filed January 22, 1883. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in the Manufacture of Incandescing Electric Lamps, (Case No. 537,) of which the following is a specification.

The object of this invention is to provide a simple and convenient method of decreasing the resistance of the carbon filament of an incandescing electric lamp, which it is often desirable to do when a filament after carbonization is found to be of so much higher resistance than others that it cannot be used in the same system.

In carrying out my invention I attach to the vacuum apparatus by which the lamp-globe is exhausted a tube having its other end open, an air-tight stopper being provided for closing it when desired. I inclose within an envelope of gelatine or other suitable substance a quantity of a volatile carbon or silicon compound sufficient to reduce the resistance of the particular filament under treatment to the proper point. Suitable compounds for the purpose are chloride of carbon, chloroform, or the volatile chlorides of silicon. Said envelope should consist of such a substance that the application of heat will cause it to open either by melting or by bursting from the expansion of the inclosed liquid, such substance also not being chemically affected by the substance inclosed by it. Other suitable materials than that mentioned are collodion, fusible metal, lead, and tragacanth. The capsule thus formed is dropped into the open end of the tube, a portion of which is formed to receive it. After the lamp is exhausted heat is applied externally to this portion of the tube, when the external envelope is destroyed, and the carbon or silicon compound is freed and volatilizes, the vapor entering the globe and depositing carbon or silicon upon the filament, which is at this time heated to incandescence by an electric current. Such deposition of carbon or silicon reduces the resistance of the filament to the proper point.

The apparatus described is illustrated in Figure 1 of the annexed drawings, Fig. 2 being a sectional view of the capsule used.

A represents the inclosing-globe, and *a* the flexible carbon filament, of an incandescing electric lamp. The globe is provided with an exhaust-tube, *b*, which is attached to the Sprengel vacuum apparatus B. A tube, C, is connected with said vacuum apparatus, having an open end, a rubber stopper, *c*, with a handle, *d*, being provided to close said opening.

D is the capsule, consisting of an envelope, *e*, of a substance readily affected, as described, by heat, and not chemically affected by the volatile carbon or silicon compound *f*, which is inclosed by it. I find this mode of introducing the carbon or silicon to be a convenient one, because I can thus employ precisely the desired amount, and because if the volatile liquid was introduced in a free state it would volatilize under the decrease of atmospheric pressure and pass off through the pump, while the outer envelope protects it until the proper time. Such envelope should be of sufficient strength to withstand the pressure from within until the external heat is applied. The capsule is dropped into the tube, which is then closed by the stopper, and the lamp and tube are exhausted, after which the action of the exhausting apparatus is stopped and heat applied to the tube. The inclosing-envelope of the capsule is destroyed either by melting or by the expansion of the vapor within it, and such vapor then enters the globe. The filament *a* is heated to incandescence by an electric current, and the vapor is decomposed, depositing carbon or silicon upon said filament, the resistance of the filament being thus reduced.

The bulb E contains phosphoric anhydride or other drying agent.

I do not claim herein the capsule, such as described, as I propose to make this the subject of a separate application for Letters Patent.

What I claim is—

1. The method of reducing the resistance of the carbon filament of an incandescing electric lamp, consisting in introducing into a receptacle connected with said lamp a sufficient quantity of a volatile carbon or silicon compound, exhausting said lamp while such compound is prevented from volatilization, and then causing the volatilization of such com-

pound, at the same time heating the filament to incandescence by an electric current, substantially as set forth.

2. The method of reducing the resistance of the carbon filament of an incandescing electric lamp, consisting in first exhausting said lamp and then applying heat to a capsule such as described placed in a receptacle connected with said lamp, said filament being at the same time heated to incandescence by an electric current, substantially as set forth.

This specification signed and witnessed this 13th day of January, 1883.

THOS. A. EDISON.

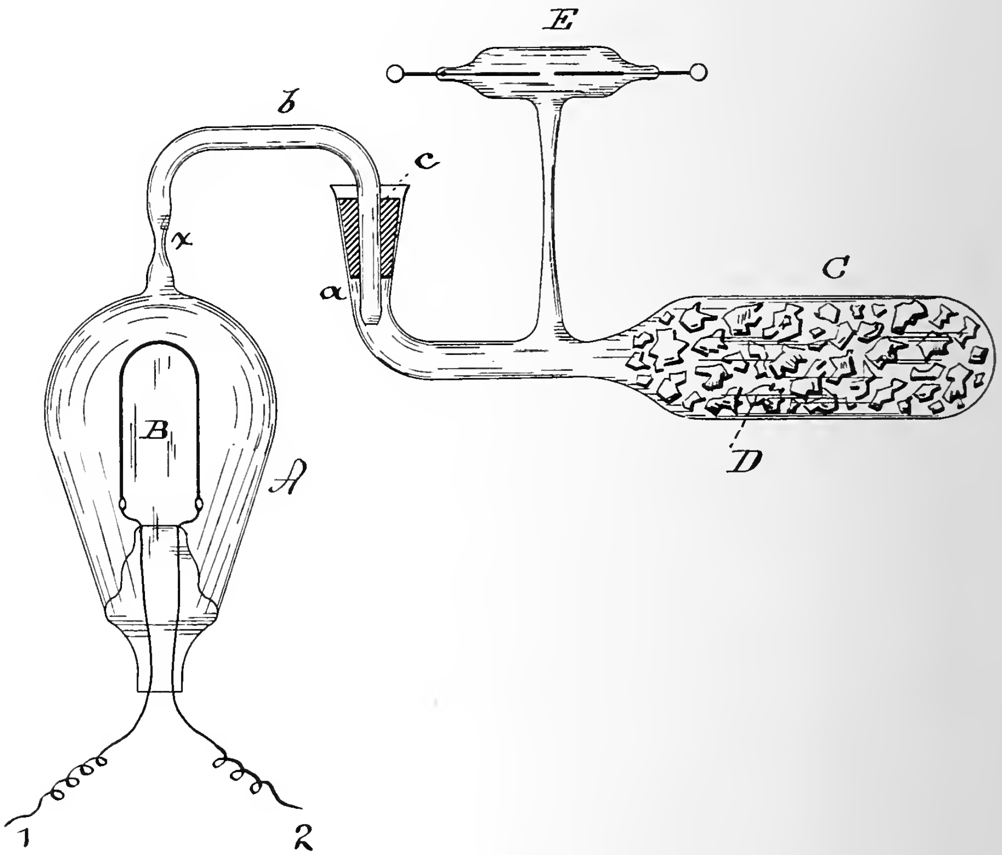
Witnesses:
H. W. SEELY,
EDWARD H. PYATT.

(No Model.)

T. A. EDISON.

MANUFACTURE OF INCANDESCING ELECTRIC LAMPS.

No. 278,416. Patented May 29, 1883.



WITNESSES:

O. D. Mott

H. W. Seely

INVENTOR:

T. A. Edison

BY Rich^d. N. Dyer.

ATTORNEY

N. PETERS. Photo-Lithographer. Washington D.C.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, ASSIGNOR TO THE EDISON ELECTRIC LIGHT COMPANY, OF NEW YORK, N. Y.

MANUFACTURE OF INCANDESCING ELECTRIC LAMPS.

SPECIFICATION forming part of Letters Patent No. 278,416, dated May 29, 1883.

Application filed August 7, 1882. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in the Manufacture of Incandescing Electric Lamps, (Case No. 400;) and I do hereby declare that the following is a full and exact description of the same, reference being had to the accompanying drawing, and to the letters of reference marked thereon.

The object I have in view is to produce a simple and efficient process and means for exhausting and completing incandescing electric lamps, so as to save the expense of the great number of Sprengel pumps which have to be used at present on account of the necessity of slowly treating the incandescing conductor of each lamp to drive the occluded gases therefrom.

The process consists, generally, in utilizing for this purpose an absorbent of gases contained in a chamber with which the lamp is connected, the incandescing conductor of the lamp being gradually heated by the passage of an electrical current therethrough after a sufficiently high vacuum has been obtained, and such incandescing conductor being finally brought up to a higher incandescence than that at which it is intended to be used commercially. The absorbent I prefer to use is charcoal, which is contained by a chamber adapted to be highly heated to drive the air out of the charcoal. The neck of this chamber is adapted for connection with the lamp by a rubber-packed joint, and is provided with a spark-gage to enable the condition of the vacuum to be ascertained. The lamp is first heated externally to drive as much air therefrom as possible, and it is then connected with the charcoal-chamber, which has been previously heated to a high degree, both the lamp and charcoal-chamber being hot at the time they are connected. The charcoal as it cools absorbs the air, and when a sufficiently high vacuum is obtained, which is ascertained by means of the spark-gage, the lamp is connected in an electric circuit and its incandescing conductor is slowly heated, throwing off the occluded gases, which are also absorbed by the charcoal. The conductor is finally brought up to higher incandescence than that at which it is intended to be used, so as to drive the air out of the clamps as far as possible. The lamp is then sealed off from the tube leading to the charcoal-chamber. The charcoal is again heated and the tube connected with another heated lamp, the operation being repeated, as before explained.

By this process mercury vacuum-pumps can be dispensed with, although in some instances a steam-operated vacuum-pump might be used with economy to partially exhaust the lamp before it is connected with the charcoal-chamber.

I may use also, in addition to the absorbent of gases, a suitable drying substance—such as phosphoric anhydride—which can be placed in the chamber with the charcoal and will absorb the aqueous vapor in the lamp. Previous to being connected with the chamber containing the gas-absorbent the lamp may be filled with an atmosphere of hydrochloric-acid gas, hydrobromic-acid gas, or ammoniacal gas, so as to displace as far as possible the air therein. The charcoal absorbs this gas without losing very greatly its capacity to absorb air, and a better vaccum may by its use be obtained.

The rubber-packed joint may also be dispensed with by extending the neck of the charcoal-chamber and sealing it directly to the globe of the lamp, or to a tube leading therefrom.

In my Patent No. 248,428 I describe the use of heated charcoal in connection with a mercury vacuum-pump for exhausting incandescing electric lamps; but in that instance the charcoal was used as auxiliary to the mercury-pump, while by my present invention I dispense altogether with such pumps.

The foregoing will be better understood from the drawing, which represents the principal parts of the apparatus used in carrying out the above-described process.

A is the globe of an incandescing electric lamp, having carbon filament B, to which are connected the leading-in wires 1 2. These are connected to form, with the carbon, a part of an electric circuit. C is a chamber, preferably of glass, containing charcoal D. The neck *a* of this chamber is connected with the lamp by tube *b* and rubber packing *c*. E is the spark-gage for ascertaining the condition of the vacuum. The lamp is sealed off at x.

What I claim is—

1. The process of exhausting an incandescing electric lamp, consisting in first removing the air from a chamber containing an absorbent of gases, connecting the lamp with such chamber, heating the incandescing conductor by an electric current when the vacuum becomes sufficiently high, and then sealing off the lamp from connection with said chamber, substantially as set forth.

2. The process of exhausting an incandescing electric lamp, consisting in heating the lamp and also a chamber containing an absorbent of gases, then connecting the two while hot, and finally heating the incandescing conductor by the passage of an electric current therethrough previous to sealing off the lamp, substantially as set forth.

3. In apparatus for producing vacua, the combination, with a chamber containing a gas-absorbing material, of means connected therewith for ascertaining the degree of exhaustion, substantially as set forth.

4. The process of producing a high vacuum, consisting in displacing the air in the chamber to be exhausted by another gas, (such as hydrochloric-acid gas, hydrobromic-acid gas, or ammonia-gas,) and then connecting such chamber with another chamber containing a substance which readily absorbs such gas, substantially as set forth.

This specification signed and witnessed this 28th day of February, 1882.

THOMAS A. EDISON.

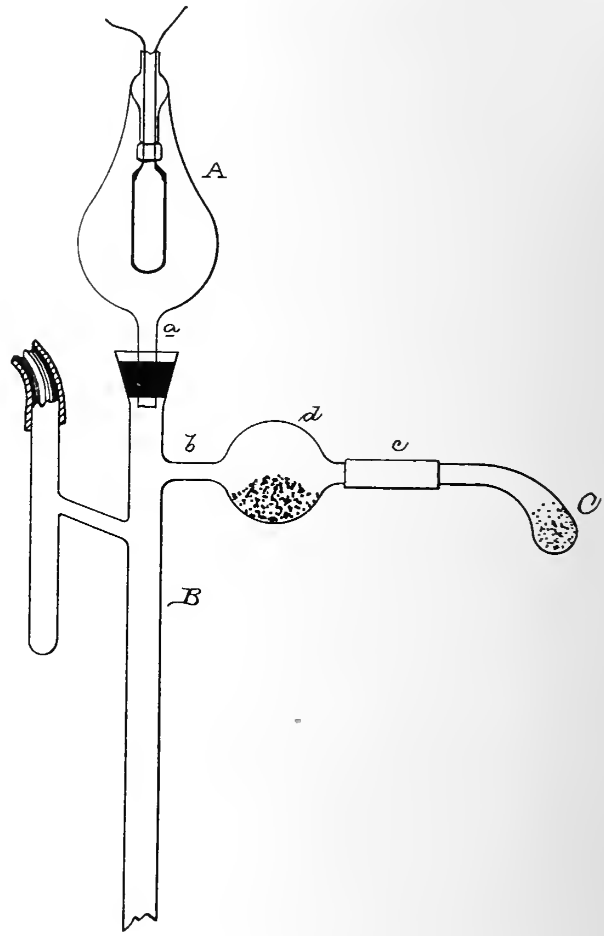
Witnesses:
H. W. SEELY,
THOMAS JOHNSTON.

(No Model.)

T. A. EDISON.

MANUFACTURE OF INCANDESCING ELECTRIC LAMPS.

No. 278,417. Patented May 29, 1883.



ATTEST:
E. C. Rowland,
H. W. Seely

INVENTOR:
Thomas A. Edison
By Richd N. Dyer,
Atty

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, ASSIGNOR TO THE EDISON ELECTRIC LIGHT COMPANY, OF NEW YORK, N. Y.

MANUFACTURE OF INCANDESCING ELECTRIC LAMPS.

SPECIFICATION forming part of Letters Patent No. 278,417, dated May 29, 1883.

Application filed January 22, 1883. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in the Manufacture of Incandescing Electric Lamps, (Case No. 536,) of which the following is a specification.

In my application No. 516 (Serial No. 77,526) is described an incandescing electric lamp whose inclosing-globe contains nitrogen at a pressure which prevents electrical carrying from the carbon incandescing conductor.

The object of my present invention is to provide a simple, economical, and efficient method of introducing such a nitrogen atmosphere into such lamp-globes, the nitrogen admitted being pure and free from moisture, such method being also applicable when it is desired to charge any vessel or receptacle with any gas in a pure and dry condition.

In applying my invention to the purposes for which it is preferred, the nitrogen is evolved by heating a dry salt containing nitrogen, such as the nitrite of ammonia, or nitrite of potassium, or nitrite of chromium; or certain mixtures may be used which include such nitrites—for instance, a mixture of potassic nitrite and chloride of ammonia. The substances, when heated, give off pure nitrogen. The lamp-globe, when ready for exhaustion, is placed in connection with a Sprengel vacuum apparatus, from the exhaust-tube of which extends a tube which terminates in a bulb or chamber in which is placed the dry salt containing nitrogen. The lamp and also this bulb or chamber are then exhausted by the vacuum apparatus, with which both are connected, to as nearly complete a vacuum as possible, after which the action of said apparatus is stopped and the bulb or chamber is heated by a lamp, or in any suitable way. The compound is decomposed, and the nitrogen given off flows through the tube and into the lamp until the desired pressure is obtained, after which the lamp is sealed off. A portion of the tube through which the nitrogen flows, and which is exhausted with the rest of the apparatus, contains phosphoric anhydride or other drying agent to take up the water of crystallization of the dry salt, the gas which enters the globe being thus free from moisture.

A convenient apparatus is illustrated in the annexed drawing.

A is the inclosing-globe of an incandescing electric lamp, provided with an exhaust-tube, *a*, which is connected with the Sprengel vacuum-pump B. From this pump extends a tube, *b*, to which is connected by a rubber section, *c*, or in any other suitable manner, a tube terminating in a bulb, C, which contains one of the substances or mixtures previously mentioned, or other equivalent substance or mixture. The tube *b* is provided with a bulb, *d*, which contains phosphoric anhydride or other drying agent. The operation of the apparatus is as before explained, the lamp being finally sealed off at *a*.

It is evident that this invention may be employed in charging any receptacle with any gas by heating a dry compound placed in said receptacle, which compound is decomposable by heat into the gas required, and said receptacle being first exhausted.

What I claim is—

1. The method of charging a receptacle with pure gas, consisting in exhausting said receptacle to a high vacuum, and then heating a dry compound decomposable by heat into the gas required, said compound being placed within said receptacle, substantially as set forth.

2. The method of providing the exhausted inclosing-globe of an incandescing electric lamp with an atmosphere of pure nitrogen, consisting in heating a dry salt capable of giving off nitrogen when decomposed by heating, placed in an exhausted receptacle connected with said lamp-globe, substantially as set forth.

3. The method of providing the inclosing-globe of an incandescing electric lamp with an atmosphere of pure nitrogen, consisting in exhausting said globe and simultaneously exhausting a receptacle connected therewith and containing a dry salt containing nitrogen and decomposable by heat, and then heating said receptacle, substantially as set forth.

This specification signed and witnessed this 13th day of January, 1883.

THOS. A. EDISON.

Witnesses:

H. W. SEELY,

EDWARD H. PYATT.

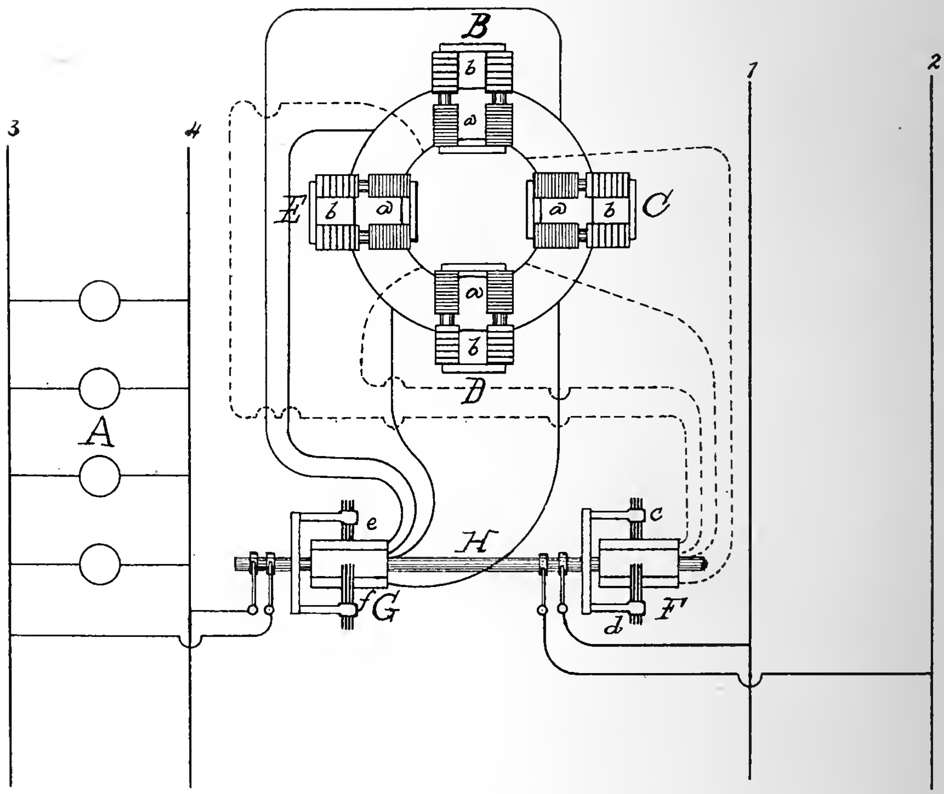
(No Model.) 2 Sheets—Sheet 1.

T. A. EDISON.

APPARATUS FOR TRANSLATING ELECTRIC CURRENTS FROM HIGH TO LOW TENSION.

No. 278,418. Patented May 29, 1883.

Fig. 1.



WITNESSES:

E. C. Rowland,

H. W. Seely

INVENTOR:

Thomas A. Edison,

By Rich. N. Dyer. Atty.

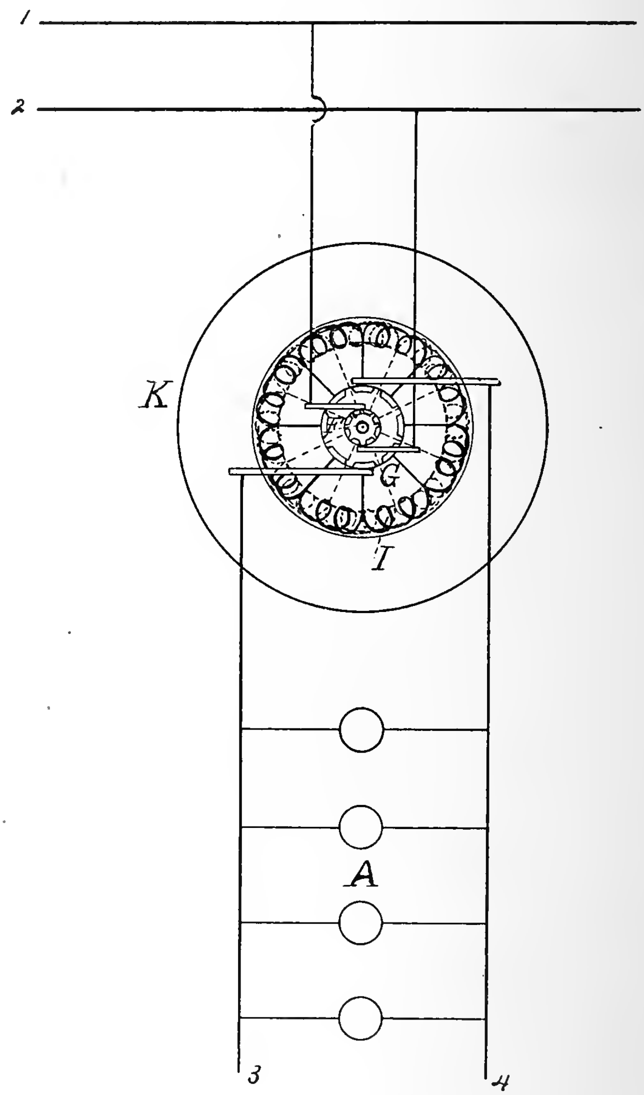
(No Model.) 2 Sheets—Sheet 2.

T. A. EDISON.

APPARATUS FOR TRANSLATING ELECTRIC CURRENTS FROM HIGH TO LOW TENSION.

No. 278,418. Patented May 29, 1883.

Fig. 2.



WITNESSES:
E. C. Rowland,
H. W. Seely

INVENTOR:
Thomas A. Edison,
By Richd. N. Dyer,
Atty.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, ASSIGNOR TO THE EDISON ELECTRIC LIGHT COMPANY, OF NEW YORK, N. Y.

APPARATUS FOR TRANSLATING ELECTRIC CURRENTS FROM HIGH TO LOW TENSION.

SPECIFICATION forming part of Letters Patent No. 278,418, dated May 29, 1883.

Application filed August 14, 1882. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Systems of Electric Lighting, (Case No. 463;) and I do hereby declare that the following is a full and exact description of the same, reference being had to the accompanying drawings, and to the letters of reference marked thereon.

The object of this invention is to produce simple and efficient means for reducing the tension of a continuous current flowing in a main circuit, and supplying consumption-circuits with a continuous current of lower tension, whereby a large saving may be made in the investment for conductors by using small main conductors, and obviating excessive loss of energy by the use of a current of high tension in the main circuit, while lamps, motors, or other translating devices requiring a continuous current can be supplied, and by the use of a current of lower tension in the consumption-circuit the translating devices can be placed in separate multiple-arc circuits and made independently controllable.

The object is accomplished by the use of induction apparatus located between the main circuit and the translating devices and transforming a continuous current of high tension into a continuous current of lower tension by the employment of a magnetic core or cores having two sets of wire coils, one of high resistance connected with the main circuit, and one of lower resistance connected with the consumption-circuit, the connections of the main and consumption circuits with their respective sets of coils being changed or advanced simultaneously, so that the inductive action of the magnetic core or cores will cause current to flow in the consumption-circuit always in the same direction.

In carrying out the invention a number of magnetic cores are preferably employed, which cores are preferably arranged in pairs to form horseshoe-magnets and have plates closed upon their poles. These magnetic cores are wound with two sets of wire placed on different portions of the cores or coiled one upon the other on the same portions of the cores. One set of coils is of high resistance, while the other set is of lower resistance, and each set of coils is connected in a closed circuit independent of the circuit of the other set. The closed circuit of each set of coils is connected with the bars or plates of a stationary commutator-cylinder at points between the pairs of magnetic cores, there being a bar on each commutator-cylinder for each pair of magnetic cores. Upon each commutator-cylinder travels a pair of commutator brushes or springs. These commutator-brushes are mounted upon a common shaft, which is revolved by any suitable means, an electromotor being used for the purpose, or a spring or weight actuated mechanism. The brushes traveling on the commutator-cylinder connected with the coils of high resistance are connected with the main circuit, while the brushes traveling on the commutator connected with the coils of low resistance are connected with the consumption-circuit. The current in the fine-wire or high-resistance coils flows from one commutator-brush to the other in two directions, one-half the pairs of cores having their coils receive current in one direction, while the other half of the cores have their coils receive current in the opposite direction. Now, the revolution of the commutator-brushes will cause the pairs of magnetic cores to have the connections of their coils reversed two at a time, thus causing a reversal of magnetic polarity. This change in magnetic polarity induces a current of lower tension in the coarse or low-resistance coils, the connections with which being advanced simultaneously with those of the fine-wire coils, the induced current is made a continuous current, or a current flowing in one direction. The action may perhaps be better illustrated by considering the points at which the current flows into and leaves the closed circuit of the fine-wire coils as in the neutral line. This is advanced by the revolution of the commutator-brushes, and the opposite pairs of magnetic cores are crossed by the line simultaneously. The same result would be produced if the magnetic cores were mounted upon a shaft and revolved with the commutator-cylinders, the commutator-brushes being held stationary.

Instead of using a number of double-wound magnetic cores, a single annular core can be used, similar to a Gramme ring, the annular core being provided with two sets of continuously-wound wire coils, one of high resistance and the other of low resistance, connected at intervals to the bars of separate commutator-cylinders.

The coils of high resistance are connected through the commutator and brushes with the main circuit, while the coils of low resistance are similarly connected with the consumption-circuit. The double-wound ring and the commutator-cylinders may be revolved, and the commutator brushes or springs held stationary; or the commutator-brushes may be revolved together and the ring and cylinders held stationary. The double-wound ring is preferably surrounded by a ring of iron to carry the magnetism between the ends of the neutral line.

The foregoing will be better understood from the drawings, in which Figure 1 is a view, partly diagrammatic, of the preferred form of the apparatus; and Fig. 2, a similar view of a modified form of the same.

1 2 are the conductors of the main circuit, having a continuous high-tension current supplied by one or more dynamo or magneto electric machines, while 3 4 are the main conductors of the house or consumption circuit, requiring a continuous current of lower tension, and provided with lamps, motors, or other translating devices, A, located in multiple-arc circuits and independently controllable. B, C, D, and E, are pairs of magnetic cores having fine-wire or high-resistance coils *a* and coase-wire or low-resistance coils *b*. These coils are connected together in two closed circuits connected at points between the pairs of magnetic cores with the bars of separate commutator-cylinders F G. Two sets of commutator-brushes, *c d* and *e f*, are mounted upon a common shaft, H, and revolved together. The brushes *c d* are in a multiple-arc circuit from the conductors 1 2 of the main circuit, while the brushes *e f* are connected with the conductors 3 4 of the consumption-circuit. The shaft H may be revolved by an electromotor or in any other suitable way, as by a spring or weight actuated mechanism.

It will be understood that each house-circuit will be connected with the main circuit through induction apparatus, all the connections being indepepdent multiple-arc connections.

Instead of the separate pairs of magnetic cores, a single annular core, I, can be used. (Shown in dotted lines in Fig. 2.) This core is wound with two sets of wire coils, each being continuous, like the winding of a Gramme ring, one set of high resistance (shown in dotted lines) connected with bars of commutator-cylinder F, the brushes or springs on which are connected with the conductors 1 2 of the main circuit, and the other set of low resistance (shown in full lines) connected with the bars of commutator-cylinder G, the brushes or springs on which are connected with the consumption-circuit 3 4.

The double-wound ring I and the commutator-cylinders F G may be revolved, or they may be held stationary and the commutator-brushes be revolved. An iron ring, K, is preferably placed outside of the double-wound ring I, to carry the magnetism between the ends of the neutral line.

In my Patent No. 265,786, dated October 10, 1882, is shown a series of combined motors and generators, the motors being placed in the main circuit and the generator-coils supplying translation-circuits with currents of reduced tension. Therefore I do not herein claim a system of this character.

What I claim is—

1. The combination, with a main circuit having a continuous current of high tension, of a consumption-circuit of low tension, provided with translating devices arranged in multiple arc, and an intermediate induction apparatus for reducing the tension of the current, substantially as set forth.

2. The combination, with a main circuit having a continuous current of high tension, of a consumption-circuit, an intermediate double-wound magnetic core or cores, and commutators for simultaneously changing or advancing the connections of the circuits with the windings of such core or cores, substantially as set forth.

3. The combination, with the main and consumption circuits, of a magnetic core or cores, provided with two sets of coils, one of high and one of low resistance, connected in separate closed circuits, and two commutators, one connecting the high-resistance coils at intervals with the main circuit and one connecting the low-resistance coils at intervals with the consumption-circuit, the connections of the main and consumption circuits being changed or advanced simultaneously, substantially as set forth.

4. The combination, with the main and consumption circuits, of the double-wound stationary core or cores, the stationary commutator-cylinders connected at intervals with the windings of such core or cores, and the simultaneously-revolving commutator brushes or springs connected with the main and consumption circuits, substantially as set forth.

5. The combination, with the main and consumption circuits, of the double-wound core or cores, the commutator-cylinders, and the exterior iron ring, substantially as set forth.

This specification signed and witnessed this 7th day of July, 1882.

THOMAS A. EDISON.

Witnesses:

RICHD. N. DYER,
EDWARD H. PYATT.

(No Model.)

T. A. EDISON.

DYNAMO ELECTRIC MACHINE.

No. 278,419. Patented May 29, 1883.

Fig 1.

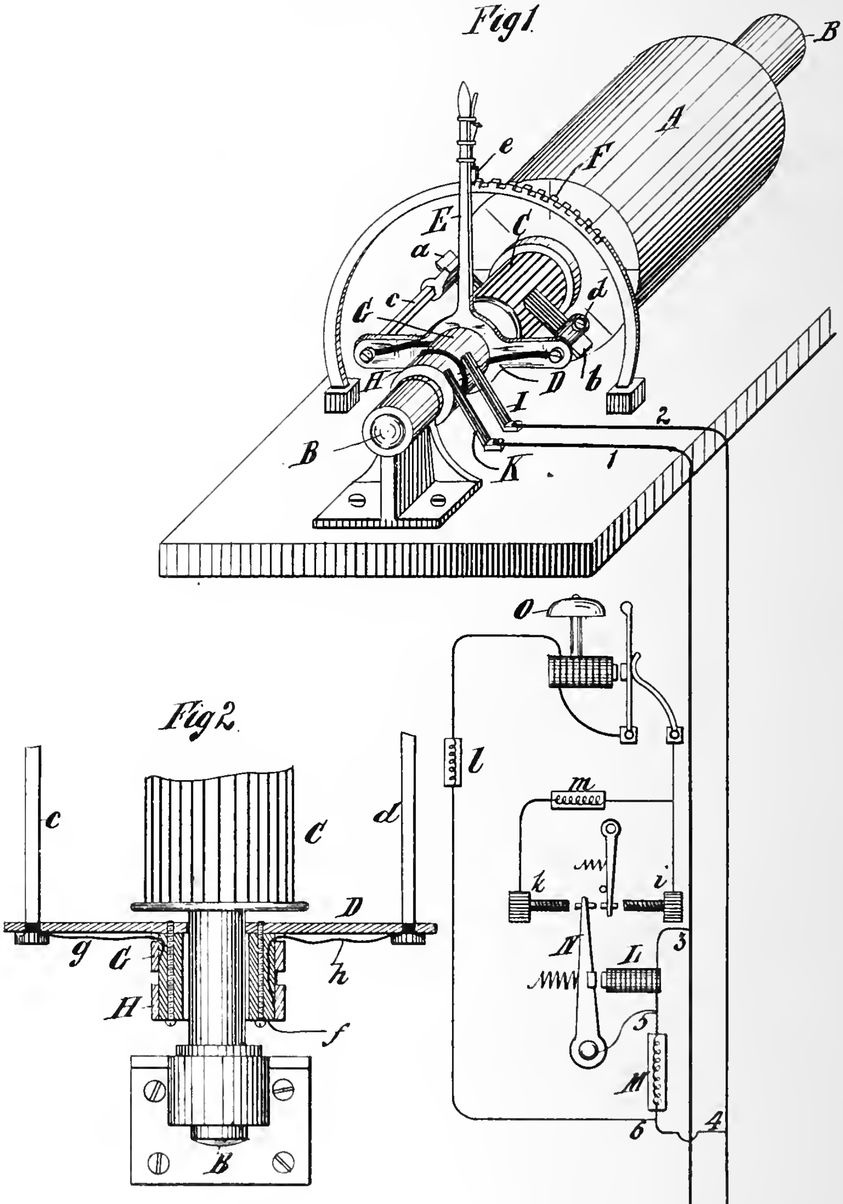


Fig 2.

WITNESSES:

Thomas E. Birch.

O. D. Mott

INVENTOR:

T. A. Edison

BY Richd. N. Dyer

ATTORNEY

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, ASSIGNOR TO THE EDISON ELECTRIC LIGHT COMPANY, OF NEW YORK, N. Y.

DYNAMO-ELECTRIC MACHINE.

SPECIFICATION forming part of Letters Patent No. 278,419, dated May 29, 1883.

Application filed August 7, 1882. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Dynamo-Electric Machines, (Case No. 388;) and I do hereby declare that the following is a full and exact description of the same, reference being had to the accompanying drawings, and to the letters of reference marked thereon.

The object I have in view is to produce simple and efficient means for regulating the generative capacity of dynamo or magneto electric machines, which means will not require in their operation and adjustment the attention of a person skilled in the working of electrical apparatus. This I accomplish by constructing and arranging the commutator-brushes so that they can be readily shifted to and can be conveniently and securely held in any desired position between the point of greatest generation and that of no generation, and by providing at the machine an indicator or alarm which will show in a simple manner the condition of the current and will serve as a guide in the adjustment of the commutator-brushes.

In carrying out my invention the commutator-brushes are mounted upon arms projecting from a pivoted yoke which surrounds the armature-shaft and turns upon the axis of rotation, such arms being insulated from the yoke and being connected electrically with the main conductors leading from the machine. From the yoke projects a hand-lever having a spring locking device which engages with a toothed quadrant. This quadrant permits the adjustment of the brushes to any desired extent, and the locking device serves to hold the lever wherever it is placed.

In a multiple-arc or derived circuit from the main conductors is placed means for indicating electrically the strength of the current, which varies directly as does the candle-power of the lamps. The device I prefer to use is that shown in a prior application filed by me, (Serial No. 45,668,) by which an alarm is sounded when a certain strength of current corresponding with a definite candle-power is exceeded, and another alarm is given when the strength of the current in each multiple-arc circuit drops below a fixed limit; but a dynamometer may be used, or other form of indicator, for showing the strength of the current, with or without an alarm for calling attention to an abnormal condition of the current. The operator will shift the brushes in the direction indicated by the nature of the alarm or by the indicator until the alarm stops sounding, which will be when the current in the main conductors is restored to its normal condition. If, after the brushes are shifted to the position of greatest generation in increasing the strength of current, the alarm continues to sound, this will show that the number of translating devices should be reduced in order to restore the current to its normal strength.

The commutator-brushes may be connected with the main conductors by coiled wires connected with the arms that carry them, since the movement of the yoke in practice is not very great; but I prefer, on account of the large size that it is desirable to give these conductors, to make a swiveled connection between them and the commutator-brushes, so that the yoke can be readily moved to any desired extent without disturbing said conductors. This swiveling device is composed of two metal rings, which surround the shaft outside of the yoke and are supported upon insulation carried by said yoke. These insulated rings turn with the yoke and are connected electrically each with one of the commutator-brush-carrying arms. Two springs of plates, strips, or wires bear on these rings and are connected with the main conductors, allowing the yoke to be shifted in either direction to any extent.

The field-magnet of the generator, provided with the means described, is preferably energized by a constant source of electrical energy, such as a galvanic battery or another generator. The field-circuit may, however, be adapted to have the current passing through it varied in strength, and such circuit may be supplied from an external source, or from the machine itself.

The foregoing will be better understood by reference to the drawings, in which Figure 1 is a perspective view of a portion of a dynamo or magneto electric machine embodying a part of my invention, and a diagram of the means for indicating predetermined limits above and below the normal condition of current; and Fig. 2, a top view and part horizontal section of the commutator end of the machine.

A is the armature of the machine, and B its shaft. The field-magnet is not shown. C is the commutator-cylinder, and *a b* the brushes bearing thereon. D is the pivoted yoke, having arms *c d*, which carry the commutator-brushes. E is the lever projecting from yoke. F is the toothed quadrant with which the lever is locked by means of spring locking device *e*. G H are the metal rings of the swiveling device, supported on hollow wood cylinder *f*, secured to the yoke. The arms *c d* are connected with rings G H by insulated arms *g h*. I K are the springs bearing on rings G H and connected with main conductors 1 2. In a multiple-arc circuit, 3 4, from the main conductors 1 2 are placed an electro-magnet, L, and a resistance, M. A shunt-circuit, 5 6, around the resistance M passes through armature-lever N in one direction, and in the other direction through a vibrating bell, O, after which the circuit is divided, and its two parts are connected with the front and back contacts, *i k*, of the armature-lever. Resistances *l m* are placed in shunt-circuit 5 6 to change the nature of the alarm, according to whether the lever makes the front or back contact, the sound of the bell being loud in one case and feeble in the other.

What I claim is—

1. A dynamo or magneto electric machine having movable commutator-brushes, and means operated by hand for adjusting and securing said commutator-brushes, in combination with means for indicating predetermined limits above and below the normal condition of the current, substantially as set forth.

2. The combination of the commutator-brushes carried by a pivoted yoke, a hand-lever and locking device for adjusting and holding said yoke, and means for indicating predetermined limits above and below the normal condition of the current, substantially as set forth.

3. In a dynamo or magneto electric machine, the movable commutator-brushes, in combination with swiveled connections between the same and the main conductors, substantially as set forth.

This specification signed and witnessed this 15th day of December, 1881.

THOMAS A. EDISON.

Witnesses:

RICHD. N. DYER,

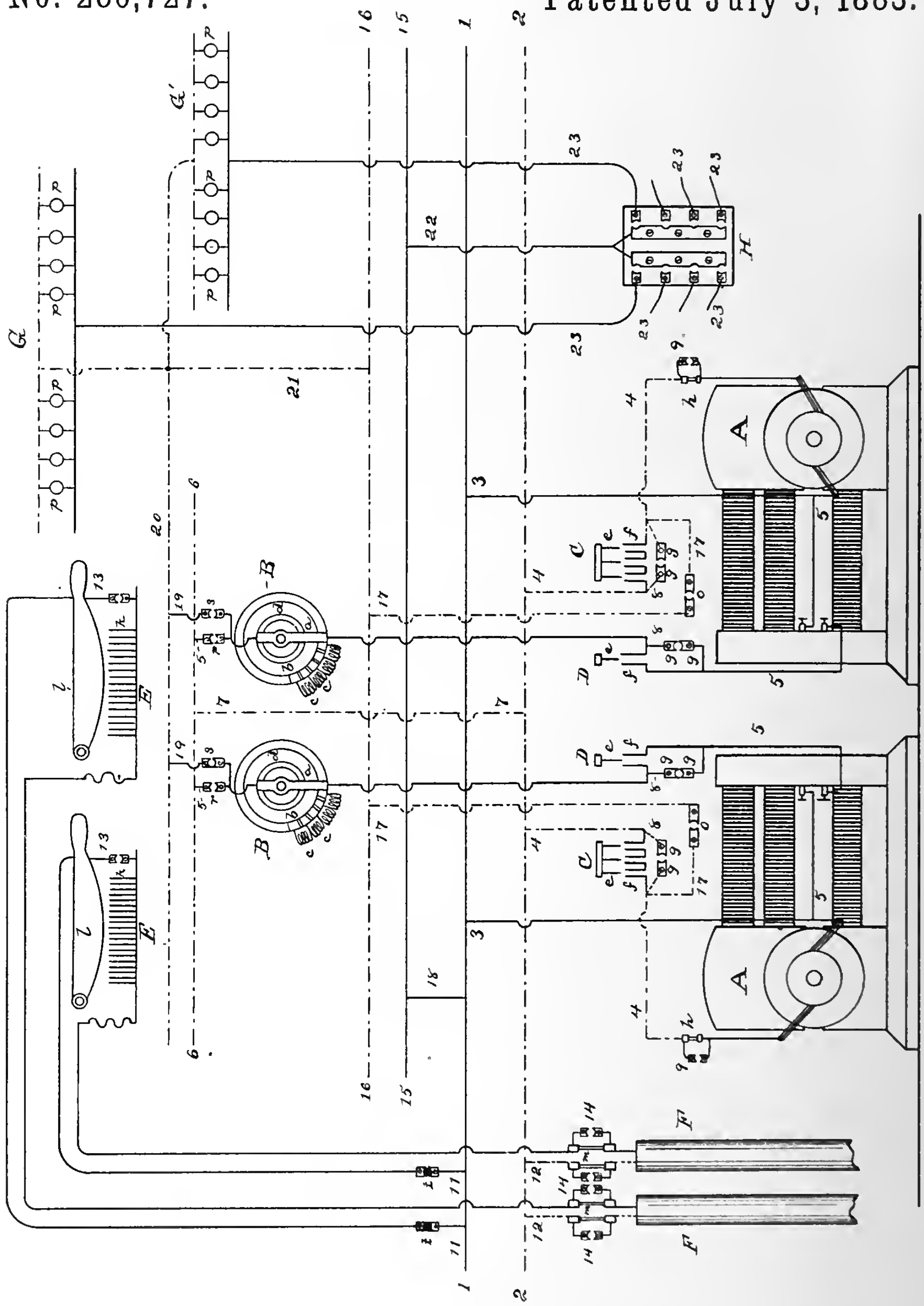
H. W. SEELY.

(No Model.)

T. A. EDISON.

SYSTEM OF ELECTRICAL DISTRIBUTION.

No. 280,727. Patented July 3, 1883.



ATTEST:

E. C. Rowland

Henry W. Seely

INVENTOR:

Thomas A. Edison,

By Rich^d. N. Dyer.

Atty.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, ASSIGNOR TO THE EDISON ELECTRIC LIGHT COMPANY, OF NEW YORK, N. Y.

SYSTEM OF ELECTRICAL DISTRIBUTION.

SPECIFICATION forming part of Letters Patent No. 280,727, dated July 3, 1883.

Application filed March 16, 1883. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Systems of Electrical Distribution, (Case No. 544,) of which the following is a specification.

In my system of electrical distribution I employ at a central station several dynamo-electric machines for generating current, which is then conveyed by feeding-conductors to the curcuits which contain the translating devices of the district.

My invention relates to the arrangement of the various devices and apparatus at such central stations, having for its object, principally, the maintaining of a constant electromotive force throughout the system, and also to promote the general efficiency and economy of the system.

In carrying out my invention I connect the two or more generators employed in multiple arc from the same main conductors, each armature and each field-magnet being in its own separate multiple-arc circuit. In connection with each machine I preferably employ a single circuit-controller of such form that it will break both the field and the armature circuit by the same movement, and the latter somewhat in advance of the former, for if the field-circuit were broken before the armature-circuit, the main conductors would be short-circuited and the armature burned out. Separate circuit-controllers might, however, be employed, care being taken to always break the armature-circuit before the field. In each field-circuit is placed an adjustable resistance of suitable construction. The feeding-conductors, which convey the current to the incandescent electric lamps or other translating devices of the system, are connected in multiple arc to the main conductors. Each feeding-circuit contains an adjustable resistance, and may be provided with a suitable circuit-controller. Within the station are provided, also, a large number of electric lamps, which are thrown into circuit whenever an additional generator is connected to the main conductors to compensate for such addition in the translating devices without the station, in order to prevent such a sudden accession of current in the district as cannot be readily compensated for by the field-resistances. This is accomplished as follows: When the generator is to be connected, instead of connecting its armature at once to the main conductors, it is connected with other conductors, from which multiple-arc connections are made to the lamps within the station, which are commonly termed "testing-lamps." These lamps are divided into groups, and a switch-board is provided by which more or less of these groups may be placed in circuit. As many lamps are first included as are being supplied in the district by each of the machines already in circuit. The armature-circuit to the main conductors is then also closed, which makes the testing-lamps a part of the circuit supplied by all the generators. The throwing in of the additional generator, therefore, produces no material effect on the current in the translating devices without the station, and any slight change in electro-motive force is compensated for by adjusting the field-circuit resistance. The testing-lamps are then gradually plugged out at the switch-board, the regulating-resistances being constantly adjusted to maintain a constant electro-motive force. The testing-lamps can, however, be used also for testing the efficiency of the generators. To accomplish this the field and armature circuits of each generator can be disconnected from the main conductors of the system and connected to the main testing-circuit. By means of the switch-board a greater or less number of the testing-lamps may be placed in circuit. The armature-circuit of each machine contains a safety-catch of the proper size to prevent injury to the armature. Each feeding-conductor also contains such a safety-catch, and around each safety-catch is a shunt, which may be closed by the insertion of a plug, if the safety-catch is destroyed, to maintain circuit while such safety-catch is replaced. Around each armature and field-circuit controller is placed a similar shunt, which is closed by a plug after the circuit is closed, to prevent heating at the contacts of the circuit-controller.

My invention is illustrated in the accompanying drawing, which is a diagram of the circuits and apparatus at a central station.

A A are dynamo-electric machines. Preferably each of said machines is driven by a steam-engine, the armature being revolved directly by the shaft of the engine without the use of belts or other gearing, and the engine and generator being both mounted on the same bed-plate. From the commutator-brushes of each machine a circuit, 3 4, leads, which is connected to the main conductors 1 2. A conductor, 5, connected to armature-circuit conductor 3, includes the field-magnet coils of the machine, and thence extends to the adjustable resistance B. This resistance is preferably of the form shown in my application No. 540, (Serial No. 82,565.) The end of arm *a* rests on a circle of contact-plates, *b*, (only a portion of which are shown,) which are connected to resistance-coils *c c*, and the revolution of said arm throws such coils in or out of circuit. Such arm bears constantly on a metal ring, *d*, from which the conductor 5 runs to a conductor, 6. A single conductor, 7, runs from wire 6 to main conductor 2, forming a common return for the field-circuits of both or all the generators.

Preferably means are provided whereby all the resistances B may be simultaneously adjusted, as set forth in my application last referred to. The resistances are to regulate the electro-motive force of the machines according to the whole number of translating devices in circuit in the system.

In each armature-circuit is placed a circuit-controller, C, and in each field-circuit a circuit-controller, D, the circuits being opened and closed by the withdrawal or entrance of contacts *e* between contacts *f*. Preferably the circuit-controllers C and D of a machine are operated by the same movement, circuit being broken somewhat sooner and closed somewhat later at C than at D, the moving contacts of both being attached to the same pivoted arm, as set forth in my application No. 543, (Serial No. 88,355.) Around each circuit-controller is a shunt, 8, broken at contacts *g g*. These shunts are to be closed by the insertion of guard-plugs when the circuits are closed at C D, to prevent heating of the latter contacts. Each armature-circuit contains, also, a safety-catch, *h*, to prevent injury to the armature by an excessive reduction of resistance of the external circuit, and around each safety-catch is a guard-plug shunt, 9, by which the circuit may be completed while the safety-catch is replaced.

To the main conductors 1 2 are connected feeding-conductors 11 12, by which current is conveyed to the different parts of the district supplied from the station. A conductor, 11, of each feeding-circuit includes an adjustable resistance, E. This resistance is preferably like that shown in the joint application of Charles L. Clarke and myself, (Serial No. 71,778.) The conductor 11 is broken, and the two parts lie parallel with each other. On one side are attached a number of carbon rods *k*, and the metal blade *l* is in sliding contact with the other side. When such blade is pressed down, it places more or less of the carbon rods in multiple arc across the break, and so decreases or increases the resistance of the circuit. These resistances are to regulate the current in the feeders for variations in the number of translating devices in the part of the district contiguous to the terminals of each feeder. A guard-plug shunt, 13, is formed around each resistance, so that circuit may be completed if it is desired to dispense with such resistances. Each feeding-circuit is provided with a plug, *t*, for opening and closing the circuit. This, however, may be dispensed with, and the circuits made and broken by inserting and removing the safety-catches and guard-plugs. Each feeding-circuit leaves the station inclosed in a tube, F. In each feeding-conductor is a safety-catch, *m*, and around each safety-catch is a guard-plug shunt, 14, for the purpose above explained.

The testing-lamps are represented by *p p*. 15 16 are the main testing-conductors. To connect the armature of a generator to this circuit, the circuit-controller C and shunt 8 are opened, and shunt 17 is closed by inserting a plug at *o*. This connects conductor 4 to 16, instead of to 2, and, as conductor 15 is already connected to conductor 1 by conductor 18, the armature-circuit is thus connected to the main testing-circuit. To connect the field of a generator, conductor 5 is broken at *r* and conductor 19 closed at *s*, making connection to conductor 20, from which conductor 21 runs to main testing-conductor 16. The lamps *p* are divided into groups, each of a suitable number. Two of such groups, G and G′, are shown. From conductor 15 a wire, 22, runs to a switch-board, H, and from the opposite terminals of the switch-board wires 23 run, one to a conductor of each group of lamps. The opposite conductor of each group is connected through conductor 21 to conductor 16. Each group of lamps is connected in circuit by the insertion of a plug between the proper terminals of the switch-board. Thus any desired load may be put upon a generator, whereby its capacity and efficiency may be tested. The main object of the testing-lamps—that is, to compensate in the translating devices of the system without the station when an additional generator is placed in circuit to prevent a sudden increase in electro-motive force by such addition—is, however, accomplished as follows: When such an increase of lamps is expected in the district as will require the addition of a generator to those already in circuit, as many groups of lamps *p* are connected by means of the switch-board H to the main testing-circuit 15 16 as are supplied by each of the already connected generators. The field-circuit of the generator is closed by the insertion of a plug in the shunt 8 around the circuit-controller D, the plugs being also inserted at *r* and *s*. The shunt 17 is then closed at *o*, which connects the generator with all the testing-lamps connected at the switch-board. The circuit-controller C is then closed, which connects both the lamps and the generator to the main circuit. The proportion of generators and lamps throughout the entire system thus remains the same or nearly the same, any slight difference being adjusted by regulating the resistances B B. The groups G of testing-lamps are then cut out of circuit at the switch-board, one after another, and the field-resistances are adjusted so that a constant electro-motive force is maintained.

By the use of the regulating means described—first, means situated within the station for compensating in the translating devices without the station for the addition of a generator to the main circuit; second, the adjustable resistances in the field-circuits for adjusting the gradual variations which occur in the total number of lamps in circuit; and, third, the adjustable resistances in the feeding-circuits, forming regulators for variations at the different centers of consumption—I am enabled to maintain a practically-constant electro-motive force throughout the system under all circumstances, and, in addition, I may, if desired, regulate the entire system by the connection and disconnection of feeders.

It is to be understood that all patentable features of invention described or shown, but not claimed herein, are reserved for protection by other patents, and have been or will be embraced in other applications for patents.

What I claim is—

1. In a system of electrical distribution, means situated within the central station for compensating in the translating devices without the station for the increased electro-motive force caused by the addition of a generator to those already in circuit, substantially as set forth.

2. In a system of electrical distribution, the combination of two or more generators, the main circuit, means for separately connecting said generators thereto, the circuit containing the testing or compensating lamps, and means for separately connecting the generators to said circuit, substantially as set forth.

3. In a system of electrical distribution, the combination of the two or more generators, the main circuit, means for separately connecting said generators to said main circuit, the circuit containing the testing or compensating lamps, means for separately connecting the generators thereto, and means for connecting the main circuit with the testing or compensating lamp-circuit, substantially as set forth.

4. In a system of electrical distribution, the combination of the two or more generators, each having its field and its armature in a separate multiple-arc circuit from the main conductors, of means for disconnecting the armature-circuit alone or both the field and armature from said main conductors and connecting them instead to a circuit containing testing or compensating lamps, substantially as set forth.

5. The testing or compensating lamps arranged in groups, in combination with means for placing more or less of such groups in connection with the generators, substantially as set forth.

6. The combination, with the testing or compensating lamps arranged to be gradually thrown out of circuit, of the adjustable resistances in the field-circuits of the generators, for compensating for the variations in electro-motive force, substantially as set forth.

7. In a system of electrical distribution, the combination of the testing or compensating lamps, the adjustable resistances in the field-circuits of the generators, and the adjustable resistances in the feeding-circuits, whereby a constant electro-motive force is maintained throughout the system, substantially as set forth.

8. In a system of electrical distribution, the combination of the adjustable resistances in the field-circuits of the generators, and the adjustable resistances in the feeding-circuits, substantially as set forth.

9. The method of maintaining a constant electro-motive force in a system of electrical distribution employing two or more generators when an additional generator is placed in circuit, consisting in first connecting said generator with a number of lamps not connected with the rest of the system, and then connecting it also with the main circuit of the system, whereby the proportion of lamps and generators remains the same, substantially as set forth.

10. The method of maintaining a constant electro-motive force in a system of electrical distribution employing two or more generators when an additional generator is placed in circuit, consisting in first connecting said generator with a number of lamps not connected with the rest of the system, then connecting it also with the main circuit of the system, and then gradually removing said lamps, at the same time regulating the adjustable resistances in the field-circuits of the generators, substantially as set forth.

This specification signed and witnessed this 13th day of February, 1883.

THOS. A. EDISON.

Witnesses:
H. W. SEELY,
EDWARD H. PYATT.

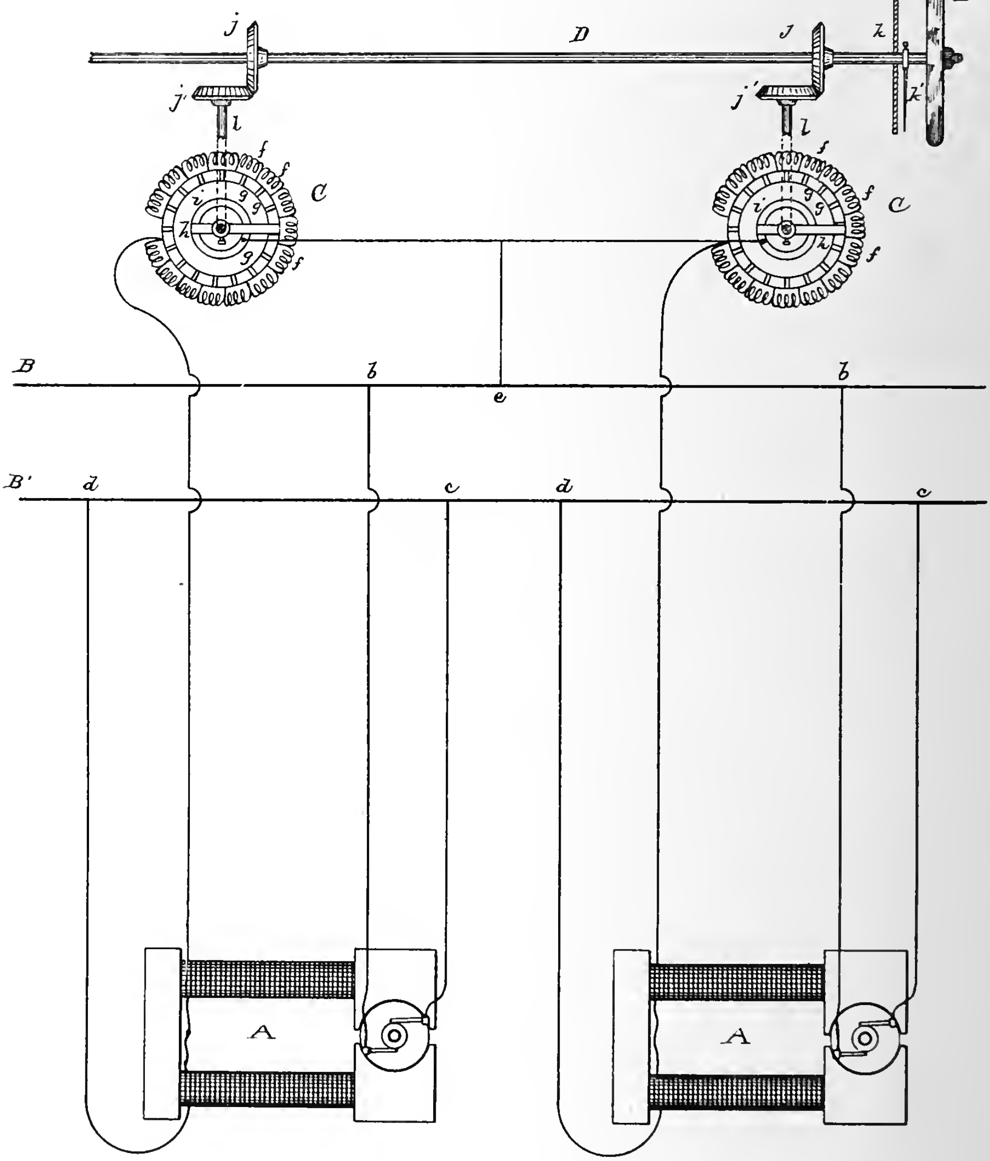
(No Model.) 2 Sheets—Sheet 1.

T. A. EDISON.

REGULATOR FOR DYNAMO ELECTRIC MACHINES.

No. 281,349. Patented July 17, 1883.

Fig. 1.



ATTEST:

E. C. Rowland

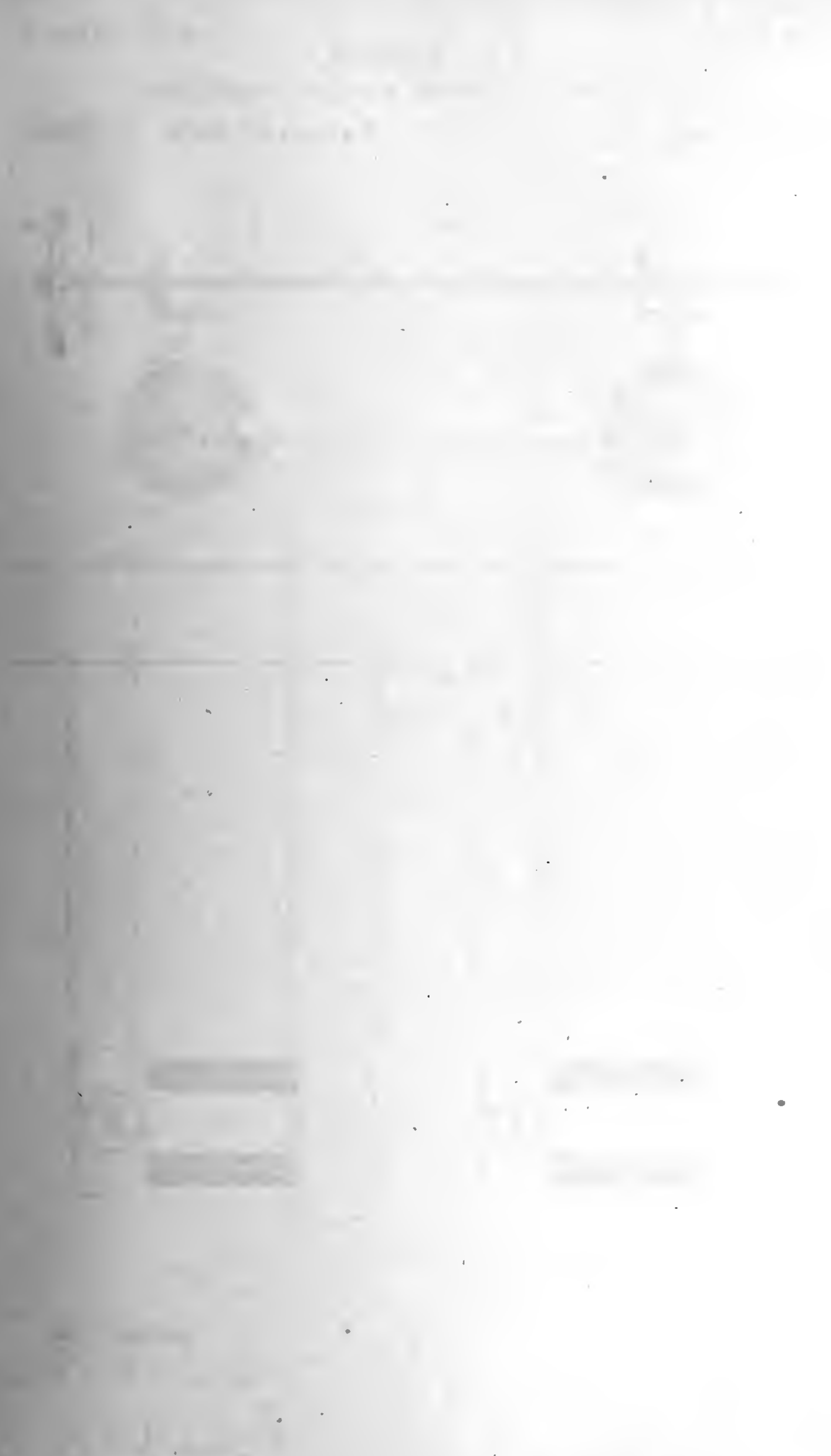
H. W. Seely

INVENTOR:

Thomas A. Edison

By Rich^d N. Dyer Atty

N. PETERS, Photo-Lithographer, Washington, D.C.

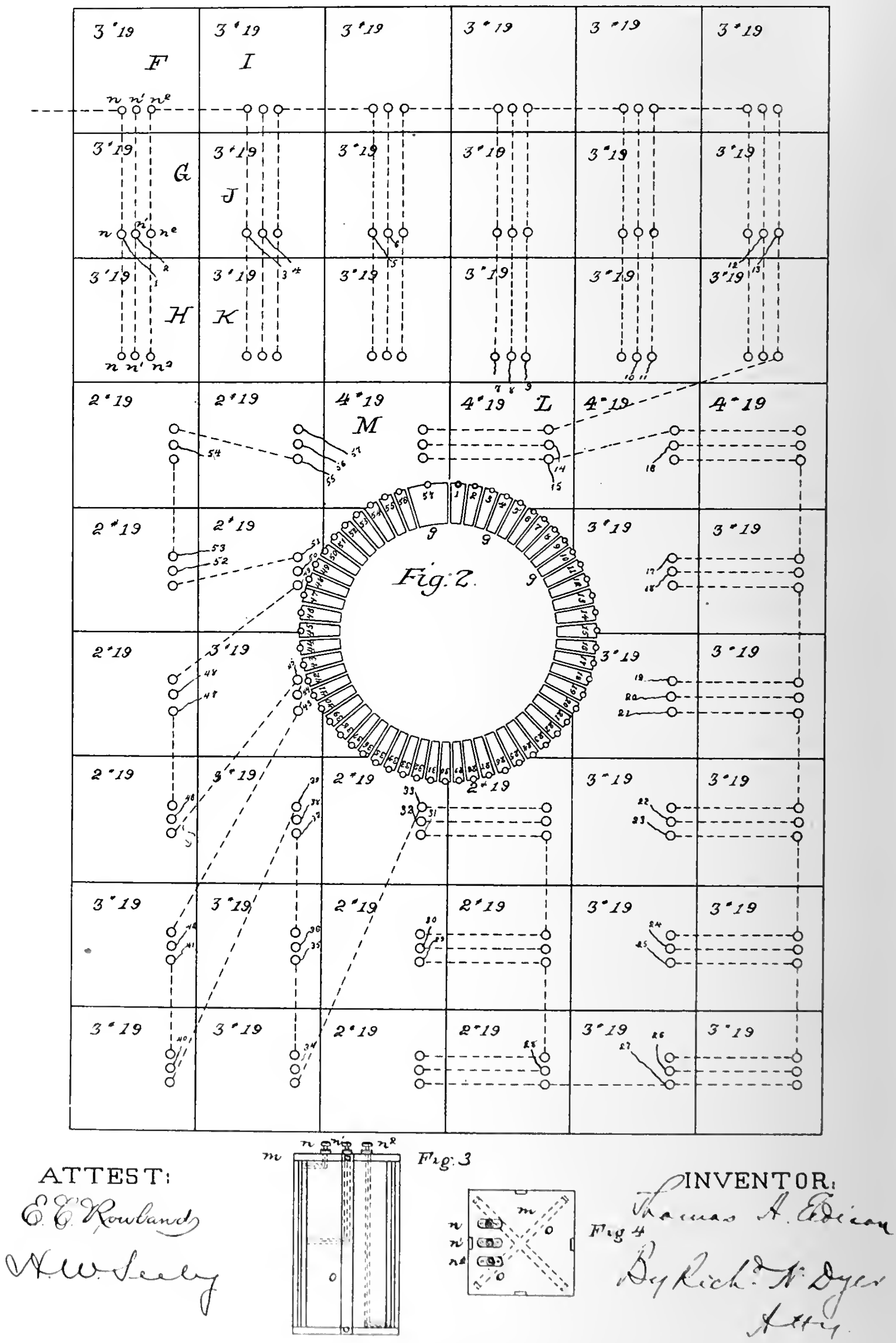


(No Model.) 2 Sheets—Sheet 2.

T. A. EDISON.

REGULATOR FOR DYNAMO ELECTRIC MACHINES.

No. 281,349. Patented July 17, 1883.



N. PETERS, Photo-Lithographer, Washington, D. C.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, ASSIGNOR TO THE EDISON ELECTRIC LIGHT COMPANY, OF NEW YORK, N. Y.

REGULATOR FOR DYNAMO-ELECTRIC MACHINES.

SPECIFICATION forming part of Letters Patent No. 281,349, dated July 17, 1883.

Application filed January 22, 1883. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Regulating Electric Generators, (Case No. 540,) of which the following is a specification.

My invention relates to the regulation of dynamo or magneto electric generators when a number of such generators are placed at a central station to supply current to the translating devices of a system. Each of such generators has its field-magnet coils in a circuit independent of the field-circuits of the other generators, and in each field-circuit is placed an adjustable resistance to regulate the generation of current according to the number of translating devices in circuit in the district supplied; and a portion of my invention consists in providing means whereby all such resistances may be adjusted simultaneously and to the same extent, it being necessary to do this because all such generators feed into the same circuit or system of circuits, so that all should have the same electro-motive force.

The object of the second part of my invention is to provide adjustable resistances for use in the field-circuits of the generators, which can be adjusted gradually and in the proper proportion, and shall be so formed that the conducting area of the resistance-coils shall be proportioned to the amount of current flowing in the circuit—that is, when but little resistance is placed in the circuit and a comparatively large current is passing the conducting area of the resistance thrown in will be correspondingly large, and as more resistances are thrown in and the current decreases the conducting area of such resistances will decrease correspondingly. By this means the heating of the coils is prevented, as there is always sufficient area to convey the current which passes. I accomplish this by providing a number of resistance-boxes of gradually-diminishing conducting capacity and means for successively throwing them into circuit. Such boxes preferably consist each of an insulating-frame upon which are wound wire coils. Each box is provided with three binding-posts, and the coils on said box are separately connected to all of said binding-posts, so that such coils are divided into two parts in multiple-arc relation to each other. Suitable connections are made between the boxes, as will be explained. A commutator is provided having an adjusting-arm connected in the circuit, and from each commutator-plate a wire runs to one of the binding-posts of a resistance-box. Preferably, to connect the adjusting arm in the circuit, a ring is provided, upon which said arm bears in its revolution, a wire of the circuit being connected to said ring. The connections between the boxes and from the boxes to the commutator-plates are so made that when it is first commenced to throw resistance into the circuit several coils in multiple arc will be thrown in, so that sufficient current-carrying area is provided. As more coils are thrown in the number in multiple arc with each other is lessened, until finally coils are thrown in in series one after another. To allow a still further graduation, some of the boxes are wound with two, some with three, and some with four strands of wire, and the different kinds are arranged so that they will be thrown in at the proper times.

The above will be better understood by reference to the drawings, in which Figure 1 is a view mostly in diagram, representing the resistances in the field-circuits of two generators and means for regulating them simultaneously; Fig. 2, a diagram illustrating the resistance-connections; Fig. 3, an elevation of one of the resistance-boxes, with part of the coils in dotted lines; and Fig. 4, a top view of the same.

Referring to Fig. 1, A A represent dynamo-electric machines having their armatures in multiple-arc circuits *b c* from the main circuit B B′. The field-magnets of the machines are each connected in a multiple-arc circuit, *d e*, from said main circuit. Each field-circuit contains an adjustable resistance, C, consisting of wire coils *f f*, connected to commutator-plates *g g*. A pivoted arm, *h*, makes contact with the plates *g*, and is also constantly in contact with a metal ring, *i*, which ring is connected in the circuit, a flat spring being preferably attached to the under side of said arm to insure good contact. The movement of the arm h thus varies the resistance of the circuit. Each arm h is placed on a shaft, l, which, for convenience, is shown in dotted lines, and both shafts l are turned by means of bevel-gears j j', the gears j being on a shaft, D, which is turned by a hand-wheel, E. A dial, k, is provided, and a pointer, k', is placed on the shaft D, whereby the amount of resistance in circuit is indicated. The turning of the hand-wheel E varies the resistance of the field-circuits of both generators.

The resistance-boxes used are preferably of the form shown in Figs. 3 and 4, consisting of a wooden top, m, provided with three binding-posts, n n' n^2, surrounding a frame, o o, (shown in dotted lines in Fig. 4,) the edges of each frame having grooves in which the coils are wound. Such coils are wound around the entire frame, and are connected to all the binding-posts, there being thus two sections of coils in multiple-arc relation to each other.

The wire used is preferably copper wire No. 19, B. W. G., and two, three, or four strands twisted together are used on the different boxes.

Fig. 2 illustrates the preferred arrangement of the boxes. The commutator-plates g g are numbered, respectively, from 1 to 57. Wires p from binding-posts n n' n^2 extend to such plates, the connections to the plates being, for convenience, shown by placing the numbers at the ends of said wires. The dotted lines indicate the connections from box to box, the connections within the respective boxes not being shown, they being made as previously explained. When the adjusting-arm rests on plate No. 1, which is connected with binding-post n of box G, it is evident that no resistance is in circuit, the current passing directly from binding-post n of box F to that of box G; but on swinging the adjusting-arm to plate No. 2, which, as indicated, is connected with post n' of box G, the current will pass through half the coils of each of the boxes F G H, such halves being in multiple arc to each other. Thus while resistance is placed in circuit sufficient conducting area is provided for the large amount of current which so small a resistance allows to pass. The boxes mentioned are each wound with three strands of No. 19 wire, as indicated. When plate No. 3 is connected, all the coils of boxes F G H are in circuit in multiple arc to each other. No. 4 adds half of each of the boxes I, J, and K, and this continues, half of each set of three boxes being thrown in with each successive commutator-plate until plate No. 14 is reached. The passage from plate No. 13 to No. 14 throws in in multiple arc to each other half of each of the two boxes L and M, this being done because the current has now decreased so far that the current-carrying capacity may be diminished. In order, however, that the change may be made gradual, the boxes L and M are wound, as indicated, with four instead of three strands of No. 19 wire. Beginning with plate No. 18, halves of two boxes of three strands are used, this continuing as far as plate No. 27. From plate No. 28 to No. 33, inclusive, halves of two boxes of two strands each are used. With plate No. 34 half a box of three strands is thrown in in series, and this continues to plate No. 45. With 46 to 57 half-boxes of two strands each are thrown in in series.

I do not confine myself, of course, to the particular number of plates or of boxes and coils shown, or to the especial arrangement and connections of such plates and coils. I have, however, shown an efficient arrangement for accomplishing my object—that is, to so construct an adjustable resistance that the resistances first thrown into circuit will be of comparatively great conducting capacity, while those afterward thrown in gradually decrease in this respect.

What I claim is—

1. The combination of two or more dynamo or magneto electric machines, each having its independent field-circuit, with an adjustable resistance in each of said field-circuits, and means for adjusting all of said resistances simultaneously, substantially as set forth.

2. The combination of two or more dynamo or magneto electric machines, a resistance in the field-circuit of each machine, an arm for adjusting each resistance, and means for moving all such arms simultaneously, substantially as set forth.

3. A rheostat composed of a series of resistance-boxes connected together in multiple arc and series, as described and shown, in combination with commutator-plates to which such boxes are connected, and an adjusting-arm, substantially as set forth.

This specification signed and witnessed this 13th day of January, 1883.

THOS. A. EDISON.

Witnesses:

H. W. SEELY,

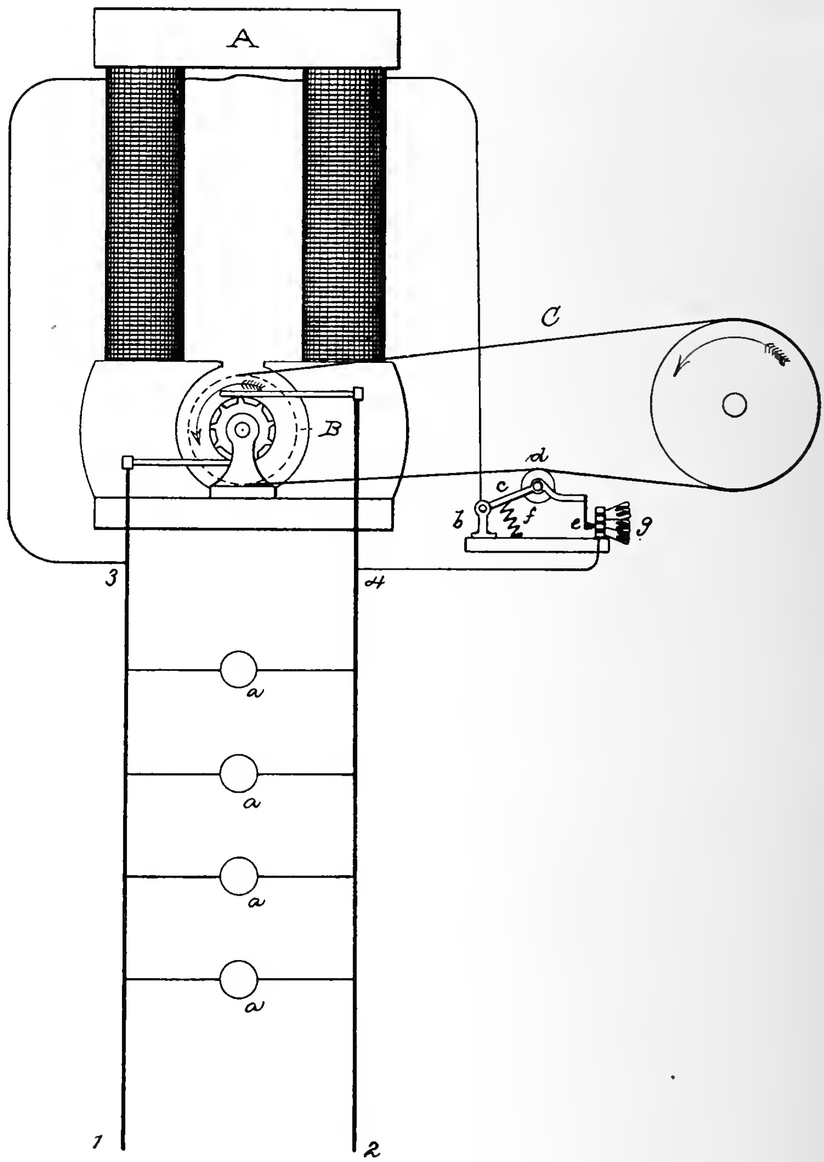
EDWARD H. PYATT.

(No Model.)

T. A. EDISON.

REGULATOR FOR DYNAMO ELECTRIC MACHINES.

No. 281,350. Patented July 17, 1883.



ATTEST:

E. C. Rowland

H. W. Seely

INVENTOR:

Thomas A. Edison,

By Richd. N. Dyer,

Atty.

United States Patent Office.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, ASSIGNOR TO THE EDISON ELECTRIC LIGHT COMPANY, OF NEW YORK, N. Y.

REGULATOR FOR DYNAMO-ELECTRIC MACHINES.

SPECIFICATION forming part of Letters Patent No. 281,350, dated July 17, 1883.

Application filed November 23, 1882. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Regulators for Dynamo-Electric Machines, (Case No. 519,) of which the following is a specification.

The object of my invention is to produce simple and efficient means for automatically varying the current generated by a dynamo or magneto electric machine supplying translating devices arranged in multiple arc, according to variations in the number of such translating devices in circuit from the machine.

Heretofore various electrical devices have been employed whose variations of energy, occasioned by changes in the current flowing, due to variations in the number of translating devices, have caused the adjustment of resistances for regulating the generation of current. By my present invention I do away with such electrical apparatus, said invention consisting in causing the variations in the number of translating devices to set in operation mechanical means whose operation causes the proper regulation. Preferably such mechanical means operate to vary the resistance in the field-circuit of the machine.

My invention may be accomplished as follows: The armature is revolved by a belt from suitable motive power. Upon the tight or driving side of the belt bears a wheel or roller carried by an arm and pressed closely against the belt by a powerful spring. One end of this arm makes contact with the contact-points of an adjustable resistance in the field-circuit of the machine, the arm being also included in such field-circuit, which is preferably a multiple-arc circuit from the main conductors, though it may be a shunt from one of said main conductors, or a circuit supplied with current from an external source. As the number of translating devices in circuit, and consequently the load driven by the belt, increases, the driving side of the belt tightens, and, pressing on the wheel, compresses the spring and moves the arm, so as to throw resistance out of the field; and a decrease in the number of translating devices allows the belt to slacken, when the spring presses the arm in the opposite direction from before, so as to place resistance in the field, the generation of current being thus regulated according to the requirements of the system.

My invention is illustrated in the accompanying drawing, which is a partly diagrammatic view of a dynamo-electric machine, with the accompanying circuits and regulating apparatus.

A is the field-magnet, and B the armature, revolved by belt C, as indicated by the arrows. From the commutator-brushes of the machine extend main conductors 1 2 in multiple-arc circuits, from which are placed lamps, motors, or other translating devices, *a a*.

To any suitable support, *b*, is pivoted an arm, *c*, carrying a wheel, *d*, and a contact-point, *e*. A heavy spring, *f*, tends to press the wheel *d* closely against the belt C. The point *e* is arranged to make contact with the contacts of an adjustable resistance, *g*, placed in the multiple-arc circuit 3 4, which includes the field-magnet coils of the machine. As above explained, the tightening of the belt C, caused by an increase in the number of translating devices in circuit, presses down the arm *c* and cuts out a part of the resistance *g* from the field-circuit, while on a decrease in the number of lamps or motors the spring *f* presses the arm up and increases the resistance in the field.

What I claim is—

1. The combination, with a dynamo or magneto electric machine and translating devices arranged in multiple arc, of mechanical means operated directly by variations in the load or pull upon the armature for regulating the generation of current by the machine, substantially as set forth.

2. The combination, with a dynamo or magneto electric machine, an adjustable resistance in the field-circuit thereof, and translating devices arranged in multiple arc, of mechanical means operated directly by variations in the load or pull upon the armature for varying said adjustable resistance, substantially as set forth.

3. The combination, with a dynamo or mag-

neto electric machine, the motor actuating the same, and the belt connecting said machine and said motor, of means actuated by variations in the tightness of such belt for regulating the generation of current by said machine, substantially as set forth.

4. The combination, with the belt connecting the generator with the motor which actuates it, of the arm carrying a wheel bearing on said belt, the spring holding said wheel against said belt, the contact-point carried by said arm, and the adjustable resistance in the field-circuit of the generator, substantially as set forth.

This specification signed and witnessed this 13th day of November, 1882.

THOS. A. EDISON.

Witnesses:

H. W. SEELY,

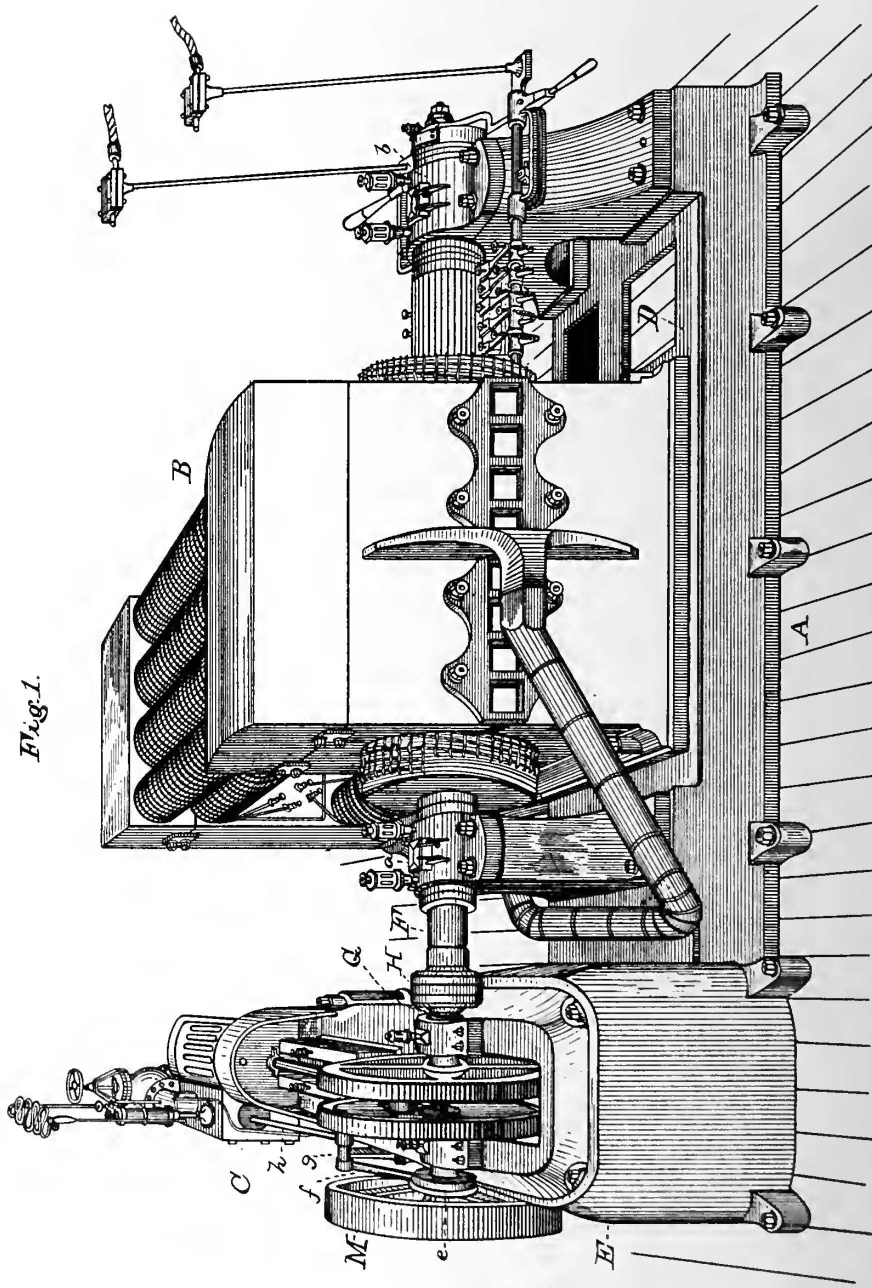
EDWARD H. PYATT.

(No Model.) 3 Sheets—Sheet 1.

T. A. EDISON.

ELECTRICAL GENERATOR.

No. 281,351. Patented July 17, 1883.



ATTEST:

E. C. Rowland

H. W. Seely

INVENTOR:

Thomas A. Edison

By Richd. N. Dyer.

Atty.

N. PETERS. Photo-Lithographer. Washington. D. C.

(No Model.) T. A. EDISON. 3 Sheets—Sheet 2.

ELECTRICAL GENERATOR.

No. 281,351. Patented July 17, 1883.

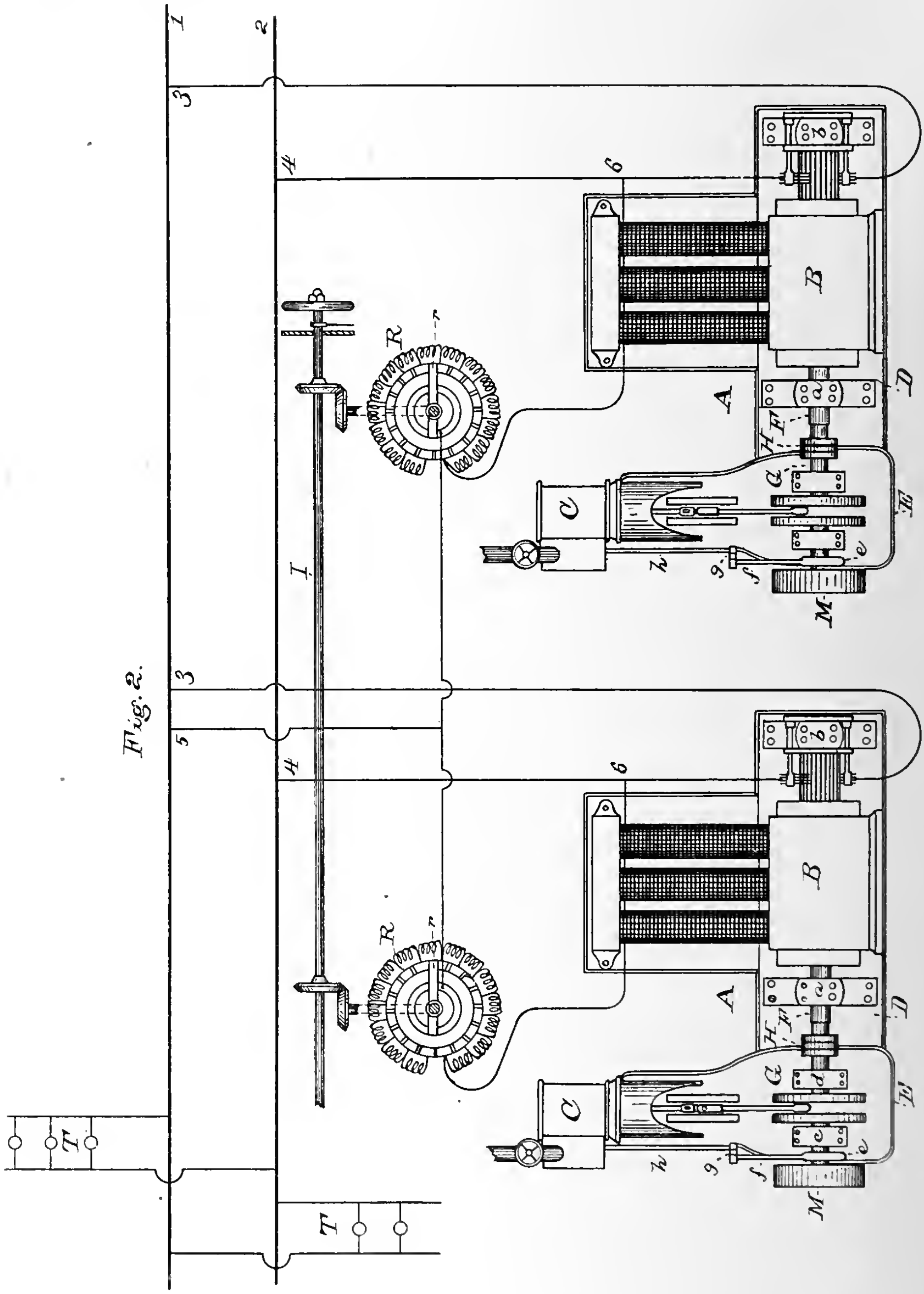


Fig. 2.

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Atty.

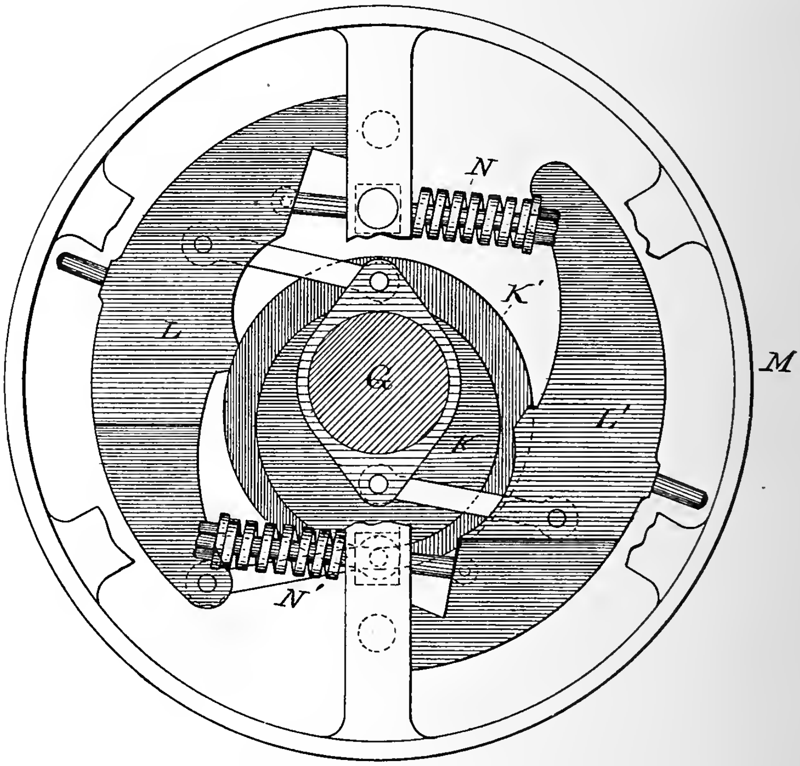
(No Model.) 3 Sheets—Sheet 3.

T. A. EDISON.

ELECTRICAL GENERATOR.

No. 281,351. Patented July 17, 1883.

Fig. 3.



ATTEST:

E. C. Rowland,

H. W. Seely

INVENTOR:

Thomas A. Edison,

By Rich^d N. Dyer, Atty.

N. PETERS, Photo-Lithographer, Washington, D. C.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, ASSIGNOR TO THE EDISON ELECTRIC LIGHT COMPANY, OF NEW YORK, N. Y.

ELECTRICAL GENERATOR.

SPECIFICATION forming part of Letters Patent No. 281,351, dated July 17, 1883.

Application filed March 16, 1883. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Electrical Generators, (Case No. 552,) of which the following is a specification.

The object I have in view is an arrangement and construction of electrical generators and operating steam-engines suitable for use in a central-station plant for supplying electricity to conductors of a system of general distribution, wherein a continuous and constant pressure is maintained on the mains or in other locations where two or more generators are employed, feeding separately into the same circuit. For such a plant I provide separate and independent high-speed and high-pressure steam-engines for operating the dynamo or magneto electric machines, the advantages possessed by this construction over the use of a large low-speed and low-pressure engine for running all of the machines being of vital importance in a general system of electrical distribution. There is greater economy in running generators by separate high-speed engines, since the number of engines in operation can be changed as required by the work to be done or the number of translating devices in circuit. To get a certain speed with a large low-speed engine a definite boiler-pressure has to be maintained, no matter how small the load upon the engine may be; hence there is a great loss of power when the load is small, which loss increases largely as the load is decreased below the point of greatest economy. With the large low-speed engine, when the load is small, the friction becomes an important factor in the work of the engine, and the economy is greatly lessened. These difficulties are not met with when separate high-speed engines are used, since the engines can be thrown out of operation as the load decreases, and the engines left running be worked with good economy. The boilers (of which there would be a number, preferably the same number as the engines) can be thrown out of operation, and hence the boilers can also be worked in the most economical way. With the large low-speed engine an extra engine of equal power would have to be provided for operating the machines in case the first engine should break down or had to be stopped for repairs, cleaning, or for other purposes. This makes it necessary to have double the engine capacity required for running the machines, making the investment for engines larger than when separate engines are used, since with the separate engines I have found that one extra or spare engine in every six is sufficient, making the reserve capacity only one-sixth the entire capacity, and this proportion might be still further reduced. In addition, with the large engine, the breaking down of such engine would cause the total extinguishing of the lamps for a time until the reserve engine could be started; but with a number of separate engines, when one engine breaks down, the load is taken by the other engines, and the lamps are not extinguished, but only a momentary drop in the candle-power occurs, which is instantly corrected by the regulation of the generators in the manner hereinafter stated. The wear upon the separate engines is also less, since they will be thrown out of operation a much greater proportion of the time than the large engine. A most important commercial advantage is the large saving in the investment for real estate for a central-station plant, it being possible to place the separate engines with the small reserve power in much less space than is required by the two large engines, with the necessary shafting, belting, clutches, &c.

The dynamo or magneto electric machines and steam-engines are made of the same capacity, and each dynamo or magneto electric machine is mounted upon the same base or bed with a steam-engine. This base is preferably made of cast-iron formed in convenient sections bolted or otherwise suitably secured together to form a solid support for the combined machine. The engine and dynamo have their shafts placed in line with each other and connected directly together to form a shaft common to both the engine and dynamo. The dynamos may be of any desired size. I have found that dynamos capable of supplying economically about fifteen hundred (1500) sixteen (16) candle incandescing electric lamps are well adapted for large central-station plants. By the use of the direct connection between the engine and dynamo great economy results, since no power is lost in intermediate shafting or from the pull or slip of belts. The use of clutches is avoided for connecting the dynamos with and disconnecting them from the shafting. There is no danger of stoppage from breaking of belts or from the breakage or disarrangement of other parts of the intermediate mechanism, as there would be with the low-speed engine and its shafting. The direct connection makes the combined machine simple and reliable and adds greatly to the compactness, which is a feature of great importance, in that less room is required for the plant and the investment in real estate diminished.

With the high-speed engines the movement is uniform and a steady current is produced. The movement is made more uniform by the inertia of the armature, which has considerable weight. For a high-speed engine I have found that one making three hundred and fifty (350) revolutions per minute is suitable for the purpose; but it is evident that the dynamo could be constructed to work at a different speed. I also prefer to use a high boiler-pressure. About one hundred and ten pounds (110 lbs.) is an economical pressure; but it is evident that a lower pressure could be employed. The high-speed steam-engines used by me are provided with automatically-variable cut-off mechanisms. Engines of this kind possess the general advantage over throttling-engines of greater economy in the use of steam, and the especial advantage, when used to operate dynamo or magneto electric machines connected with and feeding into the same circuit, of closer regulation and greater uniformity of speed. Throttling-engines are wholly unsuited for the purpose on account of the loss of power and on account of the want of uniformity in speed. It is necessary that the engines should not vary more than about three per cent. (3%) in speed, and within this the regulation of the engine must be performed. A greater variation would cause the dynamos to differ in electro-motive force to such an extent that those of lowest electro-motive force at any given time would be converted into electromotors and be run as such by the dynamos of greatest electro-motive force. This relation would be reversed by the movement of the governors, and in this way the power would be partly used up in the plant itself, and there would be an overloading of part of the dynamos, accompanied by extra sparking at the commutators and overheating of the armatures.

The most effective governor for cut-off engines for my purpose I have found to be a spring-governor—that is, a governor in which centrifugally-acting weights are opposed by heavy springs. The springs overcome the inertia of the weights, and the governor responds almost instantly to the slightest variation in speed, making all the engines work practically in unison, so that the differences in electro-motive force of the dynamos are not sufficient to cause the unequal loading of the machines; but I do not wish to limit myself to engines with spring-governors, since the variable cut-off mechanisms may be worked by other forms of governor. I have also found that the spring-governor and ball-governor engines may be worked together, one spring-governor engine being capable of compensating for irregularities in two or three ball-governor engines, preventing the occurrence of the peculiar operation before described.

With the base common both to the steam-engine and the dynamo or magneto electric machine, the direct connection between the engine and armature shafts, and the automatically-variable cut-off, the combined machine becomes a self-contained electrical generator, controlled by and accommodating itself to the external load automatically and with economy, and suitable for use in a central-station plant. The automatically-variable cut-off engine and the dynamo have a combined action and react one upon the other. An increase in the number of lamps in circuit throws more work upon the dynamo, and this in turn causes the cut-off of the engine to act at a later point in the stroke, admitting more steam into the cylinder and increasing the power of the engine. A decrease in the number of lamps in circuit has the reverse effect upon the dynamo and engine.

In a central-station plant there is a mutual action and reaction of the dynamos and cut-off engines, which is caused by the fact that the dynamos are connected with and feed into the same circuit. Suppose, for illustration, the maximum capacity of each dynamo to be fifteen hundred lamps, and that there are four dynamos in connection with the circuit and supplying six thousand lamps. Now the load will be equally distributed among the combined dynamos and engines, fifteen hundred to each combined machine, and the cut-offs of all the engines will be acting at the same point. As the lamps are gradually reduced in number the cut-offs of all the engines will vary in unison, cutting off steam earlier in the stroke, until there are but forty-five hundred lamps in circuit, eleven hundred and twenty-five to each dynamo, or something less than that number. Then the connection of one dynamo with the circuit can be broken and its engine stopped. The entire load is then thrown upon the three dynamos, which react upon the cut-offs of their engines and cause them to change in unison the point of cut-off to meet the increase of load. If more lamps are taken off, the same operation takes place until the number of lamps is reduced to three thousand or somewhat under that number, when another machine is disconnected from the circuit. The reverse operation takes place when lamps are being added to the circuit.

When a machine breaks down and has to be stopped, the other machines take the load, dividing it up among them and acting in unison until an additional machine is started, when another division of the work takes place.

The engines have to regulate in unison and quickly, in order to prevent the overloading of part of the dynamos, and this can only be accomplished by the use of the self-contained generators. The generators are preferably dynamo-electric machines having their field-magnets in separate multiple-arc circuits derived from the main circuit; but a separate exciter may be employed. The lamps or other translating devices are arranged in multiple arc, and a change in the number of such translating devices produces variations in the arrangement of resistances and in the electromotive force of the machine independent of the speed at which the machine is driven. To compensate for this variation in electro-motive force, another species of regulation has to be resorted to in addition to that furnished by the automatically-variable cut-offs of the engines. For this purpose the strength of the field-magnets is varied by varying in unison and to the same extent the current flowing through the field-circuits of the several machines. This may be accomplished by the use of an adjustable resistance in the field-circuit of each machine, all the resistance-adjusting arms being operated simultaneously by a common shaft.

In the drawings, Figure 1 is a perspective view of the self-contained electrical generator; Fig. 2, a top view, partly diagrammatic, showing two of such machines in connection with the same circuit; and Fig. 3, an elevation of the spring-governor cut-off mechanism.

A is a cast-iron base, preferably made in sections bolted together, and forming a support for the dynamo or magneto electric machine B and the high-speed cut-off engine C.

The dynamo or magneto electric machine is preferably constructed as described in my Patents Nos. 263,133, 263,140, 264,647, and 265,785. The field-magnet is arranged horizontally and supported upon a depressed portion, D, of the base, to which it is bolted, while the engine-frame is bolted to an elevated portion, E, of the base.

The armature-shaft F of the machine B is journaled in bearings at *a b* upon the depressed portion D of the base, while the engine-shaft G is journaled in bearings *c d* on the elevated portion E of the base. The shafts F G are brought into line with each other, and are coupled directly together at H by any suitable coupling, preferably one accommodating itself to any slight deviation in the alignment of the shafts.

The commutator-brushes of the several dynamos used in a central-station plant are connected with the same main circuit, 1 2, the armatures being in multiple-arc or derived circuits 3 4 from such main circuit. The field-circuit 5 6 of each machine is a multiple-arc circuit from 1 2. It contains a resistance, R, adjusted by an arm, *r*. The arms *r* of the several resistances are connected with and moved simultaneously by a common shaft, I.

The lamps or other translating devices T are arranged in multiple arc from 1 2 or from circuits derived therefrom.

As before stated, the steam-engines C have cut-off mechanisms, and these are automatically operated by governors.

I prefer to use a spring-governor. In Fig. 3 is shown a form of spring-governor cut-off which I find well suited to the purpose, although I do not wish to limit myself to any particular form of governor. The engine-shaft G is provided with a double eccentric, K K′, connected by links to weights L L′, which are pivoted to the arms of the wheel M, keyed to the shaft. The weights L L′ are opposed by heavy springs N N′. Around the outer eccentric K′ is the eccentric-strap *e*, which is connected by rod *f* with a rocking arm, *g*, which in turn is connected with the valve-rod *h*.

I do not claim herein the peculiar features of the self-contained machine, *per se*, independent of its connection with other machines, or independent of the nature and arrangement of the translating devices supplied by it, since the same will be made the subject of another application for patent; and it is to be understood that all other patentable features of invention described or shown but not claimed herein are reserved for protection by other patents, and have been or will be embraced in other applications for patents.

What I claim is—

1. The combination, with one circuit, of two or more dynamo or magneto electric machines connected with such circuit and feeding into the same, and two or more independent steam-engines operating such dynamo or magneto electric machines, substantially as set forth.

2. The combination, with one circuit, of two or more dynamo or magneto electric machines connected in multiple arc with such circuit, and two or more independent steam-engines operating said dynamo or magneto electric machines, substantially as set forth.

3. The combination, with one circuit, of two or more dynamo or magneto electric machines connected with such circuit and feeding into the same, and two or more independent steam-engines operating such dynamo or magneto electric machines and having automatically-variable cut-off mechanisms, substantially as set forth.

4. The combination, with one circuit, of two or more dynamo or magneto electric machines connected with such circuit and feeding into the same, and two or more independent steam-engines operating such dynamo or magneto electric machines, and having cut-off mechanisms varied automatically by spring-governors, substantially as set forth.

5. The combination, with one circuit, of two or more dynamo or magneto electric machines

connected in multiple arc with such circuit, two or more independent steam-engines operating said dynamo or magneto electric machines, and translating devices connected in multiple arc with such circuit, substantially as set forth.

6. The combination of a dynamo or magneto electric machine, a steam-engine with automatically-variable cut-off, the direct connection, and common base, with translating devices connected in multiple arc with said machine, substantially as set forth.

7. The combination of two or more self-contained electrical generators connected with and feeding into the same circuit, each of such self-contained electrical generators being composed, essentially, of the following parts, viz: a dynamo or magneto electric machine, a high-speed steam-engine having an automatically-variable cut-off, a direct connection between the shaft of said engine and that of said dynamo or magneto electric machine, and a supporting base or bed common both to said steam-engine and said dynamo or magneto electric machine, substantially as set forth.

8. The combination of two or more self-contained electrical generators connected with and feeding into the same circuit, each of such self-contained electrical generators being composed, essentially, of the following parts, viz: a dynamo or magneto electric machine, a high-speed steam-engine provided with a variable cut-off and a spring-governor varying such cut-off automatically, a direct connection between the shaft of said engine and that of said dynamo or magneto electric machine, and a supporting base or bed common both to said steam-engine and said dynamo or magneto electric machine, substantially as set forth.

9. The combination, with one circuit, of two or more dynamo or magneto electric machines connected with such circuit and feeding into the same, two or more independent steam-engines operating such dynamo or magneto electric machines, and means for varying the electro-motive force of the machines independent of the speed of the engines, substantially as set forth.

10. The combination, with one circuit, of two or more dynamo or magneto electric machines connected with such circuit and feeding into the same, two or more independent steam-engines operating such dynamo or magneto electric machines and having automatically-variable cut-offs, and means for varying the electro-motive force of all the machines simultaneously independent of the speed, substantially as set forth.

11. The combination of a dynamo or magneto electric machine, a steam-engine with automatically-variable cut-off, the direct connection, and common base, with means for varying the electro-motive force of the machine independent of the speed, substantially as set forth.

12. The combination, with one circuit, of two or more dynamo or magneto electric machines connected in multiple arc therewith, two or more independent steam-engines operating such dynamo or magneto electric machines, means for varying the electro-motive force of all the machines simultaneously independent of the speed, and translating devices connected in multiple arc with said circuit, substantially as set forth.

This specification signed and witnessed this 5th day of March, 1883.

THOS. A. EDISON.

Witnesses:

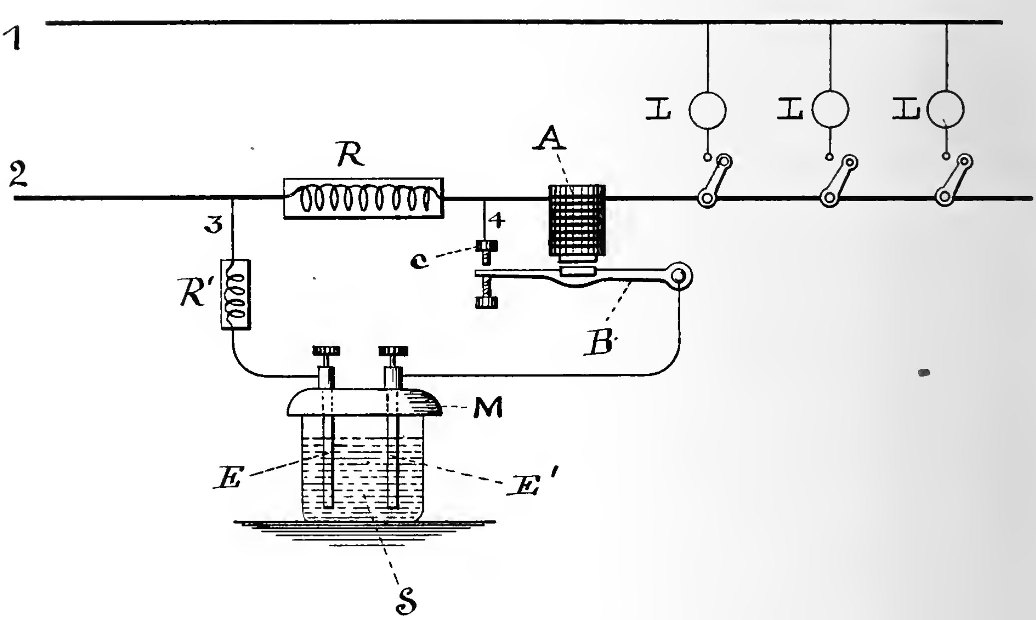
WM. H. MEADOWCROFT,
H. W. SEELY.

(No Model.)

T. A. EDISON.

WEBERMETER.

No. 281,352. Patented July 17, 1883.



WITNESSES:

D. D. Mott

W. J. Clagett.

INVENTOR:

T. A. Edison

BY Dyer & Wilber

ATTORNEYS.

United States Patent Office.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, ASSIGNOR TO THE EDISON ELECTRIC LIGHT COMPANY, OF NEW YORK, N. Y.

WEBERMETER.

SPECIFICATION forming part of Letters Patent No. 281,352, dated July 17, 1883.

Application filed November 11, 1881. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Webermeters, (Case No. 356;) and I do hereby declare that the following is a full and exact description of the same, reference being had to the accompanying drawings, and to the letters of reference marked thereon.

This improvement relates to the electroplating or metal-depositing cell electric meter for measuring the amount of electrical energy consumed in my system of electric lighting, in which meter the metal is taken from one electrode of the cell and is deposited upon the other by the action of the current. This depositing-cell is arranged so that only a small part of the current will pass through it, the total current being determined by the measurement of a definite fractional portion thereof, as set forth in my application filed March 20, 1880, (Serial No. 5,539.)

Now, the object of the present invention is to produce an electric meter of this character which will produce a correct deposit of metal by the use of a much weaker current (or smaller portion of the entire current) than is possible with the employment, as heretofore practiced by me, of simple copper electrodes, thus causing a considerable saving in electrical energy. This I accomplish by using amalgamated electrodes in the depositing-cell. The electrodes which I prefer to use, and which are the most accurate, are made of metallic zinc placed in a strong solution of sulphate of zinc. I prefer that such electrodes, before being used in the meter, should have a heavy coating of deposited zinc placed on them by the action of an electric current, which zinc will be thoroughly amalgamated while being deposited. This is done by coating the plates with mercury and then depositing the zinc thereon, and removing the plates from the depositing-cell and coating with mercury as often as is necessary to secure a thorough amalgamation of the zinc. Plates thus prepared are precisely alike and give accurate results. Other metals which can be amalgamated—such as cadmium, lead, and tin—are capable of being used in this connection when immersed in solutions of their salts, not acting upon the mercury, such as the sulphate of cadmium and acetate of lead; but none are as accurate as zinc treated as described. The depositing-cell meter is arranged in a shunt from one of the conductors of a house or other consumption circuit, a resistance being placed in the line to shunt a definite small portion of the entire current through the meter. A wire resistance is placed in the same shunt as the depositing-cell, and is arranged to compensate for the effect of changes in temperature on the resistance in the cell-circuit. The wire being increased in resistance by a rise of temperature, and the cell proportionately decreased, and a fall of temperature having exactly the opposite effect on the wire and cell, the total resistance of the shunt will always be the same, and consequently the same fraction of the current will always pass through it. Two or more depositing-cells may be used instead of one cell in the same shunt, or two cells may be placed in separate shunt-circuits, so that one will act as a check upon the other, as set forth in my application filed August 30, 1881, (Serial No. 40,990.) Although with the amalgamated-zinc electrodes there is the minimum amount of counter electro-motive force to the cell, still it is practically impossible to produce two electrodes which are so precisely alike that there will be no counter force at all.

To prevent the establishing by the cell of a counter current when no lamp is on and no current is flowing through the house or consumption circuit, I provide a device for automatically breaking the shunt when the circuit of the last lamp is broken and for closing such shunt when the first lamp-circuit is completed. This device may consist of an electro-magnet placed directly in the house or consumption circuit, or in a multiple-arc circuit therefrom, or in a shunt from one of the conductors of the consumption-circuit, and operating a lever arranged to make and break the meter-shunt; or this magnet may be the resistance around which the meter-shunt is placed.

The drawing shows a diagrammatic view of the meter and connections.

1 2 are the conductors of the house or consumption circuit, and L lamps or other translating devices placed in multiple-arc or derived circuits.

R is resistance in conductor 2.

3 4 represent the meter-shunt.

M is the depositing-cell forming the meter, having amalgamated-zinc electrodes E E′ and a solution of sulphate of zinc, S.

R′ is the wire resistance in shunt 3 4, to compensate for the varying resistance of S.

A is the electro-magnet in the conductor 2, operating lever B, placed in shunt 3 4, and making and breaking said shunt at contact *c*.

What I claim is—

1. In an electric meter, an electro-depositing cell provided with amalgamated metallic electrodes, substantially as set forth.

2. In an electric meter, an electro-depositing cell having amalgamated-zinc electrodes, substantially as set forth.

3. The combination, with an electro-depositing cell acting as a meter, of a circuit closer and breaker arranged to break the meter-circuit completely when no translating devices are in operation, and to close such meter-circuit completely when the first translating device is put in operation, substantially as set forth.

4. The combination, with an electric circuit including a definite and known resistance, of one or more electro-depositing cells arranged in a shunt around such resistance, and an electro-magnet in the main circuit, or in a shunt or multiple-arc circuit therefrom, operating to open and close the meter-shunt, substantially as and for the purpose set forth.

This specification signed and witnessed this 5th day of October, 1881.

THOS. A. EDISON.

Witnesses:
RICHD. N. DYER,
H. W. SEELY.

(No Model.)

T. A. EDISON.

DYNAMO OR MAGNETO ELECTRIC MACHINE.

No. 281,353. Patented July 17, 1883.

Fig. 1.

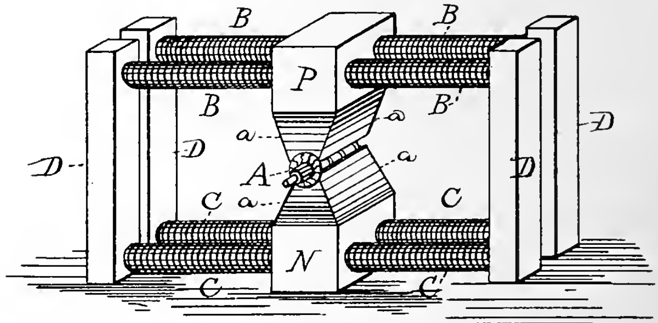


Fig. 2.

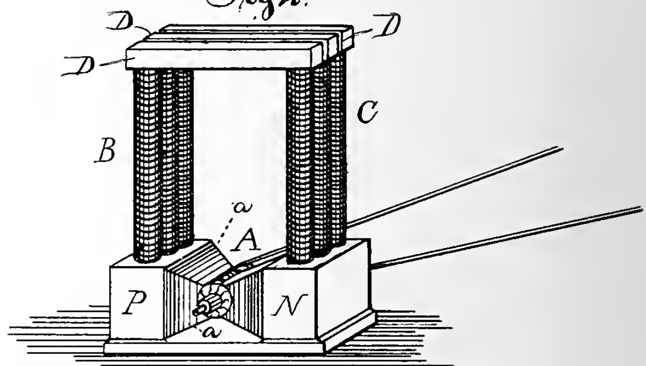


Fig. 3.

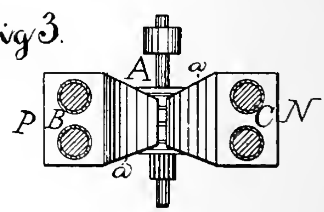
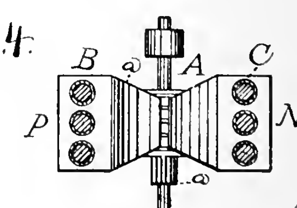


Fig. 4.



ATTEST:

E. C. Rowland

H. W. Seely

INVENTOR:

Thomas A. Edison,

By Richd N. Dyer

Atty.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, ASSIGNOR TO THE EDISON ELECTRIC LIGHT COMPANY, OF NEW YORK, N. Y.

DYNAMO OR MAGNETO ELECTRIC MACHINE.

SPECIFICATION forming part of Letters Patent No. 281,353, dated July 17, 1883.

Application filed September 13, 1882. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Dynamo or Magneto Electric Machines, (Case No. 434;) and I do hereby declare that the following is a full and exact description of the same, reference being had to the accompanying drawings, and to the letters of reference marked thereon.

The object I have in view is such an improvement in dynamo or magneto electric machines that greater economy of construction may be secured and machines of greater efficiency obtained than heretofore for the same outlay. This I accomplish by contracting the field of force of the machines, and in this way increasing the lines of force or the strength of the lines of force per unit of surface of the armature. The armature is made to correspond in size with the active faces of the polar extensions, which nearly surround such armature. It will be seen that smaller armatures can be used, and that powerful machines may be built without the increase heretofore required in the size and cost of the armatures, and with but a small increase, comparatively, in the cost of the other parts of the machines, and also diminishing greatly the resistance of the armature. The contraction of the field of force is brought about by making the polar extensions smaller at their active opposing faces than at any other point, such polar extensions being made convergent in one or in two directions. One or more pairs of electro-magnet cores are attached to one or to each side of the polar extensions. Two or more pairs of cores are preferably thus attached to the same polar extensions, and are placed either in a horizontal or in a vertical position. Each pair of cores is provided with its separate magnetic yoke or back piece, while the polar extensions, to which all the pairs of cores are attached, are made each of one piece magnetically.

The foregoing will be better understood from the drawings, in which Figure 1 is a perspective view of a machine embodying the invention; Fig. 2, a perspective view of a somewhat different form of machine; Fig. 3, a vertical section through the cores on one side of the machine shown in Fig. 1, and Fig. 4 a horizontal section through the cores of the machine shown in Fig. 2.

A represents the revolving armature of a dynamo or magneto electric machine having a continuously-wound bobbin connected with the bars of a commutator-cylinder, as usual. This armature is supported, in the ordinary way, in the space between the opposing faces of the polar extensions P N of the field-of-force magnet or magnets. The active opposite faces of the polar extensions are curved to nearly surround the armature, which is made of proper size to fit in the chamber formed by the curved faces at the reduced ends of the polar extensions. These polar extensions have their bodies made of the proper size to receive the magnet-cores, while from these bodies the polar extensions are made convergent in one or two directions, or are contracted toward the field of force, the bevel surfaces being shown at a. This contraction may be made in one or in two directions, and from one or both sides of the polar extensions—that is to say, each polar extension may be beveled on one or both sides, or on one or both ends; or it may be beveled on one or both sides and on one or both ends at the same time. Two or more pairs of cores, B C, are preferably used, arranged on each side of the polar extensions, Fig. 1, or on one side only, Fig. 2, and connected with the bodies of the polar extensions. Each pair of cores has a separate magnetic yoke or back piece, D, as shown, while the polar extensions P N are magnetically each in one piece.

The armature, it will be seen, is made the size of the contracted ends or active faces of the polar extensions, and thus it can be made much smaller than heretofore, and, being the most expensive portion of the machine to construct, the machine is made cheaper than those of equal power heretofore constructed. It is evident that machines constructed in this way have corresponding advantages when used as electric engines or motors.

I do not claim herein the two or more cores or sets of cores attached to the same polar extensions and located at different distances from the armature, as this is claimed in my application No. 71,757; and it is to be understood that all other patentable features of invention shown or described but not claimed herein are reserved for protection by other patents, and have been or will be embodied in other applications for patents.

What I claim is—

1. In a dynamo or magneto electric machine, the combination, with a revolving armature, of the field-magnet provided with convergent polar extensions nearly surrounding the armature, substantially as set forth.

2. In a dynamo or magneto electric machine, the combination, with the field-magnet and its polar extensions having reduced opposite active ends made with curved faces, of an armature revolving in the space formed by the curved faces of the reduced active ends of the polar extensions, and nearly surrounded by such curved faces, substantially as set forth.

3. In a dynamo or magneto electric machine, the combination, with a revolving armature, of a field electro-magnet composed of polar extensions, each of which is magnetically in one piece, and two or more pairs of wound cores attached to such polar extensions, and provided with magnetically-separate yokes or back pieces, substantially as set forth.

4. In a dynamo or magneto electric machine, the combination, with a revolving armature, of the field-magnet provided with convergent polar extensions nearly surrounding the armature, and two or more pairs of magnet-cores, substantially as set forth.

5. In a dynamo or magneto electric machine, the combination, with a revolving armature, of the field-magnet provided with convergent polar extensions made each in one piece magnetically and nearly surrounding the armature, and with two or more pairs of magnet-cores having separate magnetic yokes or back pieces, substantially as set forth.

This specification signed and witnessed this 3d day of June, 1882.

THOS. A. EDISON.

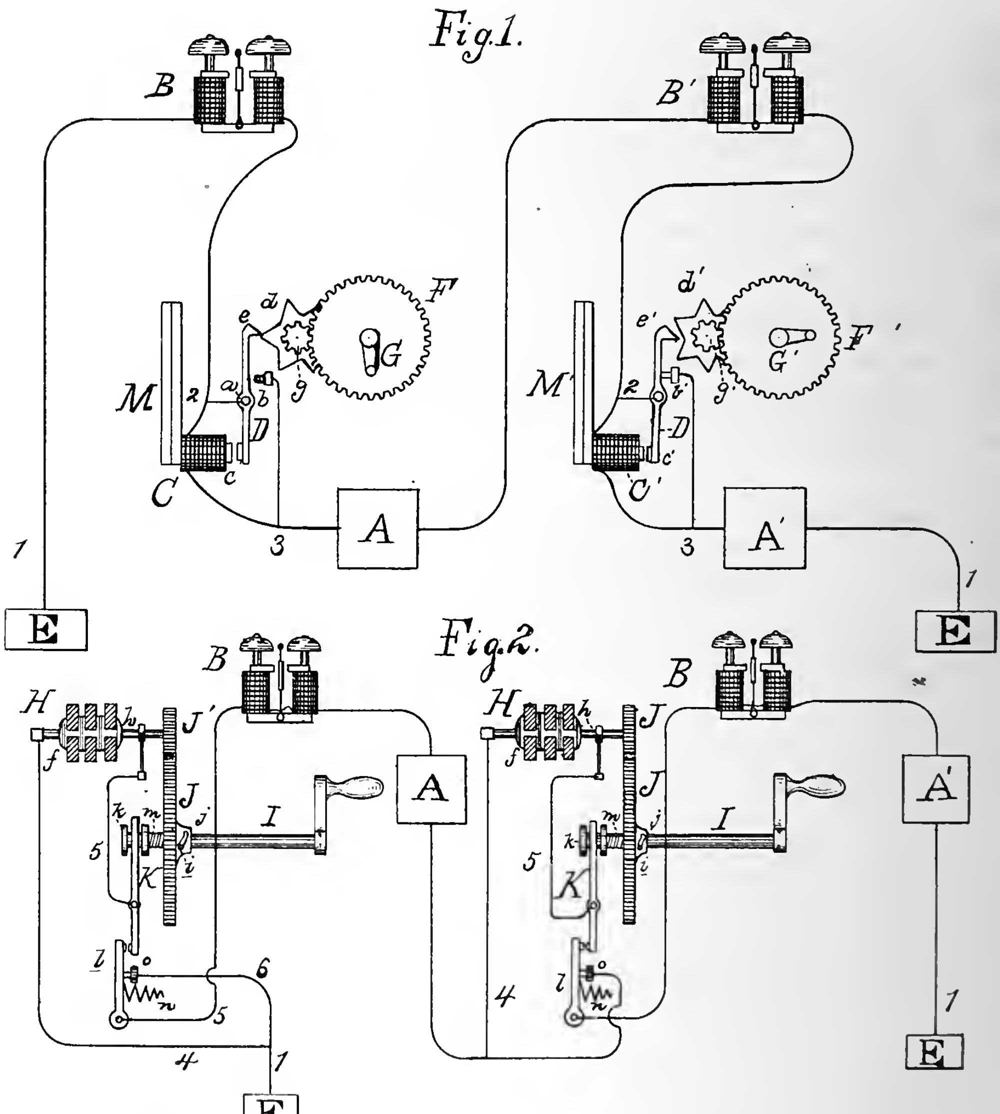
Witnesses:
RICHD. N. DYER,
H. W. SEELY.

(No Model.)

T. A. EDISON.

MAGNETO ELECTRIC SIGNALING APPARATUS.

No. 282,287. Patented July 31, 1883.



WITNESSES:

E. C. Rowland,

H. W. Seely

INVENTOR:

Thomas A. Edison,

By Rich^d. N. Dyer, Atty.

Corrections in Letters Patent No. 282,287.

It is hereby certified that in Letters Patent No. 282,287, granted July 31, 1883, to Thomas A. Edison, of Menlo Park, New Jersey, for an improvement in "Magneto-Electric Signaling Apparatus," an error appears requiring correction as follows: in line 94, page 2, of the printed specification, the following words should have been inserted after the word "generator," "and causing the coils of the generator;" and that the specification should be read with this correction therein to make it conform with the records of the case in the Patent Office.

Signed, countersigned, and sealed this 14th day of August, A. D. 1883.

[SEAL.]

M. L. JOSLYN,
Acting Secretary of the Interior.

Countersigned:

E. M. MARBLE,
Commissioner of Patents.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

MAGNETO-ELECTRIC SIGNALING APPARATUS.

SPECIFICATION forming part of Letters Patent No. 282,287, dated July 31, 1883.

Application filed August 7, 1882. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Magneto-Electric Signaling Apparatus, (Case No. 470,) of which the following is a specification.

My invention relates to apparatus for transmitting signals by electricity back and forth over the same line, in which apparatus the current used for signaling is generated by dynamo or magneto electric machines, my object being to provide an arrangement of such machines and the alarms operated by them so that the alarms at both ends of the line will be operated simultaneously by the working of the dynamo or magneto electric machine at either end of the line, and to provide means, to be used in connection with each dynamo or magneto electric machine, controlled by the act of operating the machine, for automatically throwing it into circuit when in use and removing it when the operation ceases, it being desirable to remove the resistance of each dynamo or magneto electric machine from the circuit when such machine is not in use. This is accomplished by arranging the dynamo or magneto electric machine at opposite ends of the line in series with the electrically-operated alarms at opposite ends of the line. The generators may be thrown automatically into and out of circuit by providing means, in connection with each generator, which shall, immediately upon the operation of the generator, open a shunt around said generator, (the generator-circuit being always closed,) which shunt is normally kept closed, and returns to such normal condition immediately on the cessation of such operation.

The breaking of the shunt-circuit may be accomplished by means of a vibrating circuit-breaker whose vibrations are caused by the act of operating the generator, it being so arranged as to close the circuit when the generator is stopped; or means may be provided for holding the shunt-circuit open continuously during the operation of the generator. As such a shunt is practically of no resistance, its closure amounts practically to the throwing of the generator entirely out of circuit. Instead of this arrangement, however, the shunt may be dispensed with, and the same effect produced by closing the main line and opening the generator-circuit when the generator is not in use, and opening the main line and closing the generator-circuit when the generator is in use.

It is preferable that the generator and the circuit-breaker employed should be operated by a continuously-revolving movement, suitable devices being employed to convert this movement into a vibrating one in case a vibrating circuit-breaker is used.

It will be understood that by the arrangement described the dynamo or magneto electric machines at both ends of the line will be normally and while at rest out of circuit. By the working of either dynamo or magneto electric machine it will be thrown automatically into circuit (the generator at the other end of the line remaining out of circuit) and into series, with the alarms at both ends of the line, which will be sounded simultaneously. Upon the cessation of the operation the generator is thrown automatically out of circuit, leaving the apparatus in its normal condition, ready for the operation of either generator.

In the annexed drawings, Figure 1 is a view, partly diagrammatic, of apparatus embodying my invention; and Fig. 2, a similar view of a modification of the same.

1 1 represent the main line, E E being the earth or ground connections. The squares A A′ represent telephones, and B B are the electrically-operated bells which produce the signals. These signal-bells are arranged in series in the main line, as shown.

In Fig. 1, C C′ are electro-magnets in series in the main line. The magnet C has a permanent magnet, M, or series thereof, attached to its cores, and is provided with an armature, *c*, the whole forming a magneto-electric generator, current being produced by the movement of the armature before the poles of the magnet. Such movement is produced by the following mechanism: A cog-wheel, F, turned by a crank, G, meshes with another cog-wheel, *g*, on the shaft of a star cam-wheel, *d*, having beveled pointed teeth, which engage with a point, *e*, on the end of an arm, D, to whose other end the armature *c* is attached. This arm D is pivoted at *a*, and is connected by a wire, 2, with the main wire 1. It is adapted also to make contact with a point, *b*, from which a wire, 3, runs also to the wire 1, a shunt-circuit, 3, thus being formed around the generator.

It will be seen that when the crank G is turned a vibrating movement is imparted to the arm D and armature *c*, so that a current is generated which operates the signal; but when the revolution of the crank ceases, the point *e* falls into one of the indentations of wheel D, and the circuit 2 3 is closed at *b*, such circuit 2 3 being a short-circuit around the generator. The magnet M will have sufficient power to hold the armature *c* and maintain the contact at *b*, although a spring may be employed to assist the magnet. A similar arrangement exists at the other end of the line, consisting of magnet C′, armature *c*′, arm D′, contact *b*′, and gearing G′ *g*′ *d*′.

Instead of the arrangement of electro-magnets and permanent magnets shown, an electro-magnet could be used having a vibrating polarized armature, by which current would be generated in the coils of the electro-magnet.

Instead of using a vibrating circuit-breaker, means may be employed which will keep the circuit constantly broken during the operation of the generator. Such means are shown in Fig. 2, wherein H is a dynamo or magneto electric generator whose field-magnets are shown in horizontal section. Its armature *f* is mounted on a shaft, *h*, and is revolved by crank-shaft I through cog-wheels J J′; or two grooved wheels connected by a belt may be substituted for the cog-wheels.

The wheel J is loose on the shaft I, the connection between them being by a pin, *i*, attached to the shaft which enters an oblique slot, *j*, in the hub of the wheel J. The traveling of pin *i* in oblique slot *j* moves the shaft I longitudinally in one direction, while a spiral spring, *m*, is used to move it in the other. The shaft I has a grooved collar, *k*, which holds the pivoted lever K, whose lower end makes contact with the end of a lever, *l*, provided with a spring, *n*, and making contact with point *o*. The main line 1 1 passes through the lever *l* and contact *o*, and the generator-circuit 4 5 is connected with the lever K.

When the crank-shaft I is turned, it will move longitudinally, and lever K will strike lever *l*, forcing it from contact *o*, and keeping it separated therefrom until the movement is stopped, when it will again make contact with *o*. This movement of lever K, forcing *l* from *o*, completes the generator-circuit at the same time that it opens the main line. A similar apparatus is placed at the other end of the line in series with the first.

Instead of giving the crank-shaft itself a longitudinal movement, a sleeve upon said shaft may be made to move, as in my application for a patent filed September 19, 1881, and either of these forms may be used in connection either with a shunt-circuit or with the main line and generator-circuit.

In all the arrangements described the electrically-operated alarms are located in series in the line, and so are the dynamo or magneto electric machines, both alarms being sounded when either machine is worked, and both machines being normally out of circuit, and being thrown automatically into and out of circuit in the manner already fully explained.

What I claim is—

1. In a magneto-electric signaling apparatus, the combination, with the line, of electrically-operated alarms located in series in such line, dynamo or magneto electric generators located in series with such alarms, means actuated automatically by the stopping of each generator for removing its coils from the resistance of the line, and means operated automatically by the action of moving each generator to make its coils a portion of the resistance of the line, substantially as set forth.

2. In a magneto-electric signaling apparatus, the combination, with a dynamo or magneto electric generator, of a vibrating circuit-breaker operated automatically by the movement of the generator to become at short intervals a portion of the resistance of the line, and means actuated automatically by stopping the movement of the generator for removing said coils from the resistance of the line, substantially as set forth.

This specification signed and witnessed this 5th day of August, 1882.

THOS. A. EDISON.

Witnesses:
H. W. SEELY,
EDWARD H. PYATT.

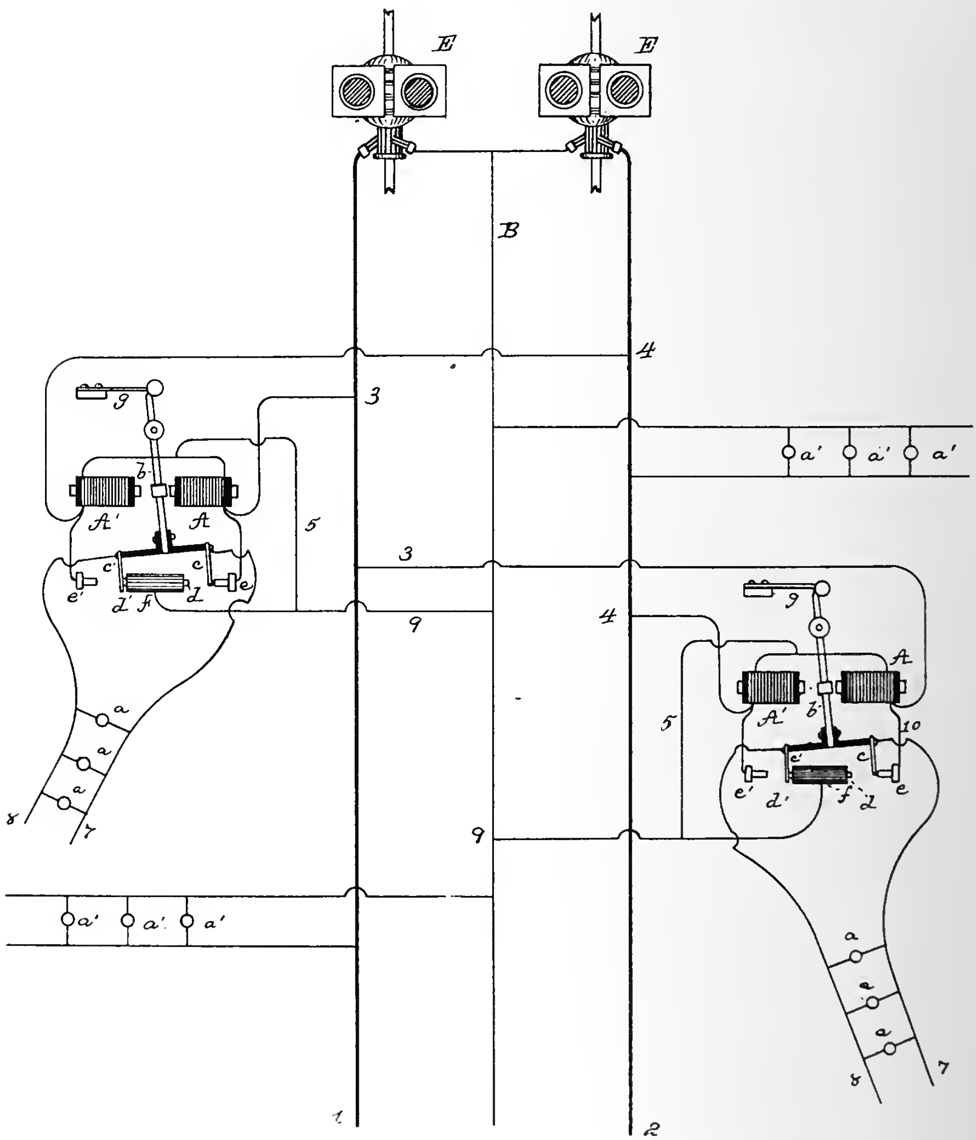
(No Model.) 3 Sheets—Sheet 1.

T. A. EDISON.

SYSTEM OF ELECTRICAL DISTRIBUTION.

No. 283,983. Patented Aug. 28, 1883.

Fig. 1.



ATTEST:

E. C. Rowland,

H. W. Seely

INVENTOR:

Thomas A. Edison

By Rich^d N. Dyer,
Atty.

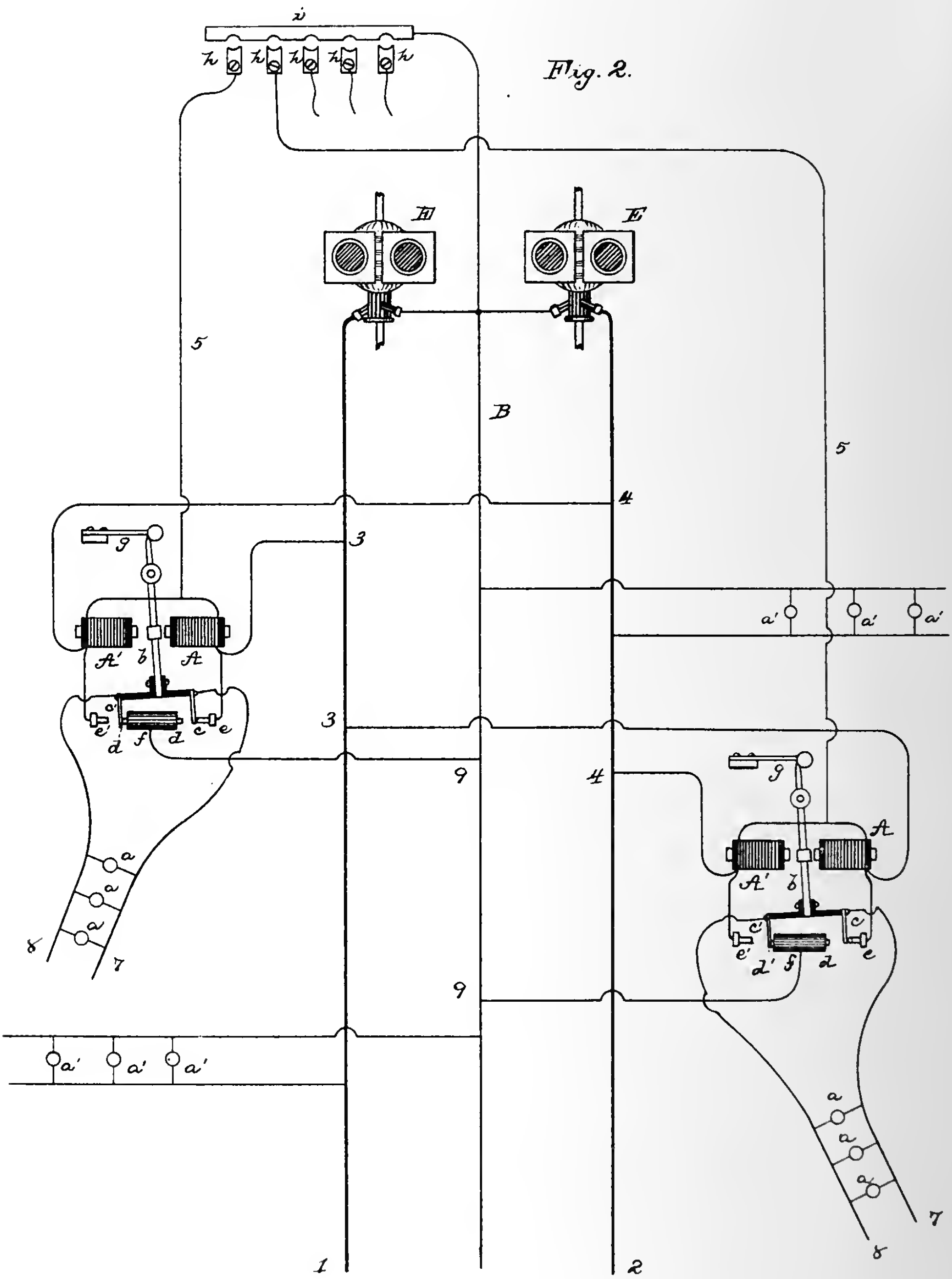
(No Model.) 3 Sheets—Sheet 2.

T. A. EDISON.

SYSTEM OF ELECTRICAL DISTRIBUTION.

No. 283,983. Patented Aug. 28, 1883.

Fig. 2.



ATTEST:

E. C. Rowland

H. W. Seely

INVENTOR:

Thomas A. Edison,

By Rich'd N. Dyer

Atty

(No Model.)

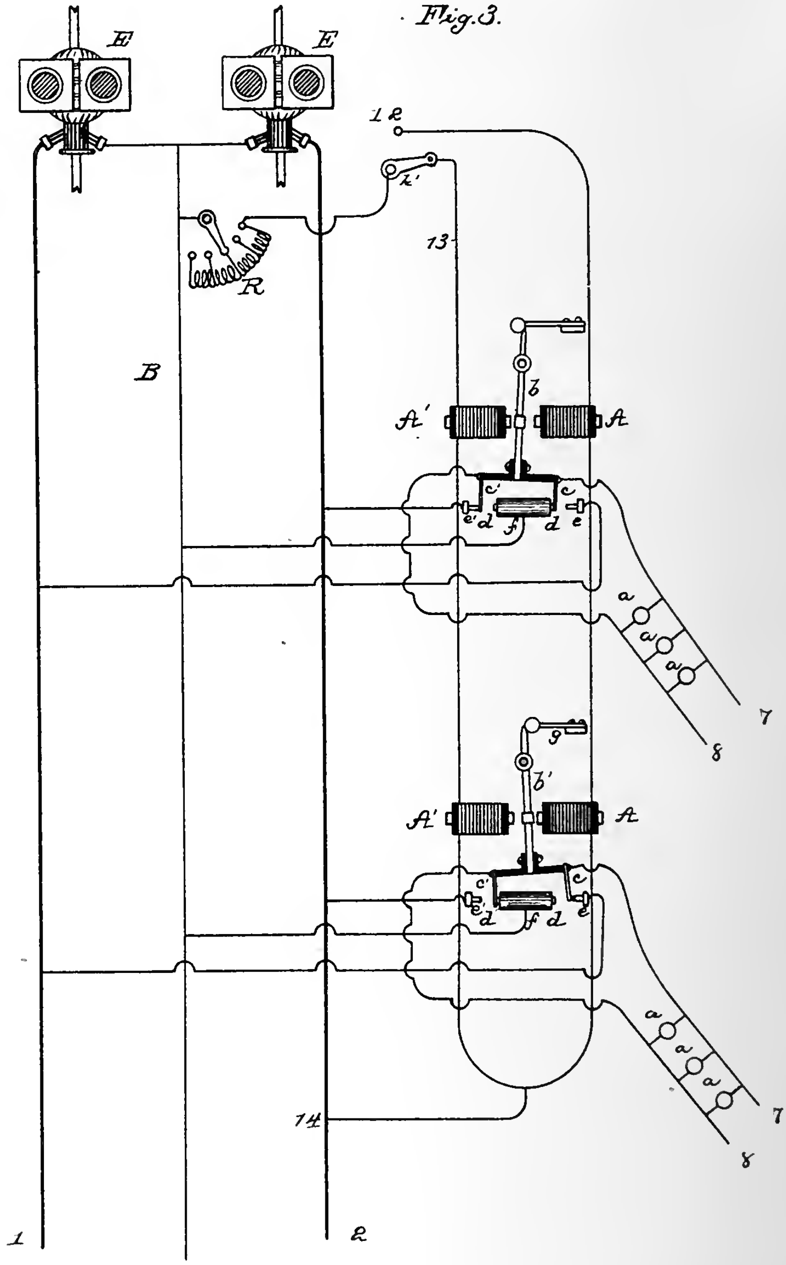
3 Sheets—Sheet 3.

T. A. EDISON.

SYSTEM OF ELECTRICAL DISTRIBUTION.

No. 283,983. Patented Aug. 28, 1883.

Fig. 3.



ATTEST:

E. C. Rowland
H. W. Seely

INVENTOR:

Thomas A. Edison.
By Rich^d. N. Dyer.
Atty.

N. PETERS. Photo-Lithographer. Washington, D. C.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

SYSTEM OF ELECTRICAL DISTRIBUTION.

SPECIFICATION forming part of Letters Patent No. 283,983, dated August 28, 1883.

Application filed April 17, 1883. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Systems of Electrical Distribution, (Case No. 557,) of which the following is a specification.

This invention relates, mainly, to compensating systems of electrical distribution such as are described in my Patent No. 274,290, in which a divided source of electrical energy is employed to supply electric lamps or other translating devices arranged in multiple series, and a compensating conductor or conductors extend from between the translating devices to the point or points of division of the source of energy to preserve the balance of the system. The invention is also applicable, however, to those systems in which a main conductor is divided into series of branches, such branches containing the translating devices.

The object of the invention is to preserve, by devices either operating automatically or controlled from the central station or source of supply, the equality of the number of translating devices in the different parts or branches of systems of the character described. To accomplish this automatically I provide means controlled by variations in current, which, when the number of translating devices in one part of the system is too great, so that the current declines in such part, operate circuit-controlling devices, which shift a portion of the translating device from that part of the system to another, whereby the balance is maintained.

To control the devices from the central station, which may be preferable to the automatic operation, I may place each set in connection with a circuit running back to said station, so that by opening and closing such circuit the devices may be put in condition to be operated according to the preponderance of current in either part of the system; or I may place all the electric controlling devices which operate in the same direction and are arranged to be affected by different amounts of current in the same circuit, and vary the current in such circuit so as to throw into operation more or less of such controlling devices and shift a greater or less number of translating devices from one part of the system to another.

In the accompanying drawings is shown the application of my invention to a compensating system.

Figure 1 is a diagram illustrating the preferred automatic arrangement; Fig. 2, one showing the mode of controlling the devices from the central station, and Fig. 3 illustrates the mode of both controlling and operating the devices from the central station.

E E are dynamo-electric machines placed in series and forming the divided source of energy, the compensating-conductor B extending from the point of division. 1 2 are the main conductors. The circuits containing lamps or other translating devices, *a*, are arranged to be thrown from one side of the system to the other. The lamps *a'* are connected in permanent multiple-arc circuits, each connected to a main conductor and the compensating-conductor.

Referring to Fig. 1, A A' are electro-magnets. Each magnet A is connected by conductor 3 and conductors 5 and 9 between the main conductor 1 and the compensating-conductor B. Each magnet A' is similarly connected between main conductor 2 and conductor B by conductors 4, 5, and 9. Thus the magnet A is affected where there is an excess of current in main conductor 1, and magnet A' when such excess occurs in conductor 2, by reason of the decrease in the number of translating devices on either side.

Between the magnets A A' is the pivoted armature-lever *b*, which carries the two-armed circuit-controller *c c'*.

To the arm *c* is connected the conductor 7, and to arm *c'* the conductor 8, which form a circuit, across which the translating devices *a a* are arranged in multiple arc. Arm *c* plays between contact *d* and contact *e*, the latter of which is connected with main conductor through wire 3. Arm *c'* is placed between contacts *d'* and *e'*, the latter being connected to conductor 2 through wire 4. Both contacts *d d'* are connected to compensating-conductor B by conductor 9, *f* being a metallic cylinder.

When the current in main conductor 1 is in excess of that in main conductor 2, it is desirable to shift a portion of the translating devices from the latter to the former. The magnet A is energized by the excess of current and draws the armature *b* toward it, the ball and spring *g* assisting to throw the armature over, the arm *e* making contact with *e*, and the arm *c'* with *d'*, as shown. A circuit is thus formed, including the lamps *a*, from conductor 1 to conductor B *via* 3, 10, 7, 8, *f*, and 9.

When the current becomes stronger in conductor 2, the magnet A' is more greatly energized and draws the armature *b* toward it, closing circuit at *c'* and *d*, and thus placing the lamps *a* between the conductors 2 and B.

It is evident that as many sets of magnets A A', with devices controlled thereby, may be provided, as desired. Each house or building in the district may be so provided, or only a few arranged to preserve the balance to a sufficient extent. The magnets would be arranged to operate with different amounts of current, so that successive changes would be made as desired.

It is evident, also, that the invention can be as readily applied if the system is divided into more than two parts by more than one compensating-conductor.

The arrangement illustrated in Fig. 2 is the same as that just described, except that the conductors 5 of each set, instead of being connected directly with the compensating-conductor, runs to the central station, where it is connected with a contact-plate, *h*. Circuit is completed by the insertion of plugs between the plates *h* and plate *i*, which is connected by conductor 11 with the compensating-conductor.

Indicating circuits and devices are provided, as shown in my Patent 266,793, of October 31, 1882, to show the electrical condition at different parts of the system.

When it is desired to throw any set of translating devices into connection with the opposite side of the system, circuit is closed at *h i* to the set of controlling-magnets A A', which it is desired to operate, and that magnet will be affected which is in connection with the side having the preponderance of current, the effect being the same as before explained. The electrical devices are thus controlled from the station, but operated automatically.

In Fig. 3 the two magnets A are placed in series in a circuit, 12 14, and the magnets A' are similarly arranged in a circuit, 13 14. The switch *k* closes either of these circuits, as desired. The operation of the magnets upon the devices affected by them is similar to that described with reference to Fig. 1.

R is an adjustable resistance in the conductor which runs to the switch *k*. By adjusting this resistance the current in the circuit 12 14 or 13 14, as the case may be, is varied.

The magnets A are so arranged, either by difference of winding, difference in distance between magnet and armature, or otherwise, that a different amount of current is required to cause each magnet to attract its armature, and the magnets A' are similarly arranged with relation to each other. Hence by adjusting the resistance R to different extents more or less of the series of magnets which is in circuit at the time can be made to act and to throw the circuits controlled by them into connection with the opposite side of the system from before.

Suitable indicating devices are provided at the central station, as before explained.

As shown, the magnets A' are in circuit, but the current is insufficient to cause both to attract their armatures. By adjusting the resistance the other magnet may be caused to act, and the circuit controlled by it can be connected across the other side of the circuit. By this arrangement the devices are both controlled and operated from the central station.

It is evident that any desired number of magnets with their accompanying apparatus may be used.

It is evident that instead of using an adjustable resistance each magnet could be placed in a separate circuit, means being provided at the central station for closing the circuit of any magnet, as desired.

In applying this invention to a system in which feeding-conductors are used it is preferred to place near the extremity of each feeding-circuit, a number of the electrically-operated compensating arrangements indicating circuits being provided, as usual. When the indicators show too much or too little pressure at the terminals of any circuit, one or more of the magnets at that locality will be energized and caused to change the connection of the devices controlled by it.

In series systems wherein a main conductor is divded into two or more series of divisions or branches, each branch containing a translating device, and the source of energy not being divided, my invention may be applied to change the connection of a branch from one series to another. It is evident that this arrangement is the same as that in Fig. 1, except that the compensating-conductor B would not be connected between the generators, one generator being used alone, or two or more with ordinary series or multiple-arc connections.

In a compensating system, if the number of translating devices in the district becomes at any time so small that it can be supplied by one division of the source of energy, all such translating devices can be thrown onto one side of the district, the system becoming then an ordinary multiple-arc system, with the unnecessary generators out of use, and the compensating-conductor forming one of the main conductors of the system.

It is to be understood that all patentable features of novelty shown or described, but not claimed herein, are reserved for protection by other patents, and have been or will be included in other applications for patents.

What I claim is—

1. In a compensating system of electrical

distribution, the combination, with a translating device or group thereof, of automatically operated means for changing the connections of such device or group from one part of the system to another, to maintain the balance of the system, substantially as set forth.

2. In a compensating system of electrical distribution, the combination, with a translating device or group thereof, of electrically-operated means for changing the connection of such device or group from one part of the system to another, substantially as set forth.

3. In a compensating system of electrical distribution, the combination, with a translating device or group thereof, of means controlled from the central station for changing the connection of such device or group from one part of the system to another, substantially as set forth.

4. In a compensating system of electrical distribution, the combination, with a translating device or group thereof, of means, controlled from the central station and operated automatically by the current in the system, for changing the connection of such device or group from one part of the system to another, substantially as set forth.

5. In a compensating system of electrical distribution, the combination, with a translating device or group thereof, of oppositely-acting electro-magnetic devices energized by the current in the system, and circuit-controlling mechanism controlled by said electro-magnetic devices for changing the connections of such translating device or group from one part of the system to another, substantially as set forth.

6. In a compensating system of electrical distribution, the combination, with a translating device or group thereof, of two electro-magnets, one connected with each part of the system, and circuit-controlling devices controlled by said electro-magnets, whereby when the current in one part is stronger than in another, the connections of such translating device or group are changed from the weaker side to the stronger, substantially as set forth.

This specification signed and witnessed this 5th day of April, 1883.

THOS. A. EDISON.

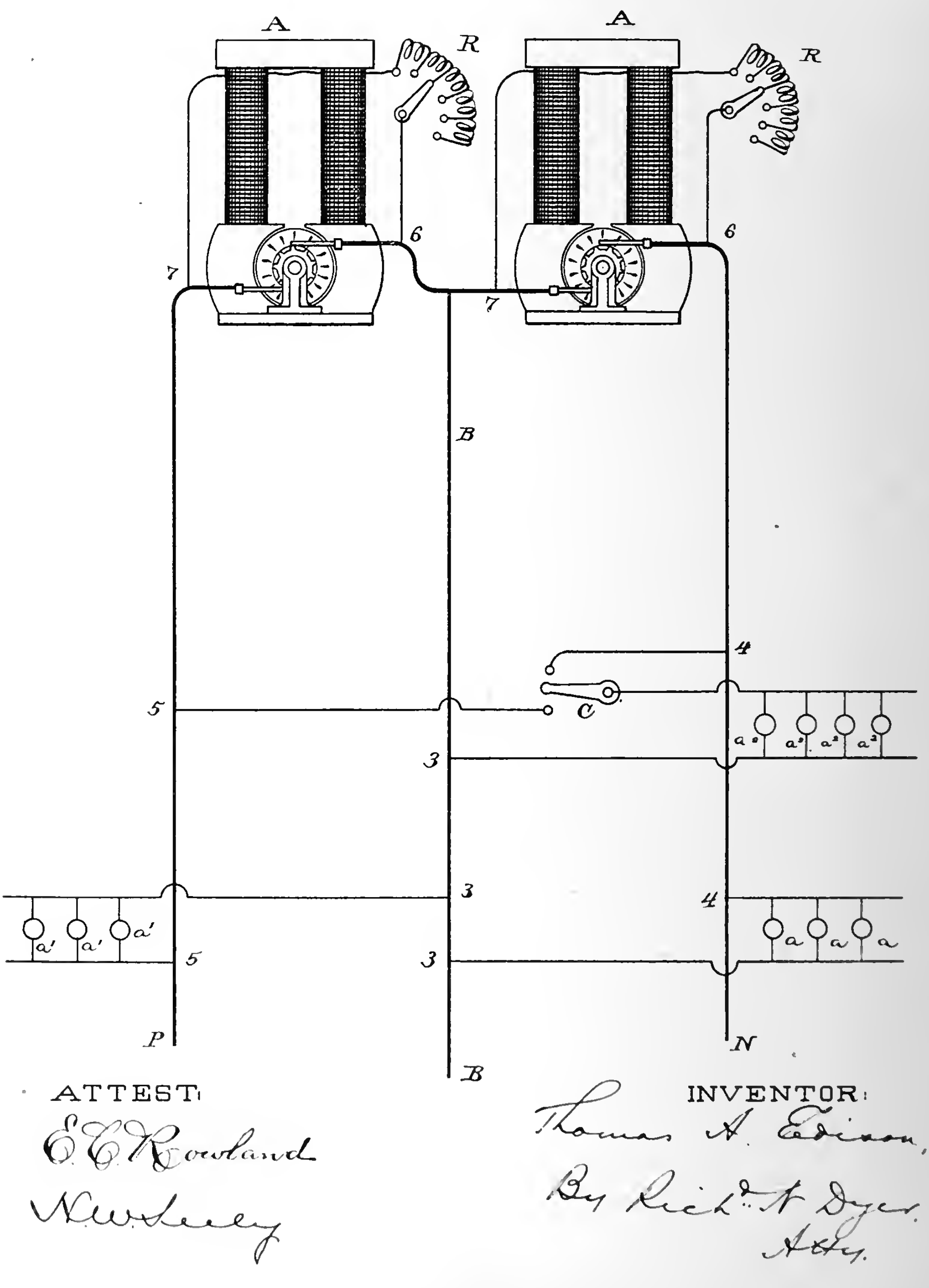
Witnesses:
H. W. SEELY,
EDWARD H. PYATT.

(No Model.)

T. A. EDISON.

SYSTEM OF ELECTRICAL DISTRIBUTION.

No. 283,984. Patented Aug. 28, 1883.



UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, ASSIGNOR TO THE EDISON ELECTRIC LIGHT COMPANY, OF NEW YORK, N. Y.

SYSTEM OF ELECTRICAL DISTRIBUTION.

SPECIFICATION forming part of Letters Patent No. 283,984, dated August 28, 1883.

Application filed March 16, 1883. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Systems of Electrical Distribution, (Case No. 551,) of which the following is a specification.

My invention relates to "compensating" systems of electrical distribution such as are set forth in my Patent No. 274,290, dated March 20, 1883, in which a divided source of energy is employed and one or more compensating-conductors extend from the points of division of said source and are connected between the translating devices arranged in multiple series across the main conductors.

The objects of my invention are to keep the electro-motive force equal in both or all the divisions of the system, and to prevent as much current as possible from traversing the compensating conductor or conductors.

In accomplishing these objects I provide each division of the source of energy with means for regulating its electro-motive force independent of the other divisions. Where two or more dynamo-electric machines are connected in series, each forming one division of the source, an adjustable resistance is preferably placed in the field-circuit of each machine for regulating its electro-motive force. Thus, if the drop in electro-motive force is greater on one main conductor than on the other, if one machine runs faster than the other, or if in any way the electro-motive force on one side becomes greater than on the other, the resistances in the field-circuits of the machines are independently adjusted to compensate for the difference, so that the same electro-motive force is constantly maintained. This keeps the lamps in the different divisions equal in candle-power, and also assists in preserving the balance of the system, keeping the current equal on the main conductor, and preventing it from flowing in the compensating conductor or conductors. If more than one generator is included in each division of the source of energy, such generators could all be regulated simultaneously by one or more adjustable resistances.

As stated in the application above referred to, the translating devices of the system are preferably arranged in such manner that the number on one side of the compensating-conductor will constantly remain about the same as that on the other.

In order to assist still further in preserving this equality, I may employ, in connection with a translating device or group of such devices, a switch or other means whereby such device or group may be transferred from one side of the system to the other, should the numbers become so unequal as to render such a change desirable.

The accompanying drawing is a diagram of a compensating system employing the above-described improvements.

A A are dynamo-electric machines connected in series and feeding into main conductors P N.

B is the compensating-conductor connected between the generators. The lamps or other translating devices, a, are placed across multiple-arc circuits 3 4, connected with compensating-conductor B and main conductor N, and translating devices a' are placed across the circuits 3 5 between said compensating-conductor and main conductor P. Each generator A has its field-coils in a muliple-arc circuit, 6 7, and each of such multiple-arc circuits contains an adjustable resistance, R. It is evident that by separately adjusting these resistances the electro-motive force on each side can be regulated separately, and consequently the candle-power of all the lamps in the system can be kept equal and at the proper point.

C represents any suitable switch or circuit controller. It is evident that by throwing such switch in one direction or the other the lamps a^2 may be connected with either side of the system, being either in a circuit, 3 4 or 3 5, as desired. It is evident that each house or building in the system, or any group of translating devices or single translating device may be provided with similar connections, whereby it can be placed in connection with either side of the system to maintain the balance.

In the system described in my application No. 538, (Serial No. 82,564,) in which the lamps of a building or locality are divided between two circuits, one connected with each side of the system, each of such circuits could of course be arranged to be thrown from one side of the system to the other, as in the present case. If the source of electric energy is divided into more than two parts and more than one compensating-conductor is used, each division of said source would be provided with its independent regulator, and the groups of translating devices could be provided with means for throwing them into connection with either part of the system—that is, for connecting them with a compensating-conductor and either main conductor, or between two compensating-conductors.

I do not claim herein the broad idea of regulating independently a number of electrical generators connected in series, as this is claimed in my prior application, No. 424, (Serial No. 68,641;) but

What I do claim is—

1. In a compensating system of electrical distribution, substantially as set forth, the combination, with the divided source of energy, of independent means for regulating the electro-motive force of each division of said source, substantially as set forth.

2. In a compensating system of electrical distribution, substantially as set forth, the combination, with the two or more dynamo or magneto electric machines connected in series and forming a divided source of energy, of an adjustable resistance in the field-circuit of each machine, substantially as set forth.

3. In a compensating system of electrical distribution, substantially as set forth, the combination, with a translating device or group of such devices, of means whereby such device or group can be connected with one division or another of the system, as desired, substantially as set forth.

4. In a compensating system of electrical distribution, substantially as set forth, the combination, with a multiple-arc circuit, including one or more translating devices, and having one terminal connected with a compensating-conductor, of means whereby the other terminal may be connected with either of the main conductors, substantially as set forth.

This specification signed and witnessed this 5th day of March, 1883.

THOS. A. EDISON.

Witnesses:

WM. H. MEADOWCROFT,
H. W. SEELY.

(No Model.)

T. A. EDISON.

SYSTEM OF ELECTRICAL DISTRIBUTION.

No. 283,985. Patented Aug. 28, 1883.

Fig. 1.

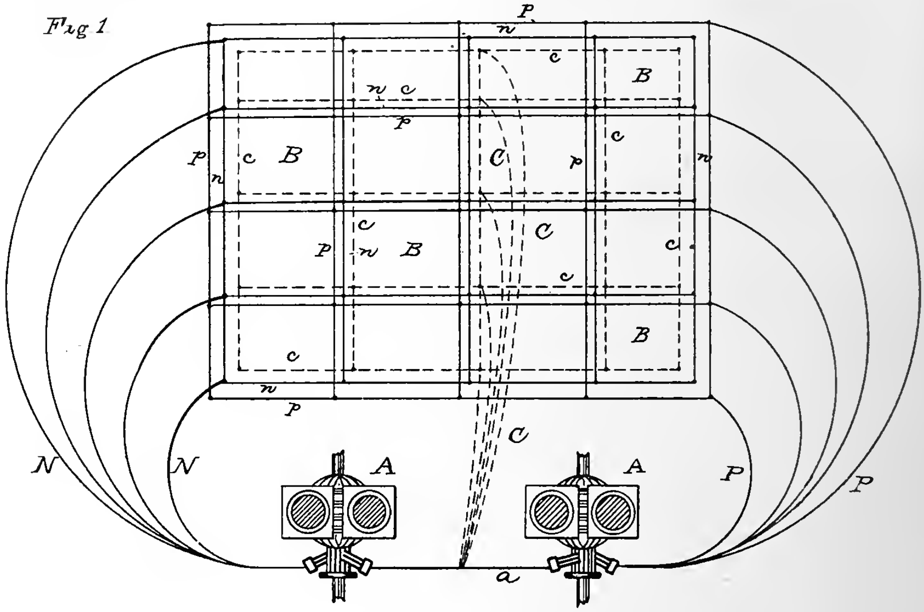


Fig. 2.

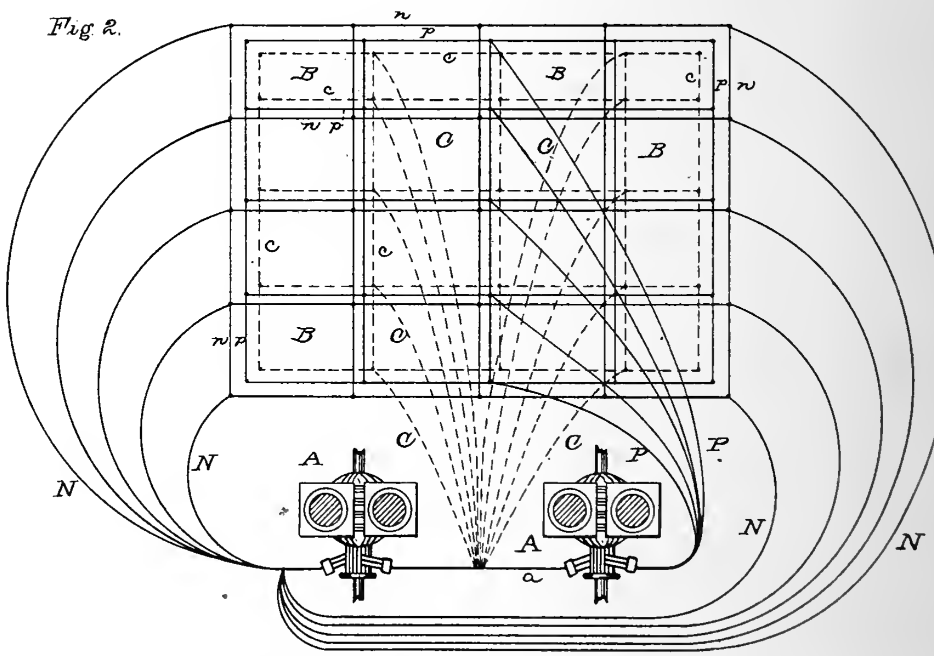
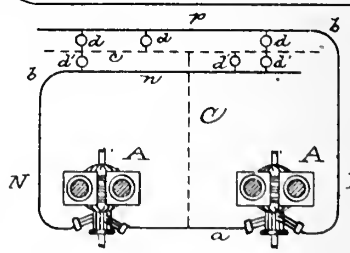


Fig. 3.



ATTEST:

E. C. Rowland

H. W. Seely

INVENTOR:

Thomas A. Edison.

By Rich^d N. Dyer.

Atty.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, ASSIGNOR TO THE EDISON ELECTRIC LIGHT COMPANY, OF NEW YORK, N. Y.

SYSTEM OF ELECTRICAL DISTRIBUTION.

SPECIFICATION forming part of Letters Patent No. 283,985, dated August 28, 1883.

Application filed January 22, 1883. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Systems of Electrical Distribution, (Case No. 535,) of which the following is a specification.

My invention relates to systems of electrical distribution, such as are described in my application No. 520, (Serial No. 77,776,) wherein translating devices arranged in multiple series are made independently controllable by the use of a compensating conductor or conductors extending from the points of division of a divided source of electrical energy and connected between the translating devices in multiple series; and my invention consists, primarily, in the application of this compensating principle to a system of intersecting and connected positive and negative conductors to which current is conveyed by feeding-circuits containing no translating devices. Such feeding-circuits are preferably so arranged that all parts of the system will practically be electrically equidistant from the central station or source of energy, so that the same, or practically the same, pressure or electro-motive force will be maintained in all parts of the system without the use of adjustable resistances in the feeding-conductors.

In carrying my invention into effect the main conductors of the system are arranged in the manner set forth in several of my prior patents—that is, all the positive conductors are connected together at intersecting points, and likewise all the negative conductors.

The source of electrical energy may consist of any desired number of dynamo or magneto electric machines or other generators arranged in series or in multiple series. If one dynamo or magneto electric machine is used, one or more extra commutator-brushes are provided, from which the compensating-conductors extend for dividing the source of energy into the proper number of parts, and where two or more generators are placed in series the compensating-conductors are connected between them to the conductor which extends from one to another.

The several positive feeding-conductors which extend from the positive pole of the source of energy are preferably all connected at different points to the positive main conductor at one side or boundary of the district supplied, and all the negative feeders are correspondingly connected to the negative main conductor at the opposite side of the system. By this arrangement all the translating devices supplied from the same feeding-circuit are made electrically equidistant from the source of energy.

The conducting capacity of the feeding-conductors is so proportioned that all the points at which they are connected to the main conductors will be electrically equidistant from the source of energy—that is, those conductors which are connected at points near the source are made smaller than those which extend to a greater distance—so that the drop in electromotive force will be the same on all the feeding-circuits, such circuits, although of different lengths, being of practically the same resistance.

Throughout the system, parallel with the intersecting main conductors, extends a system of intersecting compensating-conductors, connected together at their intersecting points. The number of such compensating-conductors depends upon the number of translating devices in series, they being used to divide the multiple-arc circuits into a number of parts equal to the number of translating devices which it is desired to place in multiple series, which number, of course, varies according to the electro-motive force of the current used.

Each multiple-arc circuit which contains a translating device is connected across from a compensating-conductor to either a positive or a negative main conductor, the number of translating devices on each side of the compensating-conductor being as nearly equal as is conveniently practicable. The translating devices therefore are arranged in multiple series.

At the centers of the system—that is, at points midway between the junctions of the positive and negative feeding-conductors with the main conductors—are connected to the intersecting compensating-conductors one or more conductors, which extend to the source of energy, being connected at the points of division of such source. These I term the "main compensating-conductors."

As explained in the application above referred to, when differences occur in the number of translating devices in circuit on each side of a compensating-conductor the difference of current is taken up by such compensating-conductor, such current flowing therein in one direction or the other according to whether the preponderence is on the positive or on the negative side. Thus each translating device always receives a constant supply of current, and they are independently controllable, although arranged in multiple series.

Instead of connecting all the positive feeders at one side of the system and all the negative at the other, a portion of the positive (or negative) may be connected at one side and the remainder at the other, while all of the opposite kind are connected midway between them. In this case I employ two sets of main compensating-conductors, each set running to points midway between the pairs of feeding-conductors, but both sets being connected at the point of division of the source of energy.

My invention may be more readily comprehended by reference to the annexed drawings, in which Figure 1 is a diagram illustrating a system in which opposite feeding-conductors are connected to opposite sides of the district; Fig. 2, a diagram illustrating the system in which conductors of one kind are connected in the center and those of the other kind at the sides; and Fig. 3 is a diagram illustrating the principle of the invention.

Referring to Fig. 3, A A are dynamo or magneto electric machines, connected in series by a conductor, *a*. A positive conductor, P, and negative conductor N, extend from the respective poles of the series of generators. These may be considered as feeding-conductors as far as the points *b b*, the remainder, *p n*, being considered, respectively, as the positive and negative main conductors. Parallel with the main conductors *p n* is run a compensating-conductor, *c*, and a main compensating-conductor, C, runs from the center of conductor *c*, and is connected with conductor *a* between the generators. The multiple-arc circuits which contain translating devices *d* extend from the compensating-conductor *c* to the positive main conductor *p*, and the circuits containing devices *d'* extend from conductor *c* to negative conductor *n*. The translating devices *d* and *d'* are thus in multiple series, but are independently controllable by reason of the compensating-conductors C and *c*, as is fully explained in my prior application, above mentioned. It is evident that where currents of higher electro-motive force are used, so that more translating devices are placed in series, the source of energy would be divided into three or more parts, and two or more compensating-conductors would be used.

Referring, now, to Fig. 1, it is readily apparent that the complete system of electrical distribution there shown is merely a multiplication or extension of the arrangement illustrated in Fig. 3.

Instead of one positive conductor, P, and one negative conductor, N, a number of such conductors extend from the generators A A, and a series of intersecting positive and negative main conductors, *p* and *n*, are arranged surrounding the blocks B B of a town or village or district thereof. The feeding-conductors are connected on opposite sides of the systems, those of each pair terminating at points opposite to each other and at the same distance from the source of supply. The conductors of those pairs which terminate near the source of supply are of smaller mass than those which extend to a greater distance, in order that the electro-motive force may be the same in all parts of the system. A system of intersecting and connected compensating-conductors, *c*, are arranged parallel to the main conductors *p n*, and the connections of the circuits which contain translating devices are made as illustrated in Fig. 3. The main compensating-conductors C are connected to one of the compensating-conductors *c* midway between the positive and negative feeding-circuit terminals, there being as many conductors C as there are feeding-circuits P N, so that all the intersecting compensating-conductors are connected to the divided source of energy, all the conductors C being connected at the same point to the conductor *a*.

It will be seen that by this arrangement of conductors the electro-motive force, and consequently the relative candle-power, of the lamps in every part of the system will remain equal and constant, while the compensating-conductors cause the lamps in series to always receive the same current, although one or more of the same series may be thrown out of circuit.

The generators A A should be provided with suitable means for regulating their electro-motive force according to the whole number of translating devices in circuit throughout the system.

The arrangement shown in Fig. 2 is similar in principle to that in Fig. 1. In the former a portion of the negative feeding-conductors N are connected at one side of the district and the remainder at the opposite side, while all the positive feeders P are connected at the middle of the district between the negative ones. Thus the translating devices in both halves of the district are practically electrically equidistant from the central station. Two sets of main compensating-conductors are used, connected, as shown, midway between the positive and negative terminals, and all running to the same point in conductor *a*. Of course in both arrangements the number of intersecting compensating-conductors would be increased according to the number of translating devices placed in series, as explained with reference to Fig. 3.

What I claim is—

1. A system of electrical distribution having in combination the following elements, viz: a divided source of electrical energy, one or more feeding-circuits extending therefrom,

a series of intersecting and properly-connected positive and negative main conductors to which said feeding-circuits are connected, translating devices in multiple series, a series of intersecting compensating-conductors, and one or more main compensating-conductors extending from said intersecting compensating-conductors to the point or points of division of the source of energy, substantially as set forth.

2. In a system of electrical distribution, the combination of the divided source of energy, the intersecting and properly-connected main conductors, feeding-conductors extending from said source and connected to said main conductors at points electrically equidistant from said source, translating devices arranged in multiple series, and a system of intersecting and main compensating-conductors, substantially as set forth.

3. In a system of electrical distribution, the combination of a divided source of energy, a system of intersecting and properly-connected positive and negative main conductors, a system of intersecting compensating-conductors, one or more feeding-circuits, the conductors of each feeding-circuit being connected to the main conductors at different points, and one or more main compensating-conductors, one connected to the intersecting compensating-conductors at a point intermediate between the conductors of each feeding-circuit, substantially as set forth.

This specification signed and witnessed this 13th day of January, 1883.

THOS. A. EDISON.

Witnesses:

H. W. SEELY,

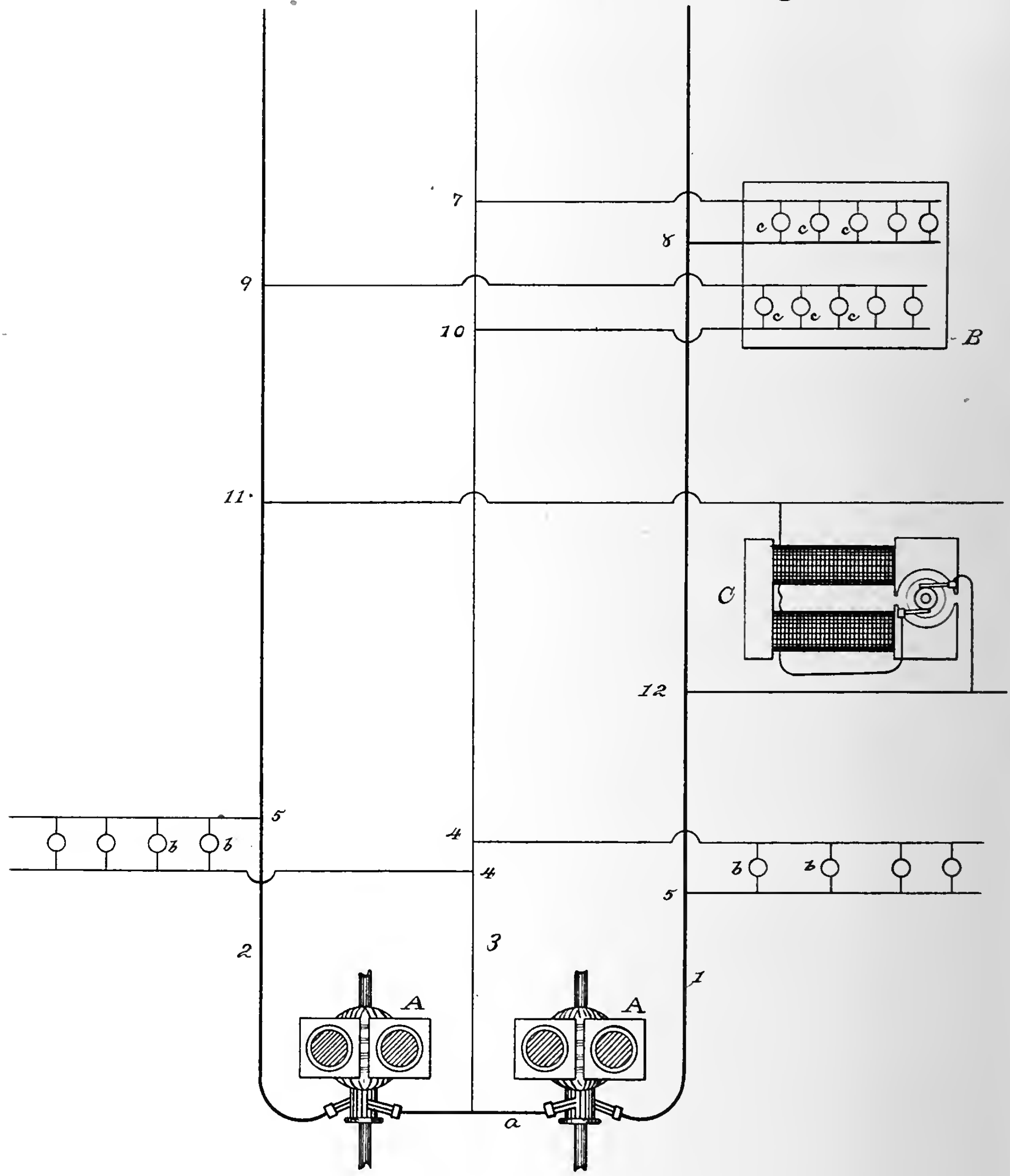
EDWARD H. PYATT.

(No Model.)

T. A. EDISON.

SYSTEM OF ELECTRICAL DISTRIBUTION.

No. 283,986. Patented Aug. 28, 1883.



ATTEST:

E. C. Rowland

H. W. Seely

INVENTOR:

Thomas A. Edison

By Rich^d N. Dyer

Att'y.

N. PETERS, Photo-Lithographer, Washington, D.C.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, ASSIGNOR TO THE EDISON ELECTRIC LIGHT COMPANY, OF NEW YORK, N. Y.

SYSTEM OF ELECTRICAL DISTRIBUTION.

SPECIFICATION forming part of Letters Patent No. 283,986, dated August 28, 1883.

Application filed January 22, 1883. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Systems of Electrical Distribution, (Case No. 538,) of which the following is a specification.

My invention relates to such systems of distribution of electric energy for illumination, motive power, &c., as are set forth in my application No. 520, (Serial No. 77,776)—that is, to a system in which a divided source of energy is employed supplying translating devices arranged in multiple series, one or more compensating-conductors being provided whereby said translating devices are made independently controllable, and the system is divided into two or more parts. Such a system I term a "compensating" system of electrical distribution. In such a system, as explained in the application referred to, when one or more translating devices are thrown out of circuit in one part of the system, so that the numbers in the different parts become unequal, the current which would otherwise be supplied to said translating devices traverses said compensating-conductor in one direction or the other. It is, however, desirable that as little current as possible should ever traverse a compensating-conductor, so that such conductors may be made as small as possible, and it is therefore desirable to preserve the balance of the system—that is, to keep equal numbers of translating devices in circuit between the compensating-conductor and each main conductor, and also between two compensating-conductors, if more than one of such conductors are used. To accomplish this is the object of my invention.

This invention is intended to be applied to cases where a considerable number of translating devices are thrown into or out of circuit simultaneously—as, for instance, the lights in a theater or similar place—or where a single translating device, consuming a large amount of current—such as a large electro-dynamic motor—is placed in and out of circuit, the balance of the system being thus destroyed and a large amount of current being caused to traverse the compensating-conductor; or in a store or any other place employing a greater or less number of lamps which are not turned off simultaneously, but one or more at a time in different parts of the place, my invention is equally applicable.

Said invention consists in providing in a compensating system such connections that when one or more translating devices are thrown out of circuit the balance of the parts of the system will be self-preserved, and but little current will traverse the compensating conductor or conductors in either direction.

My invention may be practically carried into effect in the manner illustrated in the annexed drawing, which is a diagram of a compensating system embodying said invention.

A A are dynamo or magneto electric machines forming the source of energy of the system and placed in series, being connected by a wire, *a*.

1 2 are main conductors extending from the source of energy, and 3 is the compensating-conductor, connected to the wire *a* and dividing said source into two parts. Multiple-arc circuits 4 5 extend from the main circuit, each multiple-arc circuit being connected to the compensating-conductor and to one of the main conductors. Each of such multiple-arc circuits contains translating devices *b b*, each translating device on one side of the system being, it is evident, in series with one on the other side. When a translating device is thrown out of circuit on one side, a certain amount of current traverses the compensating-conductor. This illustrates what has hitherto been the ordinary arrangement of a compensating system. To constantly preserve the balance or general average of the two parts of the system, I employ the connections now to be described.

B represents a building or any place in which all the lamps *c c* are under the same control. I divide all said lamps, making as nearly an equal division as possible, between the two multiple-arc circuits 7 8 and 9 10. The circuit 7 8 is connected to main conductor 1 and compensating-conductor 3, and circuit 9 10 to main conductor 2 and to said compensating-conductor. By this arrangement, if all the lamps *c* are simultaneously thrown into or removed from circuit, there is practically no change in the relative number of translating devices in the two parts of the system, little or no current traverses the compensating-conductor, and a constant balance of the system is automatically preserved. The building B may, however, be one in which the lights are thrown on and off a few at a time—as, for instance, in a store where at certain hours a large number of lights are required, while at other times less numbers are required and lights are extinguished in different parts of the store. In this case the lamps *c c* are arranged on the two circuits 7 8 and 9 10 in such manner that as lamps are gradually extinguished about as many will be thrown off on one circuit as on the other, keeping the numbers nearly equal and preserving the general average in the two parts of the system; or, if in this store this should not be the case, some other store, with its circuits similarly arranged and supplied from the same main circuit, would, in extinguishing its lights, produce the desired compensation and preserve the balance.

C represents a large electro-dynamic motor, consuming a large amount of current, and of such resistance that it may be placed directly across the multiple-arc circuit 11 12. If such motor were placed across one of the ordinary circuits 4 5 of the system, its removal would cause all such current to traverse the compensating-conductor. Therefore I place it in a multiple-arc circuit, 11 12, connected to the two main conductors 1 2, but not to the compensating-conductor 3. Thus its removal from circuit still keeps the balance on the opposite sides of the system equal, and does not affect the amount of energy which traverses the compensating-conductor.

It is evident that where it is desired to place more than two translating devices in series, and the system is divided into more than two parts, two or more compensating-conductors being used, my invention is equally applicable. For, if two compensating-conductors are employed, the lamps *c* would be nearly equally divided between three separate circuits, two of which are connected each to a main conductor and a compensating-conductor, and the third to the two compensating-conductors, while the motor C would still be connected to the two main conductors, as in the drawings, and these arrangements could of course be carried out with any number of compensating-conductors.

What I claim is—

1. In a compensating system of electrical distribution, the electric lamps of a building, divided between the two or more parts of the system, substantially as and for the purpose set forth.

2. In a compensating system of electrical distribution, the combination, with the main and compensating conductors, of two or more multiple-arc circuits containing electric lamps, entering the same building, and connected to the main and compensating conductors in such manner that the lamps of the building are divided between the parts of the system and the balance of the system is constantly preserved, substantially as set forth.

3. In a compensating system of electrical distribution, the combination, with the source of energy and main conductors, of lamps arranged in multiple series, compensating-conductors extending from between the lamps to the source of energy, and translating devices arranged in separate circuits between the main conductors without connection with such compensating-conductors, substantially as set forth.

This specification signed and witnessed this 13th day of January, 1883.

THOS. A. EDISON.

Witnesses:

H. W. SEELY,
EDWARD H. PYATT.

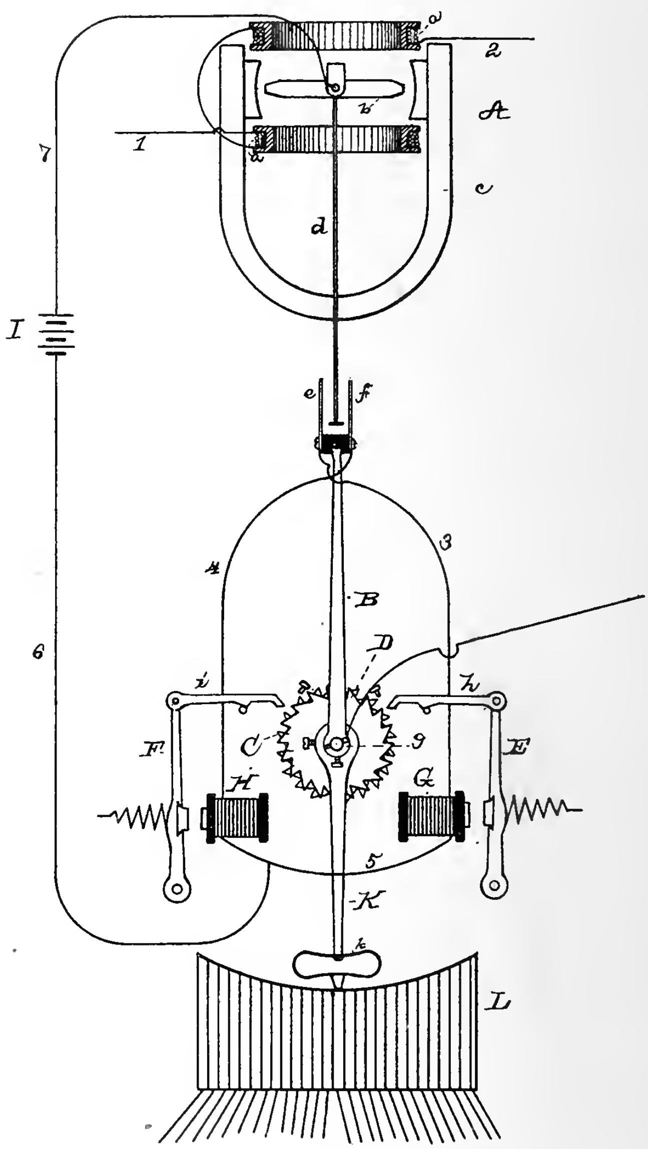
(No Model.) 2 Sheets—Sheet 1.

T. A. EDISON.

ELECTRIC REGULATOR.

No. 287,511. Patented Oct. 30, 1883.

Fig. 1.



ATTEST:

E. C. Rowland

H. W. Seely

INVENTOR:

Thomas A. Edison,

By Richd. N. Dyer,

Atty.

(No Model.)

2 Sheets—Sheet 2.

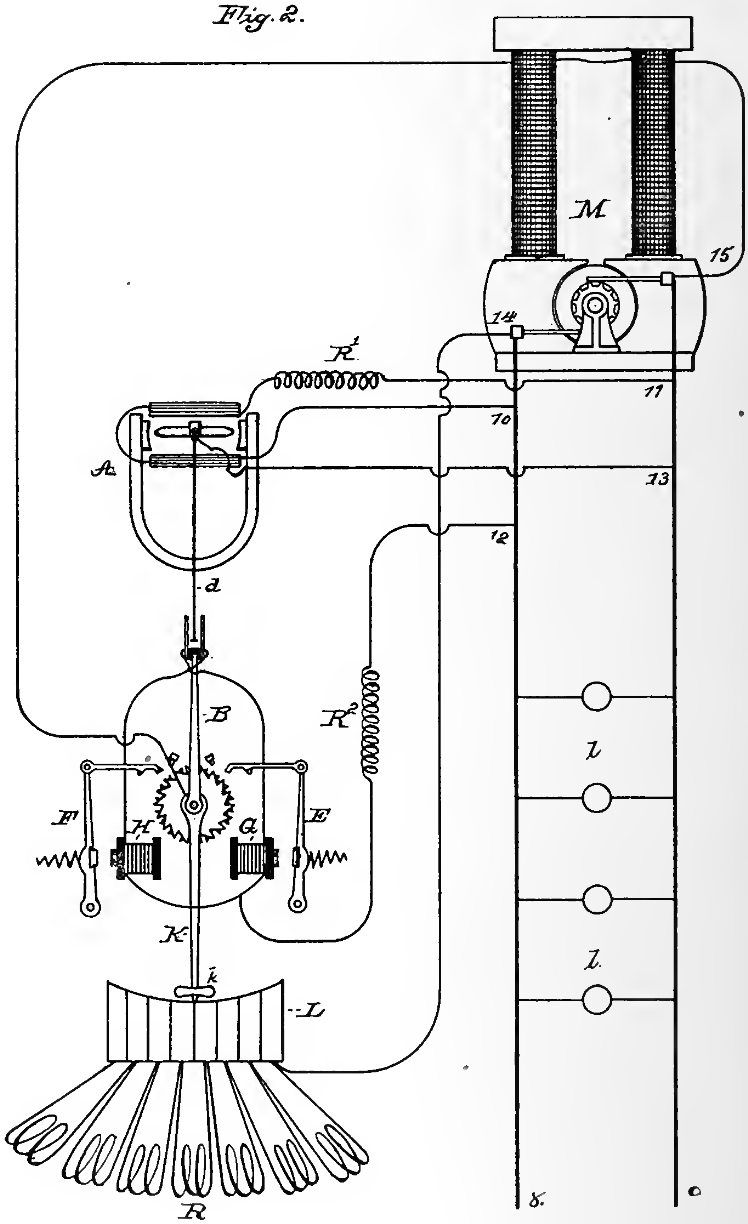
T. A. EDISON.

ELECTRIC REGULATOR.

No. 287,511.

Patented Oct. 30, 1883.

Fig. 2.



ATTEST:

E. C. Rowland

H. W. Seely

INVENTOR:

Thomas A. Edison,

By Rich^d N. Dyer,

Att'y

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

ELECTRIC REGULATOR.

SPECIFICATION forming part of Letters Patent No. 287,511, dated October 30, 1883.

Application filed June 29, 1883. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Electrical Regulators, (Case No. 583,) of which the following is a specification.

The object I have in view is to obtain simple and efficient means for producing movement by variations in the electro-motive force of the current of an electrical circuit, which means will be exceedingly sensitive in their action, responding with great exactness to the variations in the electro-motive force of the current; and my object herein is more especially to provide simple, efficient, and sensitive means for regulating, automatically, the electro-motive force of one or more dynamo or magneto electric machines, and particularly when such a machine is used to supply incandescing electric lamps arranged in multiple arc. This I accomplish by the employment of a galvanometer the coils of which are located in the circuit, the variations of whose current are utilized to set the moving devices in action, and the bar or needle of which carries an arm making and breaking circuit at moving contacts. The galvanometer-arm closes at the moving contacts circuits to devices which move such contacts in the same direction as the galvanometer-arm, but away from the same, breaking contact with such arm, which continues to follow up the contact and make the circuit after each break until the entire deflection in that direction due to the variation in the current is accomplished. The reverse movement of the galvanometer-arm produces a movement of the contacts in the opposite direction. These contacts are preferably two springs carried by an insulating-head mounted upon a pivoted arm. The end of the galvanometer-arm plays freely between these springs. The arm carrying the contacts is secured to a shaft on which are mounted two ratchet-wheels with teeth turned in opposite directions. Pawls carried by armature-levers work in the teeth of these ratchet-wheels. The coils of the electro-magnets operating these armatures are in circuit each with one of the spring-contacts. The other ends of the coils of these two magnets are connected together and form one side of a local circuit, the other side of which extends to the galvanometer-arm. By this arrangement a positive motion can be obtained, corresponding closely to the sensitive movement of the galvanometer-arm, without destroying the sensitiveness of such galvanometer by any unusual friction opposing its movement. The particular use herein explained to which this movement is applied is that for regulating the electro-motive force of one or more dynamo or magneto electric machines; but the movement may also be applied to various other uses—as, for instance, to the operation of electrical meters; but, although such other uses are included in the broad scope of this invention, they are not herein specifically claimed, such specific matter being reserved for protection by other patents.

In the application of the devices described to the regulation of dynamo or magneto electric machines, the coils of the galvanometer are located in circuit from the machine. If the machine is employed to supply incandescing electric lamps arranged in multiple arc, the galvanometer-coils are located in a multiple-arc circuit with or without extra resistance, as desired, so that such coils will be affected the same as any one of the lamps by variations in the electro-motive force of the current, caused either by changes in the number of translating devices or in the speed of the engine. The local circuit closed by the galvanometer-arm may be supplied by a galvanic battery, or be a multiple-arc or other circuit from the conductors supplied by the machine, it being only necessary that sufficient current should be supplied to work the magnets. The shaft of the ratchet-wheels is provided with a second arm, which makes contact with the vertical plates of a resistance-commutator, and by moving thereon throws resistance into and out of the field-circuit of the machine.

In the accompanying drawings, forming a part hereof, Figure 1 is a separate view, partly diagrammatic, of the apparatus; and Fig. 2, a view partly diagrammatic, showing the apparatus applied to the regulation of a dynamo-electric machine.

With reference more especially to Fig. 1, A is a galvanometer of any suitable construction, having coils a arranged in circuit 1 2. In the galvanometer shown a soft-iron needle or bar, b, is used, pivoted between the poles of a permanent magnet, c; but the constant field of the galvanometer may be produced by a coil of wire or in any other well-known way. The arm d projects from the pivoted bar b, and plays freely at its ends between contact-springs e f, carried by an insulating-head on an arm, B. This arm is secured to a shaft g, to which are also secured two ratchet-wheels, C D, with teeth turned in opposite directions, as shown. Pawls h i, carried by armature-levers E F, work in the teeth of wheels C D, and these armature-levers are drawn forward by electro-magnets G H, and are retracted by springs. One end of the coils of G is connected with e by wire 3, while one end of the coils of H is connected with f by wire 4. The other ends of the coils of these two magnets are connected together by wire 5 and to a local battery, I, or other source of electrical energy by wire 6. The other pole of I is connected by wire 7 to the pivot of the bar or needle b. Movement will be produced in the manner already explained. The shaft g will preferably be arranged in line with the pivot of the needle or bar b, or nearly so, and the arm B will project above or below the galvanometer-arm d and in the same direction, the springs e f being bent downwardly or upwardly to embrace the end of the arm d; but for clearness of illustration the parts are arranged as shown, and they may be so used, although the other arrangement just mentioned is preferred. The application of this apparatus to the regulation of a dynamo-electric machine is shown in Fig. 2, to which reference is now made, as well as to Fig. 1. The shaft g has secured thereto another arm, K, carrying a spring contact-piece, k, working on the vertical plates of the commutator L, connected to the sections of a resistance, R.

M is a dynamo-electric machine, from which extend conductors 8 9, having electric lamps, motors, or other translating devices, l, located in multiple-arc circuits therefrom. The coils of the galvanometer are in a multiple-arc circuit, 10 11, from 8 9, an extra resistance, R', being used or not, as desired. The magnets G H and galvanometer-arm are in a multiple-arc circuit 12 13 from 8 9, with extra resistance R^2. The field-circuit 14 15 of the machine is a multiple-arc circuit from 8 9, including the resistance R and the arm K'.

The operation will be understood from the foregoing description.

I do not claim herein the resistance-commutator composed of plates set on edge, since the same is covered by my application No. 78,775; nor do I claim herein the multiple-arc arrangement of the several elements, since the same is covered by my application No. 68,630; and it is to be understood that all patentable features of invention described or shown but not claimed herein are reserved for protection by other patents, and have been or will be embraced in other applications for patents.

What I claim is—

1. The apparatus for producing movement by the variations in electro-motive force of an electric current, consisting of a galvanometer affected by such current, moving contacts at which the galvanometer-arm closes circuit, and electrically-operated devices in circuit from said contacts, for moving said contacts away from said arm to break the circuit, substantially as set forth.

2. The combination, with a galvanometer, of moving contacts between which the galvanometer-arm plays, electrically-operated devices moving such contacts, and an electrical circuit including the galvanometer-arm, the moving contacts, and said electrically-operated devices, substantially as set forth.

3. The combination, with a galvanometer-arm included in an electrical circuit, of another arm following the movement of such galvanometer-arm, and electrically operated devices moving such second arm, the circuit to said electrically-operated devices being closed by the galvanometer-arm, substantially as set forth.

4. The combination, with a galvanometer-arm, of another pivoted arm, carrying on its free end insulated contacts between which the galvanometer-arm plays, two electro-magnets located in circuit with such contacts and operating pawl-levers, and oppositely-arranged ratchet-wheels worked by such pawl-levers and moving said second pivoted arm, the circuit of the electo-magnets being closed at the moving contacts by the galvanometer-arm, substantially as set forth.

5. The combination, with a dynamo-electric machine, of a regulator therefor, consisting of a galvanometer located in circuit from the machine, and closing at moving contacts local circuits to the regulator-operating devices, and to electrically operated devices for moving such contacts away from the galvanometer-arm, substantially as set forth.

6. The combination, with a dynamo or magneto electric machine, of an adjustable resistance for primarily varying the current flowing through its field-circuit, electrically-operated devices adjusting such resistance, and a galvanometer in circuit with the machine and controlling the circuits of such electrically-operated devices, substantially as set forth.

7. The combination, with a dynamo-electric machine, of translating devices located in multiple-arc circuits therefrom, the field-magnet coils of the machine, also in a multiple-arc circuit from the circuit supplied by the machine, an adjustable resistance in said field-circuit, electrically-operated devices adjusting such resistance, and a galvanometer located in a

multiple-arc circuit and controlling the circuits to such electrically-operated devices, substantially as set forth.

8. The combination, with a dynamo or magneto electric machine, of the galvanometer in circuit therefrom, the pivoted arm carrying contacts controlled by the galvanometer, the electro-magnets working such arm, and the resistance adjusted by such arm, substantially as set forth.

This specification signed and witnessed this 25th day of June, 1883.

THOS. A. EDISON.

Witnesses:

H. W. SEELY,

EDWARD H. PYATT.

(No Model.)

2 Sheets—Sheet 1.

T. A. EDISON.

DYNAMO ELECTRIC MACHINE.

No. 287,512.

Patented Oct. 30, 1883.

Fig. 1.

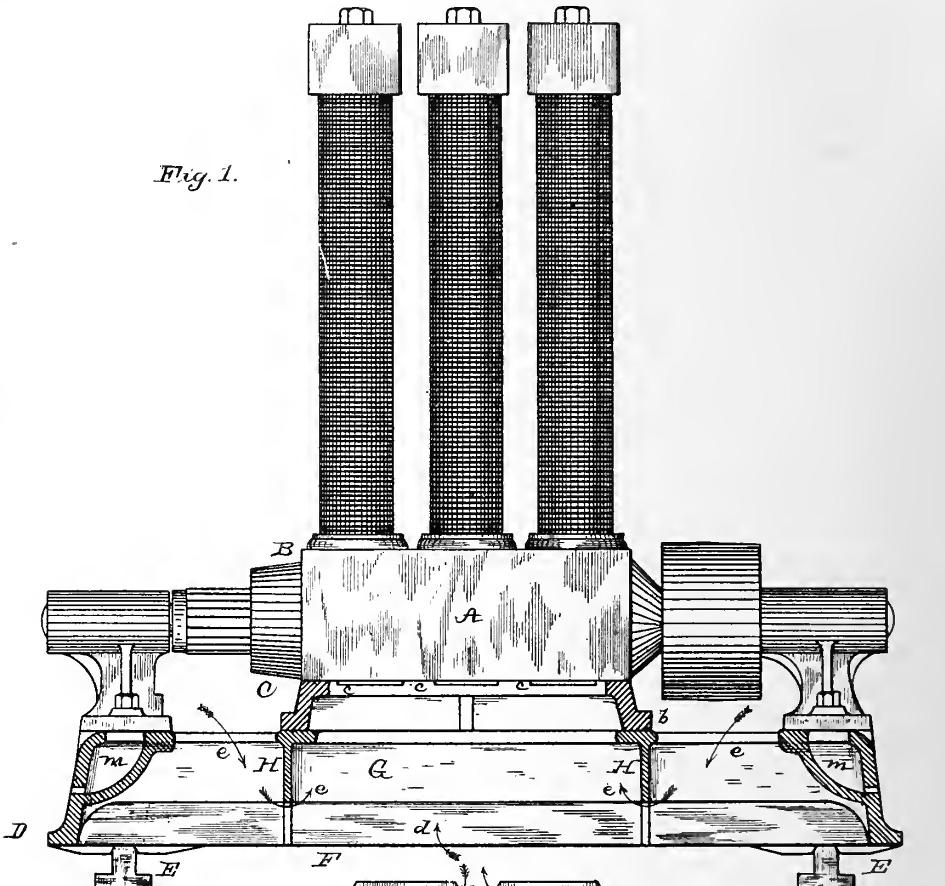
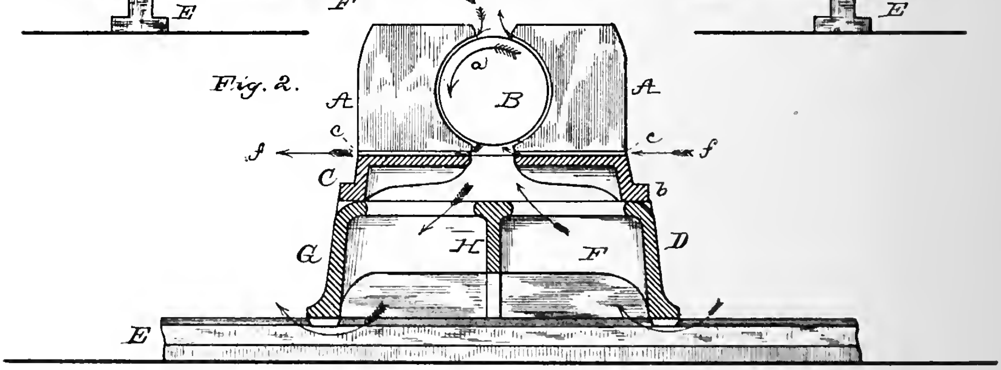


Fig. 2.



ATTEST:
Edw. C. Rowland
H. W. Seely

INVENTOR:
Thomas A. Edison,
By Rich. N. Dyer,
Atty.

(No Model.)

2 Sheets—Sheet 2.

T. A. EDISON.

DYNAMO ELECTRIC MACHINE.

No. 287,512.

Patented Oct. 30, 1883.

Fig. 3.

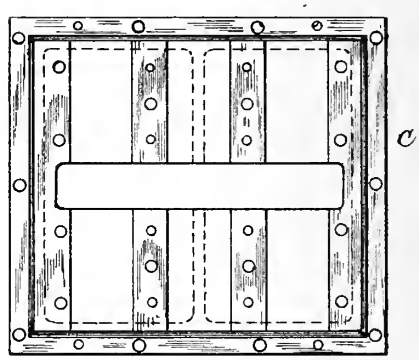
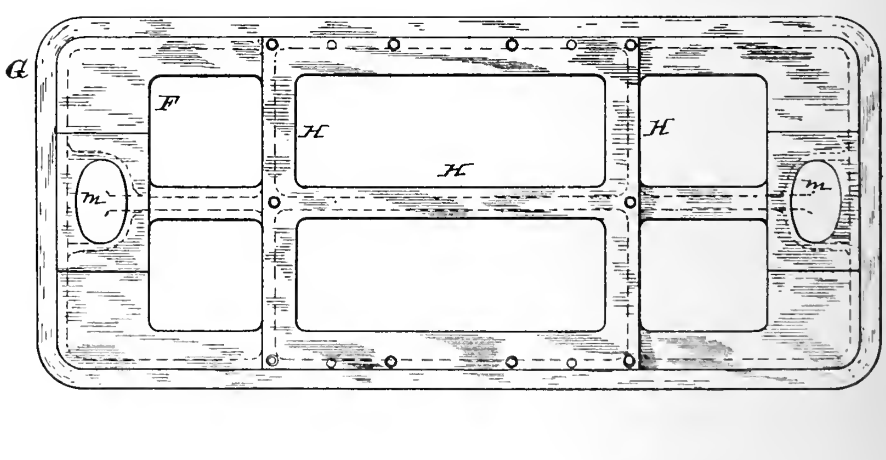


Fig. 4.



ATTEST:

E. C. Rowland

H. W. Seely

INVENTOR:

Thomas A. Edison,

By Rich^d N. Dyer Atty.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

DYNAMO-ELECTRIC MACHINE.

SPECIFICATION forming part of Letters Patent No. 287,512, dated October 30, 1883.

Application filed June 29, 1883. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Dynamo-Electric Machines, (Case No. 577,) of which the following is a specification.

This invention relates to the bed-plates on which dynamo-electric machines are mounted, its object being to maintain a circulation of air about the armature and between the armature and pole-pieces of the machine, whereby undue heating of the armature is prevented; and I accomplish this object by providing openings in the bed-plate upon which the machine rests, which openings permit air to penetrate to the space between the polar extensions in which the armature revolves. The bed-plate is preferably of iron, having a smaller plate of non-magnetic material, preferably zinc, placed upon it, to separate it from the magnet-poles. Both plates are made in the form of ribbed frames, the bed-plate being mounted upon ways, so that the air penetrates under it and through it and the zinc plate to the armature and polar extensions. Both plates are made of as open a form as is consistent with the proper degree of strength.

The invention is illustrated in the annexed drawings, in which—

Figure 1 is an elevation of a dynamo-electric machine with the bed-plates in longitudinal vertical section; Fig. 2, a vertical transverse section of the plates; Fig. 3, a plan view of the zinc plate, and Fig. 4 a plan view of the iron bed-plate.

A A are the polar extensions of the field-magnet of the machine, between which the armature B revolves in the direction shown by arrow *a*.

C is the zinc plate or frame, whose lower edge, *b*, rests upon the iron bed-plate D. The polar extensions A A rest upon the zinc plate C, whose upper edge is provided with apertures *c c*.

The plate D is set upon ways E E, (whereby it may be moved to tighten the belt connecting it with the source of power, as set forth in another application made by me,) and the air is thus enabled to penetrate beneath it. Such plate D is an open frame composed of an open bottom part, F, with raised sides G G. The bottom of the plate rests on the ways E E. Longitudinal and transverse ribs H H extend across, forming a rigid frame.

Upon the plate D is set the zinc plate C, which also consists of an open ribbed frame, on which the polar extensions rest.

The lower bed-plate, D, is provided with oil-receptacles *m m*, to which the oil is conveyed from the bearings. This feature will, however, be included in another application.

The arrows in Figs. 1 and 2 show the air circulation when the armature is revolving in the direction indicated. Air will enter below the plate D and pass through both plates to the armature, as shown by arrow *d*. It will enter, also, as shown by arrows *e*, at the top of the plate D, passing down, and then up through the center of the plate to the armature; and, also, the air will pass to and around the armature through the apertures *c* at the top of the zinc plate, as shown by arrows *f*.

It is to be understood that all patentable features of invention shown or described, but not claimed herein, are reserved for protection by other patents, and have been or will be included in other applications for patents.

What I claim is—

1. The combination, with a dynamo-electric machine, of an open bed-plate therefor, through which air penetrates to the space between the polar extensions of the machine in which the armature revolves, substantially as set forth.

2. The combination, with a dynamo-electric machine, of a bed-plate provided with openings and mounted upon ways, substantially as set forth.

3. The combination, with a dynamo-electric machine, of an open iron bed-plate and an open non-magnetic plate between said iron plate and the field-magnet of the machine, substantially as set forth.

4. The non-magnetic plate provided with apertures in its upper edges for admitting air to the armatures, substantially as set forth.

5. The combination, with a dynamo-elec-

tric machine, of a bed-plate therefor, formed as a ribbed frame and mounted upon ways, substantially as set forth.

6. The combination, with a dynamo-electric machine, of a non-magnetic plate placed between the polar extensions of the machine and the iron bed-plate, and formed as a ribbed frame, substantially as set forth.

This specification signed and witnessed this 25th day of June, 1883.

THOS. A. EDISON.

Witnesses:
H. W. SEELEY,
EDWARD H. PYATT.

(No Model.)

T. A. EDISON.

DYNAMO ELECTRIC MACHINE.

No. 287,513. Patented Oct. 30, 1883.

Fig. 1.

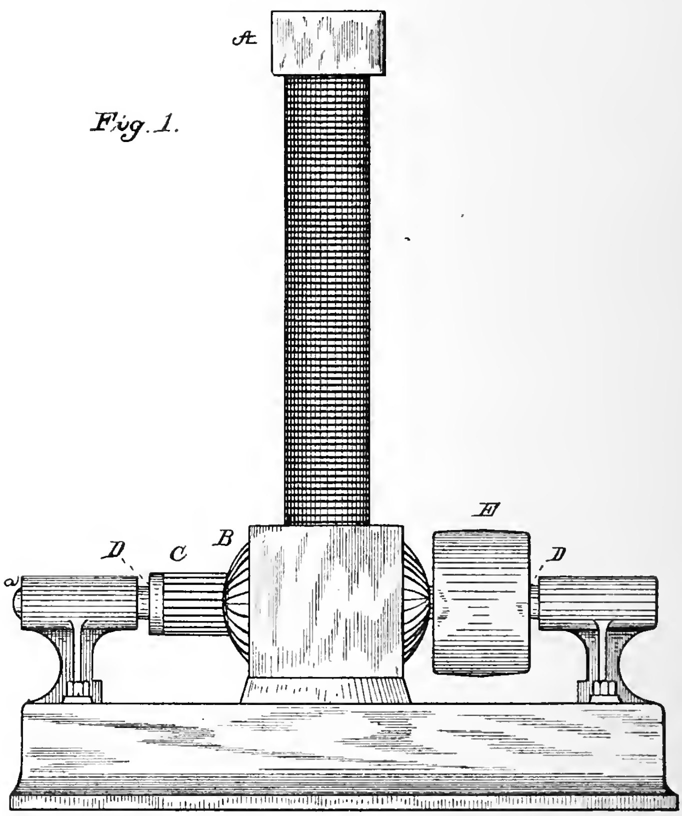
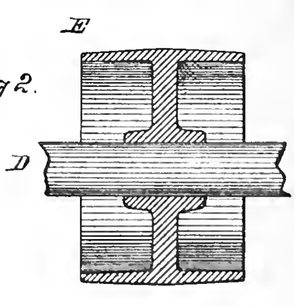


Fig 2.



ATTEST:

E. C. Rowland,

H. W. Seely

INVENTOR:

Thomas A. Edison,

By Rich'd N. Dyer,

Att'y

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

DYNAMO-ELECTRIC MACHINE.

SPECIFICATION forming part of Letters Patent No. 287,513, dated October 30, 1883.

Application filed June 29, 1883. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Dynamo-Electric Machines, (Case No. 574,) of which the following is a specification.

In the operation of dynamo-electric machines by means of belts passing over pulleys on their armature-shafts difficulties or inconvenience is sometimes experienced from the fact that the pulley, having a considerable mass of magnetic material, is magnetically attracted by the field-magnet of the machine, and therefore the armature-shaft may be drawn toward the magnet, causing friction and heating at the bearing at the opposite end of the shaft.

The object of my invention is to obviate this difficulty; and to this end the invention consists in the use, in connection with the armature-shaft of a dynamo or magneto electric machine or electric motor of such construction that the pulley is sufficiently within the magnetic influence of the poles of the field-magnets to produce the objectionable result above specified, of a pulley of non-magnetic material. I prefer to employ brass for this purpose, though other non-magnetic metals, or suitable substances not metallic, may be used, if desired.

The invention is illustrated in the accompanying drawings, in which—

Figure 1 is a side elevation of a dynamo or magneto electric machine embodying said invention, and Fig. 2 a sectional view of the pulley used.

A is the field-magnet, B the armature, C the commutator, and D the armature-shaft, of the generator.

E is the pulley, by which the shaft is connected to a suitable source of power. Heretofore such pulleys, having been made of iron or steel, have been attracted toward the field-magnet A, and consequently the armature-shaft had a tendency to move toward the end *a* farthest from the pulley, so that friction and heating were produced at this point. I construct the pulley E of brass or other non-magnetic material, and hence it is not magnetically attracted, and this difficulty is obviated.

It is evident that the invention is readily applicable to electromotors in which a pulley is attached to the armature-shaft for connection with the driving machinery.

It is to be understood that all patentable features of the invention shown or described, but not claimed herein, are reserved for protection by other patents, and have been or will be embodied in other applications for patents.

What I claim is—

1. The combination, with a dynamo-electric machine or electric motor whose field-magnets are so arranged that the driving-pulley is within the attractive influence of their poles, of a pulley of non-magnetic material, whereby the attraction of the pulley toward the poles is prevented, substantially as set forth.

2. The combination, with a dynamo-electric machine or electric motor whose field-magnets are so arranged that the driving-pulley is within their attractive influence, of a brass pulley, whereby the attraction of the pulley toward the poles of the magnet is prevented, substantially as set forth.

This specification signed and witnessed this 25th day of June, 1883.

THOS. A. EDISON.

Witnesses:

H. W. SEELY,

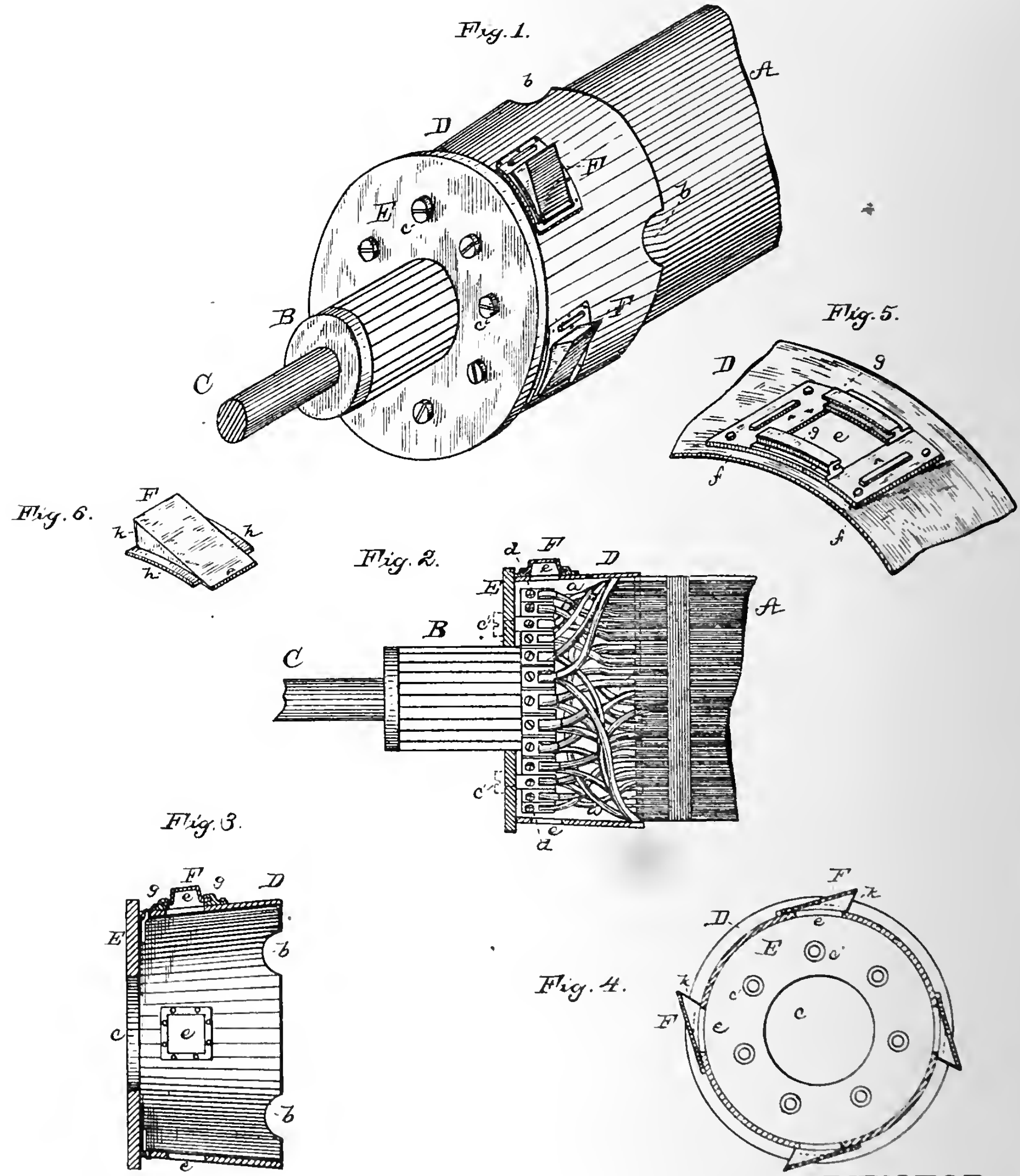
EDWARD H. PYATT.

(No Model.)

T. A. EDISON.

DYNAMO ELECTRIC MACHINE.

No. 287,514. Patented Oct. 30, 1883.



ATTEST:

E. C. Rowland

H. W. Seely

INVENTOR:

Thomas A. Edison,

By Rich^d. N. Dyer,

Atty.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

DYNAMO-ELECTRIC MACHINE.

SPECIFICATION forming part of Letters Patent No. 287,514, dated October 30, 1883.

Application filed June 29, 1883. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Dynamo-Electric Machines, (Case No. 582,) of which the following is a specification.

The object of this invention is to maintain a current of air upon the armature of a dynamo-electric machine, to prevent heating thereof, and especially to keep cool the connecting devices between the armature-coils and the commutator.

Said invention relates to the arrangement of a blower with relation to the armature of the machine, and also to the construction of a blower suitable for the purpose mentioned.

In carrying out my invention I employ a blower external to the armature, and mounted directly thereon. Such blower is placed directly over the connections between the armature and commutator, so as to inclose such connections, extending, however, over the end of the armature, so as to force air along the surface of said armature. The blower which I prefer to use consists of a cylinder, of wood or other insulating material, open at one end, and having an aperture at its other end of such size as to fit closely upon the commutator-cylinder. In the surface of said blower-cylinder are several openings, and over said openings are placed buckets, cups, or fans, so that when the cylinder is revolved air is caught by said buckets, cups, or fans and forced in directly upon the commutator-connections and out at the open end of the blower-cylinder. Said open end fits closely upon the armature-cylinder, but several notches or slots are formed in its edge, so that the air can escape through such notches to the surface of the armature. The buckets on the outside of the blower-cylinder are removable and reversible, so that they may be turned around to catch the air if the direction of revolution of the armature should at any time be reversed.

My invention is illustrated in the annexed drawings, in which Figure 1 is a perspective view of the end of an armature with the blower placed thereon; Fig. 2, an elevation of the end of the armature with the blower in longitudinal section; Fig. 3, a longitudinal section of the blower detached from the armature; Fig. 4, a cross-section of the blower, viewed from the armature end; Fig. 5, an enlarged view of a portion of the outside of the blower, showing an air-opening with the bucket removed; and Fig. 6, a view of the detached bucket.

A is the armature, B the commutator-cylinder, and C the armature-shaft, of a dynamo or magneto electric machine. The coils *a a* upon the armature are connected with the commutator-bars by suitable connecting devices, preferably as shown in other applications made by me.

D is the wooden shell or cylinder of the blower. Its open end rests closely upon the end of the armature, and is provided with notches *b*, which form openings through which the air escapes. The other end of the cylinder is the wooden plate E, having the aperture *c*, which fits upon the commutator-cylinder. The plate E is secured by means of screws *c′ c′*, which enter certain of the metallic connecting-pieces *d d*, some of these pieces being extended out toward the commutator for this purpose.

The sides of the blower cylinder or shell are provided with a suitable number of openings, *e*. Around such openings the plates *f* are attached, which are preferably of metal—such as brass—and on opposite sides of each of said openings are placed the grooved strips *g g*. The projecting edges *h h* of the bucket F are inserted in the grooves of the two strips *g g*, and the bucket is thus slid into and held in position over the opening *e*. It is evident that a bucket may be placed with its open end *k* in either direction, and that the buckets may be readily removed and reversed, according to the direction in which the machine is run.

When the armature is revolved, air is caught by the buckets and forced in through the openings *e*, directly upon the connections and out through the notches *b* upon the surface of the armature.

The blower, arranged as described, is especially adapted for cooling the connections between the armature and commutator of the machine, although it is efficient also for cooling the entire surface of the armature.

I do not claim herein the peculiar construction of the blower, *per se*, as I propose to make this the subject of a separate application for Letters Patent; and it is to be understood that all patentable features of invention shown or described, but not claimed herein, are reserved for protection by other patents, and have been or will be embodied in other applications for patents.

What I claim is—

1. The combination, with a dynamo-electric machine, of an air-blower inclosing the commutator-connections of said machine, substantially as set forth.

2. The combination, with a dynamo-electric machine, of an air-blower mounted directly upon the armature of said machine and inclosing the commutator-connections, substantially as set forth.

3. The combination, with a dynamo-electric machine, of an air-blower inclosing the commutator-connections, and provided with outlets opening upon the surface of the armature, substantially as set forth.

4. The combination, with a dynamo-electric machine, of a blower consisting of a cylindrical shell having inlet-openings and external buckets, cups, or fans, and one or more outlets for blowing air upon the surface of the armature, substantially as set forth.

5. The combination, with a dynamo-electric machine, of a blower mounted upon the armature of said machine and inclosing the commutator-connections, having air-inlets in its sides and one or more openings for blowing air upon the surface of the armature, substantially as set forth.

6. The combination, with the armature of a dynamo-electric machine, of a blower having an open end fitting over the end of said armature, and provided with notches forming air-outlets, substantially as set forth.

7. The combination, with a dynamo-electric machine, of a blower formed of insulating material, and placed directly upon the commutator-cylinder and armature of the machine, substantially as set forth.

8. The combination, with a dynamo-electric machine, of a blower formed of insulating material, mounted directly upon the armature of said machine and secured to the conducting-pieces between the armature-coils and the commutator, substantially as set forth.

9. The combination, with a dynamo-electric machine, of a blower revolved from the armature-shaft of said machine, and provided with reversible buckets, cup, or fans, substantially as set forth.

10. The combination, with a dynamo-electric machine, of the blower shell or cylinder having its open end fitting over the end of the armature, and provided with notches forming air-outlets, and its other or closed end provided with an aperture fitting upon the commutator-cylinder, substantially as set forth.

This specification signed and witnessed this 25th day of June, 1883.

THOS. A. EDISON.

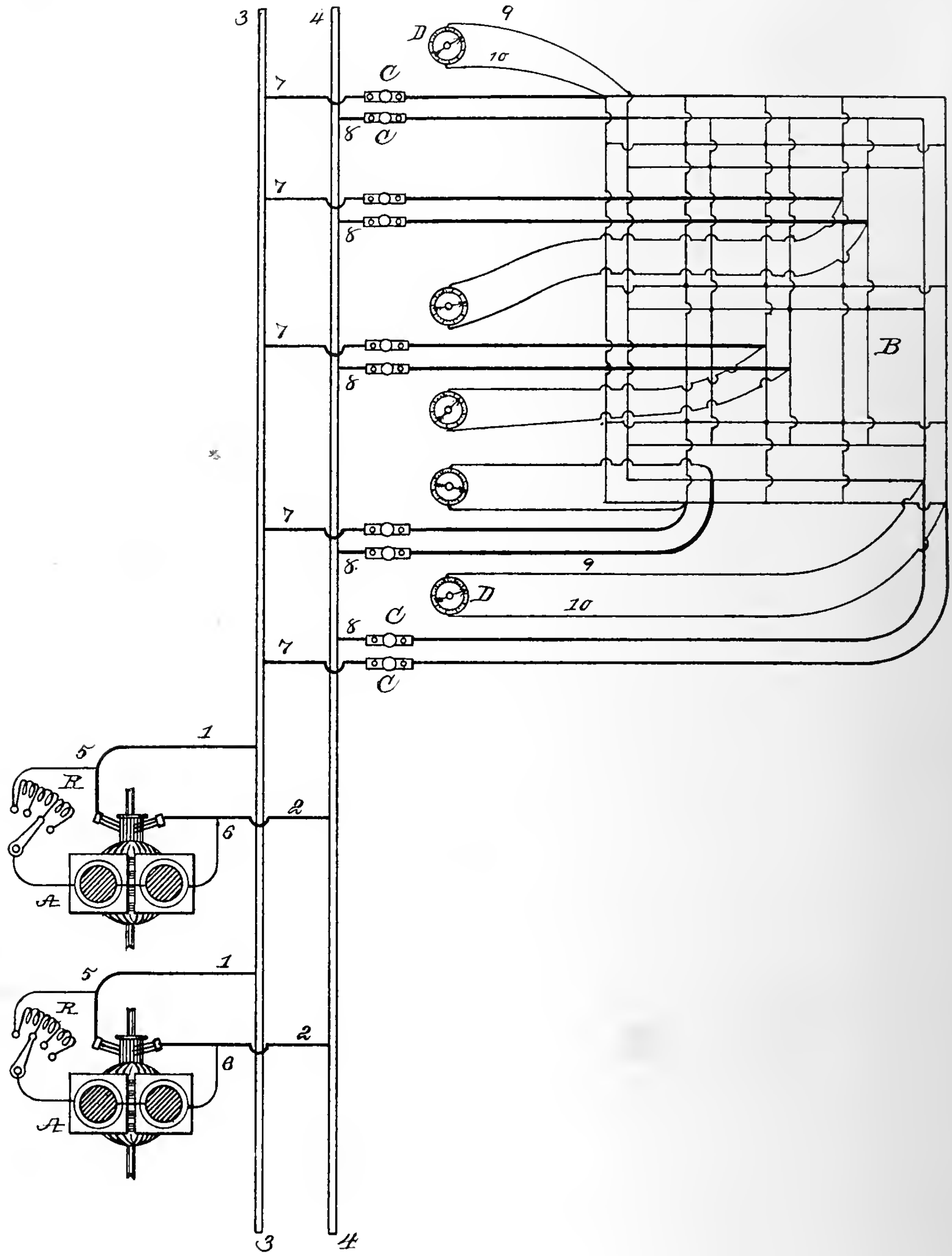
Witnesses:
H. W. SEELY,
EDWARD H. PYATT.

(No Model.)

T. A. EDISON.

SYSTEM OF ELECTRICAL DISTRIBUTION.

No. 287,515. Patented Oct. 30, 1883.



ATTEST:

E. C. Rowland

H. W. Seely

INVENTOR:

Thomas A. Edison,

By Rich. N. Dyer,

Atty.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

SYSTEM OF ELECTRICAL DISTRIBUTION.

SPECIFICATION forming part of Letters Patent No. 287,515, dated October 30, 1883.

Application filed June 29, 1883. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Systems of Electrical Distribution, (Case No. 581,) of which the following is a specification.

In my system of electrical distribution the lamps or other translating devices are arranged in multiple arc in circuits connected with a net-work of intersecting main conductors, and feeding - conductors without translating devices, and upon which the principal part of the loss of energy in conductors is sustained, are connected to the net-work of main conductors at various points and extend to a central station, where the current for supplying the system is generated by machines, with each of which all the feeders are connected. Two kinds of regulation are required—one of the electromotive force of the generators, and one of the distribution of the current to various parts of the system. In my Patent No. 266,793 the latter kind of regulation is performed by throwing resistance into and out of the feeding-circuits; but I have discovered that this regulation can be efficiently performed by breaking and making the feeding-circuits. This method of regulation is set forth in my application No. 88,363, wherein is described and shown a circuit-controller for making and breaking one side of each feeding-circuit, and a method of regulation is set forth by the manipulation of such circuit-controllers.

The object of my present invention is to obtain by the making and breaking of feeding-circuits a much finer regulation with the same number of feeding-circuits than can be obtained by the means set out in said application No. 88,363, and my object is further to produce a simple and efficient connection between the feeders and the generators. The net-work of main conductors forms, it will be understood, the sides of a single circuit, the circuit being completed from one side of the net-work to the other through the translating devices, and hence the feeding-conductors extending to the central station are in fact all divisions of one circuit. Now, if one side only of the feeding-circuits is adapted to be made and broken, the other side of the feeding-circuits will always remain of the same conductivity, and all the regulation will be performed upon one side of such feeding-circuits. Now, I propose to provide each side of each feeding-circuit with a circuit-controller, and thus it will be seen not only will the chances for regulation be doubled with the same number of feeding-circuits, but a great number of variations can be made in the arrangement of the points at which the current will enter and leave the net-work of main conductors, and hence the regulation can be made quite a perfect one with a moderate number of feeding-circuits. At the central station all the generators are connected to a pair of large parallel conductors, which extend to that point in the building where the feeding-conductors are grouped together. There the conductors of the feeding-circuits are connected with the two conductors from the machines, each through a suitable circuit-controller. This manner of connecting the conductors is found very convenient in practice, the parallel conductors being preferably run along the wall of the room in which the generators are placed, past all the generators, while conductors extend from each generator to them. The feeding-conductors may be connected at any desired point. Means are provided for indicating at the central station the electro-motive force at the end of each feeding-circuit, where the feeding-conductors are connected with the net-work of main conductors. For this purpose a circuit is run back from the terminus of each feeding-circuit to the central station, and is there provided with an electro-dynamometer. The regulation described of the distribution of the current to various parts of the system is used in connection with a regulation of the electro-motive force of the generators. This latter regulation is preferably effected by throwing resistance into and out of the field-circuits of the machines.

The invention is illustrated diagrammatically in the accompanying drawing, forming a part hereof.

A A are dynamo or magneto electric machines, connected by conductors 1 2 to the large parallel conductors 3 4 common to all the machines. The field-circuits 5 6 of the machines are preferably multiple-arc circuits from the conductors supplied by the machines, and are provided with adjustable resistances R. The feeding-circuits 7 8 extend from the common conductors 3 4, with which they are connected at different points lengthwise of such conductors 3 4, to different points in the net-work B of connected main conductors. Each feeding-conductor is provided within the central station with a circuit-controller, C, which may be of any suitable construction, it being shown, for convenience, as the ordinary hand-plug. Circuits 9 10 are run back to the central station from the terminals of the feeding-circuits, and are provided with the electro-dynamometer D.

Some features of invention which are described or shown herein are not claimed, for the reason that they are claimed in my applications Nos. 88,356 and 88,363, and it is to be understood that all patentable features of invention described or shown but not claimed herein are reserved for protection by other patents, and have been or will be embraced in other applications for patents.

What I claim is—

1. The method of regulating the supply of current in a system of electrical distribution, comprising a system of intersecting and properly-connected main conductors, and feeding-circuits connecting such main conductors with the source of supply, consisting in making and breaking in the desired order both sides of the requisite number of said feeding-circuits, substantially as set forth.

2. In a system of electrical distribution, the combination of the intersecting and properly-connected main conductors and the feeding-circuits, the latter having circuit-controllers in both sides, substantially as set forth.

3. In a system of electrical distribution of the character described, the combination of the feeding-circuits having circuit-controllers in both sides thereof, and means for indicating the electrical condition at the termini of said feeding-circuits, substantially as set forth.

4. In a system of electrical distribution of the character described, the combination, with the feeding-circuits provided with circuit-controllers on both sides, of the generators, and means for regulating the electro-motive force of such generators, substantially as set forth.

5. In a system of electrical distribution, the combination, with two or more generators, of a pair of common parallel conductors, to which the generators are connected, and the feeding-conductors connected with such common conductors at different points lengthwise thereof, substantially as set forth.

This specification signed and witnessed this 25th day of June, 1883.

THOS. A. EDISON.

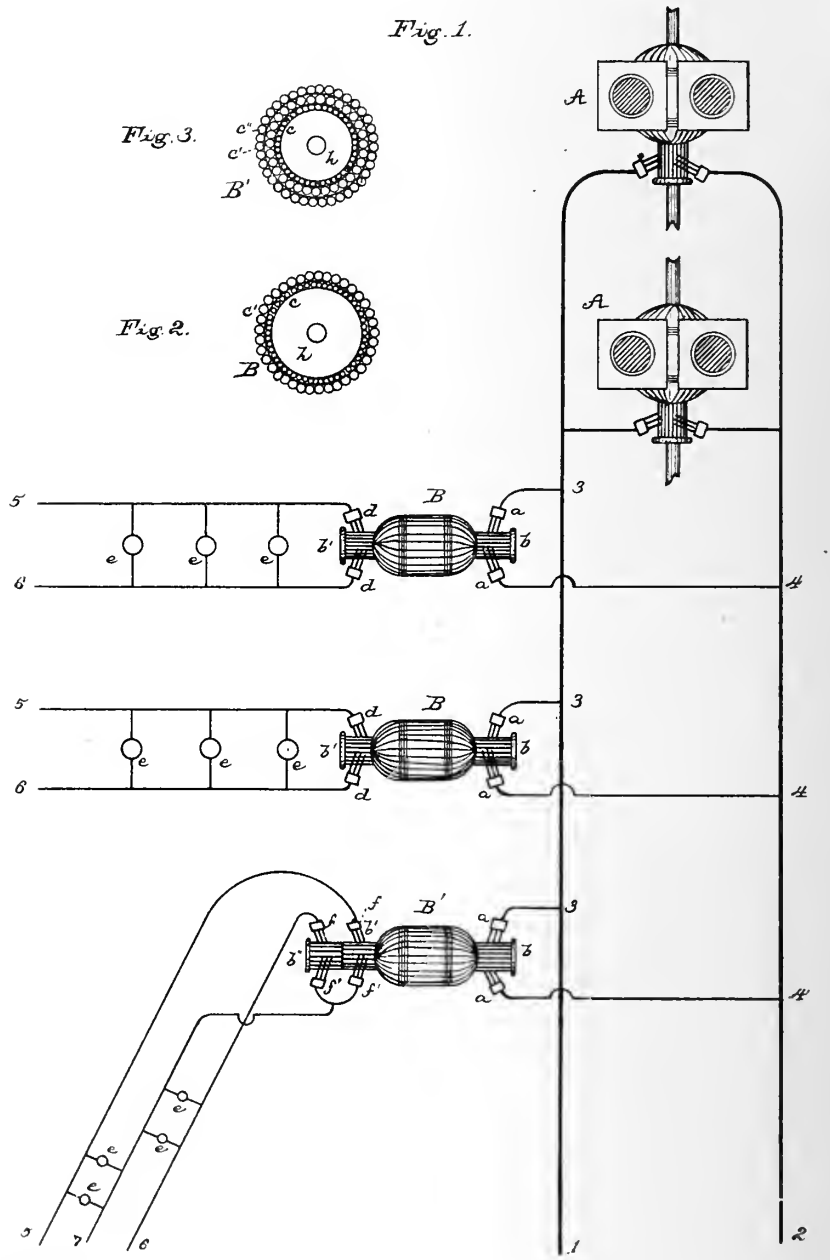
Witnesses:
H. W. SEELY,
EDWARD H. PYATT.

(No Model.)

T. A. EDISON.

SYSTEM OF ELECTRIC DISTRIBUTION.

No. 287,516. Patented Oct. 30, 1883.



ATTEST:

Edw. C. Rowland

H. W. Seely

INVENTOR:

Thomas A. Edison

By Rich^d N. Dyer,

Atty.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

SYSTEM OF ELECTRIC DISTRIBUTION.

SPECIFICATION forming part of Letters Patent No. 287,516, dated October 30, 1883.

Application filed May 14, 1883. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Systems of Electrical Distribution, (Case No. 564,) of which the following is a specification.

The object of this invention is to provide a system of electrical distribution wherein currents can be economically transmitted from a distant source of energy—such as a water-power—to the town, village, or other locality which is to be supplied, and there distributed from different independent central stations, situated at convenient points, to the various parts of such locality.

Generally speaking, such system consists of a sufficient number of electrical generators of high electro-motive force situated at the source of power, main conductors of small area extending from such generators to the locality to be supplied, devices connected with such conductors in multiple arc for reducing the tension of the current, each device or set of devices being placed at a distributing-station, a circuit or circuits extending from each of such distributing-stations for conveying the low-tension currents, and translating devices—such as electric lamps or electromotors—connected with such low-tension circuits.

The device which I prefer to use for accomplishing the reduction of tension consists of a field-magnet and an armature-core, on which are wound two sets of coils—one of fine wire, connected with a commutator whose brushes are placed in the multiple-arc circuit from the main conductors, the other of coarser wire, connected with a commutator from whose brushes the circuit or circuits extend, on which the translating devices are arranged, preferably, in multiple arc. The field-magnets may be energized by a constant current in any suitable manner.

Where it is desired to employ the compensating system set forth in my Patent No. 274,290, I wind the core with three sets of coils, one acting as a motor-coil and the other two as generator-coils. Preferably two commutators are provided for these generator-coils, one set of coils being connected to each commutator. The main conductors of the distributing-circuit are each connected to a brush on one of the commutator-cylinders, while the compensating-conductor is connected with two brushes—one on each cylinder—and the translating devices are connected each between a main conductor and the compensating-conductor, as usual.

My invention is illustrated in the annexed drawings, in which—

Figure 1 is a diagram of the system, the field-magnets being omitted from the combined generators and motors; Fig. 2, a sectional view of the armature with two windings, and Fig. 3 a section of the armature with three windings.

A A represent generators of high electromotive force, connected in multiple arc to main conductors 1 2; or two or more generators may be connected in series to produce the electromotive force required. At a point where it is desired to place stations or centers of distribution a multiple-arc circuit, 3 4, is connected with the main conductors 1 2. The conductors of such multiple-arc circuits extend to brushes *a a*, bearing on a commutator-cylinder, *b*, of an armature, B or B′.

The armatures B each consist of a core, *h*, on which are wound two sets of coils—one coil, *c*, of fine wire, connected with commutator *b*, the other, *c′*, of coarser wire, connected with commutator *b′*. The coils *c* are of such high resistance that the main conductors are not short-circuited through them. A common field-magnet is employed for both sets of coils, as will be readily understood, and, as explained in my Patent No. 265,786, the transmission of current through the coils *c* and through the field-magnet causes the revolution of the armature, and the coils *c′* thus cut the lines of force and cause the generation of a continuous current of such tension as is provided for by the winding of the coils.

Commutator-brushes *d d* rest upon the cylinder *b′*, and conductors 5 6 extend from such commutator-brushes, translating devices *e e* being placed in multiple-arc circuits across such conductors, and being thus supplied with currents of the proper tension.

The armature B′ has three sets of coils, one, *c*, forming the motor-coils, the others, *c′ c″*, being the generating-coils. The coils *c′* are connected to the commutator-cylinder *b′*, and the coils *c″* to the cylinder *b″*. The conductors

5 6 extend from the brushes $f f$, which bear one on each of these cylinders, and the compensating-conductor 7 is connected with the two opposite brushes, $f'' f'$. The translating devices $e e$ are connected between the compensating-conductor and the main conductors, as shown.

It is evident that a single commutator-cylinder could be employed, instead of the two commutators $b' b''$, with the conductors 5 6 connected to main brushes, bearing on said commutator, and the compensating-conductor 7 connected to an extra brush placed between them.

It is evident that the coils $c' c''$ in the triple-wound machine could be of the same size wire as the coils c, for the use of two sets of such coils will accomplish a certain reduction of tension, and in a compensating system the currents used are of higher tension than in the ordinary system.

In the system described in my Patent No. 265,786, above referred to, several combined generators and motors are shown, the motor-coils being placed in series in one of the main conductors and translation-circuits leading from the generating-coils. In this case the devices are not independent, and therefore the arrangement is inapplicable to my present purpose of providing independent distributing-stations, at which apparatus is placed for reducing the tension of the current.

It will be seen that by my present arrangement the tension-reducing devices, being placed in multiple arc, are entirely independent of each other, and either can be thrown out of use without affecting the others.

What I claim is—

1. In a system of electrical distribution, the combination of a source of electricity, main conductors extending therefrom, two or more combined generators and motors having their motor-coils connected in multiple arc with said main conductors, distributing-circuits extending from their generating-coils, and translating devices connected with such distributing-circuits, substantially as set forth.

2. The combination, with main conductors, of a tension-reducing device connected therewith, a distributing-circuit and a compensating-conductor extending from said tension-reducing device, and translating devices connected between the main conductors of said distributing-circuit and said compensating-conductor, substantially as set forth.

3. The combination, with a core, of a motor-coil connected with main conductors, two generator-coils, each connected with a commutator-cylinder, main distributing-conductors connected each with a brush bearing on one commutator, and a compensating-conductor connected with both the opposite brushes, substantially as set forth.

This specification signed and witnessed this 8th day of May, 1883.

THOS. A. EDISON.

Witnesses:

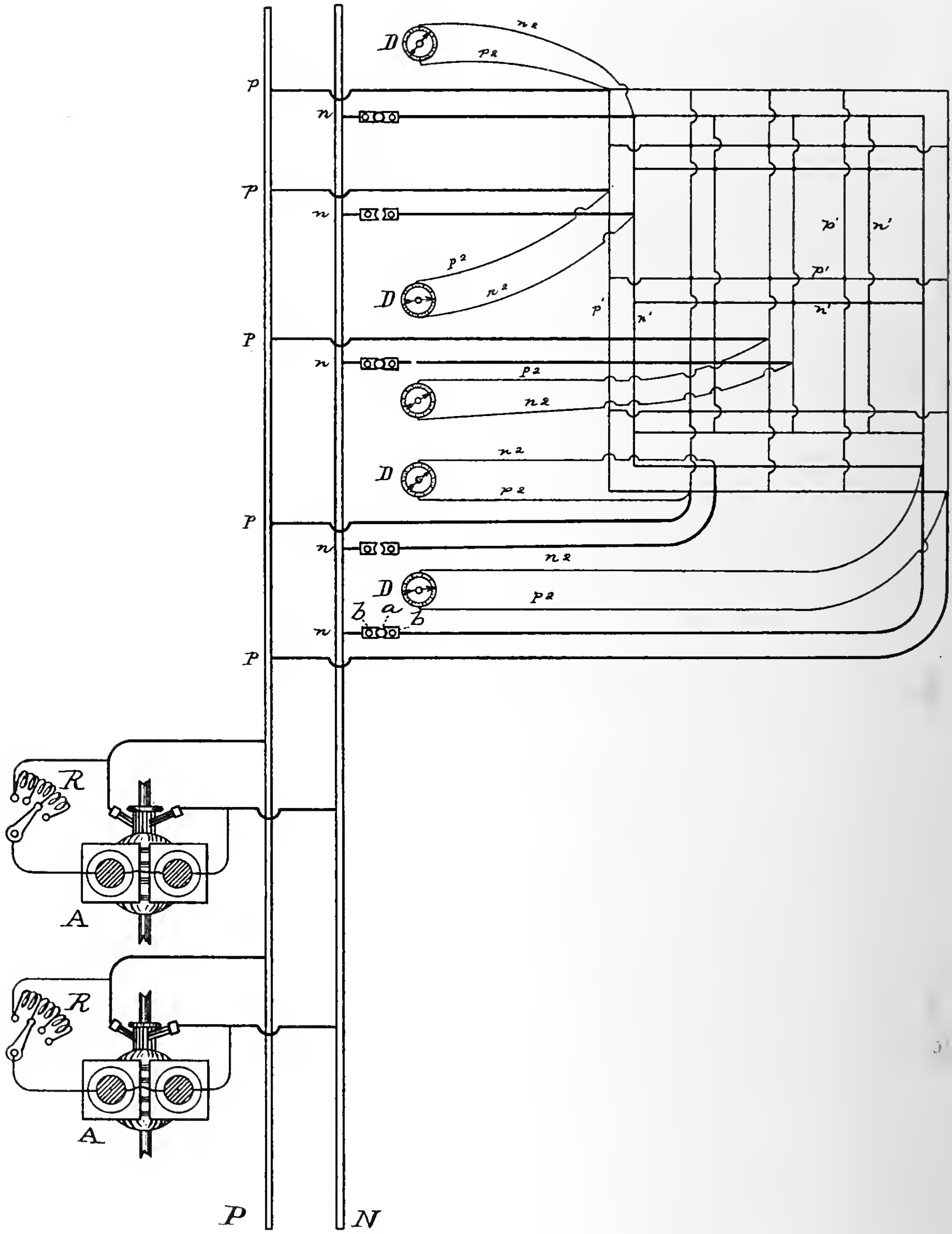
WM. H. MEADOWCROFT,
H. W. SEELY.

(No Model.)

T. A. EDISON.

SYSTEM OF ELECTRICAL DISTRIBUTION.

No. 287,517. Patented Oct. 30, 1883.



ATTEST:
E. C. Rowland,
H. W. Seely

INVENTOR:
Thomas A. Edison.
By Rich'd N. Dyer,
Att'y.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, ASSIGNOR TO THE EDISON ELECTRIC LIGHT COMPANY, OF NEW YORK, N. Y.

SYSTEM OF ELECTRICAL DISTRIBUTION.

SPECIFICATION forming part of Letters Patent No. 287,517, dated October 30, 1883.

Application filed March 16, 1883. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Electrical Distribution Systems, (Case No. 553,) of which the following is a specification.

The object of this invention is to regulate the current supplied to the translating devices of a system of electrical distribution employing feeding-circuits, so as to maintain a constant electro-motive force in the system and furnish a constant current to each translating device in circuit. Such a system consists of one or more generators situated at a central station, from which feeding-circuits containing no translating devices run to different parts of the district supplied, where they are connected to the positive and negative main conductors, these being arranged, as usual in my system, with all the intersecting positive conductors connected together, and likewise all the negative. The translating devices of the system are arranged in multiple arc upon circuits leading from these main conductors. Each feeding-circuit exerts a certain influence over the entire district, such influence being of course greatest at that part of the district contiguous to its terminals, but extending, to some extent at least, to the portions remote therefrom. I have found, therefore, that the current can be regulated and kept constant in all parts of the district simply by connecting and disconnecting the feeders. When the number of translating devices in a certain part of the district decreases to a great extent, the feeder running to this point is disconnected, and the few translating devices still in circuit will be supplied by the remaining feeders; or, when the number of translating devices in a certain part increases, a feeder terminating near such part is connected. Means are provided at the central station for indicating the electro-motive force at the terminals of the feeders. This regulation is used in connection with the regulation of the generators by the adjustable resistances in their field-circuits, or by other suitable means, which regulate for changes in the entire number of translating devices in circuit.

The accompanying drawing is a diagram of a system of electrical distribution provided with means for carrying out my invention.

A A are dynamo-electric machines, each having its field and its armature connected in multiple arc with the conductors P N, which are situated within the central station. The feeding-circuits p n are connected in multiple arc with these conductors, and extend to various points of the district, where they are connected to the intersecting positive and negative main conductors p' n', which supply the translating devices. Each feeding-circuit is provided with a suitable circuit-controller. A convenient form is a metal plug, a, inserted between two metal plates, b b, to close the circuit, and withdrawn to break the circuit. If the number of translating devices in any part of the district increases to such an extent that the current supplied is insufficient for them, the feeding-circuits leading nearest to such point would be plugged in, and the feeding-circuits would be broken, as less current is required at the points contiguous to their terminals. To indicate the electrical condition at the terminals of the feeders, the auxiliary circuits p^2 n^2, of small wire, are run back to the central station, where each is connected with an electro-dynamometer, D, and the regulation is performed in accordance with the indications of these instruments.

The adjustable resistances R R in the field-circuits of the generators are used to increase and decrease the currents supplied through all the feeders to the entire district.

It is evident that this method of regulation could be readily applied to my "compensating" system in cases where feeding-circuits are employed in such a system.

What I claim is—

1. The method of regulating the supply of current in a system of electrical distribution, comprising a system of positive and negative main conductors and feeding-circuits, connecting the source of supply with said main conductors, consisting in breaking and closing the feeding-circuits, according to the cur-

rent required in the parts of the system contiguous to their terminals, substantially as set forth.

2. In a system of electrical distribution, the combination of the intersecting and properly-connected positive and negative main conductors, and the feeding-circuits extending from the source of supply to said main conductors, each of said feeding-circuits being provided with a circuit-breaker, substantially as set forth.

3. In a system of electrical distribution of the character described, the combination, with the feeding-circuits, each provided with a circuit-controller, of means for regulating the current generated at the source of supply, substantially as set forth.

4. In a system of electrical distribution of the character described, the combination, with the feeding-circuits, each provided with a circuit-controller, and means for constantly indicating the electrical condition at the terminals of said feeding-circuits, of means for regulating the current generated at the source of supply, substantially as set forth.

This specification signed and witnessed this 14th day of March, 1883.

THOS. A. EDISON.

Witnesses:

WM. H. MEADOWCROFT,

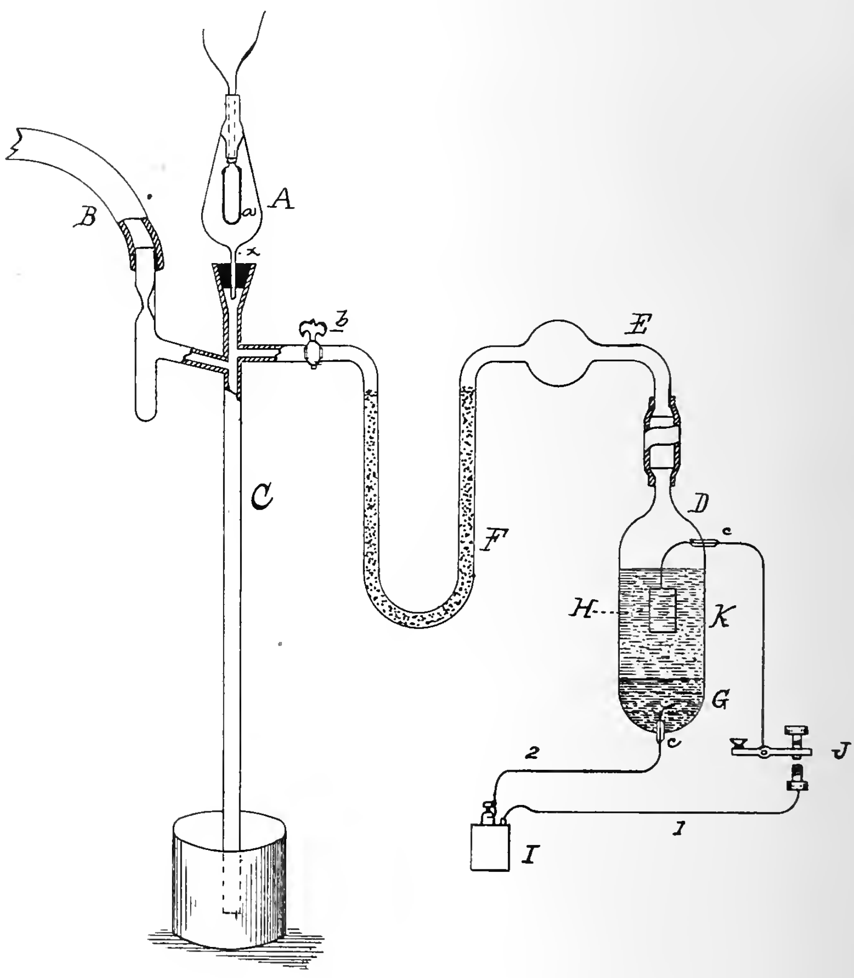
H. W. SEELY.

(No Model.)

T. A. EDISON.

METHOD OF MANUFACTURING INCANDESCING ELECTRIC LAMPS.

No. 287,518. Patented Oct. 30, 1883.



WITNESSES:

Edw C. Rowland

H. W. Seely

INVENTOR:

Thomas A. Edison,

By Rich^d N. Dyer

Att'y

United States Patent Office.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, ASSIGNOR TO THE EDISON ELECTRIC LIGHT COMPANY, OF NEW YORK, N. Y.

METHOD OF MANUFACTURING INCANDESCING ELECTRIC LAMPS.

SPECIFICATION forming part of Letters Patent No. 287,518, dated October 30, 1883.

Application filed September 13, 1882. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in the Manufacture of Incandescing Electric Lamps, (Case No. 481,) of which the following is a specification.

The object of my invention is to render the carbon filaments which form incandescing-conductors of electric lamps more durable in use. I accomplish this by first exhausting the lamp-globe as completely as possible by means of a Sprengel vacuum-pump, and then filling the globe with pure hydrogen, free from moisture, to an atmospheric pressure. I then heat the carbon filament by an electric current to a much higher temperature than that to which it is to be subjected in use. It being subjected to atmospheric pressure during such heating, the carbon becomes more compact. The hydrogen is then exhausted, and the carbon is again heated to high incandescence, to remove any of the gas which may remain within its pores, after which the lamp is sealed off from the pump.

Instead of filling the globe with hydrogen, I may employ any other inert gas—such as chlorine gas; but hydrogen is preferable.

In carrying out my invention I may employ the apparatus illustrated in the drawing.

A represents the inclosing-globe of an incandescing electric lamp, and *a* the carbon filament. The lamp is attached to a Sprengel pump, of which B is the supply-tube, and C the fall-tube.

D is a glass vessel, connected by a tube, E, with the vacuum-pump. A portion of the tube is filled with phosphoric anhydride, F, or other similar drying agent, and the tube is provided with a stop-cock, *b*.

In the bottom of the vessel D is placed an amalgam of mercury and zinc, G, and above this is placed a quantity of sulphuric acid and water, K, in which is immersed a plate, H, of platinum.

From a battery, I, wires 1 2 run, respectively, to the platinum plate H and to the amalgam G. Such wires each have a small portion, at *c*, of platinum sealed into glass, the latter being sealed into the glass of the vessel D. A key, J, is provided for opening and closing the battery-circuit.

The operation is as follows: The air is first exhausted from the lamp-globe and from the vessel D by the Sprengel pump, the stop-cock *b* and key J being open. The operation of the pump is then stopped and the circuit 1 2 closed. The liquid K in the vessel D is decomposed by the current, and the oxygen combines with the zinc of the amalgam, to form an oxide of zinc, which combines with the sulphuric acid, to form sulphate of zinc. Pure hydrogen is therefore given off, which enters the lamp-globe, a sufficient amount being allowed to enter to produce an atmospheric pressure therein, after which the stop-cock *b* is closed and circuit 1 2 is opened, so that no more hydrogen can enter the pump. The carbon filament is then electrically heated through the wires 3 4 to a higher incandescence than that at which it is intended to be used. The hydrogen is then pumped out, after which the carbon is again electrically heated, the pump still continuing in operation, the residual and occluded gases being thus almost completely removed. The lamp is sealed off at *x*, and is then ready for use.

Where another gas than hydrogen is used, suitable apparatus for generating the same would be similarly connected with the lamp and pump.

What I claim is—

1. The method of manufacturing incandescing electric lamps, which consists in charging the globe of a lamp with pure hydrogen or equivalent inert gas, next heating the conductor within said globe to incandescence by an electric current, removing said gas from the globe, and finally sealing off said globe, substantially as set forth.

2. The method of treating the carbon filaments of incandescing electric lamps, consisting in heating them to a higher incandescence than that at which they are intended to be used in an atmosphere of pure hydrogen or equivalent inert gas, substantially as set forth.

3. The method of treating the carbon filaments of an incandescing electric lamp, consisting in first exhausting the air from the globe inclosing the filament, and replacing it

by pure hydrogen or equivalent inert gas, heating the conductor to incandescence by an electric current, removing the hydrogen from the globe, and again heating the filament, the operation of the exhausting apparatus being continued during this latter heating, substantially as set forth.

This specification signed and witnessed this 25th day of August, 1882.

THOS. A. EDISON.

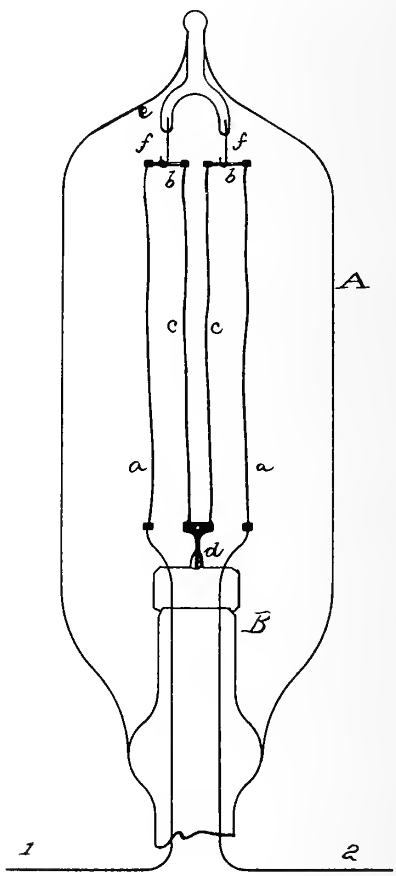
Witnesses:
H. W. SEELY,
EDWARD H. PYATT.

(No Model.)

T. A. EDISON.

INCANDESCING ELECTRIC LAMP.

No. 287,519. Patented Oct. 30, 1883.



ATTEST:

E C Rowland

H W Seely

INVENTOR:

Thomas A. Edison,

By Richd. N. Dyer

Atty.

United States Patent Office.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, ASSIGNOR TO THE EDISON ELECTRIC LIGHT COMPANY, OF NEW YORK, N. Y.

INCANDESCING ELECTRIC LAMP.

SPECIFICATION forming part of Letters Patent No. 287,519, dated October 30, 1883.

Application filed December 8, 1882. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Incandescing Electric Lamps, (Case No. 524,) of which the following is a specification.

The object of my invention is to provide for the expansion and contraction caused by the heating and cooling of the straight carbon filaments of incandescing electric lamps, in order that such expansion and contraction may not injure the filament, while at the same time the filament is held upright. To accomplish this I support the filament loosely from the top of the inclosing-globe in which it is placed, so that it will sag sufficiently to compensate for the contraction and expansion.

My invention is illustrated in the annexed drawing, which is a view in elevation of a lamp embodying said invention.

A is the glass inclosing-globe, and B is the inner stem or wire support sealed within the globe. The leading-in wires 1 2 pass through the stem B, and to their ends are attached the ends of the straight flexible carbon filaments *a a*. The other end of each filament *a* is connected by a wire, *b*, with the upper end of a similar straight filament, *c*, and the filaments *c c* are united, preferably, by electroplating, and supported from the glass of the inner stem, at *d*. A glass tube, *e*, is sealed in the glass at the top of globe A, and two wires, *f f*, terminating in hooks, extend down from said tube. Each hook supports one side of the incandescing conductor; but the wires *f f* are of such length that the filaments are held loosely, and allowed to slacken or bend when they expand under heat, and to straighten out again in cooling.

It is evident that the incandescing conductor might consist of only two straight filaments. If two were used, their upper ends would be connected by a single wire, and a single hook would depend from above to grasp the wire.

It is to be understood that all patentable features of invention described or shown but not claimed herein are reserved for protection by other patents, and have been or will be embodied in other applications for patents.

What I claim is—

1. The combination, with the incandescing conductor of an electric lamp, of one or more supports therefor, in addition to the leading-in wires of the lamp, said support or supports depending from the top of the lamp and being loosely attached to said conductor, substantially as set forth.

2. In an incandescing electric lamp, the combination of two or more straight flexible carbon filaments connected by wires at their upper ends with one or more supports loosely attached to said wires, substantially as set forth.

3. In an incandescing electric lamp, the combination, with two or more straight flexible carbon filaments united at their upper ends by wires, of wires attached to the glass of the lamp, and terminating in hooks which grasp said uniting-wires loosely, substantially as set forth.

This specification signed and witnessed this 28th day of November, 1882.

THOS. A. EDISON.

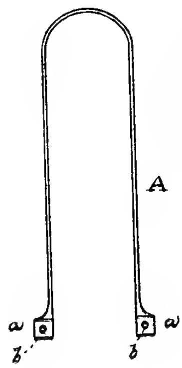
Witnesses:
H. W. SEELY,
EDWARD H. PYATT.

(No Model.)

T. A. EDISON.

INCANDESCING CONDUCTOR FOR ELECTRIC LAMPS.

No. 287,520. Patented Oct. 30, 1883.



ATTEST:
E. C. Rowland,
[illegible]

INVENTOR.
Thomas A. Edison,
By Richd N. Dyer,
Atty.

N. PETERS, Photo-Lithographer, Washington, D. C.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, ASSIGNOR TO THE EDISON ELECTRIC LIGHT COMPANY, OF NEW YORK, N. Y.

INCANDESCING CONDUCTOR FOR ELECTRIC LAMPS.

SPECIFICATION forming part of Letters Patent No. 287,520, dated October 30, 1883.

Application filed November 9, 1882. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Incandescing Conductors for Electric Lamps, (Case No. 511,) of which the following is a specification.

In my application No. 506 (Serial No. 76,378) are set forth various ways in which the incandescing conductors of electric lamps may be removably attached to the leading-in wires.

The object of my present invention is to so form the incandescing filament that such removable connections may be readily made, and be secure and durable and of good electrical conductivity. To do this I form small holes in the enlarged ends of a filament, and then electroplate such ends, preferably with copper, in such manner that the insides of the holes will be plated. By this means the strength of the ends is increased, the metal covering preventing the carbon from splitting when the hooks or other connecting devices attached to the ends of the leading-in wires are placed in the holes. Where screw-clamps attached to the leading-in wires are used, the screws would be passed through the holes, the copper giving mechanical strength and electrical conductivity to the connection.

In the accompanying drawing, forming a part hereof, a carbon filament embodying the invention is shown in elevation.

A is the flexible carbon filament, having enlarged ends *a a*, each provided with an aperture, *b*, such ends and the interior walls of such apertures being covered with a coating of electro-deposited metal. The apertures *b* may be formed in any suitable manner either before or after carbonization.

I do not claim herein the invention of providing a carbon filament with plated ends or enlarged plated ends, since the same is covered by my application No. 23,810; and it is to be understood that all patentable features of invention described or shown but not claimed herein are reserved for protection by other patents, and have been or will be included in other applications for patents.

What I claim is—

The incandescing conductor of an electric lamp, having apertures in its enlarged ends, such ends and the interiors of such apertures being electroplated, substantially as and for the purpose set forth.

This specification signed and witnessed this 3d day of November, 1882.

THOMAS A. EDISON.

Witnesses:

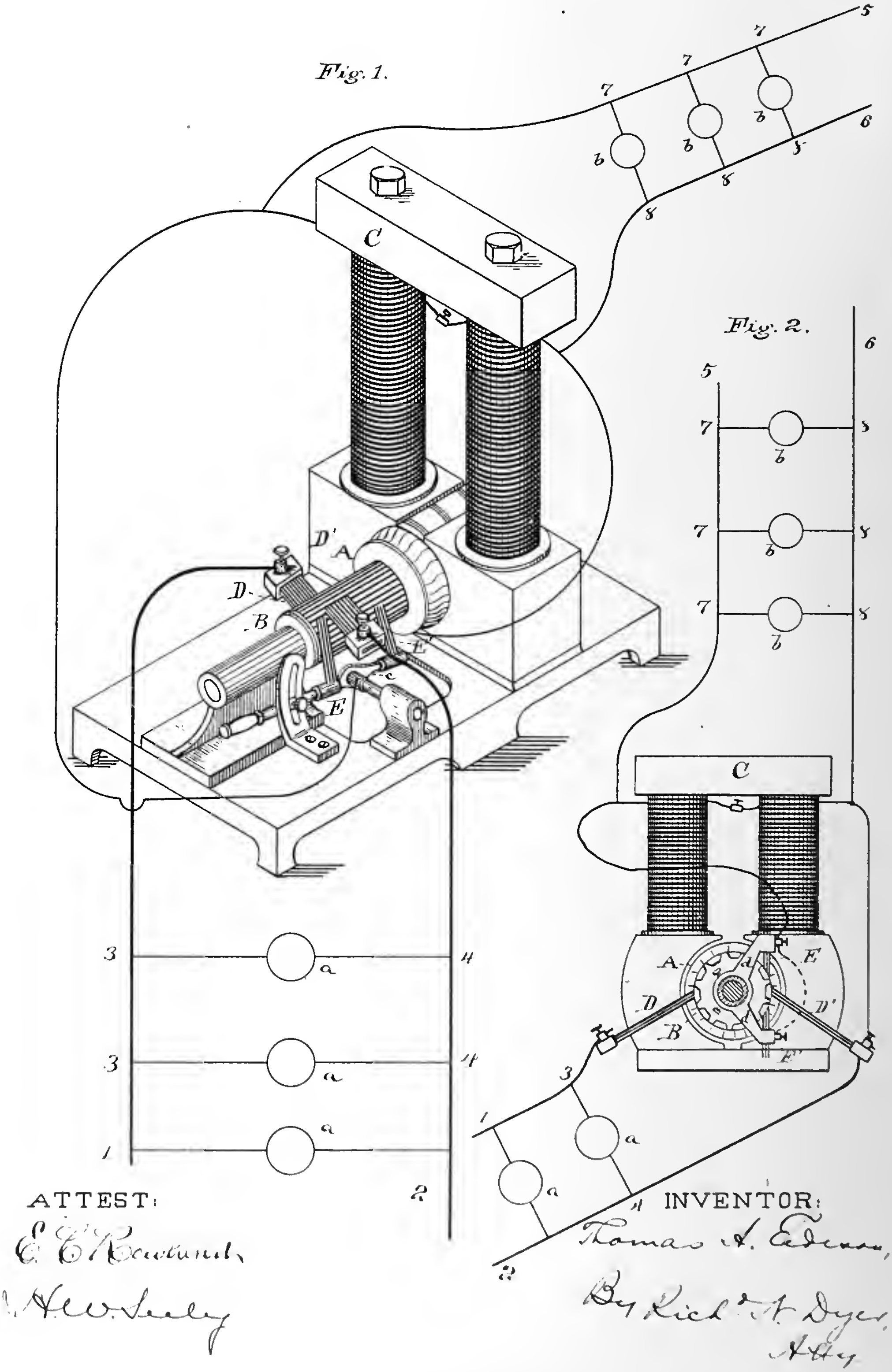
H. W. SEELY,
EDWARD H. PYATT.

(No Model.) 2 Sheets—Sheet 1.

T. A. EDISON.

DYNAMO OR MAGNETO ELECTRIC MACHINE.

No. 287,521. Patented Oct. 30, 1883.



(No Model.) 2 Sheets—Sheet 2.

T. A. EDISON.

DYNAMO OR MAGNETO ELECTRIC MACHINE.

No. 287,521. Patented Oct. 30, 1883.

Fig. 3

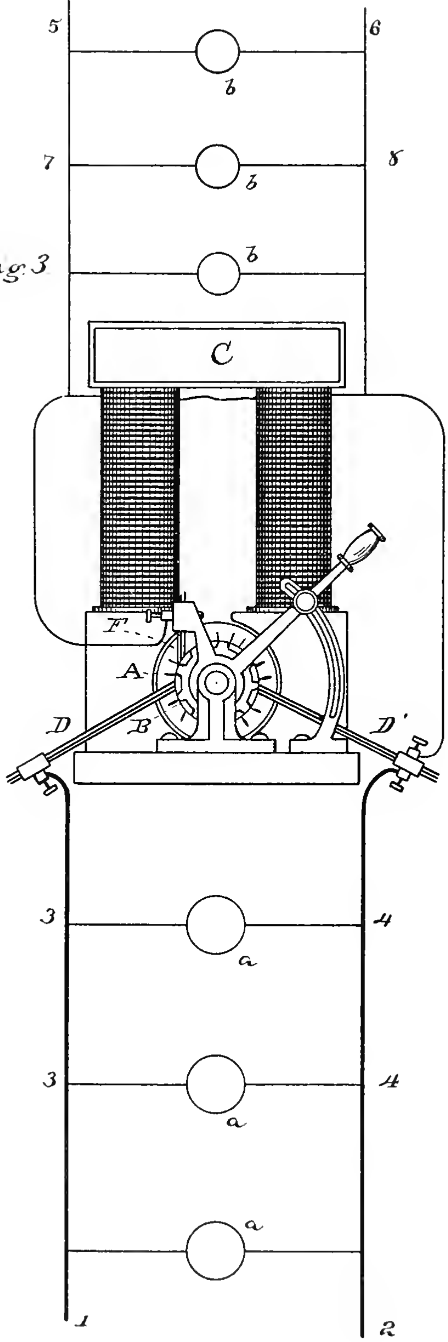
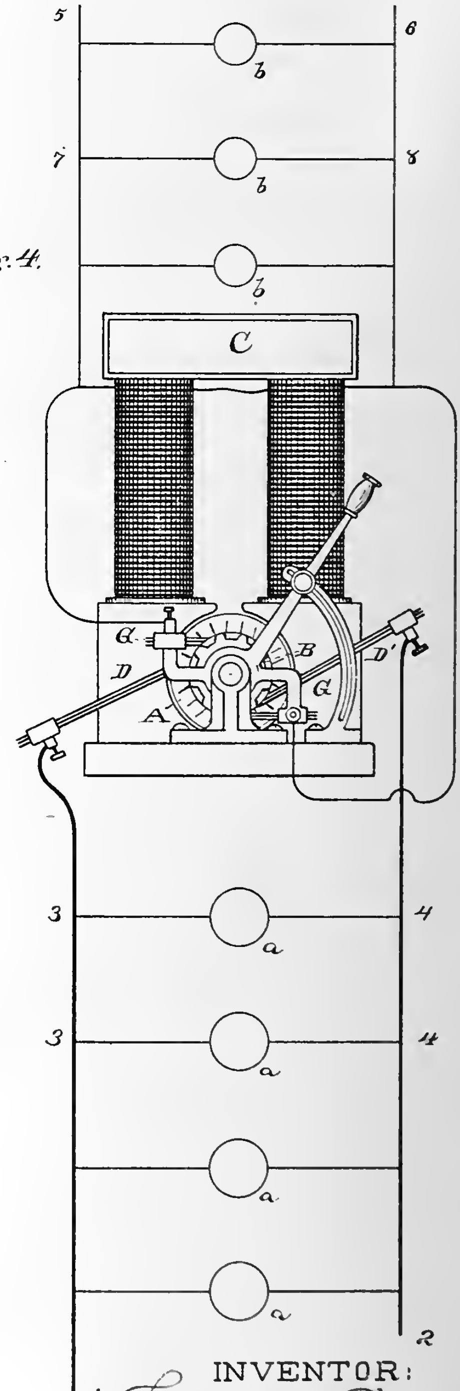


Fig. 4.



ATTEST:

E. C. Rowland

H. W. Seely

INVENTOR:

Thomas A. Edison.

By Richd. N. Dyer,

Atty.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, ASSIGNOR TO THE EDISON ELECTRIC LIGHT COMPANY, OF NEW YORK, N. Y.

DYNAMO OR MAGNETO ELECTRIC MACHINE.

SPECIFICATION forming part of Letters Patent No. 287,521, dated October 30, 1883.

Application filed March 16, 1883. (No model.) Patented in England August 5, 1882, No. 3,756, and in France October 24, 1882, No. 151,725.

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Dynamo or Magneto Electric Machines, (Case No. 549,) of which the following is a specification.

The object I have in view is to produce a method and means for deriving from a dynamo or magneto electric machine two or more independent circuits in which there will be a different electro-motive force or pressure, such circuits being adapted for independent regulation. The extra circuit (or circuits) will have a lower electro-motive force than the main circuit, and is designed more especially for use in energizing the field-of-force magnet of the machine, or for operating translating devices, of which incandescing electric lamps form the best example, placed in multiple-arc circuits, and requiring a current of lower tension than the lamps or other translating devices in the main circuit; or this extra circuit may have both the magnet-coils and the lamps connected therewith in multiple arc. The object is accomplished by arranging to bear upon the commutator-cylinder, on each side of one of the main commutator-brushes, a secondary brush, which is mounted so as to be capable of adjustment toward or away from the main brush, independent of or together with its fellow on the other side of the main brush. These two secondary brushes are connected together electrically, and from them is led one part of the secondary circuit, the other part being connected with the main brush on that side of the commutator-cylinder. The farther apart the secondary brushes are placed on opposite sides of the main brush the greater will be the tension of the current in the extra circuit, and hence the tension can be readily regulated by varying the position of such brushes with reference to the main brush. The tension of the current in the main circuit can be independently regulated by shifting the main brushes, or in any other suitable well-known manner. The connection of the secondary brushes together electrically does not short-circuit any of the coils of the armature, since currents are generated in the same circumferential direction on both sides of the armature. It is evident that in this manner two extra circuits could be derived from the same machine, instead of one, a set of secondary brushes being arranged to form a circuit with each main commutator-brush. In that case it will be seen that the extra circuits themselves may be regulated independently of each other or together, and may have currents of the same or different tension. It will also be understood that one secondary brush, instead of two, could be used in connection with a main brush to form each extra circuit, which secondary brush would be mounted for adjustment to and from the main brush forming the other pole of the extra circuit, and in this manner almost any desired number of extra circuits could be derived from one machine, the tension of the current in each depending upon the distance of the secondary brush from the main brush with which it is connected. It is also evident that an extra circuit could be formed by placing two secondary brushes on opposite sides of the commutator-cylinder at points between the main brushes, the secondary brushes forming the poles for the extra circuit, and the tension of the current in the extra circuit being dependent upon the position of these brushes with relation to the line of neutralized generation.

It will be understood that the armature of the machine is of the Pacinotti or Siemens type, being provided with a continuously-wound bobbin connected at intervals with the parallel bars of a commutator, and also that the currents of different tension are derived from this continuous bobbin, all the brushes resting upon the single commutator-cylinder.

The foregoing will be better understood by reference to the drawings, in which—

Figure 1 is a view, partly diagrammatic, illustrating the invention, and showing the form first described, with the secondary brushes mounted for simultaneous adjustment; Fig. 2, a view of the same arrangement when the secondary brushes are independently adjustable, and Figs. 3 and 4 views of other arrangements for accomplishing the same object.

A is the armature, B the commutator-cylinder, and C the field-of-force magnet, of the machine.

D D′ are the main commutator-brushes, which are mounted so as to be adjustable upon the commutator-cylinder. From these brushes run the main conductors 1 2, in multiple-arc or derived circuits 3 4, from which are the lamps or other translating devices *a*.

The secondary commutator-brushes E E′, Figs. 1 and 2, bear on the commutator-cylinder on opposite sides of the main brush D′. From the secondary brushes E E′ and the main brush D′ runs the extra circuit 5 6. The coils of magnet C and lamps or other translating devices *b* are in multiple-arc or derived circuits 7 8 from the conductors 5 6. These translating devices do not require a current of as high a tension as that required by the translating devices *a*.

In Fig. 1 the secondary brushes E E′ are shown as carried by a pivoted arm, *c*, so that they can be adjusted simultaneously in opposite directions toward and away from the main brush D′. In Fig. 2 they are carried by separate and independently-adjustable arms *d d′*.

In Fig. 3 a single secondary brush, F, is shown as used to form one pole for the extra circuit 5 6, the other pole being formed by one of the main brushes.

In Fig. 4 the secondary brushes G G are mounted to bear on opposite sides of the commutator-cylinder at points between the main brushes, and the conductors of the extra circuit are connected only with the secondary brushes.

I do not claim herein the broad idea of deriving two or more circuits of different tension from the same commutator connected with a continuously-wound bobbin, such circuits being independently regulated; neither do I claim herein the use of two or more auxiliary brushes adjustable independently of the main brushes, the circuit from said auxiliary brushes including the field-magnet coils of the machine, as these inventions form the subject of another application for Letters Patent, of which this is a division; but

What I do claim is—

1. The combination, with a dynamo or magneto electric machine having a continuously-wound bobbin and a single commutator, of main commutator-brushes and one or more auxiliary brushes bearing on said commutator, circuits having currents of different tension connected with said brushes, and translating devices arranged in mutiple arc in each of said circuits, substantially as set forth.

2. The combination, with a dynamo or magneto electric machine having a continuously-wound bobbin and a single commutator, of main commutator-brushes and one or more auxiliary brushes bearing on said commutator, circuits having currents of different tension connected with said brushes, and incandescing electric lamps arranged in multiple arc in each of said circuits, substantially as set forth.

This specification signed and witnessed this 17th day of February, 1883.

THOS. A. EDISON.

Witnesses:
WM. H. MEADOWCROFT,
H. W. SEELY.

(No Model.)

T. A. EDISON.

MOLDS FOR CARBONIZING.

No. 287,522. Patented Oct. 30, 1883.

Fig. 2.

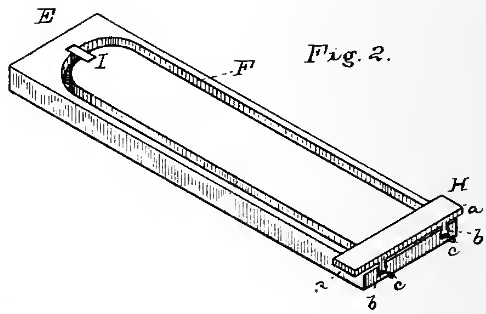


Fig. 1

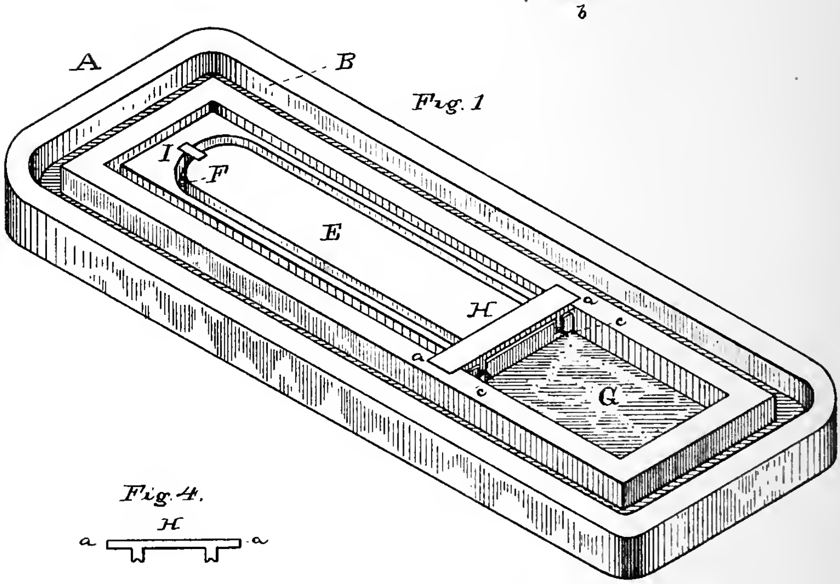
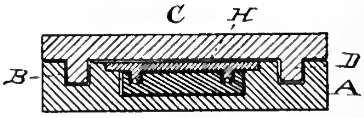


Fig. 4.

Fig. 3.



ATTEST:

E. C. Rowland

W. W. Seely

INVENTOR:

Thomas A. Edison,

By Richd. N. Dyer,
Atty.

United States Patent Office.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, ASSIGNOR TO THE EDISON ELECTRIC LIGHT COMPANY, OF NEW YORK, N. Y.

MOLD FOR CARBONIZING.

SPECIFICATION forming part of Letters Patent No. 287,522, dated October 30, 1883.

Application filed March 16, 1883. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Molds for Carbonizing, (Case No. 542,) of which the following is a specification.

My invention relates to molds for carbonizing the filaments which form, after carbonization, the incandescing conductors of electric lamps, my object being to keep the filament under strain during carbonization, while at the same time allowing contraction, the filament being so held and the strain being applied in such manner that the most delicate filaments will not be fractured or injured.

This invention is especially intended to be applied to the carbonization of very fine filaments, a number of which are to be twisted or braided together to form a single conductor.

Heretofore in molds of this character the filament has usually been placed in a chamber with movable blocks or weights set upon its ends, and its center held by either a fixed or movable block, so that either its limbs alone or its limbs and center were allowed to contract, or else one or both ends would be fixed and a movable weight placed in contact with the center, which weight would be drawn up as the filament contracted. These molds were not provided with covers; but a number of them were set one on top of another in a carbonizing-chamber. The disadvantages of these plans, where very delicate filaments are employed, are that the friction of the weights set on the ends of the filament would tend to injure such ends, and where a weight was placed in the center the filament would sometimes slip under such weight, in which case it would probably be broken; also, in both cases, the rubbing of the filament upon the bottom and sides of the mold with which it was in contact, as it contracted, would be injurious, and some parts of the filament being out of contact with the mold, the filament would be unequally heated. In addition, as no cover was provided for the mold, air would be admitted thereto, tending to oxidize the filament. By my present invention I overcome these defects by so constructing a mold that the filament, while allowed to contract and kept under constant strain, will be always in the same position relative to the parts of the mold in contact with it, so that it cannot rub against such parts, the strain is always even and constant upon every part of the filament, and every part is always in contact with the mold; and, in addition, the mold is so constructed that access of oxygen to the filament is as nearly as possible prevented.

In carrying out my invention the mold is made in two separate parts—an outer inclosing-chamber made air-tight, as nearly as possible, and a removable forming-plate, in which the filament is placed, which plate is set in the outer chamber, the ends of the filament being secured outside of the forming-plate. The forming-plate is preferably an oblong plate or block provided with a groove of the shape and length of the filament before carbonization, and the outer inclosing-chamber has a space in its center, into which said plate or block is set, such space being longer than said plate or block. The walls of said outer chamber should be of considerable thickness, and are preferably provided with a groove extending entirely around the top of said walls. Attached to the outer portion, and extending across the inner space, is a "bridge," of suitable material, having two downward projections, which enter the two sides of the grooves on the forming-plate. Each of said projections has an aperture in its lower end, through which apertures extend the ends of the filament. A closely-fitting cover is provided, having a flange extending around its lower side, which flange enters the groove in the top of the outer chamber of the mold. Preferably one or more strips are placed across the top of the groove in which the filament is laid, to prevent the filament from leaving such groove. All the parts are made of carbon, nickel, or other material capable of withstanding high temperatures.

My invention is illustrated in the annexed drawings, in which Figure 1 is a perspective view of the entire mold; Fig. 2, a similar view of the interior block or plate which holds the filament; Fig. 3, a cross-section of the entire mold, and Fig. 4 an elevation of the bridge.

A is the outer chamber, provided with a groove, B, and C is the cover, having a flange or rib, D, which enters the groove B.

E is the inner plate or block, having a groove, F, for containing the filament. The block E is set into the space G, which is, as shown, considerably larger than said block E.

H is the bridge, having its ends *a a* set into slots or notches formed in A. The bridge H has two downward projections, *b b*, each of which has a slot or groove, *d*, in its lower end, and such projections both enter the groove F. The filament is laid in the groove F, with its ends *c c* projecting, as shown, beyond the bridge H. The filament shown being a very fine one, knots are tied in its ends to hold them; but with the ordinary filaments, each of which forms an entire conductor, the usual enlarged ends would answer this purpose. It is evident that as the filament contracts, its ends being held beyond the fixed bridge H, the plate A will be drawn along the space G, which is long enough to allow of the whole contraction of the filament. The filament is thus allowed to contract freely, though under a constant and even strain. Said filament of course does not move, remaining always in the same position relative to the groove which holds it, and consequently is not injured by rubbing against the sides of the groove. There is also no danger of its slipping under the weight, as there is when loose weights are employed. The strip I is set across the groove F, being held by notches made for the purpose. This prevents the filament from slipping out of the groove. The rib of the cover, fitting in the groove in the outer block, assists in preventing the access of air to the filament. A number of these molds are piled one on top of another in a suitable closed flask, which is placed in a carbonizing-furnace. After carbonization, the molds are taken from the flask, when by removing the bridge H and strip I the flexible carbon filament may be taken out.

What I claim is—

1. A mold for carbonizing filaments, wherein the filament is kept under strain and always in the same position relative to the parts with which it is in contact, while allowed to contract freely, substantially as set forth.

2. In a mold for carbonizing filaments, the combination of a movable grooved plate for containing the filament, means independent of said plate for holding the ends of the filament, and an inclosing-chamber, substantially as set forth.

3. In a mold for carbonizing filaments, the combination, with an inclosing-chamber, of the grooved plate for shaping the filament, said plate acting also as a weight to keep said filament under strain, substantially as set forth.

4. In a mold for carbonizing filaments, the combination, with the grooved plate for holding said filament, of means preventing the filament from leaving the groove, substantially as set forth.

5. In a mold for carbonizing filaments, the combination, with the plate for holding the filament, of the inclosing-chamber and the bridge attached to the latter for securing the ends of said filament, substantially as set forth.

6. A flat shallow mold for carbonizing filaments, provided with means for holding such filaments under strain and permitting contraction during carbonization, in combination with a cover constructed to exclude air, substantially as set forth.

7. A flat shallow mold for carbonizing filaments, provided with means for holding such filaments under strain and permitting contraction during carbonization, and having an edge groove, in combination with a cover provided with a corresponding rib, substantially as set forth.

This specification signed and witnessed this 17th day of February, 1883.

THOS. A. EDISON.

Witnesses:

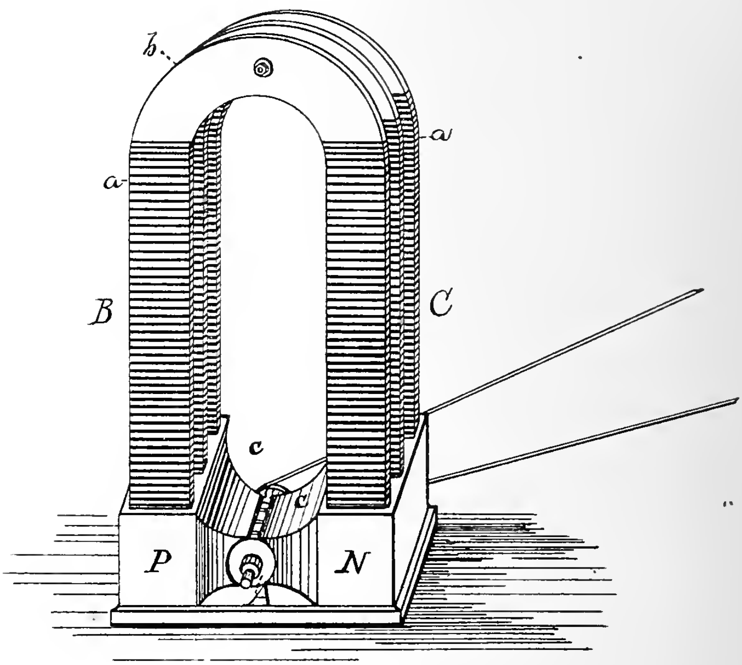
H. W. Seely,
Edward H. Pyatt.

(No Model.)

T. A. EDISON.

DYNAMO OR MAGNETO ELECTRIC MACHINE.

No. 287,523. Patented Oct. 30, 1883.



WITNESSES:

E. C. Rowland

H. W. Seely

INVENTOR:

Thomas A. Edison

BY Rich'd N. Dyer.

ATTORNEY

United States Patent Office.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, ASSIGNOR TO THE EDISON ELECTRIC LIGHT COMPANY, OF NEW YORK, N. Y.

DYNAMO OR MAGNETO ELECTRIC MACHINE.

SPECIFICATION forming part of Letters Patent No. 287,523, dated October 30, 1883.

Application filed September 13, 1882. (No model.)

To all whom it may concern:

Be it known that I, Thomas A. Edison, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Dynamo or Magneto Electric Machines, (Case No. 436;) and I do hereby declare that the following is a full and exact description of the same, reference being had to the accompanying drawing, and to the letters of reference marked thereon.

The object I have in view is to produce a more efficient construction of the field-of-force electro-magnet of dynamo or magneto electric machines, so that greater magnetic force can be produced than heretofore with the same mass of iron and with the same consumption of electrical energy. This I accomplish by employing, in connection with the polar extensions of a machine, two or more pairs of flat or plate magnet-cores made of soft iron and wound separately with insulated wire, through which the electric current passes. Each pair of flat soft-iron cores is preferably made in one piece, with a connecting back piece or yoke; but the back piece or yoke may be a separate piece secured to the flat cores. The pairs of flat cores being separately wound, they may be connected in series in the field-circuit in multiple arc or in multiple series. This construction of the field-of-force electro-magnet gives greater magnetic strength than the round cores wound separately, or cores made up of a number of flat plates covered with a common winding. In connection with this construction of the cores, to give still greater efficiency, the concentrating convergent polar extensions may be used.

The foregoing will be better understood from the drawing, which shows in perspective a machine embodying the invention.

A is the revolving armature, having a continuous bobbin connected with the bars of a commutator-cylinder, and being preferably itself of cylindrical form, and P N are the polar extensions of the field electro-magnet. These polar extensions have attached to them two or more pairs of flat soft-iron cores, B C, which are separately wound with insulated wire, as shown at *a*, forming part of the field-circuit. The yoke *b*, connecting each pair of flat soft-iron cores, is preferably made in one piece with the cores. The magnet-cores may be arranged in a vertical or in a horizontal position, and be attached to one side only of the polar extensions, or to opposite sides of the same.

To obtain greater efficiency, the polar extensions P N are constructed with bevel surfaces *c*, so as to contract the field-of-force vertically or horizontally, or in both directions. Machines constructed in this way have corresponding advantages when used as electric engines or motors.

I do not claim herein the convergent pole-pieces, or the pole-pieces forming a cylindrical space in which the armature revolves, or the polar extensions, each made in one piece and provided with two or more cores, these inventions being claimed in my application No. 71,756; and it is to be understood that all other patentable features of invention shown or described, but not claimed herein, are reserved for protection by other patents, and have been or will be embodied in other applications for patents.

What I claim is—

1. In a dynamo or magneto electric machine, the field-of-force electro-magnet having two or more pairs of flat soft-iron cores provided with separate windings and two polar extensions, to which all of such cores are attached, substantially as set forth.

2. In a dynamo or magneto electric machine, the field-of-force electro-magnet composed of two polar extensions and two or more pairs of flat soft-iron cores having separate windings and magnetically-separate yokes or back pieces, substantially as set forth.

3. In a dynamo or magneto electric machine, the field-of-force electro-magnet having two polar extensions and two or more pairs of flat soft-iron cores provided with separate windings and yokes made integral with the cores, substantially as set forth.

4. In a dynamo or magneto electric machine, the combination, with the armature, of the convergent polar extensions, the flat soft-iron magnet-cores provided with separate windings and two polar extensions, to which said cores are attached, substantially as set forth.

This specification signed and witnessed this 3d day of June, 1882.

THOS. A. EDISON.

Witnesses:
Richd. N. Dyer,
H. W. Seely.

(No Model.)

T. A. EDISON.

REGULATOR FOR DYNAMO ELECTRIC MACHINES.

No. 287,524. Patented Oct. 30, 1883.

Fig 1.

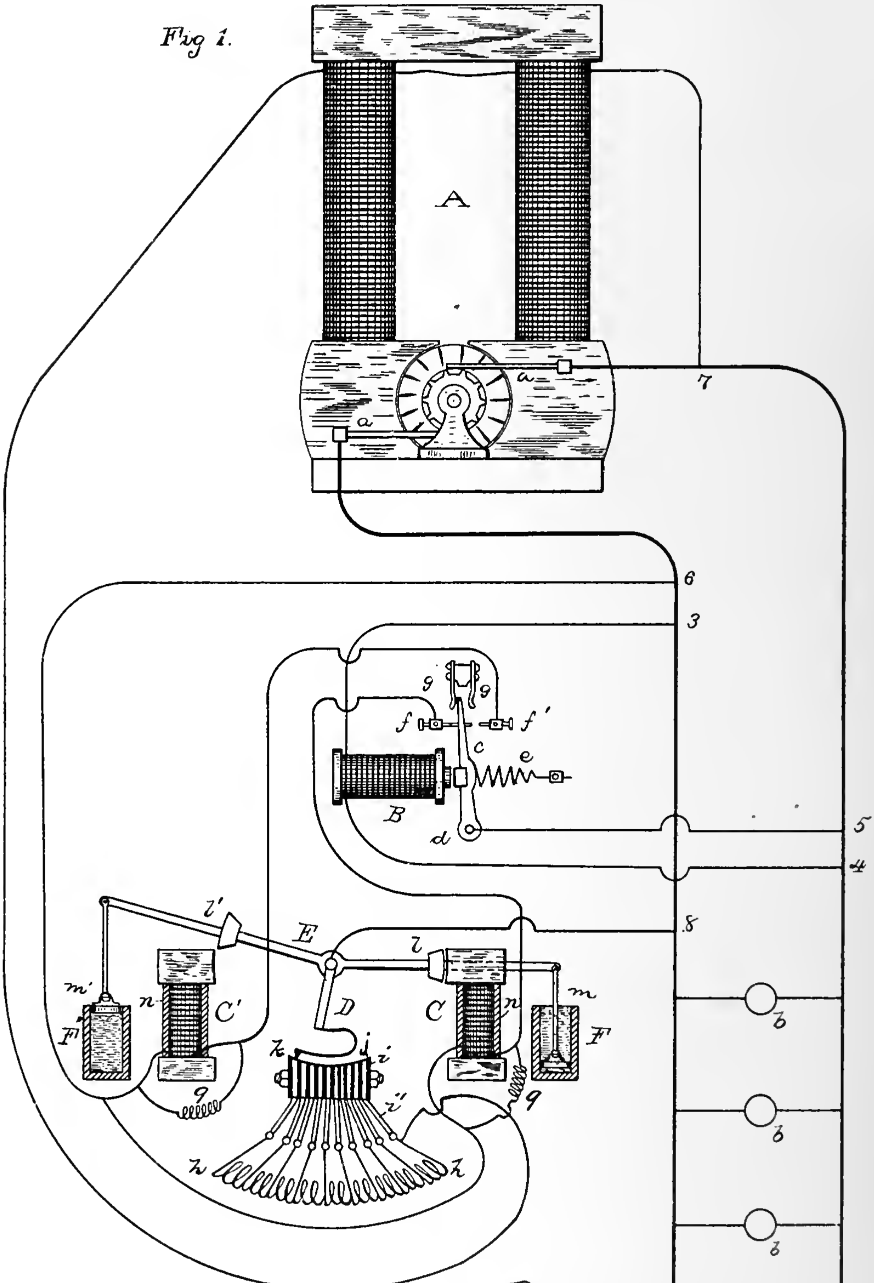
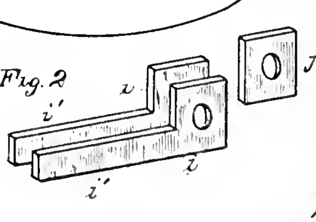


Fig. 2



ATTEST:

E. C. Rowland

H. W. Seely

INVENTOR:

Thomas A. Edison,

By Richd. N. Dyer,

Atty.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, ASSIGNOR TO THE EDISON ELECTRIC LIGHT COMPANY, OF NEW YORK, N. Y.

REGULATOR FOR DYNAMO-ELECTRIC MACHINES.

SPECIFICATION forming part of Letters Patent No. 287,524, dated October 30, 1883.

Application filed December 8, 1882. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Regulators for Dynamo-Electric Machines, (Case No. 526,) of which the following is a specification.

The object I have in view is to produce a simple and efficient apparatus for regulating the generation of current by dynamo or magneto electric machines which supply current to multiple-arc systems of electrical distribution, such regulation being accomplished by an adjustable resistance which affects the circuits energizing the field-of-force magnets of such machines.

In carrying out my invention the field-magnet coils of the generator preferably form part of a multiple-arc circuit derived from the main conductors of the machine, though the field-magnet may be energized from an external source, if desired. In another multiple-arc circuit from the main conductors is placed an electro-magnet provided with a pivoted spring-retracted armature, which armature forms part of a third multiple-arc circuit. The free end of the armature is normally held centrally between two contact-points, and as it is drawn in one or the other direction, by the magnet or by the spring, it completes circuit through one or the other of two operating electro-magnets, each placed in a division of the third multiple-arc circuit. The "pressure" or regulating electro-magnet, which is located in a derived or multiple-arc circuit, so as to be affected exactly as is a lamp or other transmitting device, if wound with copper wire, as heretofore, is unduly affected by changes in temperature, which modify its resistance to such an extent that the adjustment is destroyed. To overcome this difficulty I wind this regulating electro-magnet with German-silver wire, or wire of other metals or alloys not unduly affected by changes in temperature. Instead of having the operating electro-magnets in a multiple-arc circuit, they may be in a shunt-circuit from one of the main conductors, or other circuit having sufficient energy to work them. In the field-circuit of the generator are placed a resistance and an arm for adjusting said resistance. The adjusting-arm is attached to a centrally-pivoted bar, near each end of which is placed an armature which is attracted by one of the pair of operating electro-magnets and worked across the face of such magnet, and to each end of the bar is also attached a plunger entering a dash-pot filled with liquid. As one or the other magnet is energized one end or the other of the pivoted arm is drawn down, the movement being retarded and regulated by the plungers, and the adjusting-arm is thus moved in one or the other direction, so as to throw in or cut out resistance from the field-circuit, according to the requirements of the system. The operating electro-magnets are provided with means for preventing or diminishing the spark at the contact-points of the armature-lever of the regulating-magnet due to the breaking of a magnet-circuit, such means consisting, preferably, of a shunt around each operating-magnet, which provides a path other than that across the break at the contact-points for the current due to the discharge of the magnet, and also of a copper tube or cylinder surrounding each operating magnet-coil to provide a local or short circuit for the extra or induced currents. The dash-pot plungers are so formed and adjusted that their action will be in unison with the charging and discharging times of the field-magnet, so as to prevent oscillation of the pivoted bar and contact-arm, for if the plunger were so adjusted as to fall too quickly the resistance would be placed in or taken out of circuit too rapidly, so that the current would increase or decrease so as to cause an opposite movement of the plunger, and the plunger would vibrate until the proper point of regulation was reached, when it would stop; but the plungers being regulated so as to move in accordance with the conditions of the field-magnet the contact-arm will move to the proper point at once and will remain there without vibrating.

The commutator for the adjustable resistance is of a novel and efficient form, the object in view being to so construct a resistance that a very slight movement of the adjusting-arm will be sufficient to cause a considerable variation in the resistance. Such commutator consists of a number of thin metal plates, forming the contacting parts of the resistance, fastened together by an insulated pin or bolt, and having plates of mica or other similar insulation between them. The metal plates have outwardly-extending tongues, which are spread out in fan shape, and wires are connected with them, which include the resistance-coils, a considerable number of such coils being included between each pair of plates. The resistance is varied by means of a contact-point attached to a flexible contact-arm, such arm being attached to the pivoted center of the bar which carries the armatures and plungers, so that as such arm moves the contact-arm is carried in one direction or the other, and the contact-point slides over the edges of the contact-plates of the resistance, throwing the resistance-coils in or out of circuit as it moves from one plate to the next.

My invention is illustrated in the accompanying drawings, in which—

Figure 1 represents an apparatus embodying the same, mostly in diagram; and Fig. 2 is a representation of the plates of the adjustable resistance.

A is the field-magnet, and *a a* are the commutator-brushes of a dynamo or magneto electric machine.

1 2 are main conductors leading from the machine, and having lamps or other translating devices, *b b*, arranged in multiple arc upon them.

In a multiple-arc circuit, 3 4, is placed an electro-magnet, B, wound with German silver, for the purpose before set forth, and having an armature, *c*, pivoted at *d*, and retracted by an adjustable spring, *e*. The armature-lever *c* forms part of the operating-circuit 5 6. Its free end is provided with contact-points, and such end plays between other contact-points, *f f'*. The armature is normally held midway between *f* and *f'* by spring-fingers *g g*. The circuit 5 6 is divided, one division including an electro-magnet, C, the other an electro-magnet, C', which electro-magnets are the operating-magnets.

The field-magnet A is energized by the current in the multiple-arc circuit 7 8. In this circuit are connected the resistance-coils *h h* and the flexible contact-arm D. The wires from the coils *h h* are connected with the fingers *i'* of the metal commutator-plates *i*, such plates *i* having plates *j*, of mica or other suitable insulation, between them. The mica insulation only separates the bodies of the plates *i*, the fingers *i'* being spread out into a fan shape, as shown in Fig. 1, to permit of the attachment of the wires thereto. The contact-point *k*, attached to the spring-arm D, rests on the edges of the plates. The contact-arm D is attached to the middle of the pivoted bar E. To the bar E are attached armatures *l l'*, one for each of the magnets C C', which armatures work across the faces of the polar extensions of the magnets, so as to have an increased movement. Plungers *m m'* are attached one to each end of the bar E, entering, respectively, dash-pots F F', containing liquid.

As the number of lamps in the main circuit is increased the decrease of current in the circuit 3 4 causes the spring *e* to draw armature *c* away from magnet B, completing circuit at *f'* through magnet C', attracting armature *l'*, and throwing up armature *l*, and so moving spring-arm D and contact *k* as to remove a portion of the resistance *h h* from the field-circuit 7 8, the movement being regulated by the plungers *m m'*, which, as stated, are adjusted to act in unison with the charging and discharging times of the field-magnet, such adjustment being obtained by varying the size of the plungers, or of the apertures in them, until the proper adjustment is obtained, or in any other suitable way.

It is evident that only one plunger might be employed, attached to either end of the pivoted bar E and properly adjusted.

The removal of lamps from circuit by causing the magnet B to attract armature *c* against contact-point *f* causes magnet C to attract armature *l* and place resistance in the field-circuit. Around each magnet C C' is placed a shunt-circuit, 9, to form a path for the discharge of the magnet when the circuit is broken at *f f'*, and prevent the destruction of these contact-points by the spark. Around each magnet-coil is a non-magnetic cylinder, *n*, (shown in section,) for the purpose before explained.

I do not claim herein any of the devices covered by my patents numbered 265,783 and 264,660.

The resistance-commutator, *per se*, is not claimed herein, but will be included in a separate application for patent; and it is to be understood that all features of patentable novelty described or shown, but not claimed herein, are reserved for protection by other patents, and have been or will be included in other applications for patents.

What I claim is—

1. In regulators for electrical generators, the combination, with the regulating electro-magnet, of the oppositely-acting operating electro-magnets and armatures moving across the faces of the polar extensions of such operating-magnets, substantially as set forth.

2. The combination, with a dynamo or magneto electric machine and translating devices arranged in multiple arc, of an adjustable resistance for regulating the generation of current, an arm for varying such resistance, a pivoted bar carrying said arm and having armatures at the ends thereof, two electro-magnets acting oppositely on said bar, the armatures of which move across the faces of the polar extensions of said operating electro-magnets, and a controlling electro-magnet located in a multiple-arc circuit, substantially as set forth.

3. In regulators for electrical generators of the character herein described, the combina-

tion, with the operating electro-magnets, of the regulating electro-magnet wound with German silver, or other alloy or metal not unduly affected by changes in temperature, substantially as set forth.

4. The combination, with the adjustable resistance and the arm for varying the same, of the two operating electro-magnets acting oppositely upon armatures moving across the faces of the polar extensions of said electromagnets and working the arm in opposite directions, and one or more dash-pots and plungers for retarding the movement of said arm, substantially as set forth.

5. The combination, with the adjustable resistance in the field-circuit of the generator and the arm for varying the same, of the regulating and operating electro-magnets and the dash-pots and plungers, said plungers being adjusted, as explained, to act in unison with the charging and discharging times of the field-magnet, substantially as set forth.

6. The combination, with the controlling-magnet B, its armature-lever, and the contact-points of said lever, of the magnets in the divided circuits from said contact-points, and means for preventing the spark at such points, due to the discharge of the magnets, substantially as set forth.

7. The combination, with the controlling electro-magnetic switch and the operating electro-magnets, of shunts around said operating-magnets, and metallic shells upon the same, for preventing spark at the contact-points of said switch, substantially as set forth.

8. The combination, with the resistance-commutator, such as described, of the flexible contact-arm carrying a contact-point, the pivoted bar carrying said spring-arm, the operating electro-magnets acting oppositely upon said bar, and one or more dash-pots and plungers for retarding the movement of said bar, substantially as set forth.

This specification signed and witnessed this 28th day of November, 1882.

THOS. A. EDISON.

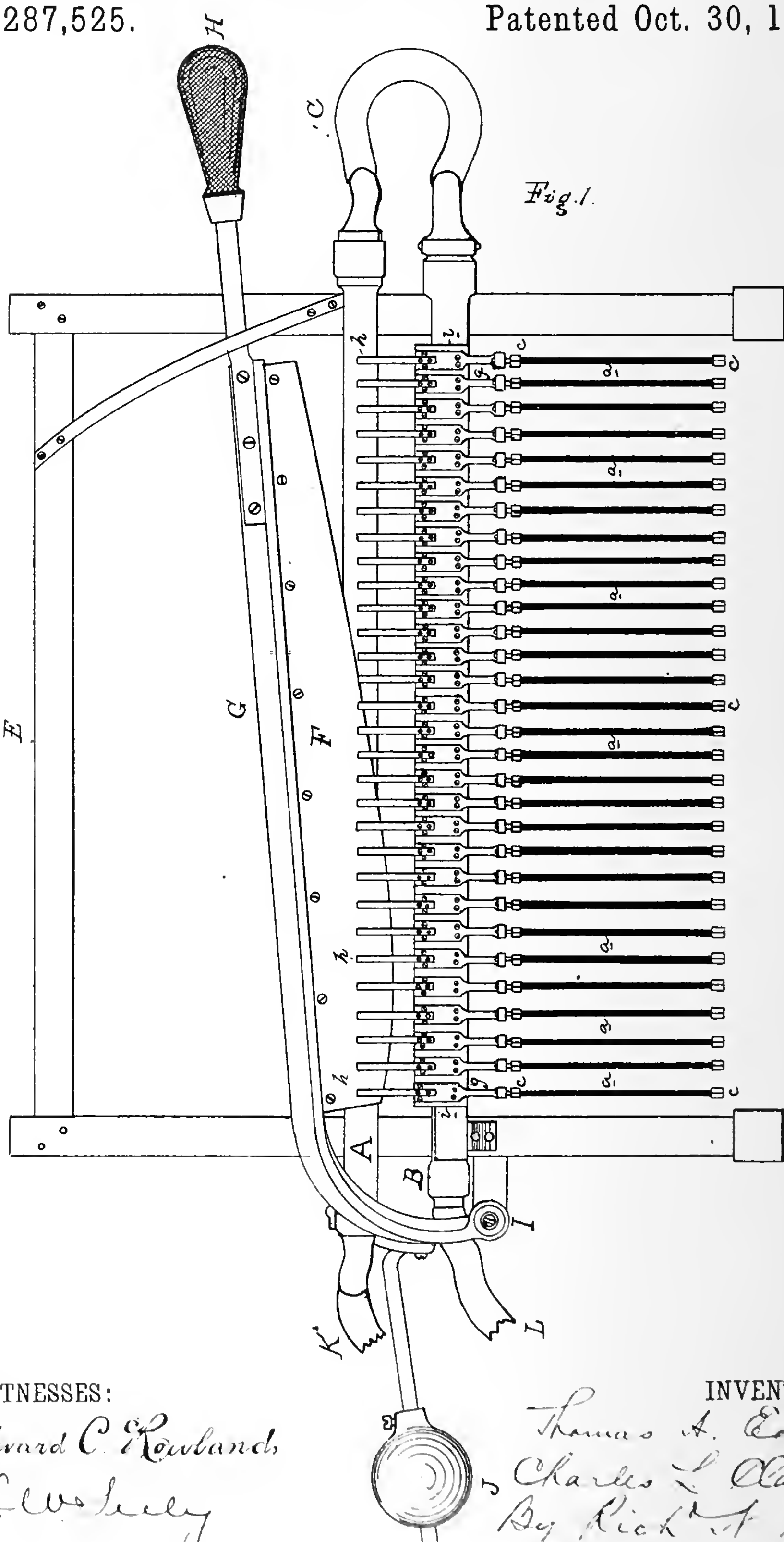
Witnesses:
H. W. SEELY,
E. H. PYATT.

(No Model.) 2 Sheets—Sheet 1.

T. A. EDISON & C. L. CLARKE.

REGULATOR FOR SYSTEMS OF ELECTRICAL DISTRIBUTION.

No. 287,525. Patented Oct. 30, 1883.



WITNESSES:

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W. Wesley

INVENTORS:

Thomas A. Edison

Charles L. Clarke,

By Rich^d N. Dyer

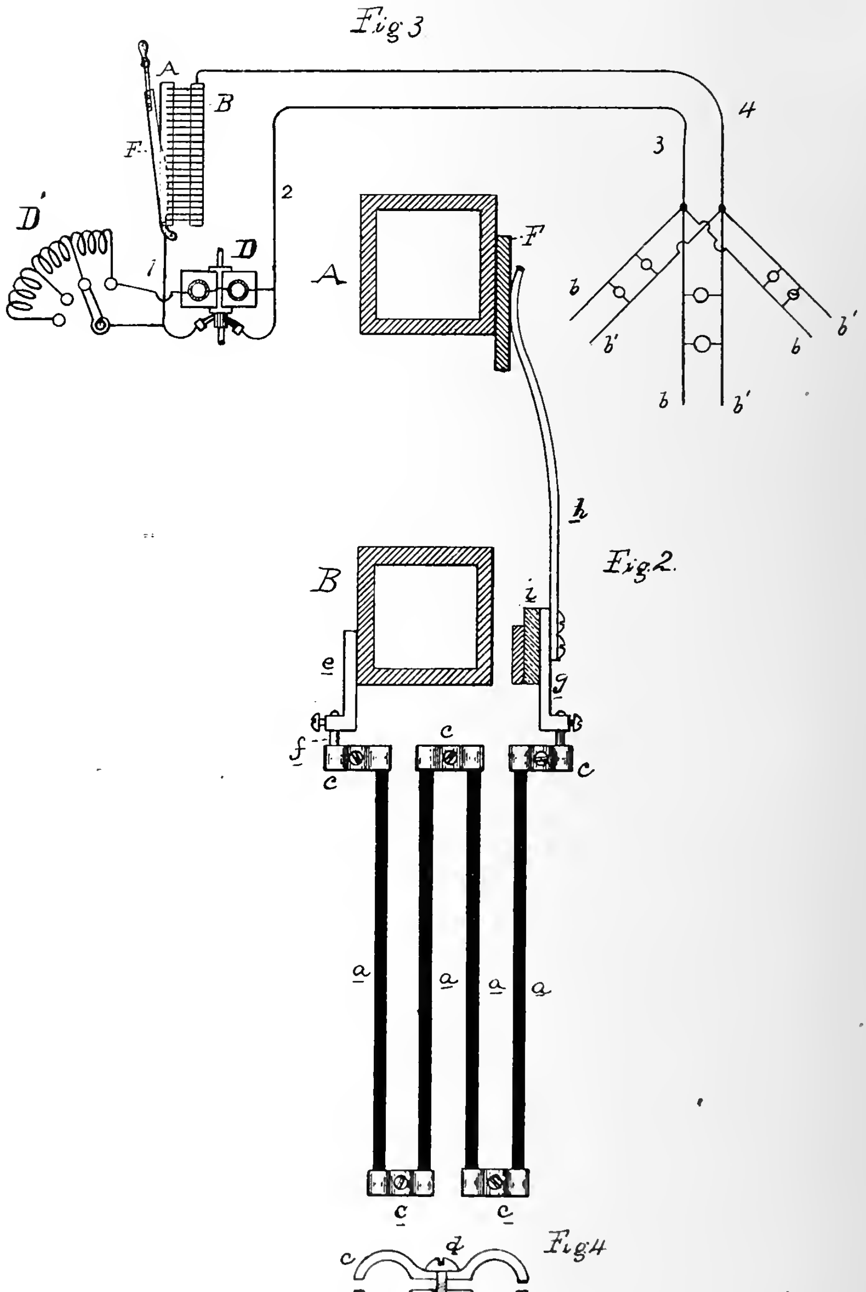
Atty

(No Model.) 2 Sheets—Sheet 2.

T. A. EDISON & C. L. CLARKE.

REGULATOR FOR SYSTEMS OF ELECTRICAL DISTRIBUTION.

No. 287,525. Patented Oct. 30, 1883.



WITNESSES:

E. C. Rowland

H. W. Seely

INVENTORS:

Thomas A. Edison,

Charles L. Clarke,

By Rich^d N. Dyer Atty.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, AND CHARLES L. CLARKE, OF NEW YORK, N. Y., ASSIGNORS TO THE EDISON ELECTRIC LIGHT COMPANY, OF NEW YORK, N. Y.

REGULATOR FOR SYSTEMS OF ELECTRICAL DISTRIBUTION.

SPECIFICATION forming part of Letters Patent No. 287,525, dated October 30, 1883.

Application filed October 20, 1882. (No model.) Patented in England October 14, 1882, No. 4,884, and in France October 31, 1882, No. 151,841.

To all whom it may concern:

Be it known that we, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, and CHARLES L. CLARKE, of the city, county, and State of New York, have invented a certain new and useful Improvement in Regulators for Systems of Electrical Distribution, of which the following is a specification.

Our invention relates to a regulating apparatus used in connection with a system of electrical distribution in which the current is distributed from a central point to various parts of a district where lamps, motors, and other translating devices are arranged in multiple arc. In such a system the generators at the central station are connected with feeding-circuits on which no lamps are placed, but which are connected at suitable points with the street-mains on multiple-arc circuits from which the lamps are placed. In such a system it is necessary to preserve a constant electro-motive force or "pressure" in the circuits where the translating devices are placed. The electro-motive force at the end of a feeding-circuit is indicated by a suitable device placed at the central station and connected by an auxiliary circuit with the end of the feeding-circuit, and it is regulated in accordance with such indications by varying the resistance of the feeding-circuit, all of which is fully set forth in the application of the said Edison filed December 9, 1881, (Serial No. 47,468.) According to our invention, this variation is accomplished by causing each feeding-circuit to be broken at a convenient point, and providing a number of paths for the current across such break, each of considerable resistance, means being provided for throwing into circuit more or less of such paths, as desired. Such paths or resistances, it will be understood, are in multiple-arc relation to each other, and consequently the more we place in circuit the less the resistance of the feeder and the greater the amount of current supplied to the lamps.

It is usually customary to vary the resistance of a circuit by throwing more or less resistance in series, so to speak, directly into such circuit. We, however, prefer the mode just described, for here as fast as we decrease the resistance, and thereby increase the current in the circuit, we correspondingly increase the current-carrying capacity of this portion of the circuits per unit of length, while in the old way, when the current is increased, the conductivity of the circuit remains the same, and there may be danger of exceeding the capacity of the conductors. The preferable form of apparatus for this purpose we have found to be as follows: The wire or cable from one pole of the generator or generators is connected to one of two metal pipes, preferably of copper, which are placed, preferably, one above the other, or in any convenient position. The conductor from the other pole is connected directly to the feeding-circuit, while the return-conductor of such circuit is connected with the second pipe. It is understood that each feeding-circuit of the district is provided with the apparatus described. To the lower pipe are attached, at short distances apart and along its entire length in any suitable manner, the ends of the carbon rods, the other end of each ot which is connected with the lower end of a spring whose upper end approaches nearly to but does not touch the upper pipe. Preferably a number of these carbon rods are placed in series between the lower pipe and each spring. Pivoted at one end to the frame which supports the pipes is a "knife," consisting of a suitable back and a handle of insulating material, with a copper plate or blade, such blade being preferably broad at its outer end and narrow near the handle. Such knife is so placed that the blade can be forced down between the upper pipe and the springs and make electrical connection between them, more or less of the springs being in contact with the pipe, according as the blade is pressed down or drawn up.

It is evident that as more springs are connected with the pipe more of the carbon rods will be placed in multiple arc between the pipes, and consequently the greater will be the conductivity of the feeding-circuit of which such pipes form a part. Therefore, when more translating devices are placed in the consumption-circuit in the vicinity of the point of connection between the feeder and such circuit, the blade is pushed down and more of the rods thrown into circuit, and when such devices are removed from circuit the blade is raised. At one end the pipes are connected by a rubber or other tube, and one pipe is connected at its other end to a source of water-supply, so that a circulation of water is kept up and the pipes are kept cool. A weight is attached to the knife as a counter-balance to hold it in the position in which it is placed; or a spring or suitable friction devices may be used for this purpose. Each dynamo or magneto electric machine of the battery of such machines supplying the feeding-circuits is regulated for the total number of translating devices in circuit in any suitable way, preferably by throwing resistance into and out of its field-circuit, while the adjustable resistances in the feeder-circuits are used to regulate for the unequal distribution throughout the system (the variations in location of translating devices) without reference to the total number of translating devices in circuit.

Instead of the form of variable resistance above described, the calorimeter-barrels shown in the application of Edison above referred to may be used, the knife above described being employed to place a greater or less number of the wire coils in circuit.

Our invention may be better understood by reference to the annexed drawings, in which—

Figure 1 is a front elevation of the regulating apparatus; Fig. 2, a transverse vertical section of the same; Fig. 3, a diagram illustrating the circuit-connections, and Fig. 4 a top view of the clamp which holds the carbon rods.

A and B are the two pipes, filled with water and connected together by rubber tube C.

Referring to Fig. 3, a main conductor, 1, from the generator or generators represented at D is connected to the pipe A, while main conductor 2 is connected to the conductor 3 of the feeding-circuit 3 4. Such feeding-circuit runs to a point where the circuits *b b'*, which supply the translating devices of the system, are connected to it in multiple arc. The conductor 4 of the feeding-circuit is connected to the pipe B. D' is the adjustable resistance in the field-circuit of the generator D.

Referring to Figs. 1 and 2, E is a suitable frame, which supports the pipes A and B. *a a* are carbon rods having their ends held in clamps *c*, such clamps being preferably of the form shown in Fig. 4—viz., being made in two parts, each part consisting of two curves joined together by a straight piece, and a screw, *d*, being passed through the straight portion of both, so that a double clamp is formed for holding two carbons. Metal pieces *e* are attached at one end to the side of pipe B, and to the other end of each a piece, *f*, is attached, which enters the clamp *c*, whose other half holds a carbon rod. Four of these rods are shown in Fig. 2 as connected in series, the end of the last carbon being attached to the piece *g*, to which is fastened the spring *h*, which approaches nearly but does not touch the pipe A. All the pieces *g* are secured to the strip *i*, which is of wood or other insulating material. F is a copper blade, of the form shown in Fig. 1, attached to a suitable back, G, and having a handle, H. The knife thus formed is pivoted at I. Such knife, it will be seen, can be forced down between the springs *h* and the tube A to any desired distance and again withdrawn, thus connecting the pipes through more or less of the carbon rods *a a*, and increasing or diminishing the conductivity of the feeding-circuit 3 4. The conductors are fastened to the pipes in any suitable manner. J is a counterbalance-weight used to hold the knife in the position in which it is placed. By means of rubber tube K water is introduced into pipe A, which flows off through tube L.

It is to be understood that all patentable features of invention shown or described but not claimed herein are reserved for protection in other patents, and have been or will be embodied in other applications for patents.

What we claim is—

1. The combination, with an opened electrical circuit, of a series of resistances connected in multiple arc with the circuit on one side of the break, separate spring-terminals to such resistances, a conductor connected with the circuit on the other side of the break and crossing said spring-terminals in close proximity thereto, and an intermediate circuit-controlling device making a sliding or rubbing contact between said conductor and more or less of the resistance-terminals, substantially as set forth.

2. The combination, with the parallel conductors, of the carbon resistances attached to one conductor, the springs attached to such resistances, and the copper blade for electrically connecting more or less of such springs with the other conductor, substantially as set forth.

3. The combination, with an electrical circuit, of a resistance, an adjusting device for throwing the resistance into and out of circuit, and a water-pipe for conducting off the heat, the circuits of the resistance being made and broken upon such water-pipe, substantially as set forth.

4. The combination, with an electrical circuit, of a series of exposed carbon rods serving as resistances, means for throwing such rods into and out of circuit, and a water-pipe for conducting off the heat, the circuits of the

carbon rods being made and broken upon such water-pipe, substantially as set forth.

5. The combination, with an opened electrical circuit, of metallic water-pipes forming the terminals of the circuit, resistances in multiple arc between such water-pipes, and means for throwing the resistances into and out of circuit, substantially as set forth.

This specification signed and witnessed this 4th day of October, 1882.

THOS. A. EDISON.
CHAS. L. CLARKE.

Witnesses:
H. W. SEELY,
E. H. PYATT.

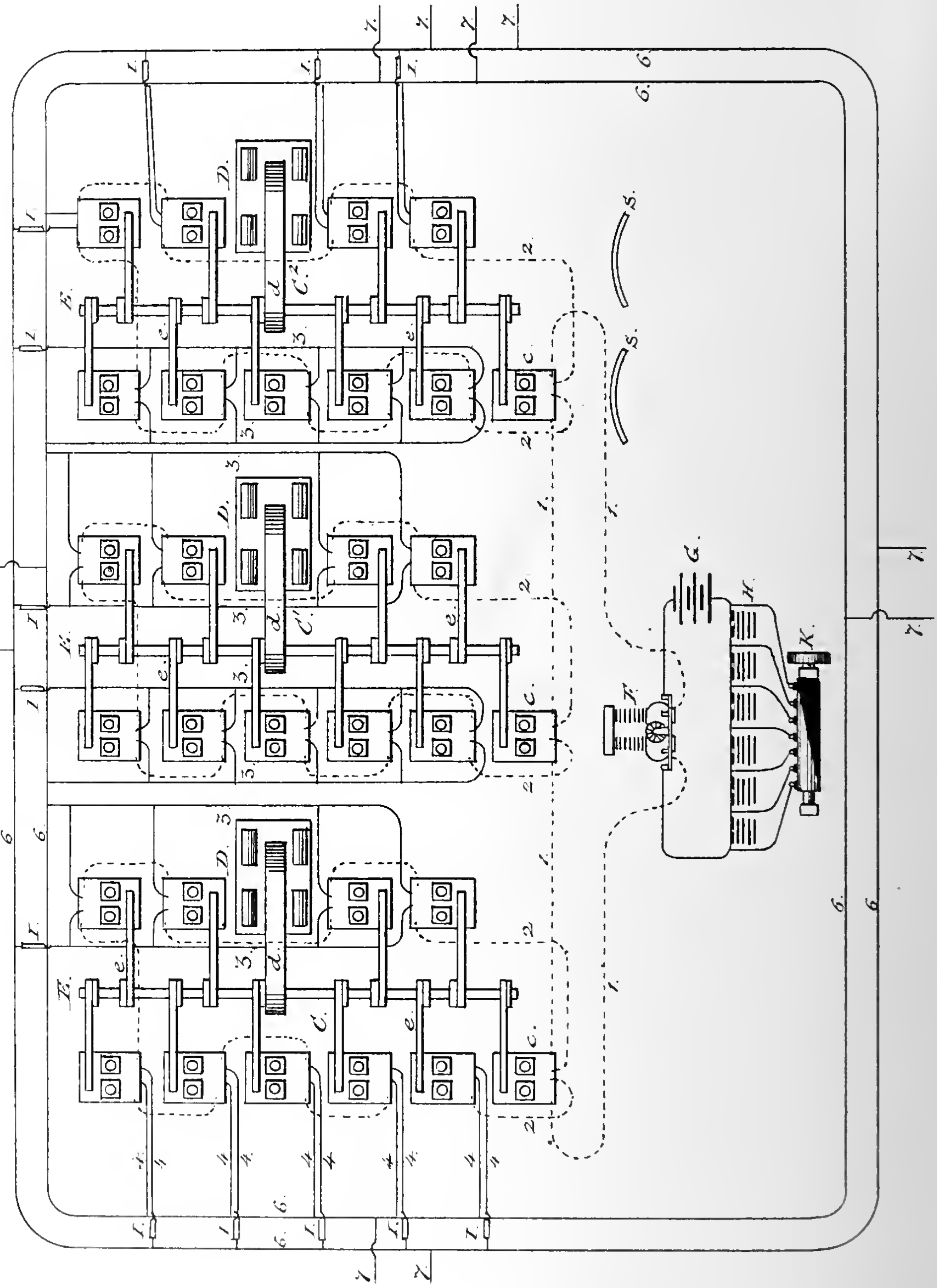
(No Model.) 2 Sheets—Sheet 1.

T. A. EDISON.

REGULATOR FOR DYNAMO OR MAGNETO ELECTRIC MACHINES.

No. 288,318. Patented Nov. 13, 1883.

Fig. 1.



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M. J. Hagott.

T. A. Edison
Inventor
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N. PETERS, Photo-Lithographer, Washington, D. C.

(No Model.)

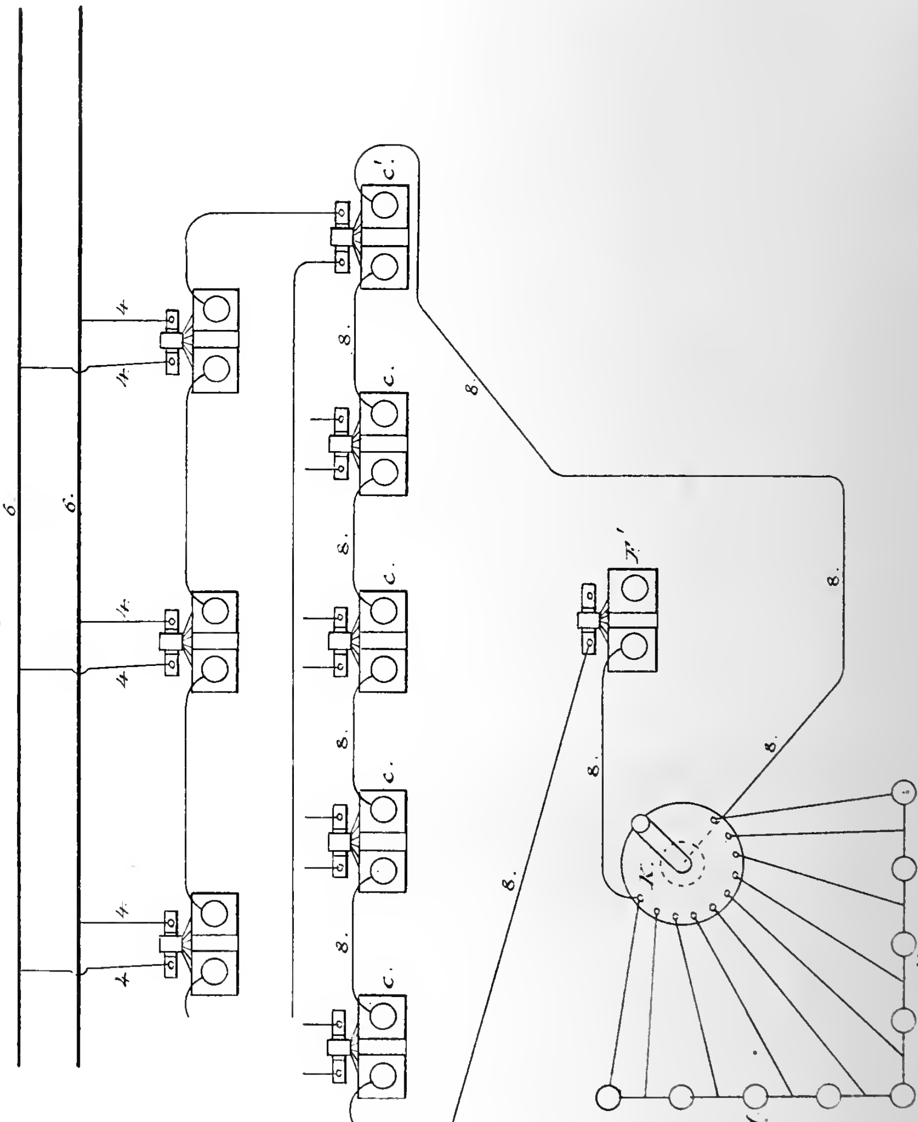
2 Sheets—Sheet 2.

T. A. EDISON.

REGULATOR FOR DYNAMO OR MAGNETO ELECTRIC MACHINES.

No. 288,318. Patented Nov. 13, 1883.

Fig. 2.



Attest
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T. A. Edison
Inventor,
per
Dyer & Wilber
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United States Patent Office.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, ASSIGNOR TO THE EDISON ELECTRIC LIGHT COMPANY, OF NEW YORK, N. Y.

REGULATOR FOR DYNAMO OR MAGNETO ELECTRIC MACHINES.

SPECIFICATION forming part of Letters Patent No. 288,318, dated November 13, 1883.

Application filed November 11, 1881. (No model.) Patented in England January 3, 1880, No. 33, and February 11, 1880, No. 602; in Italy May 10, 1880; in Belgium May 15, 1880, No. 51,329; in Victoria June 14, 1880, No. 2,841; in India June 23, 1880, No. 405; in France July 5, 1880, No. 136,399; in Canada July 21, 1880, No. 11,527; in New South Wales July 26, 1880; in Sweden July 29, 1880; in Queensland August 3, 1880; in Austria-Hungary October 5, 1880; in New Zealand October 18, 1880, No. 485; in Portugal October 27, 1880, No. 628; in Spain November 10, 1880, and in Norway December 31, 1880.

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in the Regulation of Dynamo or Magneto Electric Machines, (Case No. 358;) and I do hereby declare that the following is a full and exact description of the same, reference being had to the accompanying drawings, and to the letters of reference marked thereon.

In a prior application for Letters Patent of the United States, made by me on February 5, 1880, of which this application is a division, is set out a complete system for the generation, indication, regulation, distribution, consumption, and measurement of electricity for light and motive power. In such system it is contemplated that all the generation, indication, and distribution for a large number of consumers be done at a central station, such central station being the supply center of an area termed a district therein.

In such a system the net resistance of the external circuit is likely to be constantly varying, inasmuch as it is likely that the number of translating devices in circuit and making demands upon the central station for current will be constantly varying. This would lead to variation of pressure, so to speak, of current in the circuit. It is essential, however, that just sufficient energy be generated and sent through the circuit to keep up an equal flow through each translating device—that is, that a uniform pressure be maintained in the circuit of each translating device in circuit, whether more or less such devices be in circuit. To supply the demands upon such a central station of a district, it is necessary that a large number of generators be there grouped, arranged so that more or less thereof shall be thrown into action, that the amount of their action shall be controlled so that just the needed supply may be furnished.

To so arrange a number of generators that the generative capacity of all in circuit at any one time may be readily and definitely regulated by one operation, or the operation of one device, in order that the essentials before set forth be attained, is the object of this invention, which is particularly hereinafter set out and claimed.

A number (two or more) of generators are arranged to be driven by any suitable prime motor. If these were used as dynamo-machines proper—that is, if the field-of-force coils and the generating coils were included in one circuit, and all the current generated were passed through the field-magnet coils, a very much greater amount of current than necessary for the maintenance of a practical magnetic maximum in the field-of-force magnets would be passed around them, and the coils acting as resistances to the energy in excess of that required to magnetize the magnets to their practical maximum, a great waste of energy would ensue. Hence the field-of-force coils and the generating-coils are kept separate, one machine of the number before alluded to being set apart to supply the energy for the field-of-force coils of the remainder of the number, the number given it to feed being properly adjusted to its capacity. The one so set apart is for convenience hereinafter termed the "field-generator," and it and the generators fed by it are termed "supply," "generative," and, collectively, a "battery." This field-generator may be energized by the current from a galvanic battery or other source of energy, or it may be a dynamo-machine, its own field-coils being included in its own circuit. With it are combined means for varying instantly and at will the strength of the current passing around its field. As such variation reacts upon the field-magnets correspondingly varying the magnetic field in which its generative coils rotate, the reaction extends to the current generated, varying the force of the fields of the supply generators, and hence ultimately the current sent therefrom into the circuit external to the station. It will be understood that this regulation of the magnet of the field generator is performed below the point of saturation of the magnet, the current supplied to the magnet-coils being varied from a quantity sufficient to produce saturation, as a maximum, to a quantity producing the weakest magnetic effects desired as a minimum. So, by simply regulating the current passing around the field of one machine, the generation of current by a large number of machines connected to a supply-circuit is regulated instantly and at will.

When it is desired to use several batteries of generators, one in each battery is set apart as the field-generator; but the entire number of field-generators are energized by an extra generator provided with means of regulation, in which case such extra generator is termed the "prime field-generator." The foregoing is clearly shown in the drawings, in each of which several batteries of generators are indicated, and in which Figure 1 shows a prime field-generator energized by the current of a galvanic battery; and Fig. 2 shows the prime field-generator as a dynamo. In Fig. 1 three batteries, C C′ C², of generators are shown, which number may be increased or diminished as circumstances may require. In each battery one generator, *c*, is set apart as the field-generator, the circuit therefrom passing through the field-coils of all the remaining or supply generators of the battery, as shown in broken lines 2 2. For actuating the rotative portions of the supply-generators an engine, D, is used with each battery, connected by belt *d* to line of shafting E, from which belts *e* pass to the supply-generators; or, if preferred, each supply-generator may be provided with its own special engine. The generative coils of the supply-generators in C′ and C² are connected in multiple-arc to conductors 3 3, which in turn are connected in multiple-arc to the main conductors 6 6, from which lead supply-conductors or "mains" 7 7 throughout the district or territory to be supplied; or the supply-generators may be connected directly in multiple-arc to 6 6, as shown in C. The field-of-force coils of the field-generators *c c c* are energized by current from the prime field-generator F, whose circuit for this purpose is shown in broken lines 1 1. As here shown, its field-coils are traversed by current from the galvanic battery G, although it is evident that any other suitable source of energy may be used. In the circuit of G is interposed a series, H, of resistances connected to a cut-out, K, by which more or less of said resistances are thrown into the circuit of G. This forms a very effective and simple method of regulating the generative capacity of the batteries of supply-generators, for by the resistances the current in the field-coils of the prime field-generator is strengthened or weakened, affecting its generation, which reacts upon the field-generators *c*, reacting then upon the supply-generators, the variation in the circuit of G being immediately followed by variation in the current generated in the batteries.

Where only one battery is to be used, the resistances and cut-out are placed directly in the field-circuit of the field-generator *c* of such battery.

In Fig. 2, *c c c c* are the field-generators of batteries not shown, while *c′* is the field-generator of a battery of which three supply-generators are shown, connected to conductors 6 6, as before explained. In this case the prime field-generator F′ is a dynamo-electric machine, all its coils being included in one circuit, 8 8, which passes through the field-coils of the field-generators *c c c c c′*. The same principle of regulation is used, however, the resistances H and cut-out K being arranged, as shown, directly in the circuit 8 8, through F′, causing variation therein, with the result hereinbefore explained—that is to say, the current flowing in the field-magnet circuit 8 8 of the generators *c c′* is primarily and directly varied by variations in the resistance H in said circuit.

The adjustable resistances, which are placed directly in the circuit of the field magnet coils in either of the arrangements shown, are so proportioned to the resistance of the magnet-coils and to the energy of the source of electrical supply, and these last two elements are so proportioned with relation to each other that when all the resistance is cut out of circuit the current supplied to the field-magnet coils will be sufficient only to saturate or nearly saturate the magnet, producing the maximum magnetic power without waste of energy. The throwing of the resistance into the circuit diminishes the current and weakens the magnet, and in this way the strength of the magnet is primarily and directly regulated and varied.

I do not claim herein the method of operating a battery of generators, consisting in using the entire current of one to supply the fields of the remainder, and throwing the entire current generated by the latter into a circuit for use, as such will form the subject of a separate application; nor do I claim herein a dynamo-electric machine constructed or combined with suitable devices for primarily varying the strength of the current exciting its field-coils, nor, broadly, the combination, with the field-coils of such a machine, of an adjustable resistance, as such subject-matters form the subject of a separate application.

It is to be understood that all further patentable features of invention described or shown, but not claimed herein, are reserved for protection by other patents, and have been or will be embraced in other applications for patents.

What I claim is—

1. The combination, with an electrical generator, of an adjustable resistance in addition and external to the field-magnet coils, and located directly in the field-circuit of the generator, for primarily and directly regulating and varying the strength of the field-magnet below the point of saturation, substantially as set forth.

2. In a battery of generators, the combination of one generator feeding the field of all the supply-generators of the battery, with

means for controlling and regulating its current, substantially as set forth.

3. The combination, with a battery of generators and a separate generator supplying the field-current therefor, of means acting on the separate generator to regulate its production of current, and thereby regulate the generative capacity of the entire battery, substantially as set forth.

4. The combination, with a series of batteries of generators, each provided with its own field-current generator, of a prime field-generator supplying the field-current to such battery field-generators and provided with means for controlling the generative capacity, substantially as set forth.

5. The method of regulating the generative capacity of one battery or of a series of batteries of generators, consisting in primarily regulating the current passing around the field-coils of one or the prime field-generator, substantially as set forth.

6. The combination of a battery or series of batteries of generators, a field or prime field generator, and an adjustable resistance, substantially as set forth.

7. The combination, with the main circuit containing one or more generators and translating devices, of a separate electric circuit having no electrical connection with the main circuit, and supplied with current from a source external to said generator or generators, and means acting upon the separate circuit for controlling and regulating the force or pressure in the main circuit, substantially as set forth.

This specification signed and witnessed this 17th day of October, 1881.

THOS. A. EDISON.

Witnesses:
H. W. SEELY,
C. F. HARRINGTON.

Jan 1, 1884

To

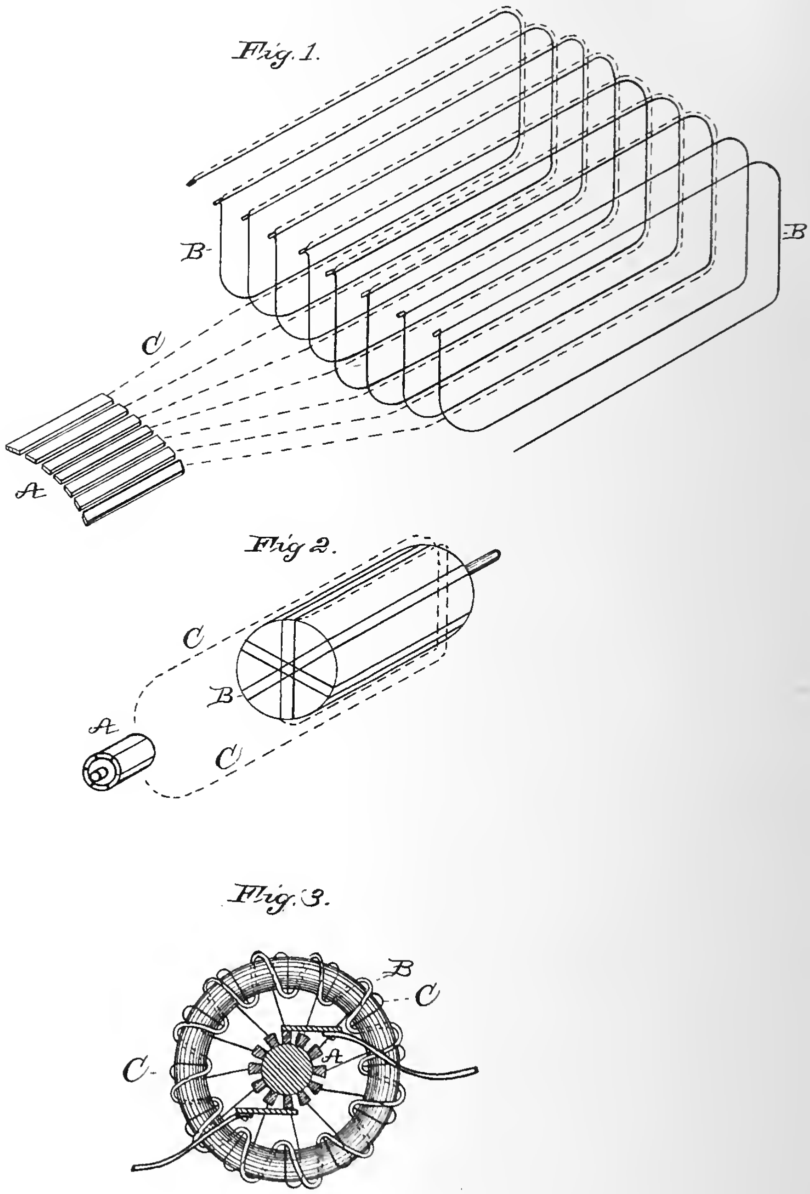
Apr 1, 1889

(No Model.)

T. A. EDISON.

ELECTRICAL GENERATOR OR MOTOR.

No. 293,432. Patented Feb. 12, 1884.



ATTEST:

E. C. Rowland

H. W. Seely

INVENTOR:

Thomas A. Edison

By Rich^d N. Dyer

Att'y.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

ELECTRICAL GENERATOR OR MOTOR.

SPECIFICATION forming part of Letters Patent No. 293,432, dated February 12, 1884.

Application filed October 18, 1883. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Electrical Generators or Motors, (Case No. 602,) of which the following is a specification.

This invention relates to the construction of dynamo-electric machines and electro-dynamic motors having continuously-wound bobbins connected at intervals to commutator-bars, whereby the sparking at the commutator will be greatly reduced or wholly obviated, overcoming the necessity for changing the current-collectors upon the commutator in accordance with variations in the load upon the machines when used either as generators or motors, increasing the capacity of the machine and decreasing the heat generated in the armature-coils, and also diminishing the wear of the commutators and the collectors. This I accomplish by opposing the electro-motive force of the coils as they are short-circuited at the commutator (by the bridging of commutator-bars by the current-collectors) by a counter electro-motive force. This counter electro-motive force is preferably equal or nearly equal to the electro-motive force of the short-circuited coils, in which case no current will flow in the short-circuited coils and the sparking will be completely obviated; or the counter force may be somewhat less or even greater than the direct force, but not sufficiently one way or the other to make the spark due to the current produced by the predominating electro-motive force of practical importance. The counter force is produced by making the connections between the bobbin and the commutator-bars through conductors which pass through the field of force, and in which there is a counter electro-motive force opposed to the direct force of the short-circuited coils. These connections are preferably in the form of loops upon the armature.

In machines with continuous windings, the commutator-bars have been heretofore connected with the armature-bobbin by conductors running directly from the commutator-bars to the bobbin. By this invention, however, each connection is made by a conductor which is connected to the bobbin, and is carried back on the armature-loop from the point of connection therewith, and follows it one or more times around the armature, and is then connected to a commutator-bar. The extra loops may be conductors of the same size as the bobbin; but much smaller conductors are preferably used, and since each extra loop is in circuit a portion of the time only, the heat due to the main current is dissipated. A counter force equal to the direct force is obtained by giving each extra loop the same length as one loop or section of loops of the main bobbin; or in constructions where this is not desirable the extra loops may be placed in advance of the loops of the main bobbin, so that as each main loop or section of loops is short-circuited the opposing extra loop or section of loops is in a stronger magnetic field, and in this way the counter force of the extra loop can be made equal or nearly equal to the direct force of the short-circuited loop.

This invention is applicable to all continuously-wound machines, whether of the Gramme, Siemens, or other type.

In the accompanying drawings, forming a part hereof, Figure 1 is a perspective view of a number of armature-loops removed from the armature and of a number of commutator-bars, the connections between the loops and bars being shown by dotted lines; Fig. 2, a perspective view of a wound armature of the Siemens type and a commutator with two commutator-connections illustrated; and Fig. 3, a side elevation of a wound armature of the Gramme type with the commutator in vertical section, all the commutator-connections being illustrated.

A represents commutator-bars, and B the coils or loops of a continuously-wound armature. The field-magnet, the location of which will be well understood, is not shown in any of the figures.

C represents the conductors connecting the loops with the commutator-bars. These conductors are wound as loops upon the armature, and hence pass through the field of force, and in them is developed a counter electro-motive force, which neutralizes wholly or partially the electro-motive force of the coils as they are short-circuited. It will be seen that each conductor C, instead of extending from the point of connection with B directly to a commutator, is run back upon the coil B, to which it is connected, and follows that coil around the armature, and is then connected to a commutator-bar. If the winding B is a plural winding, each conductor C may also be wound two or more times around the armature. In Fig. 2 two connections only are shown for clearness; but it will be understood that the other commutator-bars will be connected in the same way with the armature-coils. In Fig. 3 the connections C pass once around the ring-armature before being connected with the commutator-bars; but these connections may be run two or more times around the armature, to give the required counter electro-motive force.

The operation is not dependent upon the resistance of the extra loops, but upon their length and position with reference to the corresponding main loops; and hence I make no claim herein to the interposition of an extra resistance between the commutator and the armature-coils. A construction dependent upon the resistance is described in my application Serial No. 114,282, and that invention is therein claimed. Neither do I claim herein a resistance external to the current-collectors forming a bridge of high resistance between the short-circuited commutator-bars, for this is claimed in my application Serial No. 114,281.

What I claim is—

1. The method of overcoming wholly or partially the spark at the commutators of dynamo or magneto electric machines or electro-dynamic motors, consisting in developing a counter electro-motive force opposed to the electro-motive force of the armature-coils as they are short-circuited, substantially as set forth.

2. In an electrical generator or motor, the combination, with the armature and commutator, of means for throwing a counter electro-motive force into the armature-coils as they are short-circuited, substantially as set forth.

3. In an electrical generator or motor, the combination, with the armature and commutator, of conductors connecting the armature-coils and commutator-bars and passing through the field of force, substantially as set forth.

4. In an electrical generator or motor, the combination, with the armature-coils and the commutator-bars, of extra loops wound upon the armature, and connecting the armature-coils and commutator-bars, substantially as set forth.

This specification signed and witnessed this 17th day of October, 1883.

THOS. A. EDISON.

Witnesses:

WM. H. MEADOWCROFT.

EDWARD H. PYATT.

(No Model.)

T. A. EDISON.

INSULATION OF RAILROAD TRACKS USED FOR ELECTRIC CIRCUITS.

No. 293,433. Patented Feb. 12, 1884.

Fig. 1.

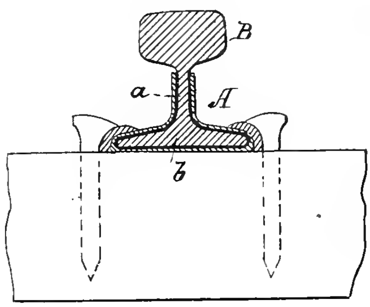


Fig. 2.

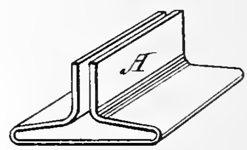


Fig. 3.

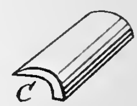


Fig. 4.

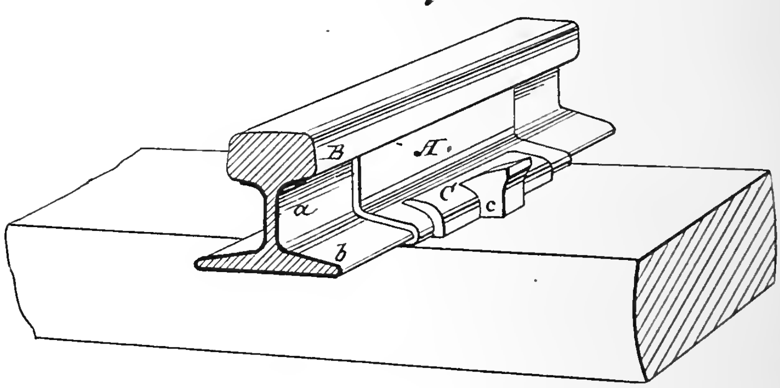
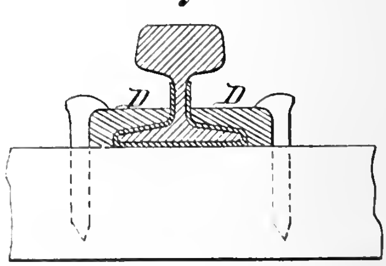


Fig. 5.



WITNESSES:

Wm Carman

James A Payne

INVENTOR:

T. A. Edison

BY Dyer & Wilber

ATTORNEYS.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE ELECTRIC RAILWAY COMPANY OF THE UNITED STATES, OF NEW YORK.

INSULATION OF RAILROAD-TRACKS USED FOR ELECTRIC CIRCUITS.

SPECIFICATION forming part of Letters Patent No. 293,433, dated February 12, 1884.

Application filed August 9, 1880. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Insulation of Railroad-Tracks Used as Electric Circuits, (Case No. 238;) and I do hereby declare that the following is a full and exact description of the same, reference being had to the accompanying drawings, and to the letters of reference marked thereon.

This invention relates particularly to the better insulation of lines of rails when the rails of each line of rails are electrically united and form conductors for conveying an electric current for utilization along the line of rails. Where it is attempted to use the rails of a railroad-track as the conductors for an electrical current, there is always more or less surface-conduction, the amount depending largely upon the dampness or dryness of the adjacent soil, the ties, &c.

The object of this invention is to largely reduce or to prevent entirely this surface-conduction, to which end the invention consists in the features more particularly hereinafter described and claimed.

Between the rail and the tie is placed a piece of felt, papier-maché, or other tough flexible insulating material, preferably so treated as to make it water-proof, which piece extends upward on the web on both sides of the rail to the head, forming an insulating-shoe. Between it and the spike is placed a piece of metal, of the general configuration of the foot of the rail, upon which the head of the spike takes and bears, so that the insulating material is protected from abrasion or damage by the spike. Instead of this metal piece, a much heavier piece of wood may be used, forming a shoe fastened down by the spike, and in turn securing the rail.

It will be observed that the insulating material which is placed under and around the rail where it rests on the tie is a tough material. Rubber will not answer the purpose; but a flexible water-proof fibrous material is preferred. The foot and web of the rails are covered with some elastic insulating composition adhering to the surface—for example, a rubber paint, or a paint of which the base is pure linseed-oil, the ties, for a space of, say, one-half foot to a foot on each side of the rails, being similarly painted.

In the drawings, Figure 1 is a cross-section, and Fig. 4 a perspective, of a rail arranged as described. Figs. 2 and 3 are views of details; Fig. 5, a cross-section of a modification of Fig. 1.

A is a piece of felting, papier-maché, vulcanized fiber, or other tough flexible insulating material, placed under and around the rail B, and extending up the web *a* to about the head of the rail, forming an insulating-shoe.

C is a washer-piece, of metal, which is placed between A and the spikes, protecting A from injury by the spikes. In place of the piece C, wooden pieces D may be used.

The foot *b* and web *a* of the rails are covered with some elastic insulating composition, leaving only the head of the rail exposed or in condition to form a connection for conduction of current. This composition may be a rubber paint or a paint having a base of pure linseed-oil, or any oxidizable oil. By these means surface conduction or leakage is almost, if not entirely, obviated, causing increased economy in the use of electric motors for traction purposes on railroads.

What I claim is—

1. A railway-rail provided with an insulating-covering except upon its head, substantially as set forth.

2. An insulating-cushion for railroad-rails, composed of a flexible water-proof fibrous material, substantially as set forth.

3. A line of rails electrically connected to form a circuit or part of a circuit, and having the foot and web of the rails covered with an elastic insulating composition adhering to the surface thereof, substantially as set forth.

This specification signed and witnessed this 6th day of August, 1880.

THOS. A. EDISON.

Witnesses:

F. L. GRIFFIN,

WM. CARMAN.

(No Model.)

T. A. EDISON.

INCANDESCENT ELECTRIC LAMP.

No. 293,434. Patented Feb. 12, 1884.

Fig. 1.

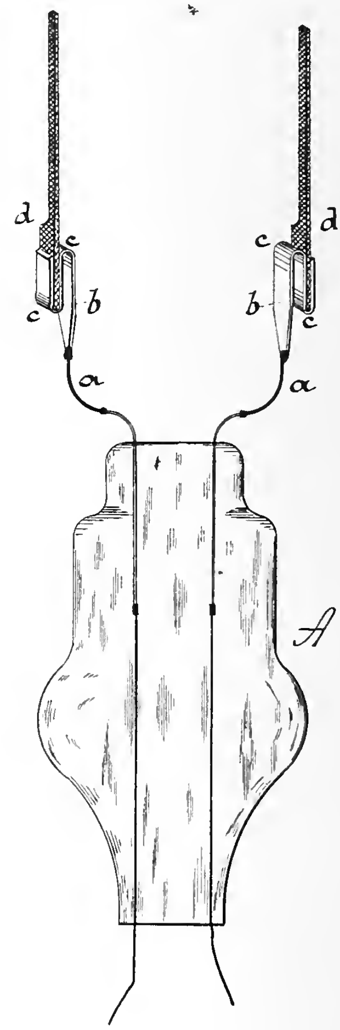
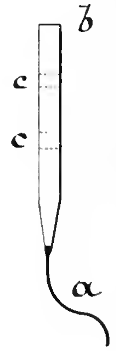


Fig. 2



WITNESSES:

D. D. Mott

H. W. Seely

INVENTOR:

T. A. Edison

BY Richd. N. Dyer

ATTORNEY.

N. PETERS. Photo-Lithographer, Washington, D. C.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, ASSIGNOR TO THE EDISON ELECTRIC LIGHT COMPANY, OF NEW YORK, N. Y.

INCANDESCENT ELECTRIC LAMP.

SPECIFICATION forming part of Letters Patent No. 293,434, dated February 12, 1884.

Application filed August 7, 1882. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in the Manufacture of Incandescing Electric Lamps, (Case No. 377;) and I do hereby declare that the following is a full and exact description of the same, reference being had to the accompanying drawings, and to the letters of reference marked thereon.

I have found that in the manufacture of incondescent electric lamps the best mode of attaching the incandescing conductor to the wires leading thereto is to electroplate the joint or union between them. In order to perform this operation, it is necessary to first attach the wires to the enlarged end of the carbon by some temporary mechanical means. To furnish convenient and efficient means for this purpose is the object of my invention. My arrangement is as follows: The copper inner extremities of the "leading-in" wires are formed into long flat strips, whose width should be about equal to that of the enlarged ends of the carbon. Each strip is then bent over twice lengthwise on itself, and the enlarged carbon ends are inserted in the upward bend. The sides of the strip may be pressed down upon the carbon as closely as is necessary to hold it. The joint is then electroplated, preferably in the manner shown in my previous application, (Serial No. 24,440.)

The accompanying drawings illustrate my invention.

Figure 1 is a view showing the carbon held as above described, and Fig. 2 a view of the flat copper extremity before bending.

A is the supporting neck or stem of an incandescing electric lamp, and *a a* the copper terminals, having their ends formed into or attached to flat strips *b b*. Each of these strips is bent back twice upon itself at points *c c*. The enlarged ends *d d* of the carbon are placed in the upward bends, as shown, and there held during the operation of electroplating.

What I claim is—

1. In an incandescing electric lamp, the device for holding an end of the carbon during the process of electroplating, consisting of a flat piece of copper bent twice lengthwise upon itself, substantially as set forth.

2. The leading-in wires of an incandescing electric lamp, having their inner extremities formed into or attached to flat metal strips, each bent twice lengthwise upon itself, substantially as and for the purpose set forth.

This specification signed and witnessed this 5th day of December, 1881.

T. A. EDISON.

Witnesses:
H. W. SEELY,
WM. H. MEADOWCROFT.

(No Model.)

T. A. EDISON.

ELECTRICAL METER.

No. 293,435. Patented Feb. 12, 1884.

Fig. 1.

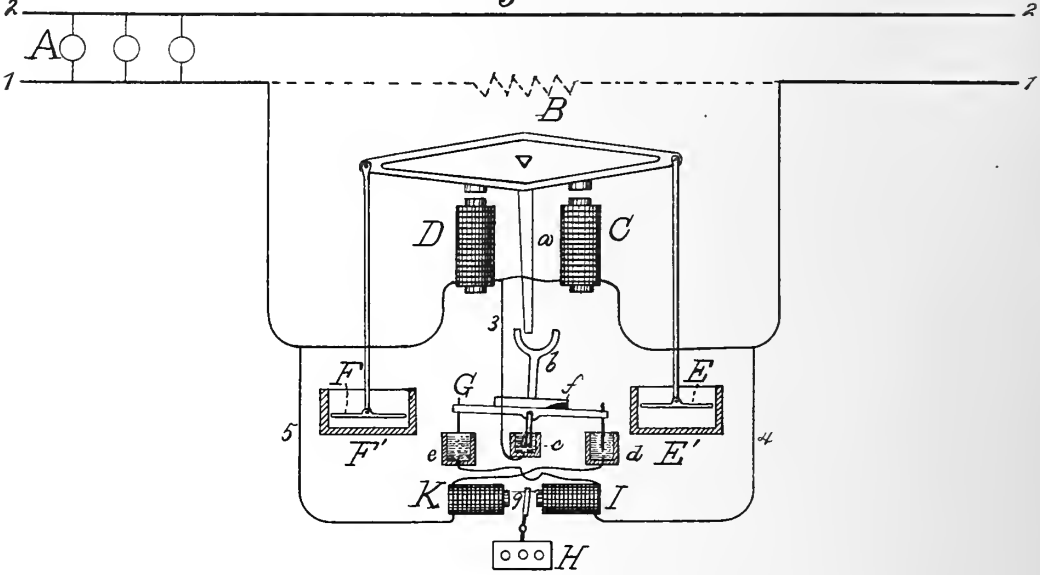
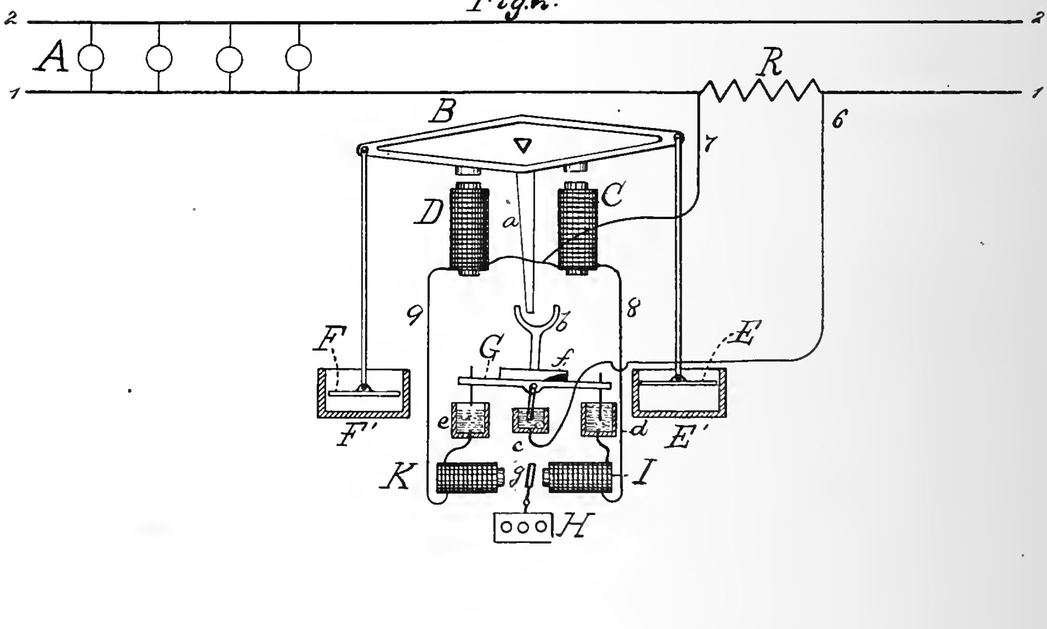


Fig. 2.



WITNESSES:

E. C. Rowland,

H. W. Seely

INVENTOR:

Thomas A. Edison,

By Richd. N. Dyer,

Atty.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, ASSIGNOR TO THE EDISON ELECTRIC LIGHT COMPANY, OF NEW YORK, N. Y.

ELECTRICAL METER.

SPECIFICATION forming part of Letters Patent No. 293,435, dated February 12, 1884.

Application filed August 14, 1882. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Electrical Meters, (Case No. 457;) and I do hereby declare that the following is a full and exact description of the same, reference being had to the accompanying drawings, and to the letters of reference marked thereon.

The object I have in view is to produce simple and efficient means for measuring the electrical energy consumed in a circuit, which will record automatically, and will be constructed wholly of mechanically-operating parts not liable to get out of order and not requiring renewal. This I accomplish by the use of one or more reciprocating dash-pot plungers, which retard the movement of an electro-magnetic mechanism operated by the current in the circuit, or a portion thereof, and working, by its movement, a recording apparatus. The dash-pot or dash-pots employed may be of ordinary construction; but, instead of using a liquid in the dash-pots, I prefer to use the air as a retarding force, which I am enabled to do effectively by making the plungers of large area. The electro-magnetic mechanism acts upon a pivoted beam, to which the dash-pot plungers are attached. It may be of any suitable construction; but I prefer to employ two electro-magnets, acting upon armatures secured to a pivoted or suspended beam on opposite sides of the point at which the beam is pivoted or suspended. The beam is connected at its ends to the reciprocating plungers of dash-pots, which retard the movement. These electro-magnets are located directly in the circuit or in a shunt therefrom. The beam has an arm which works a pivoted circuit-controller, making and breaking contact at mercury-cups. When the electro-magnets are located directly in the circuit, the movement produced by each electro-magnet opens a shunt around the other electro-magnet and closes a shunt around itself. The electro-magnets are thus made to predominate alternately, while the circuit is kept constantly closed. When the electro-magnets are in a shunt from the circuit the consumption of electrical energy in which is being measured, the circuit-controller makes and breaks the circuits of the electro magnets alternately or closes and opens shunts, as in the first case. The circuit-controller is a pivoted bar having a U-shaped arm projecting upwardly, and engaging with an arm from the pivoted beam. The circuit-controlling bar carries two points dipping alternately in mercury-cups, and a central point dipping permanently in the mercury of a third cup. To throw the circuit-controlling bar to the limit of its movement after it has been moved over the center by the arm from the beam, I employ a tube partly filled with mercury. This tube is carried by the bar, and the mercury in it flows to one end or the other as the bar tips over the center, throwing it to the end of its movement. A weight may be employed for this purpose, as heretofore in circuit-controllers of this character; but the mercury-tube is preferred.

The recording apparatus may be worked by a mechanical connection with the pivoted beam or the circuit-controller; but it is preferred to employ two electro-magnets for this purpose, the circuits of which are made and broken alternately by the circuit-controller. When the main electro-magnets are located directly in the circuit, these electro-magnets for working the recording apparatus will be located in the shunt-circuits which are completed alternately around the main magnets; but when the main electro-magnets are in a shunt from the circuit, the recording electro-magnets can be placed in the divisions of this shunt with the main electro-magnets. The lamps, motors, or other translating devices are preferably arranged in multiple-arc circuits. The speed of the electro-magnetic mechanism will vary with the number of translating devices in circuit, and the recording apparatus will indicate accurately in any units desired the electrical energy consumed in the circuit.

The foregoing will be better understood from the drawings, in which—

Figure 1 is a view, partly diagrammatic, of the preferred form of meter located directly in the circuit; Fig. 2, a similar view of the preferred form of meter located in a shunt from the circuit.

1 2 are the main conductors of a house or

other consumption circuit in which are placed lamps, motors, or other translating devices, A, preferably arranged in separate multiple-arc circuits, as shown.

The meter is composed of a pivoted or suspended beam, B, Figs. 1 and 2, carrying armatures on opposite sides of its pivot, acted upon by two electro-magnets, C D. At its ends the beam B is connected with reciprocating dash-pot plungers E F, which are preferably of large area and work against the retarding force of the air in cylinders E′ and F′, closed at one or both ends. The beam B has an arm, *a*, projecting downwardly from its center and engaging with the U-shaped stirrup on the end of the arm *b* of a pivoted circuit-controlling bar, G. This circuit-controller carries a central pin dipping permanently in the mercury of a cup, *c*, and two end pins dipping alternately in the mercury of cups *d e*. The bar G has a tube, *f*, partly filled with mercury, secured thereto, for throwing the circuit-controller to the limit of its movement after it is tipped over the center by the movement of the beam B.

H represents any suitable recording apparatus, which may be moved by a mechanical connection with the beam or circuit-controller; but it is preferably worked by two electro-magnets, I K, acting alternately upon an armature-lever, *g*.

With reference to Fig. 1, the electro-magnets C D are placed directly in the conductor 1 of the consumption-circuit. Between the electro-magnets C D a connection, 3, is made with the permanent contact-cup *c*. Outside of the electro-magnets C D connections 4 and 5 are made with mercury-cups *e* and *d*, respectively, after passing through the coils of the recording electro-magnets I and K. Conductors 3, 4, and 5 form shunts around the magnets C D, which are completed alternately by the circuit-controller, while the main circuit always remains closed.

When the parts are in the position shown in Fig. 1, the current flows from 1 on the right of C D, through C, 3, *c*, G, *d*, K, and 5, to 1 on the left of C D. Current will also flow through D, but, the shunt 3 5 being closed around D, its energy will be small compared with that of C. C will draw B down until G is thrown over the center, when contact will be broken at *d*, and made at *e*. K will also attract *g*, working the recording apparatus. Now the current will flow from 1 on the right of C D, by 4 I *e* G *c* 3 D, to 1 on the left of C D. The shunt 3 4 is now closed around C, and hence D will now predominate, although a small current will flow through C. The beam B will be tipped in the opposite direction, and I will attract *g*. This same arrangement of circuits could be used in a shunt around resistance, in which case the conductor 1 would be extended, through resistance, around the magnets C D, as shown in dotted lines in Fig. 1.

In Fig. 2 the magnets C D are in a shunt, 6 7, around resistance R, located in conductor 1 of the consumption-circuit. Conductor 7 is divided, and runs to both magnets C D, and from these magnets separate connections 8 9 extend to magnets I K and cups *d e*. Conductor 6 extends directly to the cup *c*. In the position shown in the drawings, the current flows from 1 on the right of R, by 6, *c*, G, *d*, I, 8, C, and 7, to 1 on the left of R. Magnets C I are energized, while the circuit of D and K is broken. The beam B will be attracted by C, and the lever *g* by I. The circuit-controller will be thrown after the beam B has made a definite movement, breaking contact at *d*, and making contact at *e*. Now the current will flow from 1 on the right of R, by 6, *c*, G, *e*, K, 9, D, and 7, to 1 on the left of R, and D K will be energized, while the circuit of C I will be broken.

It will be understood that the speed of movement of the electro-magnetic mechanism varies in direct proportion to the variation in the energy consumed in the circuit in a given time, and hence the recording apparatus will give an accurate record of the consumption that takes place.

What I claim is—

1. In an electrical meter, the combination of the pivoted beam, oscillated by an electro-magnetic mechanism for moving the beam in both directions by electro-magnetic action, of a recording apparatus, and reciprocating dash pot plungers attached to such beam, substantially as set forth.

2. In an electrical meter, the combination, with a pivoted beam, of electro-magnets for tipping such beam in opposite directions, a circuit-controller moved by the beam, and a recording apparatus, substantially as set forth.

3. In an electrical meter, the combination, with a pivoted beam, of electro-magnets for tipping such beam in opposite directions, means for retarding the movement, a circuit-controller moved by the beam, and a recording apparatus, substantially as set forth.

4. In an electrical meter, the combination, with the pivoted beam, the main electro-magnets, and the dash-pots, of the circuit-controller operated by the beam, the recording apparatus, and the electro-magnets for working such recording apparatus, substantially as set forth.

5. In an electrical meter, the circuit-controller composed of a pivoted bar, mercury-cups in which the circuit is made and broken, a mercury-cup for constantly maintaining electrical connection with the moving bar, and a tube partly filled with liquid, for throwing the bar to the limits of its movements, substantially as set forth.

This specification signed and witnessed this 7th day of July, 1882.

THOMAS A. EDISON.

Witnesses:
RICHD. N. DYER,
EDWARD H. PYATT.

(Model.)

T. A. EDISON.

TYPE WRITER.

No. 295,990. Patented Apr. 1, 1884.

Fig. 1.

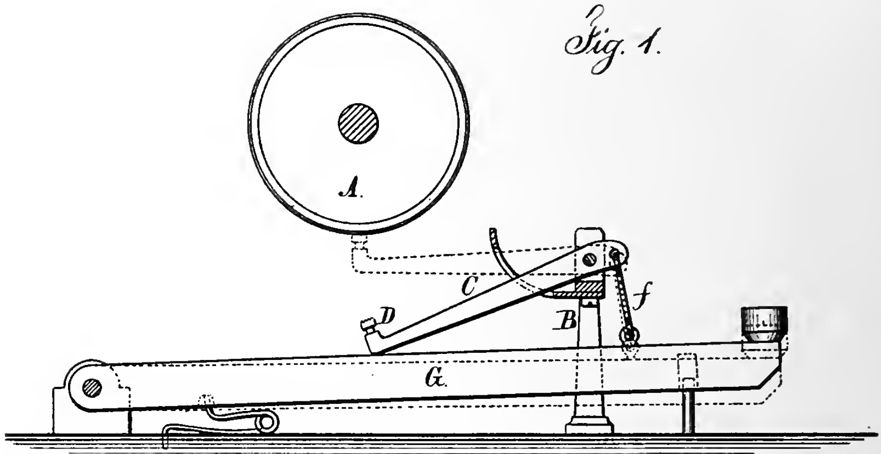
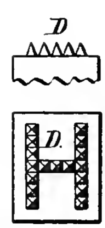


Fig. 2.



Witnesses

Chas H. Smith

Geo. T. Pinckney

Inventor

Thomas A. Edison.

per Lemuel W. Serrell

N. PETERS. Photo-Lithographer. Washington, D. C.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

TYPE-WRITER.

SPECIFICATION forming part of Letters Patent No. 295,990, dated April 1, 1884.

Application filed December 9, 1878. Renewed May 25, 1883. (Model.) Patented in England October 29, 1875, No. 3,762; in France May 6, 1876, No. 112,719; in Belgium May 8, 1876, No. 39,502; in Austria August 23, 1876, No. 26,935; in Italy August 26, 1876, No. 8,733, and in Canada September 6, 1876, No. 6,508.

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the State of New Jersey, have invented an Improvement in Duplicate Printing, (Case No. 167,) of which the following is a specification.

In Letters Patent No. 180,857, granted to me, I have set forth a pen for perforating paper, and a press in which the perforated paper is stretched in a frame, and ink from a roller forced through the perforations, and an impression made on a sheet of paper laid on a bed.

Type-writing machines have been made in which the type is impinged upon the paper to produce an impression, and in stamp-canceling machines types have been used having roughened or pointed surfaces.

My invention relates to the method of producing printed impressions in duplicate, consisting in pressing upon paper types in succession each of which has a surface of points so as to perforate the paper, and then forcing through the perforations ink upon the sheet of paper, and thereby printing upon the same.

In the drawings, Figure 1 is a section representing one key and lever of a type-writer, and Fig. 2 is a side and face view of the letter magnified.

A is the roller upon which the paper to be perforated is secured, in the usual manner, felt, blotting-paper, rubber, or other soft material being placed over the roller, and against this the paper to be perforated lies.

B is the standard or part of a ring, and all the type-levers are arranged so that the perforating-types upon their extreme ends will strike one common center at the roll A. Only one lever and perforating-type is shown in the drawings.

C is the type-lever; D, the type; *f*, the wire to the finger-key G.

The surface of each type is composed of numerous fine points that will perforate the paper when pressed upon it. The paper, after it has been perforated by the types in the words, lines, and sentences required for one page, is removed from the type-writing machine, and the printing is performed by forcing ink through the perforations upon a sheet of paper in a manner similar to that set forth in my said Patent No. 180,857. It will be evident that these perforating-types may be introduced into any type-writing machine in which sufficient force can be applied to perforate the paper and form a stencil of type-letters, each letter being composed of numerous perforations.

This method of printing is to be distinguished from that in my aforesaid patent, because each perforated letter is made complete by the pressure of a type, whereas in the said patent the letters or characters had to be written or drawn out by hand, and hence could not be made as rapidly or perfectly as by the impression of a type of numerous points. This method is also to be distinguished from the stamp-canceling devices in which a single stamp is forced into the paper to perforate or mar the same in a manner to prevent alteration, and the perforated paper was not used for printing with ink. My method of printing, therefore, necessarily comprises all of the successive operations, and is an improvement in duplicate printing.

I claim as my invention—

The method herein specified of producing printed impressions in duplicate, consisting in impressing upon paper types in succession, each of which has a surface of points, so as to perforate the paper, and then forcing ink through the perforations upon the sheet to be printed, substantially as set forth.

Signed by me this 4th day of December, A. D. 1878.

THOMAS. A. EDISON.

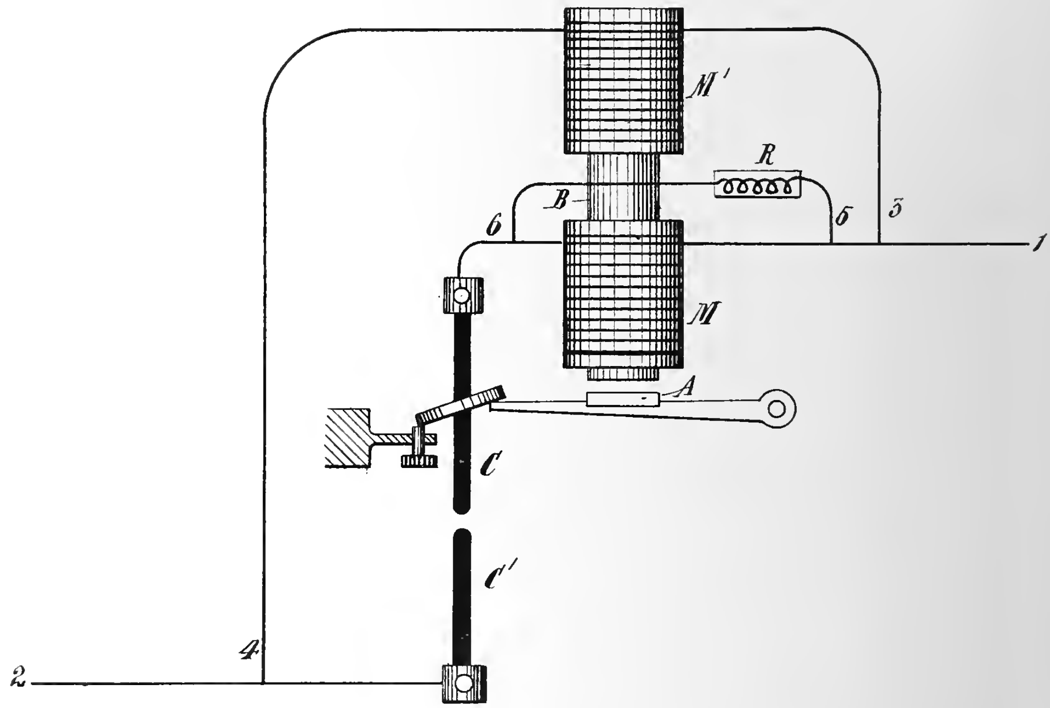
Witnesses:
STOCKTON L. GRIFFIN,
GEO. E. CARMAN.

(No Model.)

T. A. EDISON.

ELECTRIC ARC LIGHT.

No. 297,580. Patented Apr. 29, 1884.



WITNESSES:

O. D. Mott
Thomas E. Burch

INVENTOR:

T. A. Edison

BY Dyer & Wilber

ATTORNEYS.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, ASSIGNOR TO THE EDISON ELECTRIC LIGHT COMPANY, OF NEW YORK, N. Y.

ELECTRIC-ARC LIGHT.

SPECIFICATION forming part of Letters Patent No. 297,580, dated April 29, 1884.

Application filed November 28, 1881. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Electric-Arc Lights, (Case No. 368;) and I do hereby declare that the following is a full and exact description of the same, reference being had to the accompanying drawings, and to the letters of reference marked thereon.

The object I have in view is to produce means for governing the regulating mechanism of voltaic-arc lamps which will be simple in construction and efficient in action by the employment of opposing solenoids or electro-magnets having coils of the same resistance.

In carrying out my invention I arrange the coils of one solenoid or electro-magnet in the line or arc circuit, and the coils of the other solenoid or electro-magnet in a shunt-circuit around the carbons and the first solenoid or electro-magnet. Around the solenoid or electro-magnet in the line I form a shunt containing a resistance, which is proportioned to make a proper division of the current and to increase to the required degree the current-carrying capacity of the line over that of the shunt around the arc. This resistance is preferably made adjustable. The coils of the two solenoids or electro-magnets are wound in opposite directions, and may act upon the same or different movable cores or armatures. It will be understood that the magnet or solenoid in the line, while of the same resistance as that in the shunt around the arc, has a greater number of coils in its winding, so as to give it a predominating force when the carbons are in contact. This is accomplished by making the wire of the magnet or solenoid in the line of greater conductivity per unit of length than that of the magnet or solenoid in the shunt, the length being increased to equalize the resistance. Where they act upon the same movable or stationary core, one set of such coils can be wound upon the other.

Heretofore, in regulating arc-lamps by the differential action of opposing solenoids or electro-magnets, one of such solenoids or electro-magnets has been made of low resistance and placed in the line, while the other solenoid or electro-magnet located in the shunt around the arc has been made of much higher resistance; but by the use of the shunt-circuit around the solenoid or electro-magnet in the line, and by providing the magnet with a greater number of coils in its winding, I am enabled to make both of such solenoids or electro-magnets of the same resistance.

The foregoing will be better understood from the drawing, in which the figure is a diagrammatic view of my arrangement.

1 2 represent the line in which are placed the carbons C C′ and the coils of the solenoid or electro-magnet M.

3 4 represent a shunt-circuit around the carbons and the solenoid or electro-magnet M.

In 3 4 are placed the coils of the solenoid or electro-magnet M′. Both M and M′ are shown as surrounding the same stationary core B and acting on the same armature A which is arranged to control the regulating mechanism. M and M′, being wound in opposite directions, act oppositely upon the core B and armature A.

Around the electro-magnet or solenoid M is a shunt-circuit, 5 6, which is connected with the line on opposite sides of M, and is provided with a proper resistance, R, which is preferably adjustable. When the lamp is first put in circuit, the carbon-points are together; but the passing of the current through the magnet M energizes said magnet, which, acting on the armature A, draws the upper carbon, C, away from the lower one, C′, a sufficient distance to cause the formation of the voltaic arc. When the carbons become consumed, however, and the resistance of the main circuit which contains the arc becomes greater, a greater portion of the current flows through the shunt 3 4, energizing the magnet M′, which, acting in opposition to the magnet M, causes the armature A to drop and let the carbon C fall the proper distance. It is evident that in practice this operation after the arc is once formed would be a continuous one.

What I claim is—

1. In regulating mechanism for arc-lamps, the combination of the opposing solenoids or electro-magnets located one in the line and the

other in a shunt around the arc, both of such solenoids or electro-magnets having the same resistance, substantially as set forth.

2. In regulating mechanism for arc-lamps, the solenoid or electro-magnets of the same resistance located in the line and in a shunt around the arc, in combination with a shunt around the solenoid or electro-magnet in the line, substantially as set forth.

This specification signed and witnessed this 7th day of November, 1881.

THOS. A. EDISON.

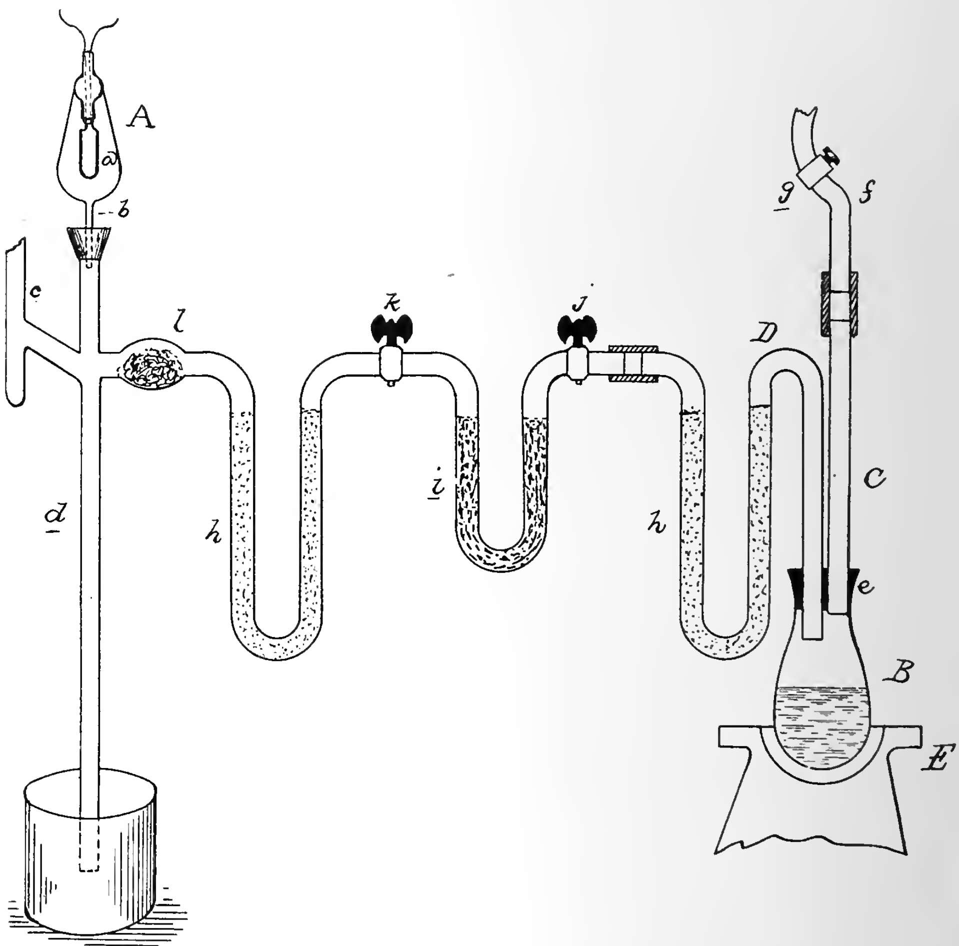
Witnesses:
RICHD. N. DYER,
H. W. SEELY.

(No Model.)

T. A. EDISON.

INCANDESCENT ELECTRIC LAMP.

No. 297,581. Patented Apr. 29, 1884.



WITNESSES:

Edw. C. Rowland

H. W. Seely

INVENTOR:

Thomas A. Edison

By Richd N. Dyer,
Atty.

United States Patent Office.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, ASSIGNOR TO THE EDISON ELECTRIC LIGHT COMPANY, OF NEW YORK, N. Y.

INCANDESCENT ELECTRIC LAMP.

SPECIFICATION forming part of Letters Patent No. 297,581, dated April 29, 1884.

Application filed September 22, 1882. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in the Manufacture of Incandescing Electric Lamps, (Case No. 483,) of which the following is a specification.

The object of this invention is to render the inclosing-globes of incandescing electric lamps as free from air as possible; and said invention consists in providing such globes with a residual atmosphere of carbonic monoxide as nearly as possible free from air. To accomplish this, I first remove the air from the globe as completely as it can be done with a Sprengel vacuum-pump, and then fill the globe with carbonic monoxide in a pure state and free from moisture. This is in turn pumped out, and the globe is refilled with the gas, this being repeated until the small amount of residual gas remaining in the globe consists almost entirely of carbonic monoxide, and this of course to the exclusion of the same amount of air.

A convenient apparatus for carrying out my invention is represented in the accompanying drawing.

A represents the inclosing-globe, and *a* the carbon filament of an incandescing electric lamp. Such globe is attached by tube *b* to the Sprengel vacuum-pump, of which *c* is the supply-tube and *d* the fall-tube.

B is a glass vessel, closed by an air-tight rubber stopper, *e*, in which are inserted tubes C and D. The tube C opens in the air, terminating in a rubber tube, *f*, provided with a pinch-cock, *g*, so that the opening may be closed. The tube D connects the vessel B with the Sprengel pump. This tube contains phosphoric anhydride *h h*, or similar drying agent, and caustic potash *i*. It is provided with stop-cocks *j* and *k*, and with a bulb, *l*, containing cotton for preventing the substances in the tube from being drawn out when the pump is working. The vessel B contains sulphuric acid and ferro-cyanide of potassium, and means (represented at E) are provided for heating the same. Such heating produces carbon monoxide. The stop-cocks *j* and *k* are left closed, and the cock *g* open until the vessel B becomes full of this gas, which displaces the air previously contained therein. The gas is then allowed to enter the lamp, from which the air has been exhausted, its moisture being removed by the phosphoric anhydride, and any carbonic acid which may have been given off is taken up by the caustic potash. After the globe is filled with the carbon monoxide the gas is pumped out and a second quantity allowed to enter. This is removed, and these operations are continued until only the smallest possible amount of carbonic monoxide, remains in the globe. During the latter stages of the operation the carbon filament of the lamp is heated to high incandescence by an electric current in order that the occluded gases may be driven off. The lamp is sealed off at *b*, and is then ready for use.

I am aware that British Patent No. 192 of 1879 describes the passing of a stream of carbon gas constantly through openings in a lamp-globe. This, however, forms no part of my invention, which relates only to lamps having sealed globes.

What I claim is—

The sealed globe of an incandescing electric lamp, provided with a residual atmosphere consisting almost entirely of carbonic monoxide, substantially as set forth.

This specification signed and witnessed this 12th day of September, 1882.

THOS. A. EDISON.

Witnesses:
WM. A. STERN,
H. W. SEELY.

(No Model.)

T. A. EDISON.

DYNAMO ELECTRIC MACHINE.

No. 297,582. Patented Apr. 29, 1884.

Fig. 2.

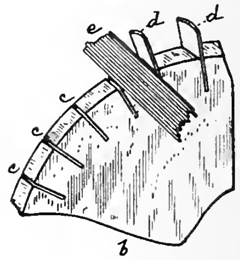
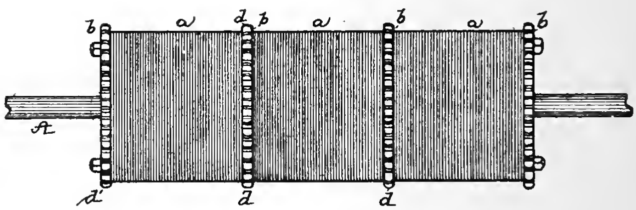


Fig. 1.



ATTEST:
E. C. Rowland
H. W. Seely

INVENTOR:
Thomas A. Edison
By Richd N. Dyer.
Atty

United States Patent Office.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

DYNAMO-ELECTRIC MACHINE.

SPECIFICATION forming part of Letters Patent No. 297,582, dated April 29, 1884.

Application filed June 29, 1883. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Dynamo-Electric Machines, (Case No. 575,) of which the following is a specification.

In the operation of large dynamo-electric machines it is sometimes found that when a heavy load is on the machine the resistance to the revolution of the armature is such as to tend to draw the wires wound thereon out of place, a strain being produced on said wires which might in some cases be so great as to break the connections between a coil and the commutator.

The object of my invention is to obviate this difficulty.

The armature-core which I prefer to use consists of a number of thin magnetic disks strung on a shaft, or on an insulating sleeve or hub, as set forth in my Patents Nos. 264,649 and 265,785; and my invention consists in the use of supports attached to said disks, between which the wires are wound longitudinally. Such supports act to prevent the strain on the wires, as the latter bear against the supports, and cannot therefore be displaced.

The preferable manner of carrying my invention into effect is to provide several thicker disks arranged at intervals among the ordinary disks of the core. Each of these thicker disks is provided with a number of slots or notches in its periphery. In each of such notches is inserted a slip or thin piece of a suitable material, preferably an insulating substance. These slips project radially from the disks to which they are attached, longitudinal rows of projecting supports being thus formed upon the core. Vulcanized fiber is a very suitable material for these supports. The wires which form the inductive portion of the armature are wound longitudinally between the supports, which prevent the wire from being drawn out of place to an injurious extent.

The invention is illustrated in the annexed drawings, in which Figure 1 is a view in elevation of an armature-core embodying said invention, and Fig. 2 a view of a portion of one of the thicker plates of said core.

A is the armature-shaft, on which are placed the thin disks of magnetic metal *a a*, which may or may not be separated from the shaft by a sleeve or hub of insulating material. Several thicker plates, *b b*, are interposed among the plates *a*, and each plate *b* is provided with a number of slots or notches, *c c*, each notch on one plate being in a line with one on each of the other plates. In each notch is placed a thin slip, *d*, of vulcanized fiber or any other suitable material. The wires *e* upon the cylinder are wound between the slips *d*, which act as previously described.

What I claim is—

1. The combination, with a solid cylindrical armature-core composed of disks strung on a shaft, and coils wound longitudinally thereon, of supports projecting from certain of said disks, forming longitudinal projecting rows, between which said coils are wound, substantially as set forth.

2. The combination, with the ordinary disks of the armature-core, of interspersed disks having slots or notches in their edges, and projecting supports inserted in said slots or notches, substantially as set forth.

3. The combination, with the ordinary thin disks of the core, of the interspersed thicker disks provided with projecting supports for the coils, substantially as set forth.

This specification signed and witnessed this 25th day of June, 1883.

THOS. A. EDISON.

Witnesses:

H. W. SEELY,
EDWARD H. PYATT.

(No Model.)

T. A. EDISON.

DYNAMO ELECTRIC MACHINE.

No. 297,583. Patented Apr. 29, 1884.

Fig. 1.

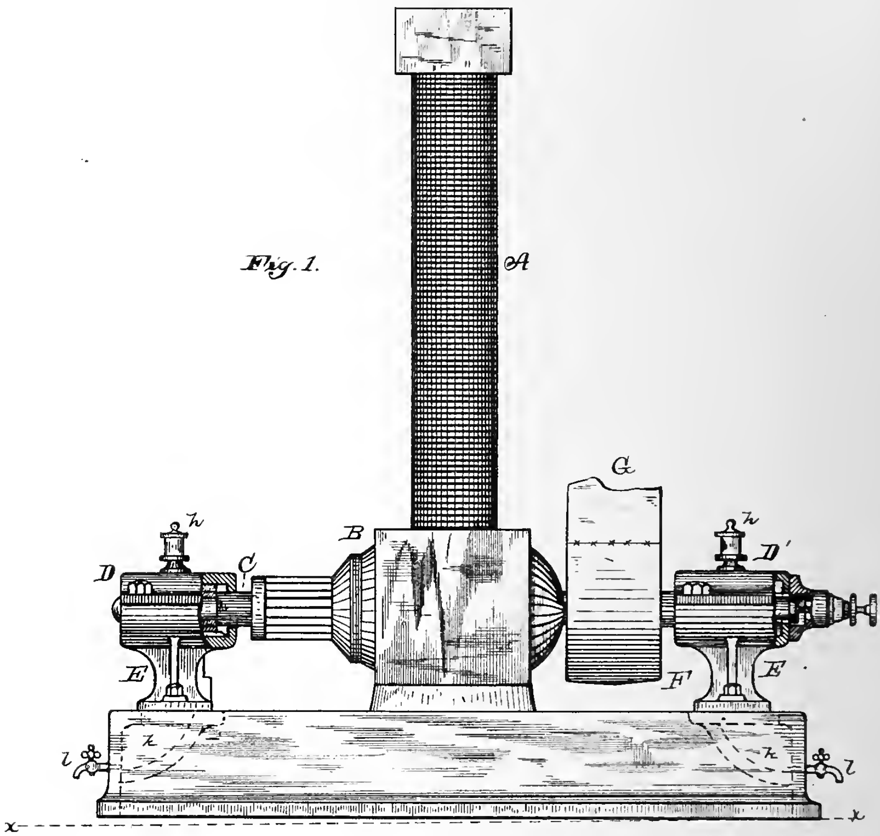


Fig. 3.

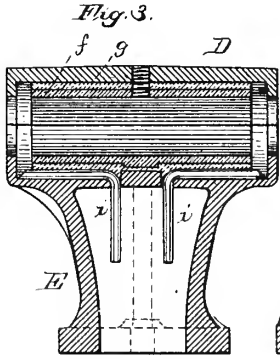


Fig. 4.

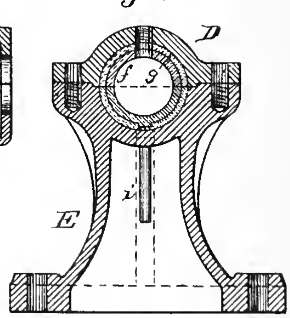
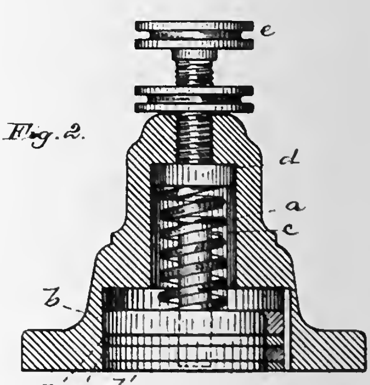


Fig. 2.



ATTEST:

E. C. Rowland

H. W. Seely

INVENTOR:

Thomas A. Edison,

By Richd N. Dyer

Atty.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

DYNAMO-ELECTRIC MACHINE.

SPECIFICATION forming part of Letters Patent No. 297,583, dated April 29, 1884.

Application filed October 10, 1883. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Dynamo-Electric Machines, (Case No. 587,) of which the following is a specification.

This invention relates to the bearings in which the armature-shaft of a dynamo-electric machine is supported, my objects being to produce an even wear upon the journals, preventing grooves from being worn therein; to produce also an even wear upon the commutator-cylinder of the machine; to produce an effectual lubrication by distributing the oil over the whole length of the journals, and to retain the surplus oil which runs down from the bearings, instead of allowing it to drip over the sides of the pillow-blocks upon the floor.

In carrying out my invention I so support the armature-shaft that it is free to move slightly in either longitudinal direction. There will then be a slight oscillation of the shaft back and forth in its bearings, caused by the jar of running the machine, or from other causes. This oscillation works the oil along the whole length of the journals, so as to produce an even lubrication, and also prevents any grit or hard particles from remaining in one place and wearing grooves in the journals. The commutator-brushes also do not bear always on the same part of the commutator-cylinder, and hence do not wear away the cylinder in grooves. I provide also tubes or passages leading from the journal-boxes down into the pillow-blocks, so that the oil which accumulates at the ends of the bearings runs down through such passages into receptacles formed for it in the bed-plate, such receptacles being provided with cocks for drawing the oil off when they become full. The balanced supporting of the armature-shaft is preferably accomplished by placing the machine at a slight angle from a vertical position, so that the shaft would tend to slide toward one end, and placing a spring at that end so adjusted as to just balance this sliding tendency. The shaft will then have a slight oscillation, as above explained. The balancing might, however, be done by inclining the machine as before, and so aligning the machine and the engine which drives it that the belt will tend to resist the sliding down of the shaft, the spring being dispensed with. It is evident, however, that the spring is preferable.

In the annexed drawings, Figure 1 is a view in elevation of the machine with the ends of the bearings shown in section; Fig. 2, a view of the spring which presses against one end of the shaft; Fig. 3, a longitudinal section of one of the bearings, and Fig. 4 a cross-section thereof.

A is the field-magnet, and B the armature of the machine. C is the armature-shaft. D D′ are the journal-boxes, and E E are the pillow-blocks. F is the pulley, and G the belt which runs to said pulley from the driving-motor.

The machine is set at an angle from the vertical. I have indicated this in the drawings by the dotted line *x x*, which would represent the floor-line were the inclination produced by raising one end of the bed-plate. It is to be understood, however, that the angle indicated by this line is much greater than that at which the machine is in reality placed, and is shown merely to illustrate the fact that the machine is inclined. The real angle is so small that it could not be shown in a drawing of this size, as the very least inclination of the machine is sufficient to accomplish the desired object; also, it is to be understood that the above is not the method which I prefer to employ for inclining the machine. Preferably one end of the bed-plate is made a trifle thicker than the other, or the pedestal of one journal-box is raised to a slight extent higher than the other, or the inclination is produced in some other manner in the construction of these stationary parts. The inclination of the machine causes a tendency on the part of the shaft to slide down toward the journal-box D′. To balance the shaft against this tendency, the spring *a* is made to bear against the end of the shaft through alternate washers *b b′*, of metal and fiber or leather, the last washer *b′* bearing directly against the end of the shaft. The rod *c* turns through all these washers except the last, and the spring *a* is coiled around this rod between the washers and the collar *d*. The pressure of the spring upon the shaft is adjusted by turning the rod *c*, it being provided with thumb-screw *e* for this purpose. The spring is thus adjusted to balance the downward tendency of the shaft, and said shaft is thus allowed to move slightly back and forth, with the result already specified. The journal-boxes are made, as usual, in two parts bolted together, and are lined, preferably, with phosphor-bronze *f* and Babbitt metal *g*. From the oil-caps *h h* the oil descends upon the journals and lubricates them evenly in every part. The oil accumulates at the ends of the bearings, and thence runs off through the pipes *i i*, which extend into the hollow pillow-blocks, and drops off into the receptacles *k k*, which are formed for this purpose in the bed-plate, the latter being in the form of an open-ribbed frame, as set forth in my application, Serial No. 99,553. Such receptacles are provided with cocks *l l*, by which the oil is withdrawn.

It is evident that most of the improvements herein described are applicable to machines other than electrical generators.

It is to be understood that all patentable features of invention shown or described, but not claimed herein, are reserved for protection by other patents, and have been or will be embodied in other applications for patents.

What I claim is—

1. In a dynamo-electric machine driven by a belt, the shaft balanced in its bearings, and free to move in either longitudinal direction, substantially as set forth.

2. The combination, with a dynamo-electric machine driven by a belt, of means tending to move the shaft of the machine longitudinally in one direction, and means acting with equal force to move it in the opposite direction, substantially as set forth.

3. The combination, with a dynamo-electric machine driven by a belt, of a spring bearing against an end of the armature-shaft, substantially as set forth.

4. In a dynamo-electric machine driven by a belt, the combination of a spring bearing against an end of the shaft of the machine, and means tending to move said shaft against said spring, substantially as set forth.

5. A belt-driven dynamo-electric machine placed at a slight angle from a vertical position, and provided with means resisting the consequent sliding tendency of the shaft of the machine, substantially as set forth.

6. A belt-driven dynamo-electric machine placed at a slight angle from a vertical position, and provided with a spring bearing against the lower end of its shaft, substantially as set forth.

7. In a dynamo-electric machine driven by a belt, the combination of an adjustable spring bearing against an end of the shaft of the machine, and means tending to move said shaft against said spring, substantially as set forth.

8. The combination, with a dynamo-electric machine, of a bed-plate therefor, formed as an open-ribbed frame, one or more oil-receptacles within said bed-plate, and one or more ducts leading from the journal-boxes to said receptacles, substantially as set forth.

This specification signed and witnessed this 27th day of July, 1883.

THOS. A. EDISON.

Witnesses:

H. W. SEELY,

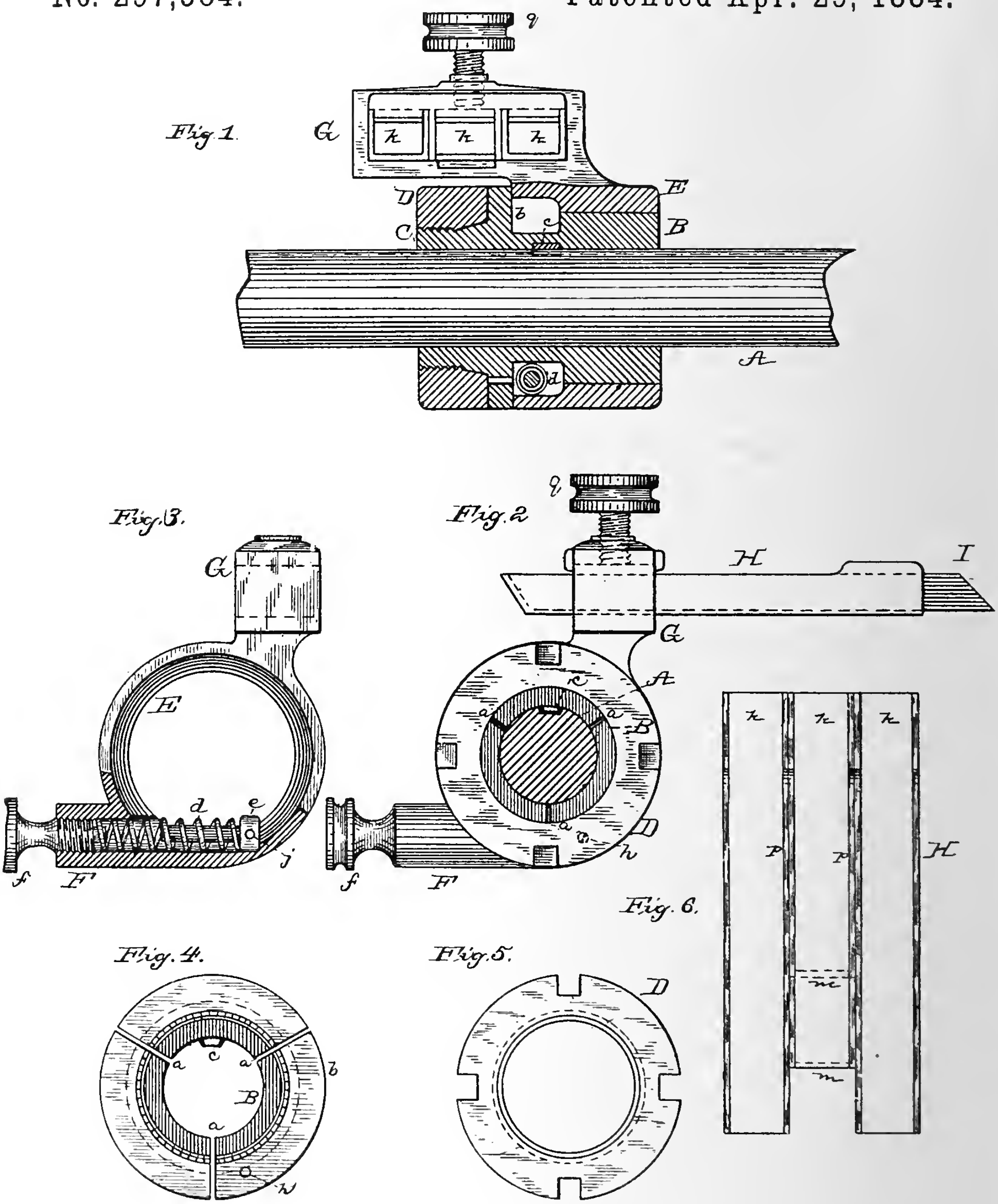
EDWARD H. PYATT.

(No Model.) 2 Sheets—Sheet 1.

T. A. EDISON.

DYNAMO ELECTRIC MACHINE.

No. 297,584. Patented Apr. 29, 1884.



ATTEST:

E. T. Rowland

H. W. Seely

INVENTOR:

Thomas A. Edison,

By Richd N. Dyer

Atty.

(No Model.)

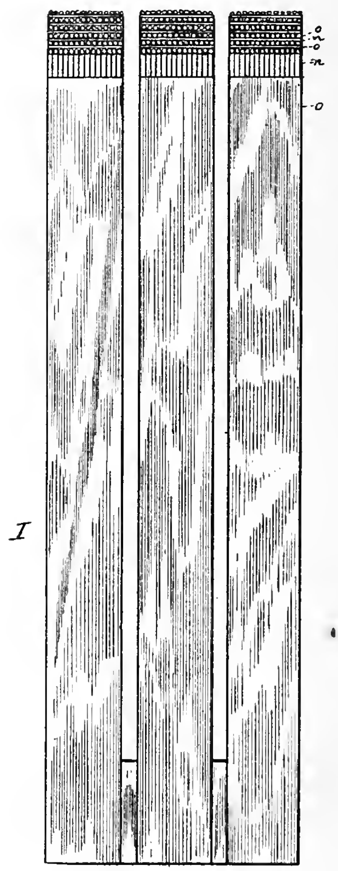
2 Sheets—Sheet 2.

T. A. EDISON.

DYNAMO ELECTRIC MACHINE.

No. 297,584. Patented Apr. 29, 1884.

Fig. 7.



ATTEST:
E. C. Rowland,
H. W. Seely

INVENTOR:
Thomas A. Edison,
By Rich^d N. Dyer,
Atty.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

DYNAMO-ELECTRIC MACHINE.

SPECIFICATION forming part of Letters Patent No. 297,584, dated April 29, 1884.

Application filed October 10, 1883. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Dynamo-Electric Machines, (Case No. 588,) of which the following is a specification.

This invention relates both to the brush-holders and the brushes themselves of electrical generators and motors. So far as it relates to the former, it is intended as an improvement on the invention set forth in my Patent No. 263,140. As is the case in that patent, I construct the main portion of the holder in two parts, one of which is fixed, while the other, which holds the brush, is held by an adjustable spring-pressure.

The present improvement has for one of its objects to render the brush-holder more compact in form and to conceal and protect the pressure-adjusting devices. The holder is also so constructed that as the end of the brush wears away it can readily be adjusted forward, while at the same time its whole length is well supported. The brush itself is preferably divided longitudinally into several (two or more) parts, so as to diminish spark, and that part of the holder which directly supports the brush is correspondingly divided.

My invention is illustrated in the annexed drawings, in which Figure 1 is a longitudinal section and partial elevation of my improved brush-holder mounted on a shaft or spindle; Fig. 2, an end view of the same holding the brush; Fig. 3, a view of the adjustable and adjusting parts of the holder; Fig. 4, an end view of that part of the holder which is placed on the spindle but with the clamping-ring removed; Fig. 5, a view of the clamping-ring; Fig. 6, a view of that part of the holder in which the brush is directly placed, and Fig. 7 a view of the divided brush.

A is the shaft or spindle, on which one or more brushes, bearing on one side of the commutator-cylinder, are mounted. Upon this spindle is placed a cylinder, B, one end, C, of which is split at *a a*, forming a split sleeve, upon which and against the flange *b* is screwed the ring or collar D, which clamps it upon the shaft. The cylinder B is also provided with a pin or projection, *c*, which enters a slot or groove in the spindle A to keep the cylinder from turning. This cylinder, therefore, forms the fixed portion of the brush-holder.

Upon the cylinder B is placed the adjustable part E, which holds the brush. From the sleeve or collar E a projecting tube, F, extends, in which is placed the spiral spring *d*, which is held between the plate *e* and thumb-screw *f*. The plate *e* bears against the inside of collar E, a depression being formed for this purpose, and plate *e* is connected with cylinder B by a pin, *h*, passing through a hole, *i*, in the split sleeve C into a hole, *j*, in the plate. The cylinder B and collar E are thus connected through the spring *d*, and their relative movement is limited by the spring. The projecting head G also extends from collar E, the collar E, tube F, and head G being all made in one piece. The head G supports the brush-holding frame H, which consists of three parts, *k k*, (or any other suitable number,) attached together, passed through the aperture in the head G and held by downwardly-projecting parts *m m*, one on each side of the head G.

The brush I is composed of layers of wires *n*, alternating with copper strips *o*. Through the greater part of its length it is divided into three parts, and these parts are placed in the three divisions of the frame H, separated by the sides *p* of the divisions. The ends of the brush-sections bear separately upon the commutator-cylinder, thus diminishing the spark. The brush is held by a set-screw, *g*, and by loosening this set-screw the brush may be adjusted forward as the ends of the wires wear away. The use of the alternate wires and strips gives strength to the brush and prevents it from spreading apart.

It will be seen that as the part E turns upon the part B, and the spring *d* bears upon the former, the brush is held against the commutator-cylinder by the spring-pressure, and such pressure is adjusted by means of the thumb-screw *f*. Several of these brush-holders may be placed upon the same shaft or spindle, all being adjustable independently.

What I claim is—

1. The combination, in a commutator-brush holder, of the shaft or spindle, a cylinder fixed thereon, a movable collar concentric to said cylinder and carrying the brush, and adjust-

ing means connecting said collar and cylinder, substantially as set forth.

2. In a commutator-brush holder, the combination of the cylinder fixed upon the shaft or spindle, the movable collar carrying the brush and sleeved upon the fixed cylinder, and the adjustable spring connecting the two parts, substantially as set forth.

3. The combination of the shaft or spindle, the inner cylinder formed as a split sleeve, the clamping-ring, and the outer adjustable collar carrying the brush, substantially as set forth.

4. The combination of the shaft or spindle, the inner cylinder having a pin entering a groove in said shaft or spindle, the clamping-ring, and the outer movable collar carrying the commutator-brush, substantially as set forth.

5. The combination, with the inner cylinder fixed upon the shaft or spindle and the outer movable collar thereon, of the adjustable spring attached to the movable collar, and the pin connecting said spring with the fixed cylinder, substantially as set forth.

6. The combination, with the adjustable collar provided with a projecting tube and the spring within said tube, of the inner fixed cylinder and a connection between the spring and said fixed cylinder, substantially as set forth.

7. The frame carried by the brush-holder and supporting the brush throughout the greater part of its length, substantially as set forth.

8. The combination, with the adjustable cylinder having a projecting head, of the brush-supporting frame carried by such head, substantially as set forth.

9. The combination of the adjustable cylinder having a projecting head provided with an aperture, the brush-supporting frame fixed in such aperture, and the brush held in such frame and adjustable through said aperture, substantially as set forth.

10. The combination of the longitudinally-divided brush and the brush-supporting frame correspondingly divided, the ends of the brush-divisions projecting beyond the frame, substantially as set forth.

11. The commutator-brush composed of alternate metal strips and layers of wires, substantially as set forth.

12. The longitudinally-divided commutator-brush composed of alternate metal strips and layers of wires, substantially as set forth.

This specification signed and witnessed this 8th day of August, 1883.

THOS. A. EDISON.

Witnesses:

H. W. SEELY,

EDWARD H. PYATT.

(No Model.)

T. A. EDISON.

INCANDESCING CONDUCTOR FOR ELECTRIC LAMPS.

No. 297,585. Patented Apr. 29, 1884.

ATTEST:
E. C. Rowland
H. W. Seely

INVENTOR:
Thomas A. Edison
By Richd N. Dyer
Atty

N. PETERS, Photo-Lithographer, Washington, D. C.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

INCANDESCING CONDUCTOR FOR ELECTRIC LAMPS.

SPECIFICATION forming part of Letters Patent No. 297,585, dated April 29, 1884.

Application filed October 10, 1883. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Incandescing Conductors for Electric Lamps, (Case No. 593,) of which the following is a specification.

The object of this invention is to produce incandescing conductors for electric lamps of even size, density, and resistance, and each of which shall be a homogeneous carbon filament. I accomplish this by twisting a strip of paper or other suitable carbonizable material tightly into an even cylindrical filament. I preferably employ a carbonizable cementing material to hold the twisted strip together. The filament thus formed is a homogeneous one, not made up of a number of separate strands, like the conductors of thread which have been sometimes used, while it possesses the advantages of such thread conductors, being cylindrical and of small area and radiating-surface. Being all in one homogeneous piece, all its parts contract and expand evenly, and all are of the same texture and resistance. The strips of paper can be cut with great exactness, so that all will be of precisely the same size, and, being cut from the same quality of paper, very even blanks are produced. Such blanks are then drawn through a die of the desired size and twisted evenly by suitable machinery, so that all the blanks will be twisted to the same extent and all the filaments will be of the same size and density. Preferably the strips of paper are formed with broadened ends, and such ends are also tightly twisted. The carbonizable cementing material binds the filament into a solid mass. Such material is preferably gum-tragacanth or other viscous carbonizable substance, with which the strip is covered before twisting. I may, however, first twist the strip, and then treat the twisted filament with hydrofluoric acid or other gelatinizing agent, gelatinizing a portion of its cellulose, and thus forming the carbonizable cementing material upon and within the filament itself; or the twisted strip might be parchmentized by sulphuric acid or chloride of zinc. The filament, prepared as described, is carbonized in a suitable manner, and may then be attached to leading-in wires and placed in the lamp.

The accompanying drawing represents a paper strip or blank partly twisted. The flat blank, as shown at A, is twisted tightly into the filamentary form shown at B. The blank is formed with enlarged ends *a*, which are twisted into cylindrical form, as at *b*.

What I claim is—

1. The incandescing conductor for an electric lamp, consisting of a carbonized tightly-twisted strip of paper or other suitable carbonizable material, substantially as set forth.

2. The incandescing conductor for an electric lamp, consisting of a carbonized tightly-twisted strip of paper or other suitable carbonizable material provided with a carbonizable cementing material, substantially as set forth.

3. The filament for forming, on carbonization, the incandescing conductor of an electric lamp, consisting of a tightly-twisted strip of paper or other suitable carbonizable material, substantially as set forth.

4. The filament for carbonization, consisting of a tightly-twisted strip of paper provided with a carbonizable cementing material, substantially as set forth.

5. The method of forming incandescing conductors for electric lamps, consisting in twisting a strip of carbonizable material into a homogeneous filament and carbonizing the same, substantially as set forth.

6. The method of forming incandescing conductors for electric lamps, consisting in twisting a strip of carbonizable material into a homogeneous filament, providing it with a carbonizable cementing material, and carbonizing the whole, substantially as set forth.

7. The method of forming incandescing conductors for electric lamps, consisting in twisting a strip of carbonizable material into a filament, treating the same with hydrofluoric acid or other gelatinizing or parchmentizing agent, to form a cementing material, and carbonizing the whole, substantially as set forth.

This specification signed and witnessed this 14th day of September, 1883.

THOS. A. EDISON.

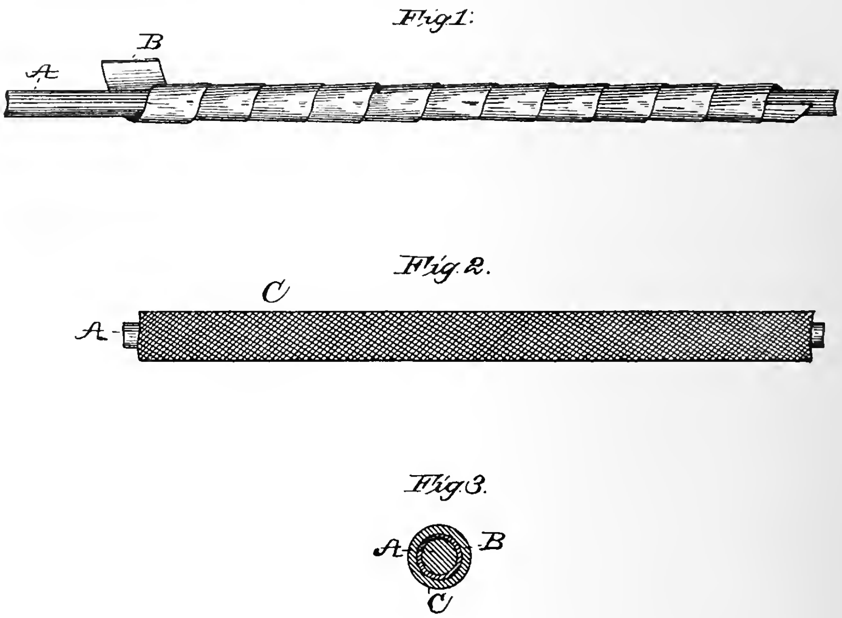
Witnesses:
H. W. SEELY,
EDWARD H. PYATT.

(No Model.)

T. A. EDISON.

ELECTRICAL CONDUCTOR.

No. 297,586. Patented Apr. 29, 1884.



ATTEST:

Edw. C. Rowland

H. W. Seely

INVENTOR:

Thomas A. Edison,

By Rich^d N. Dyer.

Atty.

N. PETERS, Photo-Lithographer, Washington, D.C.

United States Patent Office.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

ELECTRICAL CONDUCTOR.

SPECIFICATION forming part of Letters Patent No. 297,586, dated April 29, 1884.

Application filed October 10, 1883. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Electrical Conductors, (Case No. 596,) of which the following is a specification.

The object of this invention is to effectively insulate electrical conductors, the mode of insulation being especially adapted for conductors which are to form the inductive portions of the rotating armatures of dynamo-electric machines.

The invention consists, mainly, in the use of parchment-paper provided with a retaining-covering of fibrous material, braided, wound, or otherwise formed thereon. The parchment-paper may or may not be covered with Japan varnish. Being non-porous, this insulation does not allow the electricity to penetrate through it, and it is also a good conductor of heat, which it conveys from the armature coils or bars. Parchment-paper used alone possesses these characteristics to a degree practically sufficient, though the japanning of the paper increases them to some extent. I take a continuous strip of the parchment-paper and wind it spirally upon the conductor with the edges of the strip overlapping, so as to completely cover said conductor. The retaining-covering is of any suitable fibrous material, and is preferably braided tightly upon the parchment-covered conductor, though it may be wound thereon or otherwise applied. It keeps the parchment-paper in place and prevents it from unwinding from the conductor. Wire of any size, or the copper inductive bars used in large machines, may be insulated in this way, or a number of wires forming one conductor may be included in the same wrapping.

In the accompanying drawings, Figure 1 represents the wire wound with the spiral strip of parchment-paper; Fig. 2, the same with the retaining-covering braided thereon, and Fig. 3 an enlarged section of the complete insulated conductor.

A is a wire upon which is spirally wound the parchment-paper B, and over this is braided the retaining-covering C.

What I claim, is—

1. The combination, with an electrical conductor, of a strip of parchment-paper wound spirally thereon, and a braided or wound retaining-covering, substantially as set forth.

2. As an insulator for electrical conductors, japanned parchment-paper, substantially as set forth.

3. The combination, with an electrical conductor, of a strip of japanned parchment-paper wound spirally thereon with its edges overlapping, and a retaining-covering, substantially as set forth.

This specification signed and witnessed this 14th day of September, 1883.

THOS. A. EDISON.

Witnesses:

H. W. SEELY,
EDWARD H. PYATT.

(No Model.)

T. A. EDISON.

DYNAMO ELECTRIC MACHINE.

No. 297,587. Patented Apr. 29, 1884.

Fig. 1.

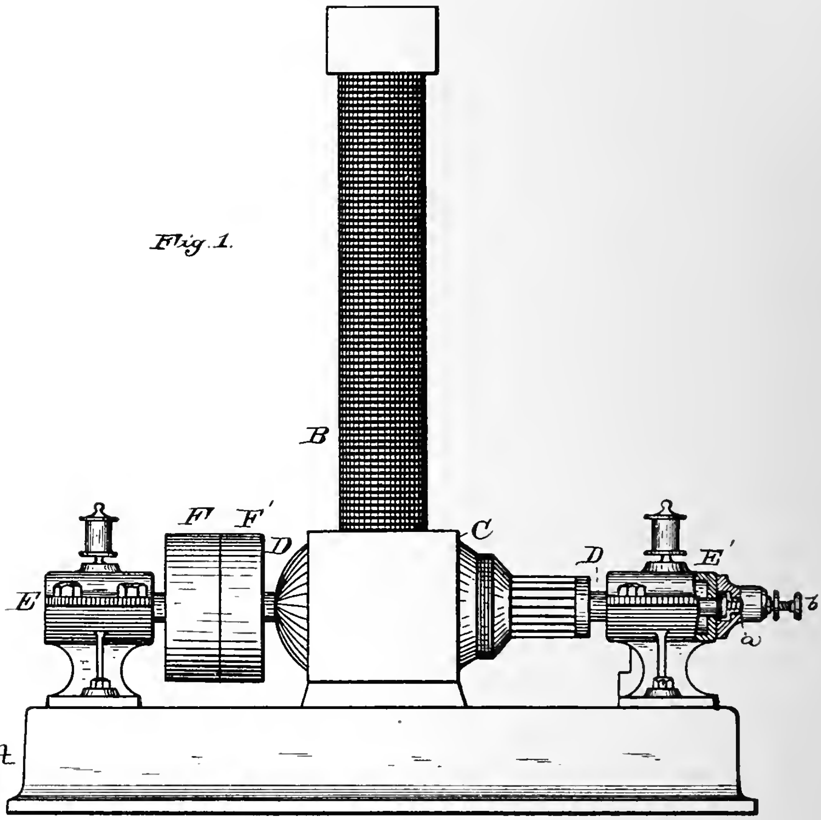


Fig. 2.

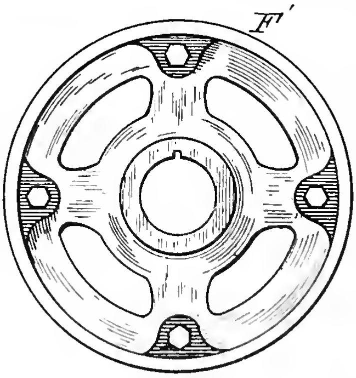
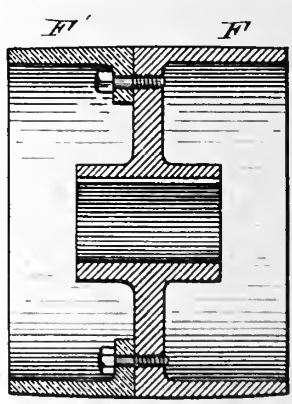


Fig. 3.



ATTEST:

E. C. Rowland

H. W. Seely

INVENTOR:

Thomas A. Edison

By Rich'd N. Dyer

Atty

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

DYNAMO-ELECTRIC MACHINE.

SPECIFICATION forming part of Letters Patent No. 297,587, dated April 29, 1884.

Application filed December 12, 1883. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Dynamo-Electric Machines, (Case No. 597,) of which the following is a specification.

In my application No. 587 (Serial No. 108,556) I have set forth means for balancing the armature-shaft of a dynamo-electric machine in its bearings, so that it is free to move longitudinally in either direction, whereby the efficient lubrication of the bearings and the even wearing of the journals and the commutator-cylinder are secured.

This invention relates to other means for accomplishing the same object. In the present case, as in that above referred to, I prefer to use a spring bearing against an end of the armature-shaft to produce the tendency in one direction of the shaft; but to balance this tendency I make use of the magnetic attraction of the field-magnet of the machine by so placing and constructing the driving-pulley that said pulley is nearly removed from the magnetic field, the attraction between the magnet-poles and the pulley sufficing merely to produce enough opposing tendency to the spring to balance its pressure. To accomplish this I prefer to make the pulley partly of magnetic and partly of non-magnetic material, the magnetic part being so proportioned and located that its attraction toward the poles will suffice to produce the result above specified. The shaft, being thus balanced, oscillates slightly in its bearings. The lubricating-oil is thus spread evenly upon the bearings, and grooves are not worn in the journals by grit or hard particles, which may enter them, or on the commutator-cylinder by the brushes.

Instead of the spring bearing against the end of the shaft, other means may be employed to balance the attraction of the magnet-poles. The machine might be set at a very slight inclination to produce a tendency for the shaft to slide slightly downward; or the alignment of the machine and its driving-motor might be such that the draft of the belt will oppose the magnetic attraction.

My invention is illustrated in the accompanying drawings, in which Figure 1 is a view of a dynamo-electric machine embodying said invention; Fig. 2, an end view of the driving-pulley, and Fig. 3 a section thereof.

A is the bed-plate, B the field-magnet, C the armature, and D the armature-shaft, of a dynamo-electric machine. The shaft is supported in journal-boxes E E'. In the box E' is placed a spring, *a*, which presses against the end of the shaft D, and whose tension is adjusted by means of set-screw *b*. The driving-pulley on the armature-shaft is made in two parts, bolted together—one, F, of iron or other magnetic metal, the other, F', of brass or other non-magnetic material. Preferably the magnetic portion F is placed on the side away from the magnet, so as to remove it farther from the magnetic field; but if it is made smaller it may be placed nearer the magnet. The attraction between the field-magnet poles and the part F of the pulley balances the pressure of the spring on the shaft, and the shaft is thus free to slightly oscillate longitudinally in its bearings.

What I claim is—

1. The combination, with a dynamo-electric machine, of means opposing the attraction of the driving-pulley by the field-magnet of the machine, substantially as set forth.

2. The combination, with a dynamo-electric machine, of a spring bearing on the end of the armature-shaft and opposing the attraction of the driving-pulley by the field-magnet, substantially as set forth.

3. The combination, with a dynamo-electric machine, of a driving-pulley nearly removed from the attraction of the field-magnet, and means opposing the slight attractive influence of said magnet upon said pulley, substantially as set forth.

4. The combination, with a dynamo-electric machine, of a driving-pulley partly of magnetic and partly of non-magnetic material, substantially as set forth.

5. The combination, with a dynamo-electric machine, of a driving-pulley partly of magnetic and partly of non-magnetic material, and means opposing the attraction of the

field-magnet for said pulley, substantially as set forth.

6. The combination, with a dynamo-electric machine, of a driving-pulley partly of magnetic and partly of non-magnetic material, and a spring opposing the attraction of said pulley by the field-magnet of the machine, substantially as set forth.

This specification signed and witnessed this 15th day of November, 1883.

THOS. A. EDISON.

Witnesses:

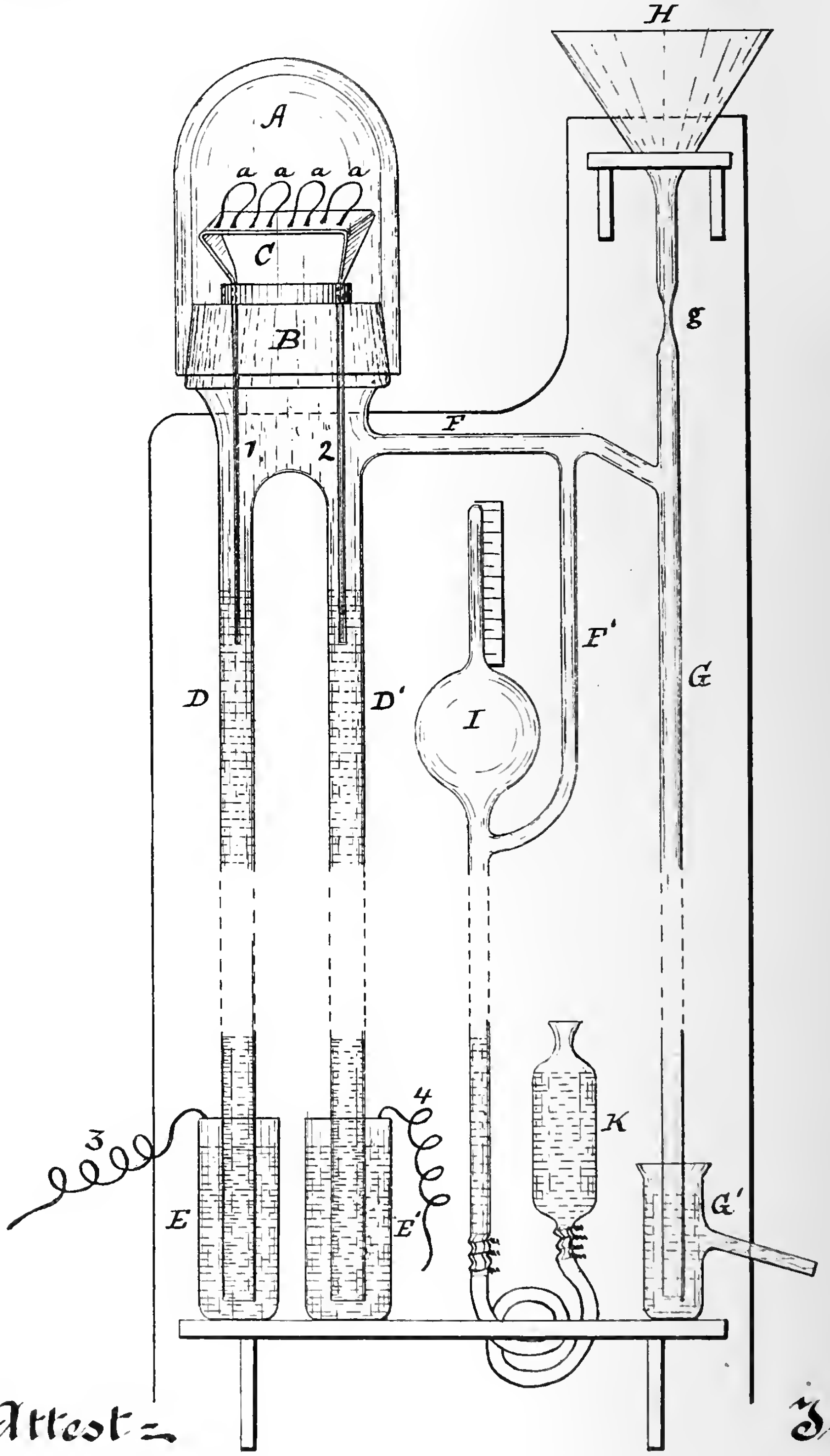
H. W. SEELY,
EDWARD H. PYATT.

(No Model.)

T. A. EDISON.

METHOD OF TREATING CARBONS FOR ELECTRIC LIGHTS.

No. 298,679. Patented May 13, 1884.



Attest:

Sam. D. Mott

James A. Payne

Inventor:

Thos. A. Edison

per Dyer & Wilber

Attys.

United States Patent Office.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, ASSIGNOR TO THE EDISON ELECTRIC LIGHT COMPANY, OF NEW YORK, N. Y.

METHOD OF TREATING CARBONS FOR ELECTRIC LIGHTS.

SPECIFICATION forming part of Letters Patent No. 298,679, dated May 13, 1884.

Application filed July 3, 1880. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Method of Treating Carbons for Electric Lights, (Case No. 221;) and I do hereby declare that the following is a full and exact description of the same, reference being had to the accompanying drawings, and to the letters of reference marked thereon.

As described in prior applications for patents by me made for improvements in electric lights, wherein the light is produced by an incandescent conductor hermetically sealed in a glass globe, the body of the incandescent conductor or carbon is very small—a mere filament or thread—but with enlarged ends for the purpose of affording better contact with the clamps. Preferably these carbons, of horseshoe form, are made of one piece of material, the entire device, body, and thickened ends being unitary and homogeneous, cut or shaped from suitable material and then carbonized. The carbonization is done in a nickel flask, the filamentary bodies being satisfactorily carbonized therein. It sometimes happens, though, that the broad ends are not thoroughly carbonized, as, owing to their greater mass the flasks would melt before the ends had reached thorough carbonization. It is essential that there should be thorough carbonization of every portion of the carbon, that every atom of hydrocarbon should be changed to carbon. If this be not done, the heat and high vacuo to which they are subjected in the lamp gradually throws out any unchanged hydrocarbon, eliminating it from the carbon and causing a deposit on the glass of a hydrocarbon. It is desirable, therefore, that the carbons should be treated by some process which will result in their entire and complete carbonization, and the object of this invention is to furnish a process or method for accomplishing that result. This method consists in subjecting the thickened ends only, but not the bodies, of the carbons, after carbonization in flasks, to a high heat *in vacuo*.

In the drawing is shown means by which this method may be readily practiced, the drawing being a front view of the apparatus necessary therefor.

B is a base of insulating material, preferably of glass, upon which rests the globe A, the two being so fashioned that their joint is air-tight, the glass surfaces being ground true for this purpose. I do not, however, claim herein the lamp of this construction, since I propose to cover it by a separate application for patent.

Attached to B hermetically are the tubes D D′, of a length somewhat greater than the height of a mercury column *in vacuo*, dipping in their lower ends in the mercury-reservoirs E E′, which seal their lower ends.

Passing through the base B are conductors 1 2, whose lower ends pass into the tubes D D′, reaching a short distance below the top of the mercury columns, and whose upper ends are united by a conductor, C, of a material capable of being rendered incandescent by an electric current—preferably platinum—and broadened on top, so as to form a seat or platform, on which carbon horseshoes may be laid.

From the body formed by the union of the two tubes D D′ a passage, F, leads to the pump, by which the air is exhausted. The pump herein shown is an exceedingly simple one, although any other suitable form of air-exhausting pump may be used. The pump consists simply of a long tube, G, whose lower end dips into a mercury-vessel, G′, provided with an overflow-spout, the upper end being formed into or provided with a mercury-reservoir, H. At a little distance from its upper end the tube G is contracted into a very narrow orifice, *g*, of a size which permits the mercury to fall through drop by drop. At a little distance below *g* the tube F enters G by a downward bend.

Connected to the tube F by tube F′, so as to be in connection with the pump and with the vessel under operation of the pump, is a McLeod gage, I, for determining the degree of exhaustion in A.

In carrying the method into practice the operation is as follows: Upon the platform C are laid the broad ends of a series of carbon horseshoes, *a a a a*, and the globe A placed on the base B, so that the joint between them is air-tight. The vessels E E and H being filled with mercury, the mercury dropping through *g*, each drop passing the tube F carries a modicum of air with it. As the air is exhausted from A and the tubes D D′ the mercury rises in the latter until, when the proper degree of exhaustion is reached, the mercury rises and contacts with 1 2. The circuit from a source of electric energy passing by 3 to E D 1 C 2 D′ E′ 4 is closed, the platinum C being thereby rendered incandescent, imparting its heat by conduction to the broad ends of the carbons *a a*. These broad ends are kept subject to this heat *in vacuo* until it is judged that they are thoroughly and evenly carbonized, the body of the carbons, on account of the poor heat-conducting qualities of the carbon, remaining unheated comparatively. When the carbons have been thus treated *in vacuo* sufficiently, the shade A is lifted off and the carbons removed and placed in lamps, where they are again subjected to heat in the process of exhausting the air, as detailed in a prior application.

Instead of being heated while *in vacuo* by an electric current, as here described, I have found that the same result may be attained by throwing upon their broad ends the rays of the sun properly focused, so as to raise them to a very high red or to a white heat while *in vacuo*. For this purpose I have used an apparatus like that shown, combined with a heliostatic arrangement adjusted to carry the lens, so that its focus shall remain at the proper spot.

The pump herein shown and described is given as showing means for carrying the invention herein claimed into practice; but no claim is now made to the pump, as such pump will form the subject of a separate application.

It will be seen that the parts shown at the left of the figure, which are connected with the pump by the glass tube F, form an incandescing electric lamp, and can be employed as such independent of their use in the method before described.

The lamp can be disconnected from the pump, as will be readily understood, by "sealing off" the tube F, and the vacuum will be maintained within the lamp by the ground-glass union or joint at the junction of the globe and base.

What I claim is—

1. The method of preparing carbons for incandescing electric lamps having broad or enlarged ends, consisting in first carbonizing the filament, converting its body into carbon, and then subjecting the broad ends or enlarged portions to the action of heat *in vacuo*, substantially as set forth.

2. The combination of a vacuum-chamber, a platform therein for the carbons, an exhausting apparatus, and means for imparting a high heat to the broad ends of the carbons while *in vacuo*, substantially as shown and described.

This specification signed and witnessed this 15th day of June, 1880.

THOMAS A. EDISON.

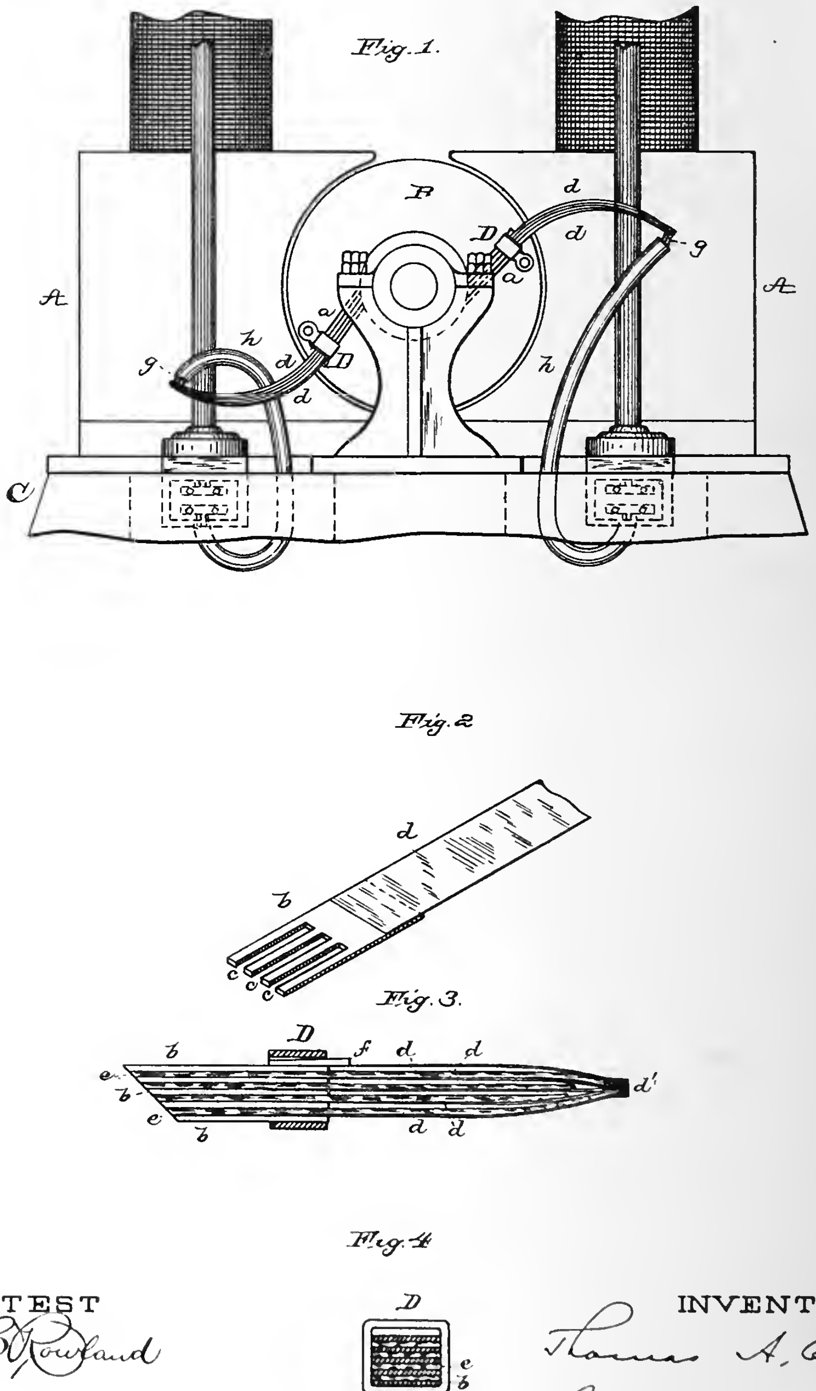
Witnesses:
S. L. GRIFFIN,
WM. CARMAN.

(No Model.)

T. A. EDISON.

DYNAMO ELECTRIC MACHINE.

No. 298,954. Patented May 20, 1884.



ATTEST

Edw. C. Rowland

H. W. Seely

INVENTOR.

Thomas A. Edison,

By Rich^d N. Dyer

Atty.

N. PETERS. Photo-Lithographer. Washington, D. C.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

DYNAMO-ELECTRIC MACHINE.

SPECIFICATION forming part of Letters Patent No. 298,954, dated May 20, 1884.

Application filed December 12, 1883. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Dynamo-Electric Machines, (Case No. 600,) of which the following is a specification.

In my Patent No. 276,233, dated April 24, 1883, are set forth the advantages of the use of current-collectors forming bridges of high resistance between the bars of the commutator-cylinder of a dynamo-electric machine or electro-dynamic motor, whereby the spark at the commutator-bars, due to the breaking of local circuits, is prevented, and in said patent is described the use for this purpose of current-collectors of inferior conducting capacity, making inferior contact at the surface of the commutator-cylinder.

My present invention relates to a different means of forming such high-resistance connections between the commutator-bars. Instead of making inferior contact at the commutator-cylinder, or forming the current-collector of inferior conducting material, I place the desired high resistance external to the current-collector, between it and the point of connection with the main conductor leading from the machine. I do this by using a divided commutator-brush composed of alternate layers of metal, preferably copper, and insulating material, and connecting all the metallic layers together through external conductors having the desired high resistance. The local current then, which passes through the brush from one commutator-bar to another, encounters the resistance of these separate conductors, having to pass through them to and from their point of connection together; and, therefore, as explained in the patent above referred to, this local current will be weak and the breaking at the surface of the cylinder of the local circuit will produce little or no spark.

My invention is illustrated in the annexed drawings, in which Figure 1 is a view in elevation of a portion of a dynamo-electric machine embodying said invention; Fig. 2, a view of one of the strips of the commutator-brush with the resistance-conductor attached thereto; Fig. 3, a side view of the brush and resistance-conductor with the clamping-sleeve in section, and Fig. 4 a cross-section of the brush.

A A are the field-magnet poles of a dynamo-electric machine or electro-dynamic motor. B is the armature thereof, and C the bed-plate, the lower portion of which is broken away in the drawings.

The commutator-brushes *a a* are each formed of several strips, *b*, of copper or other suitable metal, whose bearing ends are preferably divided by several slots or notches, *c c*, to divide and diminish spark at the ends.

To each metal strip *b* is attached a thin strip of metal, *d*. This may be copper, in which case it would be made of the desired resistance by properly proportioning its length and sectional area; or a strip of German silver or other high-resistance metal may be used, which would of course be larger and shorter than a copper strip. The ends of all these strips are soldered together at *d'*.

Between the metal strips of the brush are placed layers *e* of insulating material. Mica or asbestus is a suitable material for this purpose. The insulating-layers extend back close to the ends of the resistance-strips, and such ends are soldered together, and are all connected to the main conductor. Around the brush, at the outer end of the bearing-strips, is placed a sleeve of insulating material, which holds the metal and insulating-strips together, a wedge, *f*, of wood or other suitable material, being inserted within the sleeve to secure the whole tightly.

Instead of a single bearing-strip, *b*, with its end divided into fingers, several separate strips or wires may be secured to the resistance-strip *d*. The insulating-strips *e*, preferably, but not necessarily, are similarly divided. The ends of all the metal strips bear upon the commutator-cylinder, and the local circuit formed when the brush bridges the commutator-bars is around the outer end of the resistance-strips.

Any suitable number of current-collectors to produce the total conductivity required may be used on each side of the commutator-cylinder.

The circuit-connections from the ends of the resistance-strips are preferably made in the manner shown, conductors *g* extending through insulating-tubes *h* to clamping-plates on the bed-plate of the machine.

It is evident that many details—such as the form and arrangement of the external resistances—may be modified without departing from the spirit of my invention.

What I claim is—

1. An electrically-divided current-collector each of whose divisions is of such width as not to bridge the space between the commutator-bars, in combination with a resistance external to said brush, forming a high-resistance bridge between said bars, substantially as set forth.

2. The current-collector formed of alternate layers of metal and insulation, in combination with resistances external to said current-collector through which the metal layers are connected, substantially as set forth.

3. The combination of the metal-bearing strips or wires of a current-collector, resistances attached thereto and connected together and to the main conductor, and insulating material between the bearing ends and between the resistances, substantially as set forth.

4. The combination, with the metal bearing-strips and the interposed insulation, of the insulating-sleeve holding them together, substantially as set forth.

5. The combination, with the metal bearing-strips and the interposed insulation, of the insulating-sleeve and wedge holding them together, substantially as set forth.

6. The current-collector formed of strips of metal and interposed insulation, in combination with resistance-strips attached at one end to said metal strips, and all connected together at their other ends, substantially as set forth.

This specification signed and witnessed this 15th day of November, 1883.

THOS. A. EDISON.

Witnesses:
H. W. SEELY,
EDWARD H. PYATT.

(No Model.)

T. A. EDISON.

DYNAMO ELECTRIC MACHINE.

No. 298,955. Patented May 20, 1884.

Fig. 1.

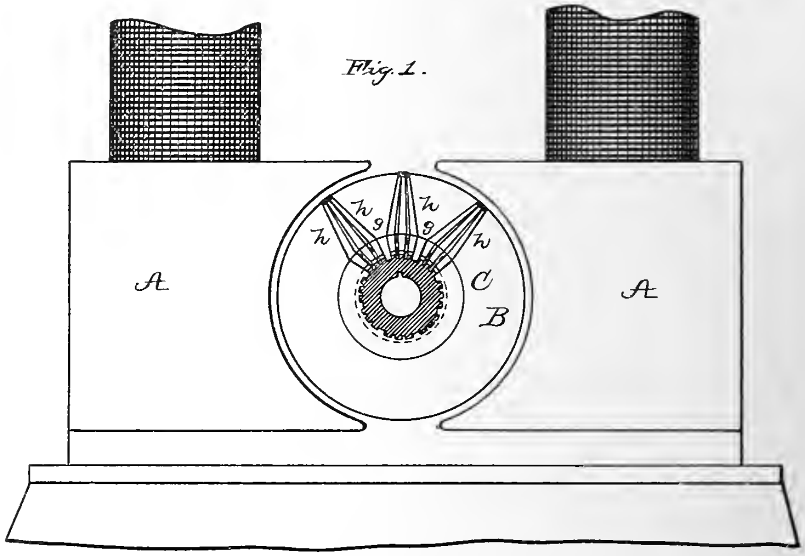
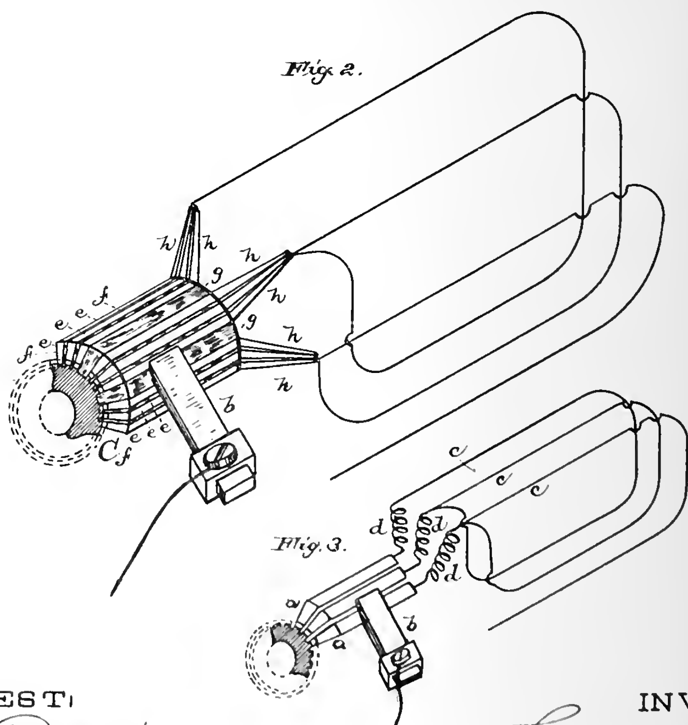


Fig. 2.

Fig. 3.



ATTEST:

E. C. Rowland

H. W. Seely

INVENTOR:

Thomas A. Edison

By Rich'd N. Dyer

Atty

N. PETERS, Photo-Lithographer, Washington, D. C.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

DYNAMO-ELECTRIC MACHINE.

SPECIFICATION forming part of Letters Patent No. 298,955, dated May 20, 1884.

Application filed December 12, 1883. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Dynamo-Electric Machines, (Case No. 601,) of which the following is a specification.

In my Patent No. 276,233 is set forth the use of current-collectors for electrical generators and motors of high resistance, whereby the local current set up when a current-collector bridges the commutator bars is weak, and little or no spark is produced by the breaking of the local circuit.

This invention relates to a different means for producing the same result; and it consists, mainly, in the use of connections of high resistance between the commutator-bars and the armature-coils of dynamo-electric machines and electro-dynamic motors; and it further consists in making this connecting resistance variable, so that a greater resistance is in the local circuit when the brush leaves a bar than when it is resting on said bar, this being accomplished by dividing each commutator-bar into several parts, all the parts of each bar being connected separately to the same coil of the armature, so that only one connection, and consequently the highest resistance, is interposed in the local circuit at the moment when the current-collector leaves the bar, whereby the spark is much lessened or entirely done away with.

The above may be better understood by reference to the annexed drawings, in which Figure 1 is a view in elevation of a portion of a dynamo-electric machine embodying my invention, the commutator-cylinder being in section. Fig. 2 is a view of a part of the commutator-cylinder, with a diagram of the armature-coils; and Fig. 3, a similar view illustrating the simplest form of the invention.

Referring first to Fig. 3, *a a* represent conducting-bars on the commutator-cylinder of a dynamo-electric machine. A commutator-brush, *b*, rests upon the bars. *c c* are coils upon the armature of the machine, and the connections of these coils with the respective commutator-bars are made through resistances *d d*. These resistances may be in the form of coils of wire, or thin strips of German silver, or other high-resistance metal; or any other suitable material in convenient form may be employed. The local circuit formed when the brush bridges two commutator-bars must include two of these resistances *d*, and consequently a weak current only can be generated in such circuit, incapable of producing any considerable spark when the circuit is broken.

Referring now to Figs. 1 and 2, A A are the poles of the field-magnet, and B is the armature of a dynamo-electric machine. C is the commutator-cylinder. Each of the ordinary bars upon its surface is divided into three parts, *e e e*, separated by mica, *f*, or other suitable insulation. Mica insulation *g* separates the divided bars from one another. All the divisions of a bar are connected at the same point to the armature-coils, the connections preferably being through resistances. Strips *h*, of German silver, are shown for forming these connections. These strips are attached to the commutator-bars, and the armature-coils to the strips in any suitable manner. When the brush *b* bears on all the divisions of a commutator-bar, the three connecting-strips *h* of that bar are all in circuit; but when it is upon the last division alone only one connecting-strip is in circuit, so that a high resistance is in circuit at the time when the circuit is broken by the brush leaving the last division of the bar.

I do not claim herein the use of resistances external to or separate from the current-collectors, forming bridges of high resistance between the commutator-bars, for this forms the subject of my application No. 600, (Serial No. 111,281.)

What I claim is—

1. In a dynamo-electric machine, the combination, with the commutator-bars and the armature-coils, of high-resistance connections between them, substantially as set forth.

2. In a dynamo-electric machine, the combination, with the commutator-bars and the armature-coils, of connections between them of varying resistance, the highest resistance being in circuit when the current-collector leaves a bar, substantially as set forth.

3. In a dynamo-electric machine, the divid-

ed commutator-bars, all the divisions of a bar being connected at the same point to the armature-coils, substantially as set forth.

4. In a dynamo-electric machine, the combination, with the armature-coils and the commutator-bars, of connecting-strips of high-resistance material between them, substantially as set forth.

5. In a dynamo-electric machine, the combination of the divided commutator-bars, the armature-coils, and the connecting-pieces of high-resistance material, all the divisions of a bar being connected at the same point to the armature-coils, substantially as set forth.

This specification signed and witnessed this 15th day of November, 1883.

THOS. A. EDISON.

Witnesses:

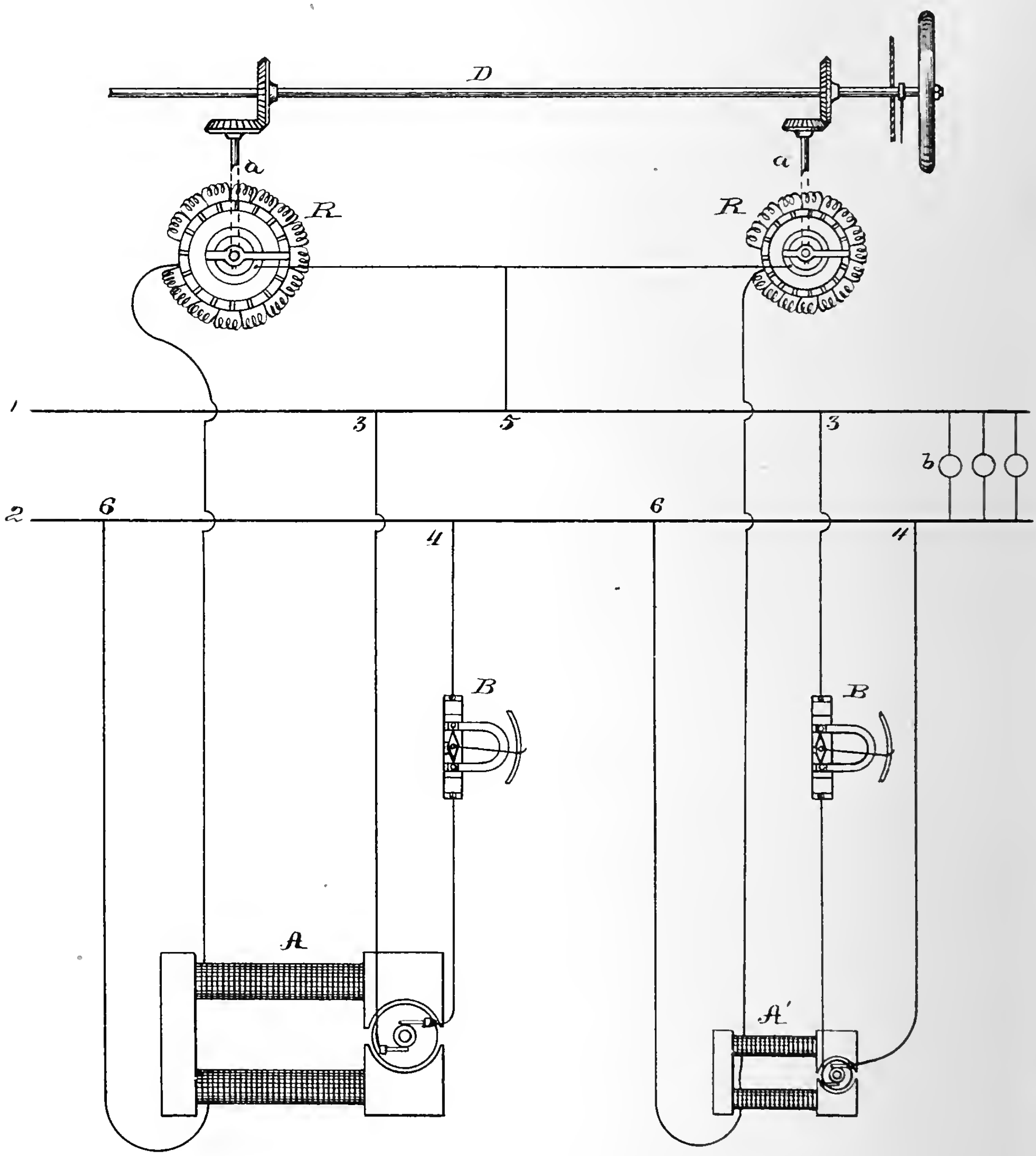
H. W. SEELY,
EDWARD H. PYATT.

(No Model.)

T. A. EDISON.

MODE OF OPERATING DYNAMO ELECTRIC MACHINES.

No. 298,956. Patented May 20, 1884.



WITNESSES:

E. C. Rowland

H. W. Seely

INVENTOR:

Thomas A. Edison

By Rich^d N. Dyer

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

MODE OF OPERATING DYNAMO-ELECTRIC MACHINES.

SPECIFICATION forming part of Letters Patent No. 298,956, dated May 20, 1884.

Application filed January 24, 1884. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Dynamo-Electric Machines and Methods of Operating the Same, (Case No. 612,) of which the following is a specification.

This invention relates to systems of electrical distribution in which two or more electrical generators are connected in multiple arc to the same main conductors.

Heretofore it has not been found practicable to use together two generators having the same electro-motive force but of different generative capacity, for the reason that, as the current is proportional to the electro-motive force and resistance, the entire current generated tends to divide itself equally between the two machines, and the smaller machine having armature-coils of less radiating capacity is unequal to the work put upon it, and has its coils injured or burned out by the excessive current which traverses them. I have often found it necessary or convenient to use machines of different capacity in connection with the same circuit. For instance, in a plant of fifteen hundred incandescent lights it might be desired to use a one-thousand-light and a five-hundred-light machine to produce the necessary quantity of current, and in some plants I may wish to keep small machines as spare machines, which are thrown into circuit when an unusual load is put upon the generating-station. To provide for such instances as these I have devised a method of operation which allows the running of two unequal machines in multiple arc from the same circuit. I do this by regulating the electro-motive force of the machines until each machine gives its proper proportion of the entire current generated. I employ indicators of ampères of current, one for each machine, whereby I can determine what current each machine is giving, and I adjust the electro-motive force (which can be done in various ways) until the indicators show the right proportion for each machine. The machines are then regulated together and in the same proportion according to variations in the current required. Where the load is constant, of course no such regulation is necessary. The way in which I prefer to vary the electro-motive force of the machine is by adjusting resistances in their field-magnet circuits. The resistance for each machine has its coils proportioned to the generative capacity of the machine. I prefer to have the resistance-arms detachably connected together, so that they can be worked alone or simultaneously. When the machines are first placed in circuit, I disconnect the arms and adjust the resistances until the ampère-meters show the right proportions. I then reconnect the arms and adjust the resistances together according to variations in the load. The reduction of electro-motive force for the smaller machine may, however, be accomplished by running it at a somewhat lower speed than the other, or in any other suitable way. The small machine, running at lower electro-motive force, does less work than the larger in the proportion of their respective capacities. The commutator-brushes are kept adjusted to the point of least spark, as such point varies with the load upon the machine. It is evident that in some cases it may be desirable to regulate the electro-motive force of only one of two machines in order to properly proportion the two.

The accompanying drawing is a diagram illustrative of the invention.

A and A′ represent two dynamo-electric machines of unequal generative capacity. Their armatures are connected in multiple-arc circuits 3 4 with the main conductors 1 2, and the field-magnets are placed in other circuits, 5 6.

B B are indicators of ampères of current. Any ampère-indicators may be employed—for instance, that set forth in my application No. 611, (Serial No. 118,543.) In each field-circuit is an adjustable resistance, R. The adjusting-arms are connected detachably with spindles *a a*, which are revolved by the shaft D. The resistances are disconnected and adjusted until the indicators B show the right proportion, and then, the resistance-coils being relatively proportioned, as shown, according to the capacity of the machines in connection with which they are used, they are connected again with the shaft and may be adjusted simultaneously if variations occur in the number of translating devices *b b* in circuit.

I do not claim herein the ampère-indicator in the armature-circuit of each machine, as this is claimed in my application No. 605, (Serial No. 114,283.)

What I claim is—

1. The combination of two machines of different generative capacity connected in multiple arc with the same circuit, and having their respective electro-motive forces adjusted as described, substantially as set forth.

2. The combination of dynamo-electric machines of different generative capacity connected in multiple arc with the same circuit, and means for regulating the electro-motive force of one or more or all of said machines, substantially as set forth.

3. The method of operating dynamo-electric machines of different generative capacity in multiple-arc connection with the same circuit, consisting in adjusting the electro-motive force of one or more or all of said machines until each gives its right proportion of the entire current, substantially as set forth.

4. The method of operating dynamo-electric machines of different generative capacity in multiple-arc connection with the same circuit, consisting in separately adjusting their electro-motive force until each gives its right proportion of the entire current, and then adjusting their electro-motive force simultaneously according to variations in the common load, substantially as set forth.

5. The combination of dynamo-electric machines of different generative capacity connected in multiple arc with the same circuit, and an adjustable resistance in the field-circuit of each, the coils of the resistances being proportioned to the machines, and said resistances being adjustable separately or simultaneously, substantially as set forth.

This specification signed and witnessed this 5th day of January, 1884.

THOS. A. EDISON.

Witnesses:
WM. H. MEADOWCROFT,
H. W. SEELY.

(No Model.) 2 Sheets—Sheet 1.

T. A. EDISON.

ELECTRICAL METER.

No. 304,082. Patented Aug. 26, 1884.

Fig. 1.

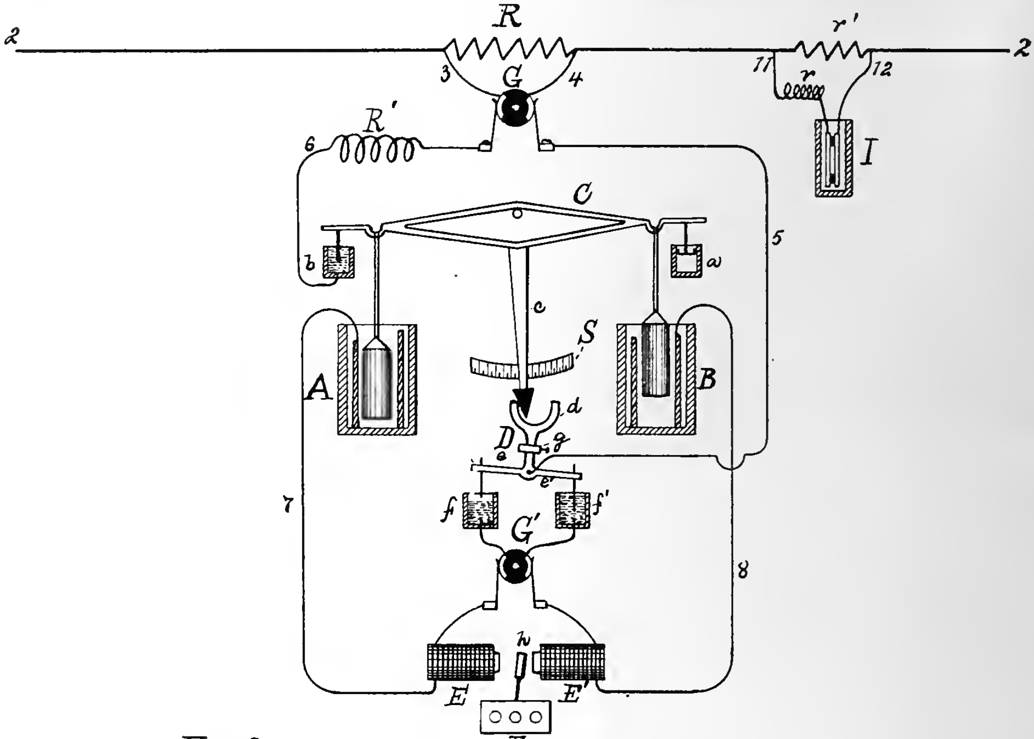
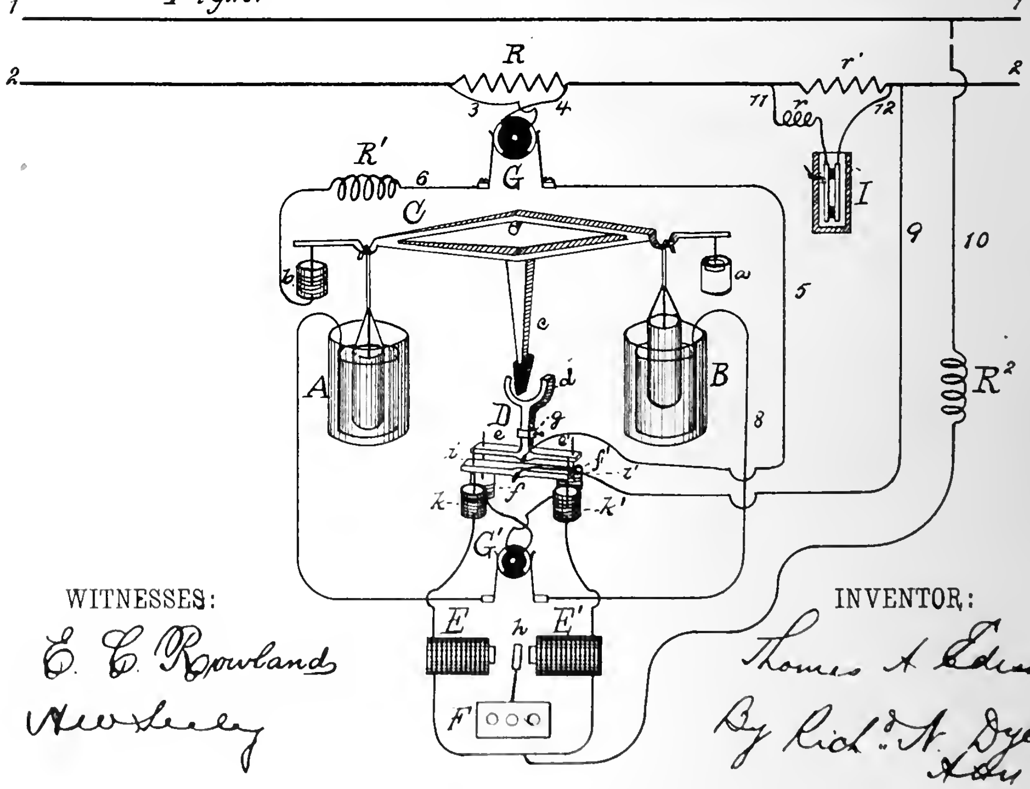


Fig. 2.



WITNESSES:

E. C. Rowland

[illegible]

INVENTOR:

Thomas A. Edison,

By Rich[d]. N. Dyer

Atty.

N. PETERS, Photo-Lithographer, Washington, D. C.

(No Model.)

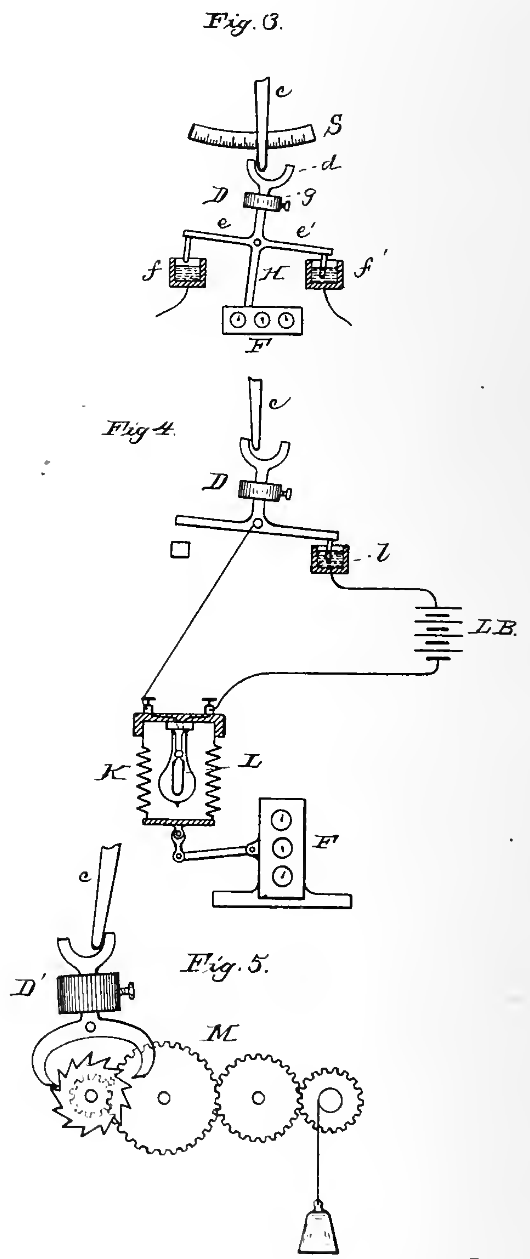
2 Sheets—Sheet 2.

T. A. EDISON.

ELECTRICAL METER.

No. 304,082.

Patented Aug. 26, 1884.



ATTEST:

E. C. Rowland,

Edward H. Pyatt

INVENTOR:

Thomas A. Edison,

By Richd. N. Dyer,

Atty.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, ASSIGNOR TO THE EDISON ELECTRIC LIGHT COMPANY, OF NEW YORK, N. Y.

ELECTRICAL METER.

SPECIFICATION forming part of Letters Patent No. 304,082, dated August 26, 1884.

Application filed August 14, 1882. (No model.) Patented in England July 10, 1882, No. 3,271; in Germany November 8, 1882, No. 23,909; in Italy November 14, 1882, No. 14,757; in Belgium November 15, 1882, No. 59,396; in France November 22, 1882, No. 139,689, and in Spain April 23, 1883, No. 3,860.

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Electrical Meters, (Case No. 454;) and I do hereby declare that the following is a full and exact description of the same, reference being had to the accompanying drawings, and to the letters of reference marked thereon.

The object of this invention is to produce an automatically-registering meter for measuring the electrical energy consumed in a circuit, which will be simple in construction and efficient in operation. This is accomplished by the use of two electrolytic cells, two of the electrodes (one of each cell) being suspended from the ends of a beam, which is supported centrally on a pivot. These cells are arranged in a shunt-circuit around resistance placed in the line of one of the main conductors of a house-circuit, and have connected with them a circuit making and breaking device operated by the beam, by which the current of the shunt always passes through the cell, having its electrode elevated or depressed, according to whether the meter is acting by depositing upon or stripping from the suspended electrodes. The deposit upon the elevated electrode increases its weight until it overbalances the depressed electrode at the other end of the beam, and the beam is tipped or metal is stripped from the depressed electrode until it becomes lighter than the elevated electrode, when the same movement takes place. The movement is utilized to break the circuit of the cell through which the current has been passing, and to complete the circuit of the other cell. The movement of the beam is also used to work a registering apparatus, either by making and breaking the circuits of electromagnets or by a mechanical connection with the beam or a part moved by it. The electromagnets (if used) may be in circuit with the cells or in other circuits. To register a partial movement of the beam, a scale may be provided, upon which will travel a finger attached to or worked by the beam. The beam will continue to tip back and forth, and its movements will be indicated by the register, the suspended electrodes acting as the cathodes of the cells, and receiving additional weight alternately, or acting as the anodes and being stripped alternately. At the end of each month or other fixed period the direction of the current through the cells and the connections of the circuit-controller will be reversed, and the suspended electrodes will become the anodes of the cells, if they have been acting as the cathodes during the previous month, or the cathodes if they have before acted as anodes. To effect the reversal of the current and the connections of the circuit-controller, a simple hand-reverser is used for such purpose, which will be mounted upon a common spindle, and will be worked simultaneously by the employé of the lighting company who makes note of the condition of the meter. To maintain electrical connection with the working-beam, such beam is provided with a rod at one end dipping in a cup of mercury, which keeps the parts in good electrical contact without producing friction. The circuit-controller worked by the beam makes and breaks the circuits of the cells by means of mercury-cups and points which are dipped into and raised out of the mercury, the movement thus requiring very little power. The working-beam has its movement retarded by means of a reciprocating dash-pot, so as to assure regularity and prevent the meter from being affected by jars. A compensating-resistance is placed in the circuit of the cells, so as to compensate for changes in resistance caused by variations in temperature, and a lamp or other heating resistance the circuit of which is closed by a thermostatic device is used with each meter to prevent the freezing of the solution of the cells. In connection with each automatic meter a simple electrolytic cell-meter may be used to keep the record intact if the automatic meter should become inoperative. For this extra cell, as well as the cells of the automatic meter, there are preferably used amalgamated-zinc electrodes placed in a solution of sulphate of zinc.

The foregoing will be better understood by reference to the drawings, in which Figure 1 is an elevation, partly diagrammatic, of the meter; Fig. 2, a perspective view, partly diagrammatic, with modified connections for the registering electro-magnets; Fig. 3, a view of detached parts, showing means for operating the register mechanically from the working-beam; and Figs. 4 and 5, views similar to Fig. 3 of other modifications.

A and B are two electrolytic cells, each composed, preferably, of two cylindrical electrodes of amalgamated zinc placed in a solution of sulphate of zinc. One electrode of each cell is suspended from the end of a beam, C, which is pivoted centrally. At one end this beam is connected with the reciprocating plunger of a dash-pot, *a*, while at its other end it has a rod projecting into a mercury-cup, *b*, and kept constantly immersed in the mercury of the cup. The beam C has an arm or finger, *c*, projecting therefrom, which plays in the U-shaped yoke *d* of a pivoted circuit-controller, D, the parts being insulated to prevent short-circuiting the cells. This circuit-controller has three arms—a vertical arm, which has the yoke *d* at its end, and two horizontal arms, *e e'*, provided with points dipping in mercury-cups *f f'*. The circuit-controller is pivoted at the junction of the arms, and its vertical arm has an adjustable weight, *g*, to throw the circuit-controller when it is carried over the center by the arm *e* of the beam C.

E E' are two electro-magnets acting upon an intermediate armature-lever, *h*, the movement of which works the register F.

G G' are simple hand-operated current-reversers, which are shown separated for clearness of illustration, but which, in practice, are mounted on a common spindle and moved simultaneously.

1 2 are the main conductors of a house-circuit, having placed therein a resistance, R, around which is the shunt-circuit through the meter. This shunt has wires 3 4 running from opposite sides of the resistance to the current-reverser G. From one spring of the current-reverser a wire, 5, extends to the circuit-controller D. From the other spring of the current-reverser a wire, 6, extends to the mercury-cup *b*, and from the stationary electrodes of the cells A B wires 7 8 extend to the coils of the electro-magnets E E', Fig. 1, and from thence to the current-reverser G' and the mercury-cups *f f'*. A resistance, R', is placed in the shunt-circuit at any particular point common to both cells, to compensate for variations in the resistance of the cells in circuit, caused by changes in the temperature of the solution.

The operation is as follows, reference being had more especially to Fig. 1: If the reversers are in the position shown in Fig. 1 and the beam C is depressed at cell A and elevated at B, then the arm *e'* of the circuit-controller D will be depressed, making contact with the mercury in cup *f'*, while arm *e* will be elevated, breaking contact with mercury in *f*. The current in the shunt will then be from 2 on one side of R, by wire 4 through G, by wire 5 through D, cup *f'*, reverser G', electro-magnet E', wire 8, from stationary to suspended electrode of cell B, arm C, cup *b*, wire 6, resistance R', reverser G, and wire 3, to 2 on the other side of the resistance R. E' will attract *h*, causing it to work the register with one impulse, and there will be a deposit upon the elevated suspended electrode of B until its weight overcomes the weight of the depressed suspended electrode of A, when the beam C will be tipped, the movement being regulated by dash-pot *a* and the electrical connection with C being maintained by the mercury-cup *b*. Now, the point of *e* will be in the mercury of cup *f*, while the point of *e'* will be raised out of the mercury of cup *f'*. The current will now flow from 2 by 4 G 5 D *f* G', electro-magnet E 7, from stationary to suspended electrode of cells A C *b* 6 R' G 3, back to 2. The electro-magnet E will now attract *h*, giving another movement to the register, while the deposit will be upon the elevated suspended electrode of A, which will finally overbalance the depressed suspended electrode of B, causing the beam C to tip again, and repeat the operation. In this operation the suspended electrodes act as the cathodes of the cells, and the meter works by depositing metal first upon one electrode and then upon the other. At the end of a month, or after any other lapse of time, the reversers G G' will be turned. The stationary electrodes will then become the cathodes of the cells, and metal will be stripped from each suspended electrode when in a depressed position, until it becomes lighter than the elevated electrode, when the beam will be tipped. The course of the current in that case will be explained in connection with Fig. 2, which shows the reversers shifted.

In Fig. 2 there is especially shown a modification of the connections of the electro-magnets E E', which operate the register. Instead of having those electro-magnets directly in the circuit of the meter, they may be in a multiple-arc circuit, 9 10 from 1 2, with additional resistance R^2, if required. In that case the circuit-controller D will operate an additional pair of arms, *i i'*, which will be insulated from the rest of the circuit-controller, and will carry points dipping in cups *k k'*. The wire 9 will run to the arms *i i'*, and from the mercury-cups *k k'* the circuit will divide to the two electro-magnets, E E', from which the wire 10 will extend to the other main conductor. With this construction the wires 7 8 pass from the stationary electrodes of the cells directly to the current-reverser G', and do not connect with the coils of the electro-magnets E E'. Each time the current-controller D is moved by the movement of the beam C, the circuit of one of the electro-magnets E E' will be broken, and that of the other electro-magnet completed, thus working the register.

When the reversers are shifted to make the suspended electrodes the anodes of the cells, Fig. 2, the current will take the following course: Supposing the beam C to be depressed at cell A and the point carried by arm e' to be immersed in the mercury of cup f', from 2 on one side of R by wire 4 to G, from thence by wire 6, resistance R′, to cup b, then by beam C to the suspended electrode of cell A, and from there to the stationary electrode of A, and by wire 7 to reverser G′, cup f', controller D, wire 5, reverser G, and wire 3, back to wire 2 on the other side of R. Metal will be stripped from the suspended electrode of A, when it will be overbalanced by the suspended electrode of B, causing the beam C to tip and the arm e to make contact in f. Now, the current will be from 2 on one side of R, *via* 4 G 6 R′ b C, through cell B, from the suspended to the stationary electrode 8 G′ f D 5 G 3, to 2 on the other side of R. The suspended electrode of B will now be stripped until lighter than that of A, when the beam C will again be tipped and the operation repeated. The electro-magnets E E′ will work the register at each movement of C, as before explained. This register will be worked by complete movements of the beam, but will not be affected by a partial movement, which it may be desirable to take account of. For this purpose a scale, S, is placed back of the arm or finger e, or is otherwise arranged in connection with the beam C, so that it will show partial movements of such beam.

Instead of using electro-magnets to operate the register, an arrangement operated mechanically by the movement of the beam C may be employed. A construction for the purpose is shown in Fig. 3, wherein an arm, H, projects downwardly from the pivoted circuit-controller D, and by its movement works the register; or the electro-magnets E E′ may be employed to operate the register, and be worked by a local battery, the circuit of which will be made and broken by the movement of the beam; or a thermostatic device worked by the expansion of a rod or chamber may be used to operate the register, the circuit through this device being made and broken by the movement of the beam.

A local battery is shown in Fig. 4 as used in connection with a thermostatic device, although the thermostatic device may be connected with the light-circuit. The use of a local battery with the electro-magnets E E′ will be readily understood. To effect the change from the arrangement shown in Fig. 2 it would be only necessary to disconnect the wire 9 10 from 1 2 and to connect 9 10 with the binding-posts of a galvanic battery, the extra resistance R^2 being omitted.

In Fig. 4, K is an expansible chamber inclosing a heating-resistance, L, which is shown as an incandescent electric lamp. F is the register connected with the chamber K, and operated by it. L B is a local battery in circuit with the resistance L, the circuit-controller D, and the mercury-cup l. When D is tipped in one direction, the circuit of the local battery is closed and the resistance heated, expanding the chamber and moving the register-arm in one direction. The tipping of D in the other direction breaks the circuit, allowing the resistance to cool and the chamber to contract, moving the register-arm in the other direction. A spring or weight operated mechanism could be used to work the register, it being released and locked by the movement of the beam. This is illustrated in Fig. 5, wherein a pivoted tipping device, D′, worked by the arm e from the beam, acts to lock and release a scape-wheel of a weight or spring operated train, M, forming part of the register. An incandescing electric lamp or other form of heating-resistance the circuit of which is closed by a thermostatic device is used in connection with the meter to prevent the solution of the cells from freezing, as shown in my Patent No. 251,558.

In connection with each automatic meter there is preferably used a simple electrolytic meter, I, placed with compensating-resistance r in a shunt-circuit, 11 12, around a resistance, r', in one of the main conductors of the house-circuit. This extra cell furnishes an accurate and reliable means of calculating the consumption, and its plates may be weighed if the automatic meter gets out of order, or as a check upon its accuracy. The automatic meter hereinbefore described differs essentially from that set forth in my Patent No. 240,678, in that in the meter of said patent the movement is produced by taking metal from one and adding metal to the other of two counterbalancing electrodes simultaneously, the current being reversed at each movement, while in the meter hereinbefore described the movement is produced by first adding metal to one and then adding it to the other of two counterbalancing electrodes, or first taking metal from one and then from the other of two counterbalancing electrodes, the current being reversed periodically by hand-reversers. The counterbalancing electrodes are thus both of the same nature, being both cathodes or anodes, and never one an anode and the other a cathode. The use of a complicated automatic current-reverser is thereby avoided, and the meter made more simple, efficient, and less liable to get out of order.

What I claim is—

1. An electrical meter having in combination two electro-depositing cells, and means for passing current through the cells alternately, substantially as set forth.

2. In an electrical meter, the combination of two electro-depositing cells, a pivoted beam from which one electrode of each cell is suspended, means for completing the circuit through the cells alternately, and a registering mechanism, substantially as set forth.

3. In an electrical meter, the combination of two electro-depositing cells, a pivoted beam from which one electrode of each cell is suspended, means for completing the circuit through the cells alternately, and reversers for periodically changing the relation of the electrodes of the cells, substantially as set forth.

4. In an electrical meter, the combination, with a pivoted beam, means operated by the current for oscillating said beam, and a registering apparatus moved by such oscillations, of a dash-pot for retarding the movement of the beam, substantially as set forth.

5. In an electrical meter, the combination, with two electro-depositing cells, of a pivoted beam from which one electrode of each cell is suspended, means for completing circuit through the cells alternately, a registering mechanism, and a movement-retarding device, substantially as set forth.

6. In an electrical meter, the combination, with the oscillating beam, of means operated by the current for oscillating such beam, a dash-pot for retarding the movement of the beam, and a mercury-cup for maintaining electrical connection with such beam, substantially as set forth.

7. In an electrical meter, the combination, with two electro-depositing cells, of a pivoted beam carrying an electrode of each cell, a pivoted circuit-controller worked by the movement of the beam and making and breaking circuits at mercury contacts, and having connections for completing circuit through the cells alternately, and a registering mechanism, substantially as set forth.

8. In an electrical meter, the combination, with two electro-depositing cells, of a working-beam from which one electrode of each cell is suspended, a circuit-controlling device for completing circuit through the cells alternately, and two current-reversers, one for reversing the connections of the meter with the main circuit and the other for reversing the connections within the meter between the circuit-controller and the cells, substantially as set forth.

This specification signed and witnessed this 24th day of June, 1882.

THOS. A. EDISON.

Witnesses:
RICHD. N. DYER,
EDWARD H. PYATT.

(No Model.)

T. A. EDISON.

DYNAMO ELECTRIC MACHINE.

No. 304,083. Patented Aug. 26, 1884.

Fig. 1.

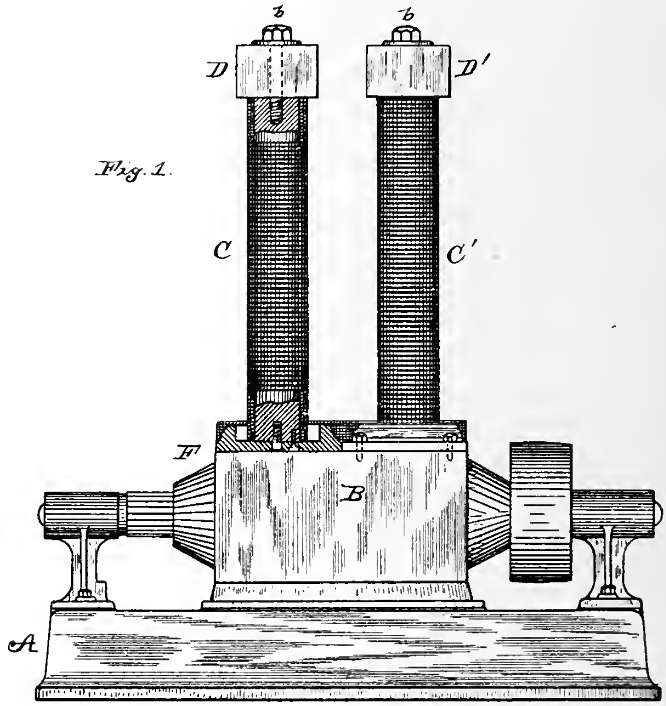


Fig. 3.

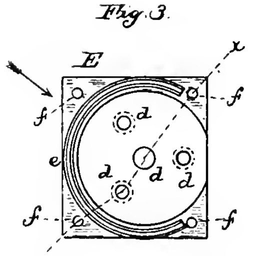
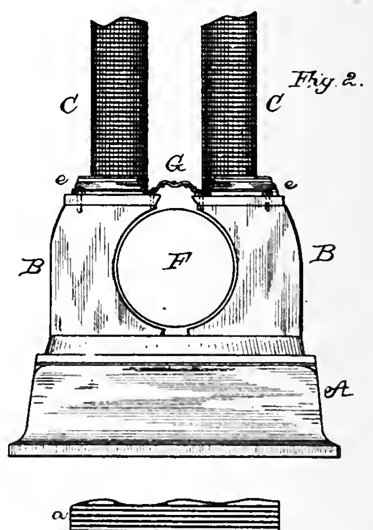


Fig. 2.



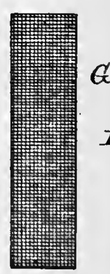
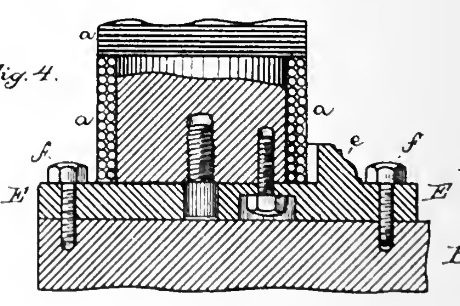


Fig. 6.

Fig. 5.

Fig. 4.



ATTEST:

E. C. Rowland

H. W. Seely

INVENTOR:

Thomas A. Edison

By Richd. N. Dyer

Atty.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

DYNAMO-ELECTRIC MACHINE.

SPECIFICATION forming part of Letters Patent No. 304,083, dated August 26, 1884.

Application filed October 10, 1883. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Dynamo-Electric Machines, (Case No. 586,) of which the following is a specification.

This invention relates, mainly, to the field-magnets of dynamo-electric machines, my object being to so construct such magnets that any core may be removed from its place without affecting the other cores.

Another part of the invention relates to the protection of the armature of an upright machine from dust and other substances which might fall upon it from above. The first object is attained by attaching each core removably to its polar extension in the manner to be presently set forth, or to the polar extension common to it and other cores, and to the yoke or back piece of the magnet of which such core forms a part; and the second object I accomplish by placing a cover of wire-gauze or other material, which, while it prevents the passage of dust, &c., will allow the circulation of air through it, across the space between the polar extensions over the armature. The cores are removably connected to the yokes or back pieces by bolts (or equivalent removable connecting devices) passing through such yokes into the tops of the cores and held by nuts, which can be unscrewed and the bolts withdrawn, and to connect a core removably to the polar extensions such core is attached to a plate by bolts passing through the bottom of said plate into the end of the core. Such plate is then removably secured to the polar extensions. The plate is preferably provided with an ornamental and protective flange extending up around the bottom of the magnet-core, except on the side toward the armature. The cores being made solid, of wrought-iron, are for cheapness and convenience made of cylindrical form from end to end. The pole-pieces are solid and rest upon a base, and hence the bolts for securing the cores to the pole-pieces could not well be passed entirely through them. The intermediate plates, which are preferably of cast-iron, are therefore used for securing the cores and pole-pieces together. These plates, however, do more than simply attach these parts. They form good magnetic joints between them. Before using these plates I experienced some difficulty in fitting the surfaces of the heavy cores and pole-pieces directly together so that there would be large surface-contact and good magnetic conductivity; but the comparatively light plates can be well fitted to the surfaces so as to make a good magnetic joint between them, and this can be done at less expense than the direct fitting of the cores and pole-pieces. The wire-gauze cover which extends across the space between the extensions may be secured to these plates.

In the accompanying drawings, Figure 1 is a side elevation of a dynamo-electric machine with the two ends of one of the magnet-cores in section; Fig. 2, an end view of the machine with the details of the armature omitted; Fig. 3, a plan view of one of the plates which are secured to the polar extensions; Fig. 4, a section of the lower part of a magnet-core, taken on the dotted line *x x* of Fig. 3, looking from the direction indicated by the arrow; Fig. 5, an elevation of one of the flanged plates, and Fig. 6 a view of the wire-gauze cover of the armature.

A is the bed-plate on which the machine is mounted. B B are the polar extensions of the machine, from each of which rise two magnet-cores, C and C′, which are wound with wire coils *a* and form the field electro-magnets. The yokes or back pieces, D D, connect the two magnet-cores C together and the two cores C′ together, respectively. The yoke D is secured to the magnet-core C by a bolt, *b*, passing through the yoke into the end of the core and secured by the nut *c*. All the other cores C and C′ are attached to the yoke in the same manner. The lower end of each core C is secured by bolts *d d* to a plate, E, such plate being of greater area than the core, and having a flange, *e*, which extends up around the lower part of the core, except on the side toward the armature F. Each plate E is secured to the polar extension by bolts *f f*. A screen, G, preferably of wire-gauze, is placed over the space *g* between the polar extensions and fastened at both sides. This prevents dust, &c., from falling upon the armature, while it does not hinder the passage of air through the space.

It is evident that by removing the necessary nuts and bolts any core may be removed from its place without affecting the other cores when it is desired to rewind a core on account of a cross in the wire, or for any other purpose, it being of course much more convenient to work on the core when it is detached from the rest of the machine.

What I claim is—

1. In a dynamo-electric machine, the combination, with the pole-pieces, of the magnet-cores and intermediate plates, secured both to said pole-pieces and such cores for removably attaching them together and forming good magnetic joints between them, substantially as set forth.

2. The combination, with a dynamo-electric machine having a vertically-placed field magnet or magnets, of a screen covering the space above the armature between the polar extensions of said magnet or magnets, substantially as set forth.

3. The combination, with a dynamo-electric machine having a vertically-placed field magnet or magnets, of a wire-gauze screen covering the space above the armature between the polar extensions of said magnet or magnets, substantially as set forth.

This specification signed and witnessed this 27th day of July, 1883.

THOS. A. EDISON.

Witnesses:
H. W. SEELY,
EDWARD H. PYATT.

(No Model.)

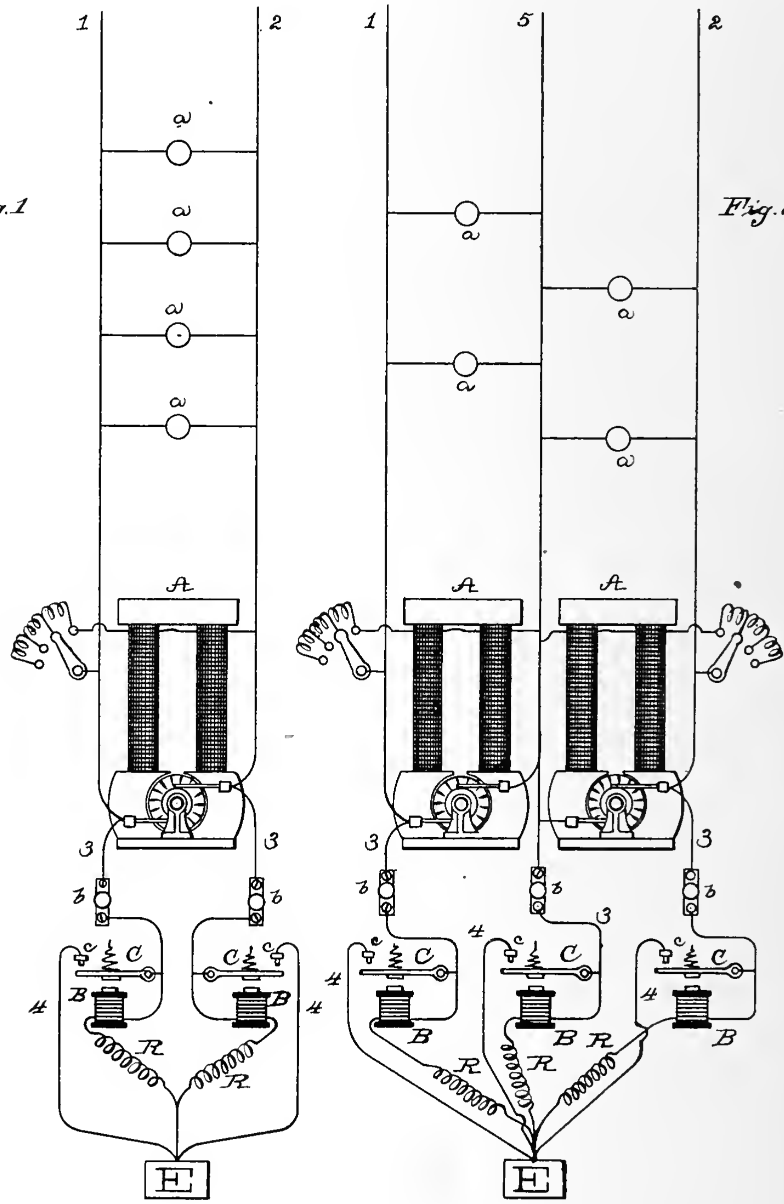
T. A. EDISON.

DEVICE FOR PROTECTING ELECTRIC LIGHT SYSTEMS FROM LIGHTNING.

No. 304,084. Patented Aug. 26, 1884.

Fig. 1

Fig. 2.



ATTEST:

E. C. Rowland

H. W. Seely

INVENTOR

Thomas A. Edison

By Rich. N. Dyer

Atty

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

DEVICE FOR PROTECTING ELECTRIC-LIGHT SYSTEMS FROM LIGHTNING.

SPECIFICATION forming part of Letters Patent No. 304,084, dated August 26, 1884.

Application filed October 10, 1883. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Systems of Electrical Distribution, (Case No. 590,) of which the following is a specification.

The object of this invention is to protect electrical generators and the translating devices connected therewith from being injured by lightning conveyed to them by the metallic conductors which extend from them.

In my application No. 589 (Serial No. 108,559) is shown an arrangement for this purpose, consisting of connections of high resistance extending from the two or more metallic conductors leading from the generator or generators to the earth, which connections do not materially detract from the current passing to the translating devices of the system, but act to convey the discharges to the earth if either of the metallic conductors should be struck by lightning. The especial object I now have in view is to allow the closed ground-circuits to be of very high resistance without impairing the degree of protection afforded. To accomplish this, I provide ground-conductors of very high resistance and devices included in such conductors, which, on the passage of an abnormal current, such as a lightning-discharge, cause the closing of low-resistance conductors, which convey the lightning to the earth. As in the application above referred to, one set of ground-connections is made from each of the two or more metallic conductors which extend from the source of energy.

My invention is illustrated in the annexed drawings, in which Figure 1 is a diagram illustrating the application of my invention to an ordinary multiple-arc system of electrical distribution, and Fig. 2 a diagram showing it in connection with a compensating or three-wire system.

Referring to Fig. 1, A is a dynamo-electric machine, and 1 2 are main conductors extending therefrom and supplying lamps, motors, or other translating devices *a a*, connected in multiple arc. From each main conductor a ground-wire, 3, extends to earth E, containing a high resistance, R, preferably of a metal having a low fusing-point. Each conductor 3 is closed by means of a plug, *b*, and these plugs are inserted upon the approach of a thunder-storm. Each conductor 3 also includes the coils of an electro-magnet, B. Each magnet is provided with a pivoted spring-retracted armature, C, which is attracted by the magnet away from a contact-point, *c*. Each armature C forms part of the low-resistance ground-connection 4. When the circuits are closed at *b*, the magnets B attract their armatures, breaking circuits at *c c*. Being of high resistance the ground-circuit 3 3 takes very little current from the system. Such circuit may, however, be arranged to convey small quantities of lightning to the earth. If, however, an abnormal current due to an excessive lightning-discharge upon either of the main conductors 1 2 reaches a conductor 3, such conductor is fused by it, the armature C is retracted by its spring, connection is made at *c*, and the lightning passes to the earth through the low-resistance conductor 4. It is necessary, as explained in the application referred to, to have the ground-connection from both main conductors, in order that whichever conductor may be struck the lightning may pass to earth without crossing through the lamp-circuits or armature-circuit.

In Fig. 2, in addition to the main conductors 1 and 2, the compensating-conductor 5 extends from between the generators A A, the translating devices *a a* being connected between said compensating-conductor and the main conductors. Each of the three metallic conductors 1, 2, and 5 is therefore provided with the ground-connections 3 4, and the accompanying circuit-controlling devices, as described with reference to Fig. 1. While it is preferred to place these devices at the central station or source of supply, it is evident that they might be arranged at any part of the system.

What I claim is—

1. The combination, with an electrical generator and the external circuit therefrom, of two conductors extending from each side of said circuit to the earth, and means controlled by the current in one of the earth-circuits thus formed for controlling the other earth-circuit, substantially as set forth.

2. The combination, with an electrical generator and the external circuit therefrom, of a high-resistance conductor and a low-resistance conductor extending from each side of the circuit to the earth, whereby two earth-circuits are formed, and means controlled by the current in the high-resistance earth-circuit for controlling the low-resistance earth-circuit, substantially as set forth.

3. The combination, with an electrical generator and the external circuit therefrom, of a high-resistance and a low-resistance ground-connection from each side of said circuit to the earth, whereby two earth-circuits are formed, and means actuated by an excess of current in the high-resistance earth-circuit for closing the low-resistance one, substantially as set forth.

4. The combination, with the fusible high-resistance conductor connected as described, of an electro-magnet therein, and a circuit-closer controlled by said magnet, and acting, upon a cessation of current in the magnet-circuit, to close circuit through a similarly-connected low-resistance conductor, substantially as set forth.

This specification signed and witnessed this 27th day of July, 1883.

THOS. A. EDISON.

Witnesses:

H. W. SEELY,

EDWARD H. PYATT.

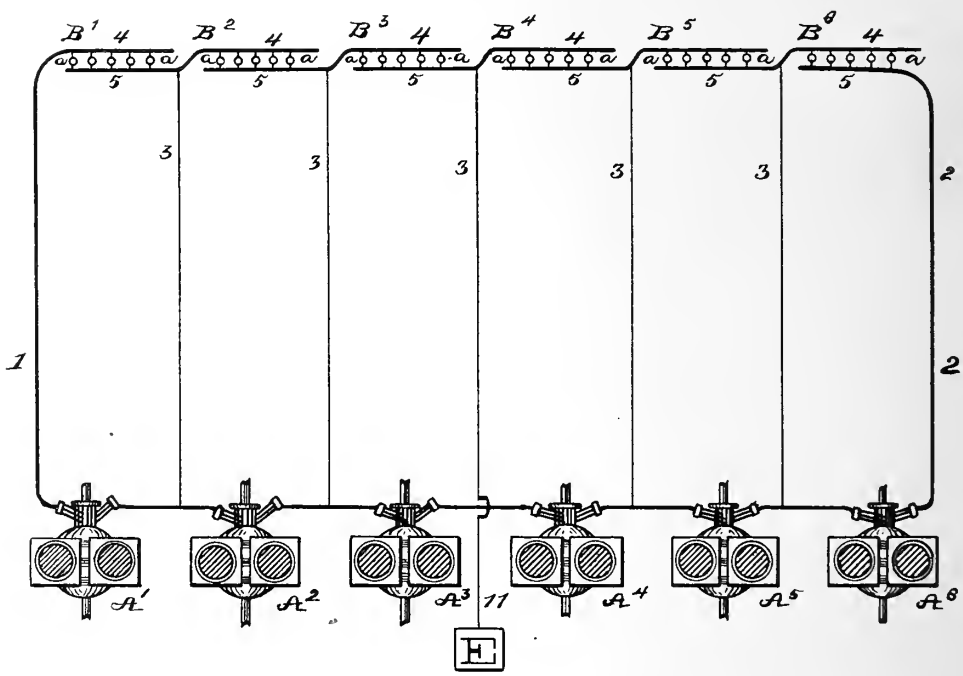
(No Model.) 2 Sheets—Sheet 1.

T. A. EDISON.

SYSTEM OF ELECTRICAL DISTRIBUTION.

No. 304,085. Patented Aug. 26, 1884.

Fig. 1.



ATTEST:

E. C. Rowland

H. W. Seely

INVENTOR:

Thomas A. Edison,

By Rich'd N. Dyer

Atty

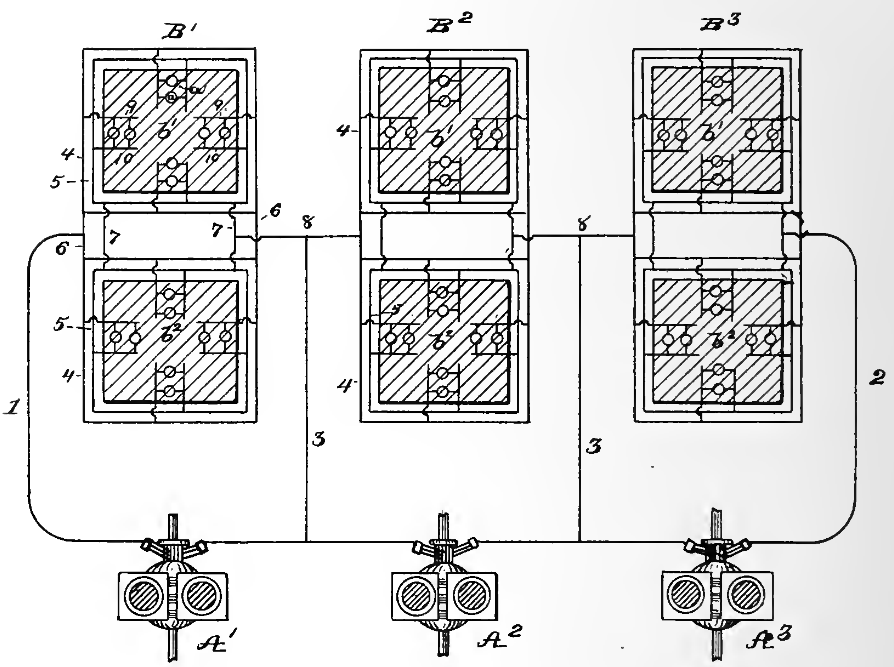
(No Model.) 2 Sheets—Sheet 2.

T. A. EDISON.

SYSTEM OF ELECTRICAL DISTRIBUTION.

No. 304,085. Patented Aug. 26, 1884.

Fig. 2.



ATTEST:

E C Rowland

H W Seely

INVENTOR:

Thomas A Edison

By Rich^d N. Dyer

Atty

N. PETERS, Photo-Lithographer, Washington, D. C.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

SYSTEM OF ELECTRICAL DISTRIBUTION.

SPECIFICATION forming part of Letters Patent No. 304,085, dated August 26, 1884.

Application filed December 12, 1883. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Systems of Electrical Distribution, (Case No. 591,) of which the following is a specification.

My invention relates to compensating systems of electrical distribution, such as the one described in my Patent No. 274,290; and the principal object I have in view is such an arrangement of the conductors and translating devices that all the translating devices will be equidistant from the source of electrical energy, and hence will be affected alike without the necessity of running feeding-circuits to various parts of the system, in order to equalize the electro-motive force at the translating devices. This I accomplish in the following manner: The conductors and translating devices of each division of the compound compensating-circuit are arranged so that for each translating device a greater length of conductor on one side of the circuit will be opposed by a correspondingly shorter length on the other side of the circuit. This feature of arrangement is carried out in the connection of the several divisions of the compound compensating-circuit, the connected conductors extending in opposite directions and forming opposite sides of the divisions connected—that is to say, the negative side of one division of the circuit is connected to the positive side of the next division, and so on. The main conductors from the source of electrical energy at the central station are connected to opposite sides of the first and last divisions of the circuit, while the compensating-conductors are run out from points between the sections of the source of energy to the conductors connecting the divisions of the circuit. By this arrangement only one set of mains and compensating-conductors is required, while the translating devices are all equidistant from the source of electrical energy. This relation is always preserved and is not affected by differences in the number of translating devices in the several divisions of the circuit, or by the total stoppage or neutralization of the current in one or more divisions, since the translating devices are equidistant from the source of electrical energy by way of the compensating-conductors as well as by way of the main conductors. In practice the district to be lighted from one source of electrical energy will be divided into as many parts as there are divisions of the compound compensating-circuit. Each division of the district may be one or more blocks of a town or city, or, if the plant is a small one, one or more buildings, or one or more floors or other parts of the building, or other object or place to be lighted. Throughout each division will be run a pair of main conductors, one being the positive and the other the negative main conductor, with relation to the translating devices of the particular division. If the district is composed of the blocks of a town or city, the pairs of main conductors of each division will be run around the blocks or through them, or both. Each conductor will be made preferably endless, and the positive conductors of the division will be connected together, and likewise the negative conductors, so far as it is practicable, in order to reduce the resistance and to make the conductors of each division to overlap throughout their length. The lamps or other translating devices will be arranged in multiple arc in circuits derived from this pair of main conductors, circuits being run, in the case of town or city blocks, from the main conductors in the streets into the houses. Each division of the circuit, it will be seen, is composed of a pair of main conductors, the conductors of like kind being all connected together, and the lamps are arranged in multiple arc in circuits derived from these main conductors. At the central station the source of electrical energy is composed, preferably, of dynamo or magneto electric machines in series or multiple series, there being one or more machines for each division of the circuit. The main conductors from the positive side of the source of electrical energy or "battery" of generators extend to the positive main conductor of the first division of the circuit. Then, by electrical test or mathematical computation, the opposite extremity of the other side of that division of the circuit is determined, and a conductor is connected to it, and runs to the positive side of the next division. In this way the two or more divisions of the circuit are connected together, and the negative side of the last division is connected with the negative side of the source of electrical energy. The compensating-conductors extend from points between the sections of the battery of generators to the conductors connecting the two or more divisions of the compound compensating-circuit. By this arrangement but one set of main and compensating conductors running from the central station is required, and, except where such conductors from the station are run, the circuit will be composed of two conductors instead of three, as in the arrangements heretofore of my compensating system. It is not essential that the district lighted or the division thereof should be symmetrical. In practice I propose to have the first and last divisions of the circuit close to or adjoining the central station, while the other divisions will be at a greater distance therefrom. In this way a saving will be effected in the main conductors leading from the central station.

A further object of my invention is to prevent to a large extent the bad effects of leaks to ground on a compensating system wherein a high electro-motive force is employed. To accomplish this I divide or diminish by half the electro-motive force of the leaks, and this I do by making a connection with earth at the center of the system. This connection may be made at the central station. The difference in potential between this central permanent ground and an accidental ground on either of the main conductors, it will be understood, is only one-half the entire electro-motive force of the generators; and a leak on a compensating-conductor (where more than one compensating-conductor is used) would have a current of proportionately less tension than the tension of the main current. By having this permanent ground at the center of the system a leak on either side of the system will appear and can be located and repaired before a corresponding leak on the other side occurs. Hence the leaks will always have currents of lower tension than if no central permanent ground were employed.

In the accompanying drawings, forming a part hereof, Figure 1 is a diagrammatic illustration of an arrangement embodying my present invention, and Fig. 2 a similar view of the same principle applied to a district composed of city or town blocks.

With reference more especially to Fig. 1, A' A², &c., represent dynamo or magneto electric machines, of which there are as many connected together in series as there are divisions of the compound compensating-circuits. Six of such machines are shown in the drawings. From opposite poles of this battery of generators run the positive and negative main conductors 1 2, while from points between the machines extend the compensating-conductors 3.

B' B², &c., represent the divisions of the compound compensating-circuit, each composed of lapping main conductors 4 5, in circuits derived from which are the lamps or other translating devices, *a*. The positive conductor 4 of B' is connected with the positive conductor 1 from the central station. The negative conductor 5 of B' is connected with the positive conductor 4 of B², and so on, the negative conductor 5 of the last division B⁶ being connected with the negative conductor 2 from the central station. The compensating-conductors 3 are connected with the main conductors at points between the divisions of the circuit. The conductors 4 5 are lapping-conductors—that is, the extreme end of 5 is located opposite the beginning of 4, and where 4 ends there 5 begins. By this arrangement all the translating devices are made equidistant from the source of electrical energy both by way of the main conductors and the compensating-conductors.

With reference more especially to Fig. 2, this figure represents the same principle applied to the lighting of a district in a city or town. A three-part system is shown, there being three dynamo or magneto electric machines, A', A², and A³, and main and compensating conductors 1 2 3, leading therefrom. These machines will be located together at a central station. The district to be lighted (represented by six blocks) is divided into three divisions, B' B² B³, each division being composed of two blocks, *b' b²*. A positive conductor, 4, is run entirely around each block, completely encircling the same, the ends of the conductor being joined to make an endless conductor. A negative conductor, 5, is run in a like manner around each block. For each division the conductors of like kind of the two or more blocks composing the division are connected together by conductors 6 7. Connections 6 7 are made between the conductors of blocks *b' b²*, at opposite extremes of each division of the circuit. Intermediate connections may also be made. Positive main conductor 1 is connected with the nearest central cross-connection, 6, of the positive main conductor 4 of division B'. From the most distant central cross-connection, 7, of the negative conductors 5 of division B' runs a conductor, 8, to the nearest positive central cross-connection, 6, of B². Divisions B² and B³ are connected in a like manner by another conductor, 8, while with the negative side of B³ is connected the negative main conductor 2 from the central station. The compensating-conductors 3 run to the division-connecting conductors 8. House-circuits 9 10 extend from the main conductors 4 5, and in them are arranged in multiple arc the lamps or other translating devices *a*. These translating devices are all equidistant from the source of electrical energy, the arrangement of endless conductors and central connections producing a true lapping of the conductors, the same as described in connection with Fig. 1.

Referring again to Fig. 1, to divide the electromotive force of the leaks to ground a ground-connection is made by conductor 11 at the center of the system.

What I claim is—

1. In a compensating system of electrical distribution, the combination, with the divided source of electrical energy, and the main conductors and compensating conductor or conductors leading therefrom, of translating devices arranged in multiple arc in each division of the compound compensating-circuit equidistant from the source of electrical energy, substantially as set forth.

2. In a compensating system of electrical distribution, the combination, with the divided source of electrical energy, and the main conductors and compensating conductor or conductors leading therefrom, of main conductors for each division of the compound compensating-circuit arranged to overlap each other, as described, and translating devices located in circuits from such main conductors equidistant from the source of electrical energy, substantially as set forth.

3. In a compensating system of electrical distribution, the combination of the main and compensating conductors, of a pair of main conductors for each division of the circuit, and translating devices located in circuits from such main conductors, substantially as set forth.

4. In a compensating system of electrical distribution, wherein a district is divided into as many sections as there are divisions of the compound compensating-circuit, the combination of a pair of main conductors for each section, translating devices in circuit from such pair of main conductors, connecting-conductors between the conductors of the sections, the positive and negative conductors from the central station connected with the first and last sections, and one or more compensating-conductors running from the divided source of electrical energy to the connection or connections between the sections, substantially as set forth.

5. In a compensating system of electrical distribution, wherein a district is divided into as many sections as there are divisions of the compound compensating-circuit, the combination, with the divided source of electrical energy, of one set of main and compensating conductors, a pair of main conductors for each section of the district, translating devices located in circuit from such pair of main conductors, connections between the conductors of the sections, and with the conductors from the central station, the conductors being arranged to overlap, whereby the translating devices are all equidistant from the source of electrical energy, substantially as set forth.

6. In a compensating system of electrical distribution, the combination, with the divided source of electrical energy, and the main conductors, and compensating conductor or conductors running therefrom, of the pairs of endless conductors for each division of the circuit, translating devices located in circuits from each pair of endless conductors, central connections between the positive and negative conductors of the two or more pairs, central connections between opposite conductors of the first and last pairs, and the main conductors from the central station, and a connection or connections between the compensating conductor or conductors and the conductor or conductors connecting the pairs together, substantially as set forth.

7. In a compensating system of electrical distribution, such as described, a central ground-connection for dividing the electro-motive force of leaks to ground, substantially as set forth.

This specification signed and witnessed this 15th day of November, 1883.

THOS. A. EDISON.

Witnesses:

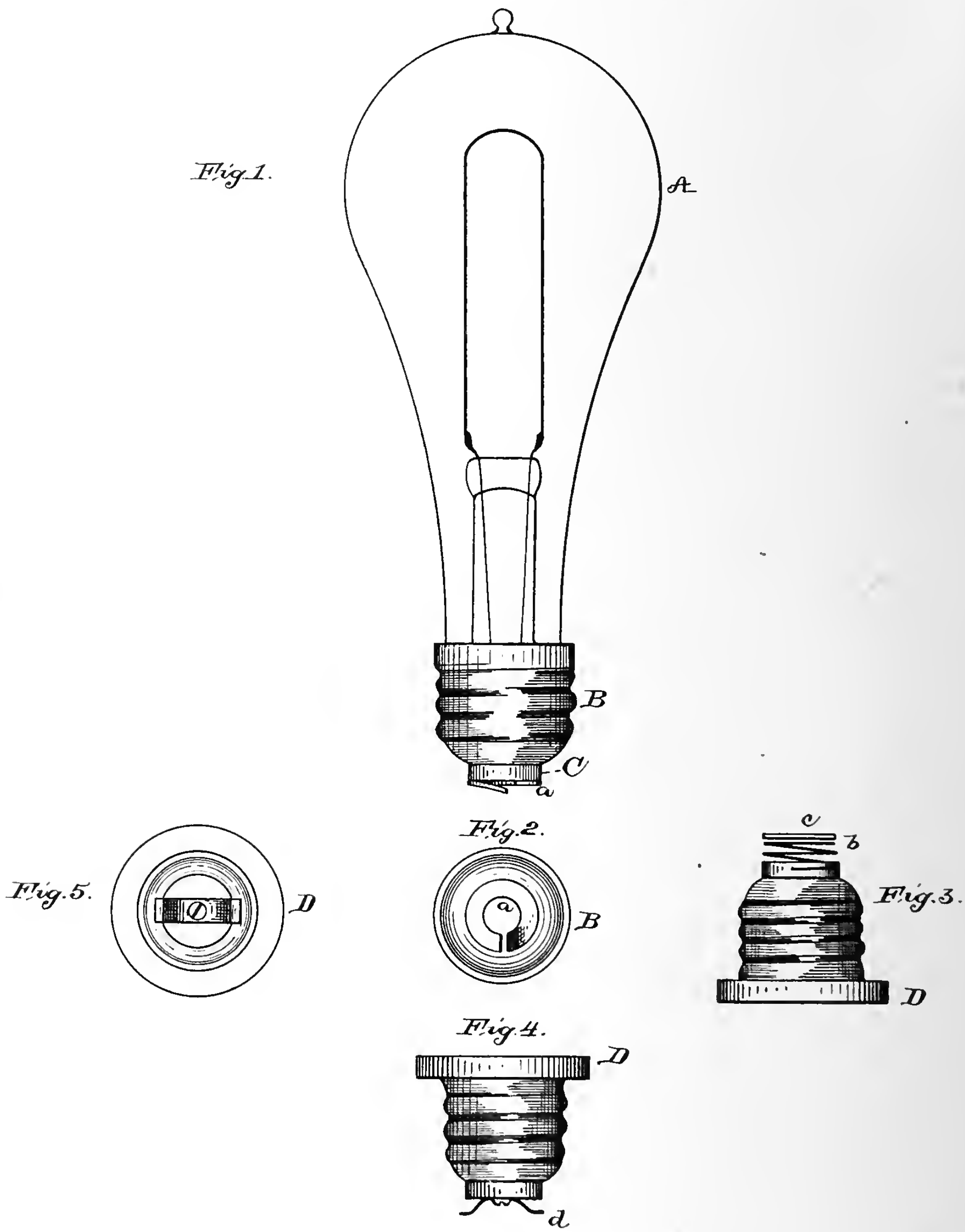
H. W. SEELY,
EDWARD H. PYATT.

(No Model.)

T. A. EDISON.

INCANDESCENT ELECTRIC LAMP.

No. 304,086. Patented Aug. 26, 1884.



WITNESSES:

E. C. Rowland

H. W. Seely

INVENTOR:

Thomas A. Edison.

By Rich. N. Dyer, Atty.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

INCANDESCENT ELECTRIC LAMP.

SPECIFICATION forming part of Letters Patent No. 304,086, dated August 26, 1884.

Application filed January 24, 1884. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Incandescing Electric Lamps, (Case No. 609,) of which the following is a specification.

The object of this invention is to provide good electrical contact between the bottom plate of a socket or receptacle and the tip or button on the base of an electric lamp or on a safety-catch plug or a drop-light plug, which is inserted in such socket or receptacle; and also in the case of an incandescing electric lamp to allow the lamp to be turned in the socket to bring the filament into any desired position without breaking connection. I accomplish this by providing the lamp base or plug with a spring tending to force the two plates apart, through which spring the electrical connection is maintained. The two plates are thus held closely together, and a better contact is obtained than where the plates are simply placed together as heretofore. In the sockets heretofore used, when the lamp is screwed down so that the base-plates are in contact, it cannot be moved any farther. Therefore the lamp cannot be adjusted so as to bring the filament into a different position. This may produce an undesirable effect, for it is of course preferable that several lamps in the same fixture should have their filaments turned so as to produce a symmetrical appearance. When my invention is employed, the lamp may be turned in the socket while the spring continues to maintain contact until the desired adjustment is reached.

In the accompanying drawings, Figure 1 is a view in elevation of an electric lamp employing one form of my invention; Fig. 2, a bottom view of the same or of a similarly-constructed safety-catch or other plug. Figs. 3 and 4 are elevations of plugs having other forms of springs, and Fig. 5 a bottom view of the plug shown in Fig. 4.

It is evident that each form of spring can be applied either to a lamp or to a plug.

A is the glass inclosing-globe of an incandescing electric lamp. The lamp is provided with a base, upon which are fixed a screw-threaded metal band or ring, B, and a metal cap, C. Upon the cap C is attached a flat spring, *a*, soldered to the cap throughout a portion of its length, while a portion of it rises from the cap, so as to form a spring.

In Fig. 3 a spiral spring, *b*, is soldered to the side of the cap and its other end to the bottom of a plate, *c*.

In Figs. 4 and 5, the bent spring *d* is attached to the bottom of the cap.

In Figs. 3, 4, and 5, D is a safety-catch, drop-light, or other plug, which is the equivalent of a lamp, so far as this invention is concerned.

What I claim is—

1. An electric-lamp base or plug of insulating material provided with a metallic screw-ring upon the exterior of its body and a metallic spring-tip forming the terminals of the base or plug, substantially as set forth.

2. An electric-lamp base or plug of insulating material provided with a metallic screw-ring upon the exterior of its body, a metallic tip, and a spring secured to such tip and forming a yielding extension thereof, substantially as set forth.

This specification signed and witnessed this 15th day of December, 1883.

THOS. A. EDISON.

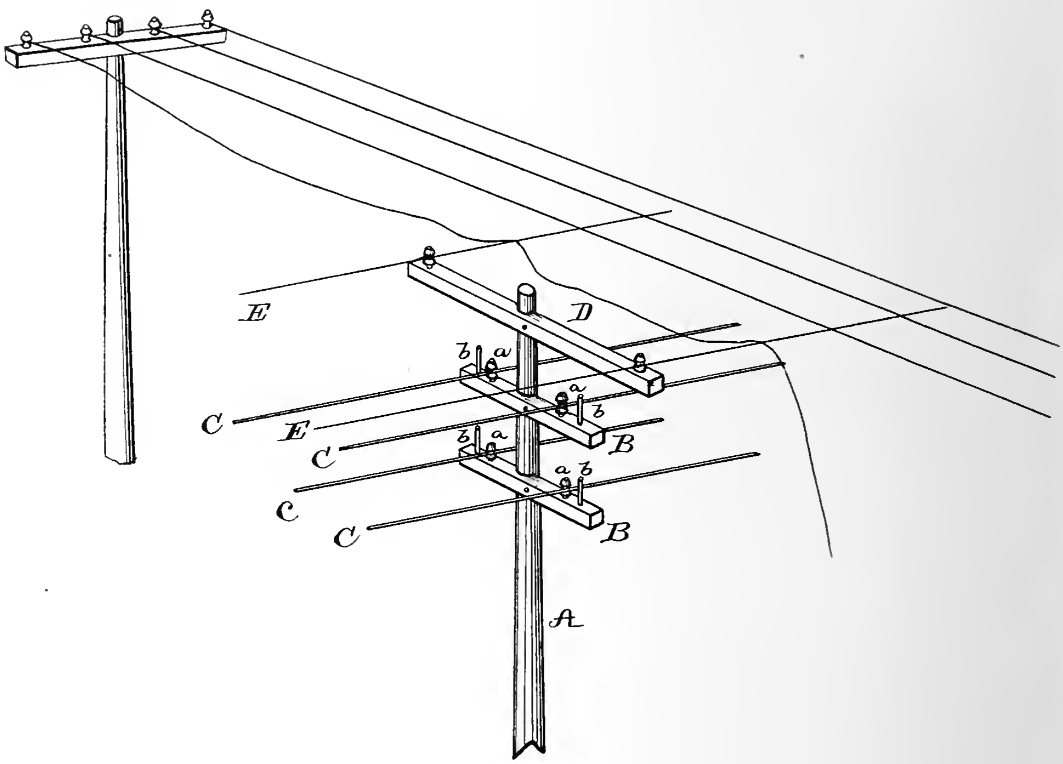
Witnesses:
H. W. SEELY,
EDWARD H. PYATT.

(No Model.)

T. A. EDISON.

ELECTRICAL CONDUCTOR.

No. 304,087. Patented Aug. 26, 1884.



WITNESSES:

E. J. Rowland

H. W. Seely

INVENTOR:

Thomas A. Edison

By Rich^d. N. Dyer, Atty

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

ELECTRICAL CONDUCTOR.

SPECIFICATION forming part of Letters Patent No. 304,087, dated August 26, 1884.

Application filed January 24, 1884. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Electrical Conductors, (Case No. 613,) of which the following is a specification.

When the conducting-wires of an electric-lighting system are placed overhead upon poles, it is necessary to provide some means for completely isolating such wires, thereby preventing telegraph, telephone, or other wires from coming in contact with them, whereby the powerful currents of the lighting-wire would be transmitted to the instruments in connection with the other wires, and also preventing the lighting-wires themselves from falling from the poles, should they become detached from the insulators, and coming in contact with other wires, or with any object contact with which would be undesirable. The first of these objects I accomplish by the use of guard-wires placed upon the poles above the lighting-wires, and which prevent the other wires from falling across or into contact with the lighting-wires. I extend the cross-pieces to which the guard-wires are attached out farther on either side than those which carry the lighting-wires, and so bring the guard-wires well outside of the vertical plane of the lighting-wires, so that it is impossible for any crossing wires coming from above to reach the latter. To prevent the lighting-wires themselves from leaving the poles, and thus from falling upon other wires, or upon any object below them, I place supports upon the cross-pieces outside the insulators. These supports are preferably pins inserted in the wood of the cross-piece, and of such height that should the insulator be broken, or the wire in any way become detached from it, the pin will keep said wire from reaching the end of the cross-piece. The guard-wires may be of small size, and may be used, if desired, as testing-wires for determining the electrical condition of the different parts of the system. Beyond the ends of the feeding-conductors, however, they are not so used.

My invention is illustrated in the accompanying drawing, which represents the upper portion of one of the poles in a line of an electric-lighting system.

A is the pole, and B B are cross-pieces which carry the electric-lighting conductors C C, which are attached to suitable insulators, *a a*. Above them is placed a larger cross-piece, D, which carries the guard-wires E E, these being placed outside the lighting-wires for the purpose mentioned. Pins or supports *b b* are placed outside the insulators on the cross-pieces B B, which prevent the wires from ever leaving the cross-pieces.

What I claim is—

1. The combination, with electrical conductors placed upon poles, of guard-wires placed above them, substantially as set forth.

2. The combination, with electrical conductors placed upon poles, of guard-wires placed above them and outside their vertical plane, substantially as set forth.

3. The combination, with electrical conductors placed upon cross-pieces upon poles, of a longer cross-piece above them carrying guard-wires placed outside their vertical plane, substantially as set forth.

This specification signed and witnessed this 12th day of January, 1884.

THOS. A. EDISON.

Witnesses:

H. W. SEELY,
EDWARD H. PYATT.

(No Model.)

T. A. EDISON.

FILAMENT FOR INCANDESCENT LAMPS.

No. 307,029. Patented Oct. 21, 1884.

Fig.1.

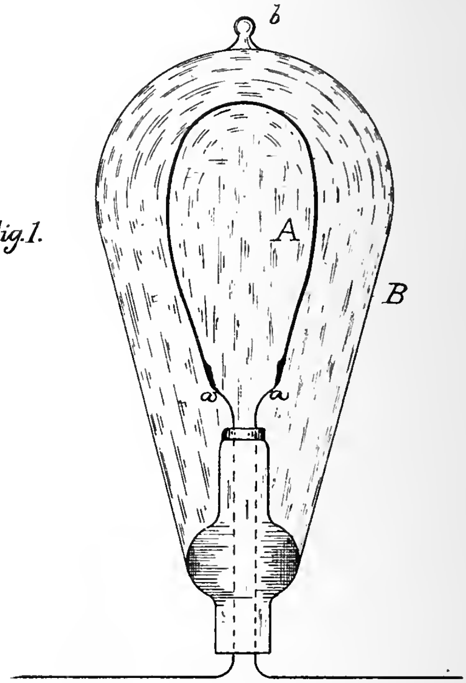


Fig.2.

ATTEST

Edw. C. Rowland

H. W. Seely

INVENTOR

Thomas A. Edison.

By Rich. N. Dyer

Atty.

N. PETERS, Photo-Lithographer, Washington, D. C.

United States Patent Office.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, ASSIGNOR TO THE EDISON ELECTRIC LIGHT COMPANY, OF NEW YORK, N. Y.

FILAMENT FOR INCANDESCENT LAMPS.

SPECIFICATION forming part of Letters Patent No. 307,029, dated October 21, 1884.

Application filed October 12, 1882. (No model.)

To all whom it may concern:

Be it known that I, Thomas A. Edison, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Electric Lamps and the Manufacture thereof, (Case No. 489,) of which the following is a specification.

The object I have in view is to provide a simple and economical process of forming the carbon incandescing filaments of electric lamps, which process shall produce flexible filament of even density and resistance, whose shape shall conform approximately to that of the glass globes which I use with my lamps. Such process consists in first cutting from a fibrous vegetable substance, preferably bamboo, a filament of somewhat more than the desired size (to allow for contraction during carbonization) and having enlarged ends, then carbonizing said filament in a closed chamber, preferably under pressure or strain, or both, and finally bending the flexible carbon filament thus produced into any desired shape, preferably one approaching that of the lamp-globe, its ends being secured, either before or after bending, to metallic wires. By taking hold of both ends of the carbonized filament and bending it in the middle it naturally assumes a shape approximating to that of a longitudinal section of the "pear-shaped" globe commonly employed by me, and this is the shape I prefer; but it is evident that the carbon may be bent into any other desired shape. The use of filaments of such shape of course adds to the symmetrical appearance of the lamp, and, in addition, the filament being equally near to the glass in every part throughout its length, the glass is more equally heated, and there is less danger of breakage than with the form of filament hitherto in general use. The carbonizing-flasks used are of simpler construction, as, instead of curved grooves for holding the previously-bent filament, or blocks for holding it both at its ends and in the middle, a single straight groove only is necessary, or means for holding its ends alone. The process adds to the economy of manufacture of the lamp, for a larger number of straight filaments can be carbonized at the same time than of filaments previously bent. The carbonized filament is sufficiently flexible to be readily bent into the proper shape.

In the drawings, Figure 1 is an elevation of a completed lamp containing a filament made according to my process, and Fig. 2 a view of the filament before bending.

The filament A is cut into the form illustrated in Fig. 2, and then carbonized, after which it is bent as in Fig. 1, its ends secured to metallic wires *a a*, preferably by the electro-deposition of metal upon the joints, and the whole placed within the inclosing-globe B, which is afterward exhausted of air and sealed off at *b*.

What I claim is—

The process of forming the flexible incandescing filaments of electric lamps, consisting in first forming a straight filament of carbonizable substance, then carbonizing the same, and finally bending the flexible filament thus formed into the desired shape, substantially as set forth.

This specification signed and witnessed this 5th day of October, 1882.

THOS. A. EDISON.

Witnesses:

H. W. Seely,

E. H. Pyatt.

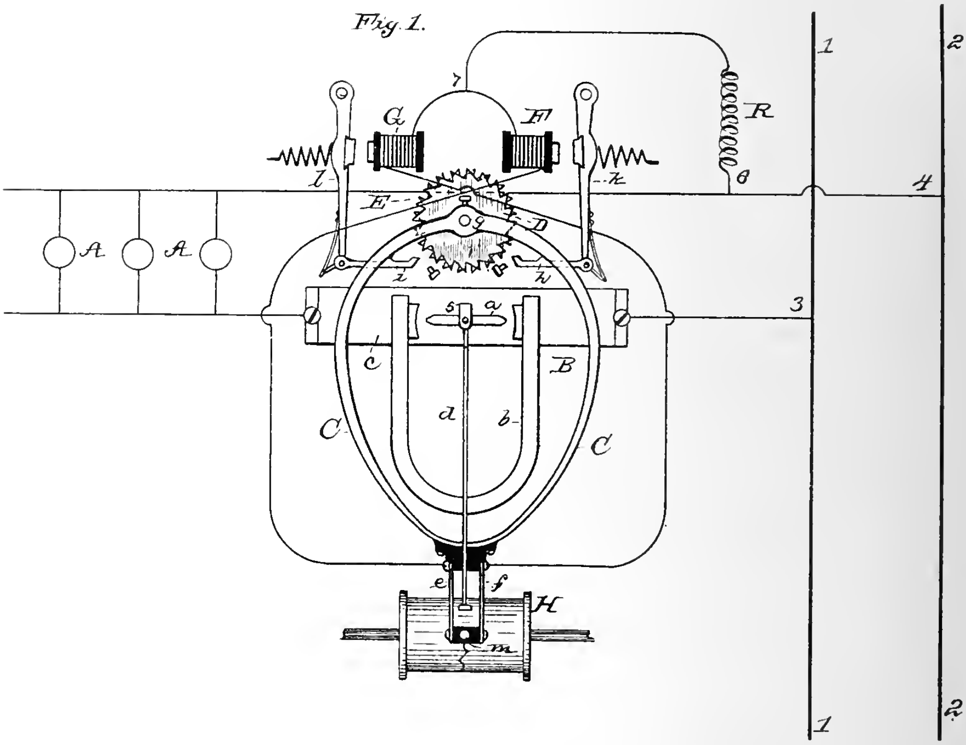
(No Model.)

T. A. EDISON.

ELECTRICAL METER.

No. 307,030. Patented Oct. 21, 1884.

Fig. 1.



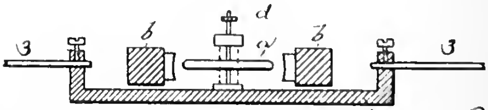


Fig. 2.

ATTEST:

Edw. C. Rowland

H. W. Seeley

INVENTOR:

Thomas A. Edison

By Rich. N. Dyer

Atty.

N. PETERS. Photo-Lithographer, Washington, D. C.

United States Patent Office.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

ELECTRICAL METER.

SPECIFICATION forming part of Letters Patent No. 307,030, dated October 21, 1884.

Application filed October 10, 1883. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Electrical Meters, (Case No. 588[a],) of which the following is a specification.

The object I have in view is to produce simple and efficient apparatus for measuring or determining the electrical energy consumed in a circuit wherein translating devices are arranged in multiple arc, and especially to produce a meter suitable for use in my multiple-arc system of electrical distribution. This I accomplish by arranging in the main line of the circuit a galvanometer the movement of whose needle controls circuits to electrically-operated apparatus, which apparatus controls an indicating or registering device. Preferably the apparatus controlled by the galvanometer is used to adjust the lateral position of a stylus bearing upon a traveling strip of paper, and marking thereon an irregular line, which will indicate at all times the flow of the current. From an inspection of the marked strip it can easily be determined what energy has been consumed in the circuit. The apparatus controlled by the galvanometer may be of any suitable character; but I prefer to use an apparatus similar to that described in my application No. 99,559, the motion being produced by the effect of the current upon a galvanometer needle or bar, which carries an arm closing circuit at moving contacts to operating magnets moving another arm carrying the stylus and following the movements of the galvanometer-arm. The needle of the galvanometer is arranged in a magnetic field, and is moved out of that field more or less by variations in the current. These variations and the movement of the galvanometer-needle are directly proportional to the energy consumed in the circuit, and hence the line marked upon the moving strip will form an accurate record of the energy consumed. The strip may be moved by any suitable device, a clockwork or an electric motor being employed for that purpose.

In the accompanying drawings, forming a part hereof, Figure 1 is a top view, partly diagrammatic, of apparatus embodying the invention; and Fig. 2, a vertical section through the galvanometer.

With reference to Figs. 1 and 2, 1 2 are the street conductors or mains, and 3 4 are the conductors of a house-circuit having lamps, motors, or other translating devices arranged in multiple-arc or derived circuits therefrom. B is a galvanometer located in the main line of the circuit 3 4; or, as will be well understood, it may be arranged in a shunt around a definite resistance in said circuit. The galvanometer shown has its needle *a* located in the field of a magnet, *b*. The electrical conductor of the galvanometer is a straight strip, *c*, of low resistance, located directly in the circuit 3 4; but one or more coils could be used if the galvanometer were arranged in a shunt around resistance. The needle *a* is pivoted directly upon the conducting-strip *c*, and carries an arm, *d*. This arm plays freely at its outer end between contacts *e f*, carried by an arm, C, which follows closely the movements of the galvanometer-arm. This arm C is secured to a shaft, *g*, which is preferably in line with the pivot of the needle *a*, but, for convenience of illustration, is shown as located back of the pivot of *a*.

Upon the shaft *g* are mounted two ratchet-wheels, D E, with teeth turned in opposite directions, and with these ratchet-wheels engage pawls *h i*, carried by the armature-levers *k l* of electro-magnets F G. The electro-magnets F G are in divisions of a multiple-arc circuit, 5 6, from 3 4. This circuit commences at 5 on the strip *c*, forming part of conductor 3, and terminates at 6 on the conductor 4. The circuit divides at the point 7, and extends to the contacts *e f*, the electro-magnets being located in the divisions of the circuit. The resistance R is preferably included in the circuit. The circuit 5 6 is completed by the touching of either contact *e* or *f* by the arms *d*, and one division or the other of this circuit is completed, according to whether the arm touches one or the other contact. The closing of either branch of circuit 5 6 causes the electro-magnet to move the arm C so that the contact will move away from the needle-arm and break the circuit. The needle-arm will follow up the contact until the entire deflection due to the variation in the current is accomplished. The arm C at any suitable point carries a stylus, *m*. This stylus bears on a strip of paper on a roller, H, which is revolved in any suitable manner by clock-work or an electro-magnet. The arm C, it will be seen, is given a positive movement by the electro-magnets, and follows closely the movement of the galvanometer-arm, such galvanometer not being rendered less sensitive by undue friction. The electrical energy consumed by the translating devices A will be accurately recorded on the traveling strip of paper.

I do not claim herein, broadly, the means for producing motion electrically described in connection with Fig. 1, since the same is claimed in my application No. 99,559.

I am aware of German Patent No. 22,991, dated May 11, 1882; but in this the controlling-galvanometer is not in the main line, as is the case in my invention.

What I claim is—

1. The combination, with an electrical circuit and translating devices arranged in multiple-arc therein, of a galvanometer in the main line, a circuit controlled by said galvanometer, electrically-operated apparatus in such circuit, and indicating or registering devices operated or controlled by such apparatus, substantially as set forth.

2. In an electrical meter, the combination, with a galvanometer arranged to be affected by the current of the circuit in which the consumption of electrical energy is desired to be measured, of moving contacts at which circuits are made and broken by the galvanometer-arm, and a registering or indicating apparatus controlled thereby, substantially as set forth.

3. In an electrical meter, the combination, with a galvanometer-arm included in an electrical circuit, of another arm following the movement of such galvanometer-arm, electrically-operated devices moving such second arm, the circuit of which is controlled by the galvanometer-arm, and a registering or indicating apparatus operated by said second arm, substantially as set forth.

4. In an electrical meter, the combination, with a galvanometer-arm, of another pivoted arm carrying on its free end insulated contacts, between which the galvanometer-arm plays, two electro-magnets located in circuit with such contacts and operating pawl-levers, oppositely-arranged ratchet-wheels worked by such pawl-levers and moving said pivoted arm, and a registering or indicating apparatus, substantially as set forth.

5. In an electrical meter, the combination, with a galvanometer, of a pivoted arm carrying a stylus, and electrically-operated means controlled by the galvanometer and moving said pivoted arm, substantially as set forth.

6. In an electrical meter, a galvanometer provided with a constant field, in which its needle is located, and a single low-resistance current-conductor located directly in the circuit the consumption of energy in which is to be measured, in combination with an electrically-operated registering or indicating apparatus controlled by the galvanometer, substantially as set forth.

This specification signed and witnessed this 8th day of August, 1883.

THOS. A. EDISON.

Witnesses:

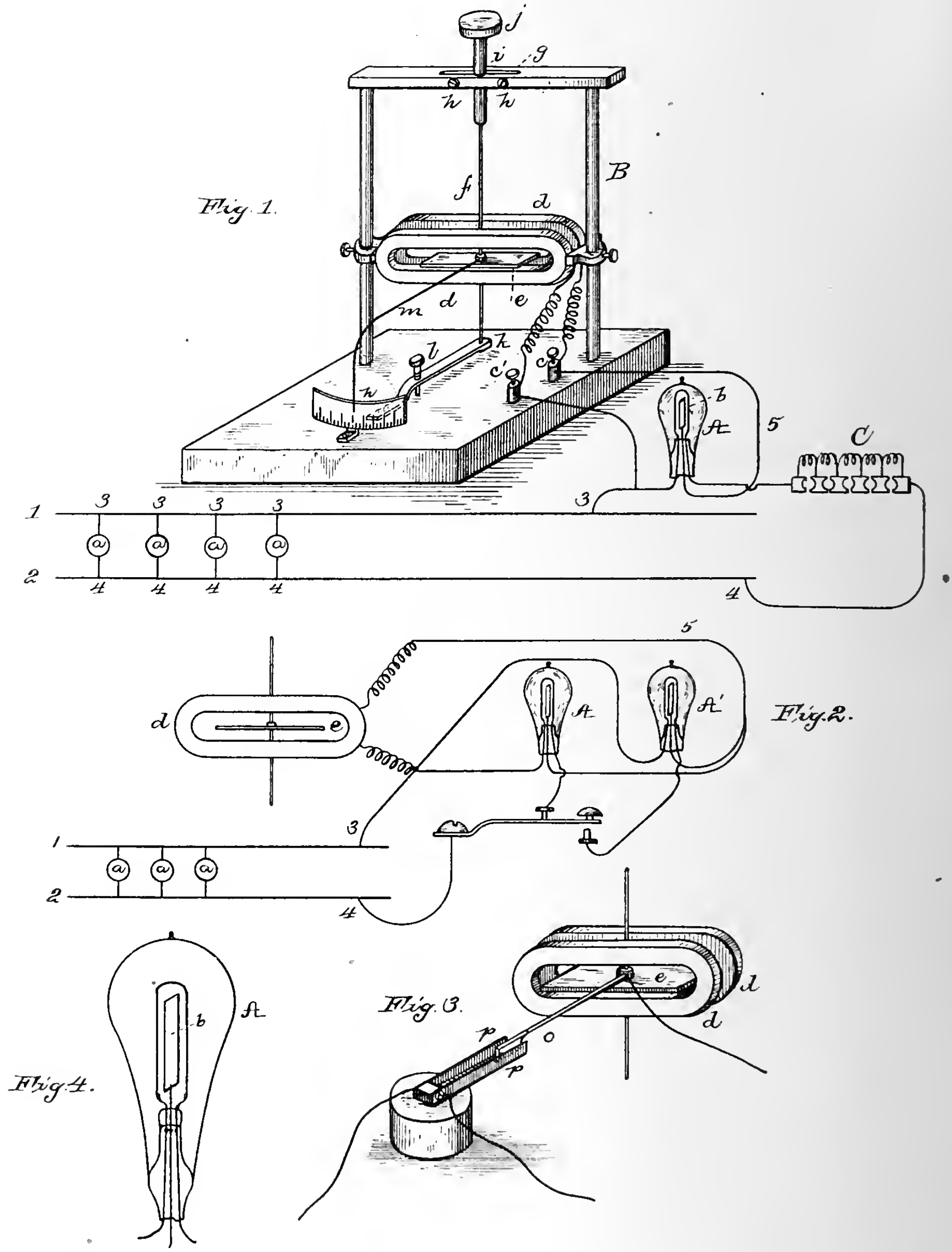
H. W. SEELY,
EDWARD H. PYATT.

(No Model.)

T. A. EDISON.

ELECTRICAL INDICATOR.

No. 307,031. Patented Oct. 21, 1884.



ATTEST:

E. C. Rowland

H. W. Seely

INVENTOR.

Thomas A. Edison.

By Rich^d N. Dyer

Atty.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

ELECTRICAL INDICATOR.

SPECIFICATION forming part of Letters Patent No. 307,031, dated October 21, 1884.

Application filed November 15, 1883. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Electrical Indicators, (Case No. 603,) of which the following is a specification.

The object of my invention is to produce an efficient apparatus for indicating variations of electro-motive force in an electric circuit, preferably for use in connection with systems of electrical distribution to show the changes in pressure in the various parts of the district. The apparatus is also capable of use in automatically regulating the electro motive force to correspond with such variations. I have discovered that if a conducting substance is interposed anywhere in the vacuous space within the globe of an incandescent electric lamp, and said conducting substance is connected outside of the lamp with one terminal, preferably the positive one, of the incandescent conductor, a portion of the current will, when the lamp is in operation, pass through the shunt-circuit thus formed, which shunt includes a portion of the vacuous space within the lamp. This current I have found to be proportional to the degree of incandescence of the conductor or candle-power of the lamp.

My invention consists in the utilization of this discovery for indicating or regulating variations in electro-motive force, or for affecting electrical apparatus in any desired manner. By connecting a device for indicating current changes in the shunt-circuit, changes in the candle-power of the lamp, and consequently in the electro-motive force of the source of supply, are made apparent; or if, instead of an indicating device, the variations in electro-motive force are made to affect circuit-controlling apparatus, automatic regulators or other electrical apparatus may be controlled thereby.

In applying my invention to a system of incandescent electric lighting I place a standard lamp having within its globe a piece of platinum, preferably a thin plate, though platinum wire may be used, placed preferably between the limbs of its carbon conductor, such platinum piece being in connection with the circuit whose electrical condition is to be observed, connecting said terminals similarly to those of the other lamps of the system, and making an additional connection from the positive terminal, preferably of the lamp-circuit, to one terminal of a galvanometer or other indicator, and from the platinum piece through a wire sealed in the glass to the other terminal of the galvanometer or indicator. The galvanometer, if one is used, is provided with a torsional device for holding its needle at zero under a normal current, so that variations above or below the normal deflect the needle in one direction or the other. If the electro-motive force in the system, and consequently the candle-power of the lamps, increases, the indicating-lamp varies with the rest, and the current from it to the galvanometer is increased, causing the deflection of the galvanometer-needle; and, conversely, a decrease in electro-motive force in the system produces an opposite deflection. The galvanometer-needle may be made to close circuit to electrically-operated devices for accomplishing the automatic regulation of the generator supplying current to the system, or for any other purpose.

My invention is illustrated in the annexed drawings.

Figure 1 is a diagram of the system and connections, with a view in perspective of the galvanometer; Fig. 2, a diagram of a modified arrangement; Fig. 3, a view showing the use of the galvanometer to close regulating or other circuits, and Fig. 4 a view of the indicating-lamp.

1 2 are main conductors of a system of electric lighting, and *a a* electric lamps connected across them in multiple-arc circuits 3 4. A is a lamp similarly connected, and similar in every way to the other lamps, except that it has a piece of platinum, *b*, placed between the limbs of its incandescent conductor, while a wire, 5, attached to said platinum, is sealed in the glass of the globe with the wires 3 4. The wire 5 leads to the binding-post *c*, while a wire, 6, connected with the positive wire 3 of the lamp, leads to the binding-post *c'*. These binding-posts are the terminals of a galvanometer which consists of coils *d d* and a needle, *e*, carried by a torsion-wire, *f*. The parts are held in a frame, B. The upper cross-bar of the frame is split at *g*, the split being held to-

gether by screws *h h*, and the torsion-wire is attached to the smooth stud *i*, which is held by friction in the split, its torsion being adjusted by turning the thumb-nut *j*. A spring, *k*, is attached to the other end of the torsion-wire, serving to keep said wire stiff, and the tension of the spring is adjusted by means of nut *l*. A pointer, *m*, extends from the needle to indicate its variations upon a scale, *n*. The torsion of the wire *f* is so adjusted as to hold the needle and the pointer centrally with a normal current—that is, when the lamps of the system are at their normal candle-power—and, as previously explained, any variations in the electro-motive force of the system causing changes in the candle-power of the lamps will produce deflections of the galvanometer-needle, which deflections will be indicated on the scale.

Instead of simply causing the variations to be indicated on the scale, a circuit-controlling arm, *o*, Fig. 3, may be carried by the needle, which may close circuit at contacts *p*, or in any other suitable manner, to electrical devices for automatically regulating the electro-motive force of the system, to electrically-operated indicating devices, or to any electrically-operated apparatus.

For regulating a dynamo-electric machine, a mechanism such as shown in my Patent No. 287,524 may be used, the lamp A and galvanometer of the present apparatus being used in place of the pressure-magnet B of said patent, the working-magnets C C′ of said patent being located in the two circuits, closed by arm *o* of the present apparatus, which takes the place of the armature-lever of said pressure-magnet B. An adjustable resistance, C, may be placed in circuit with the lamp A, to maintain said circuit at the standard-lamp resistance.

In Fig. 2 a lamp, A′, is shown placed in a shunt around the lamp A. The lamp A being constantly in use, lamp A′ is occasionally placed in circuit instead, so by observing its candle-power it may be determined whether or not the resistance of the lamp A has changed.

What I claim is—

1. The combination of an incandescent electric lamp, a circuit including the vacuous space within the globe of said lamp, and electrical apparatus controlled by the current in such circuit, substantially as set forth.

2. The combination, with a system of electrical distribution, of an indicating or regulating apparatus therefor, comprising a standard lamp, a circuit including the vacuous space within the globe of said lamp, and electrical apparatus controlled by the current in such circuit, substantially as set forth.

3. The combination, with an incandescent electric lamp, of a circuit having one terminal in the vacuous space within the globe of said lamp, and the other in connection without the lamp with one side of the lamp-circuit, substantially as set forth.

4. The combination, with an incandescent electric lamp, of a circuit having one terminal in the vacuous space within the globe of said lamp, and the other in connection without the lamp with the positive side of the lamp-circuit, substantially as set forth.

5. The combination, with an incandescent electric lamp, of a circuit having one terminal in the vacuous space within the globe of said lamp, and the other connected with one side of the lamp-circuit, and electrically controlled or operated apparatus in said circuit, substantially as set forth.

6. The combination, with an incandescent electric lamp, of a piece of conducting material placed in the vacuous space within its globe, and a conductor connected therewith and passing through and sealed in the glass of the lamp, substantially as set forth.

7. In a system of electrical distribution, the combination, with incandescent electric lamps connected in multiple arc, of a similar lamp similarly connected, a circuit having one terminal in the vacuous space within the globe of said lamp, and the other connected with one side of the lamp-circuit, and electrically-operated apparatus in said circuit, substantially as set forth.

8. The combination, with an incandescent electric lamp, of a piece of conducting material placed between the sides of the incandescent loop, and a conductor leading therefrom to the exterior of the lamp, substantially as set forth.

This specification signed and witnessed this 2d day of November, 1883.

THOS. A. EDISON.

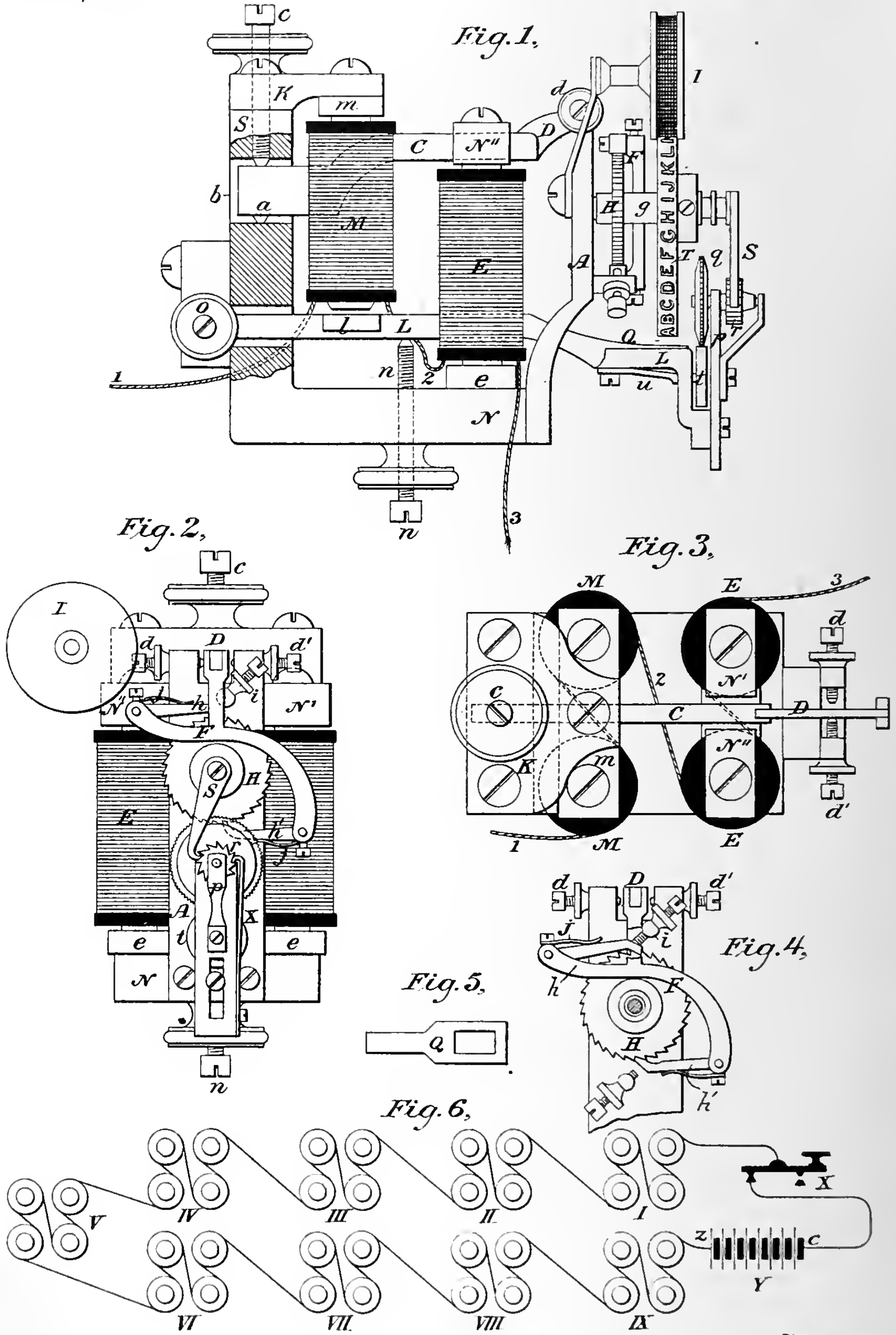
Witnesses:
H. W. SEELY,
EDWARD H. PYATT.

F. L. POPE & T. A. EDISON.

Assignors, by mesne assignments, to THE GOLD AND STOCK TELEGRAPH COMPANY.

PRINTING TELEGRAPH.

No. 10,542. Reissued Dec. 9, 1884.



Witnesses

Geo. W. Breck

C. E. Ashley

By their Attorney

Inventors

Frank L. Pope.

Thomas A. Edison.

C. M. Buckingham

UNITED STATES PATENT OFFICE.

FRANK L. POPE, OF ELIZABETH, AND THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, ASSIGNORS, BY MESNE ASSIGNMENTS, TO THE GOLD AND STOCK TELEGRAPH COMPANY, OF NEW YORK, N. Y.

PRINTING-TELEGRAPH.

SPECIFICATION forming part of Reissued Letters Patent No. 10,542, dated December 9, 1884.

Original No. 102,320, dated April 26, 1870; Reissue No. 7,621, dated April 17, 1877. Application for reissue filed November 12, 1884.

To all whom it may concern:

Be it known that we, FRANK L. POPE, of Elizabeth, in the county of Union, and THOMAS A. EDISON, now of Menlo Park, in the county of Middlesex, both in the State of New Jersey, have invented certain new and useful Improvements in Printing-Telegraphs, which improvements are fully set forth in the following specification, reference being had to the accompanying drawings.

Our invention relates to that class of printing-telegraph instruments in which the type-wheel is caused to rotate by means of a step-by-step escapement actuated or controlled by the armature of an electro-magnet in the main circuit, and when any desired character upon the type-wheel has been brought round to a given point an impression of such character may be printed by bringing into action a second armature controlled by the same circuit.

Our improvements consist, first, of a polarized electro-magnet for imparting to the type-wheel of a printing-telegraph an intermittent rotary motion by the action of successive alternate positive and negative currents of short duration, and of locking the type-wheel at any point, and at the same time printing a letter or character by prolonging the duration of the final current, whether the same is positive or negative, through a neutral electro-magnet in the same circuit; second, in the combination of a type-wheel actuated or controlled by a polarized armature under the influence of alternate reverse currents of short and uniform duration with a device for giving the impression, which is actuated or controlled by a non-polarized or neutral armature, said polarized and neutral armatures being operated by electro-magnets placed in the same line, the arrangement being such that the type-wheel may be locked, and the neutral armature brought into action to effect the printing, when the type-wheel has been brought to the required point, by prolonging the duration of the final current without reference to its polarity; third, in certain improved combinations of the mechanism of the several parts of the apparatus, whereby the efficiency and reliability of its action are materially increased.

In the accompanying drawings, Figure 1 is a side elevation of the receiving apparatus. Fig. 2 is an end elevation of the same, the type-wheel being removed. Fig. 3 is a plan view of a portion of said apparatus. Fig. 4 is a detached view, showing the details of the escapement in said apparatus. Fig. 5 is a plan view of the slotted presser; and Fig. 6 is a skeleton diagram, showing the arrangement of a number of instruments located at different stations and placed in the same electric circuit, operated simultaneously in unison by a battery placed at one point in the circuit.

Similar letters refer to like parts in the different figures.

E, Figs. 1, 2, and 3, designates a perpendicular electro-magnet, composed of two cores of soft iron united below in the ordinary manner by a cross-bar, *e*, also of soft iron. The north pole of an angular-bent permanent magnet, N S, is screwed to the cross-bar *e*, to which it communicates north polarity beyond the point of contact, and also to both cores and poles of the electro-magnet E. The soft-iron armature C is supported upon a pivot, *a*, in a slot, *b*, in the south end, S, of the permanent magnet N S, from which it receives south polarity, being secured in that position by a screw or otherwise. The said slot is situated at a short distance from the end of the magnet, exactly at the point of greatest magnetic intensity, so that the pivot end of the armature is completely surrounded by the magnetic mass, and becomes subject to the greatest possible amount of inductive influence.

The armature C is so placed that it is free to vibrate to and fro in a lateral direction between the poles N′ and N″ of the electro-magnet E. When this is arranged, it is obvious that the north polarized ends, N′ and N″, will each exert an equal attraction upon the south polarized armature, C, when the same is equidistant from each, but that it will be attracted and firmly held by either N′ or N″ when placed in close proximity or contact with one or the other. An arm, D, projects from the end of the armature C, passing between screw-stops *d* and *d′*, by means of which its lateral vibration is controlled and limited. This arm is constructed of brass or other non-magnetic metal in order to prevent the inductive magnetic action from extending beyond the poles N′ N″ of the electro-magnet E.

The screw-stops *d* and *d′* are supported by a brass standard, A. Upon this standard is secured a shaft, *f*, Fig. 4, upon which is a sleeve, *g*, carrying a ratchet-wheel, H, and a type-wheel, T, upon the circumference of which type-wheel are engraved such letters, numerals, or other characters as may be required. The characters on the type-wheel are supplied with ink by means of a fountain ink-roller, I, secured to a movable arm attached to the standard A. The vibrating arm D carries a curved bar, F, to the extremities of which are pivoted pawls *h* and *h′*, which act, respectively, at opposite points upon the circumference of the ratchet-wheel H, as shown in Figs. 2 and 4.

The to-and-fro movement of the pawls, as well as each successive step in the forward movement of the wheel H, which is driven by them, is limited by the adjustable screw-stops *i* and *i′*. The pawls are pressed against the teeth of the wheel by springs *j j′*, and when the arm D vibrates to and fro the pawls alternately fall into the interdental spaces of the wheel H and push it forward until the movement of the pawl, and consequently that of the wheel, also, is adjusted by the stops *i* and *i′*, which may be adjusted so as to allow of any desired amount of movement of the pawls *h* and *h′*; but we will here remark that the pawls *h* and *h′* may be made of spring-steel, and so arranged as to automatically bear in the interdental spaces of the wheel H, in which case the springs *j j′* may of course be dispensed with.

By means of the above-described arrangement the to-and-fro vibrations of the arm D may be caused to communicate, through the pawls, a rapid intermittent rotary motion to the ratchet-wheel H, sleeve *g*, and type-wheel T in the direction shown by the arrow marked thereon. The screw-stops *d d′* are so adjusted in reference to the stops *i i′* that when the armature C is acted upon by a powerful current, tending to bend or otherwise to disarrange the pawls *h h′*, ratchet-wheel H, and their appurtenances, the slightest deflection of the arm D after the pawls *h* or *h′* have come in contact with the stops *i* or *i′* will bring said arm D against one of the stops *d* or *d′*, thereby relieving the mechanism from undue strain or pressure.

The manner in which the vibration of the armature C and arm D is made to revolve the ratchet-wheel H will be understood more clearly by reference to Fig. 4. Suppose the arm D to be moved from its position, as shown, toward the left, carrying with it the bar F and the pawls *h h′*. The pawl *h′* will engage with a tooth of the wheel H, and carry it forward in the direction of the arrow until its movement is arrested by the pawl coming in contact with the stop *i′*. At the same time the pawl *h* will slip over one tooth of the wheel without obstruction. When the arm D, bar F, and pawls *h h′* are moved from left to right, the operation of the respective pawls is reversed, although the wheel H continues to be moved in the same direction as before. Each vibration of the arm D, either to the left or to the right, therefore advances the ratchet-wheel H the distance of one tooth.

The apparatus for taking the impression after the type-wheel has been brought to the desired position may be described as follows: M, Figs. 1 and 3, is an electro-magnet of the usual form, its poles being united by the cross-bar *m*, which is secured by a lug, K, to the south end, S, of the permanent magnet N S. This lug is made of brass or any other non-magnetic metal, for the purpose of cutting off the magnetic induction which would otherwise take place between the permanent magnet N S and the soft-iron cores of the electro-magnet M. The armature *l* of this electro-magnet is of soft iron, and attached to a lever, L, one end of which is pivoted at O, and which passes through a slot in the standard A. The lever is capable of a vertical movement upon O as its fulcrum, the extent of such movement being limited in one direction by the face of the type-wheel T, and in the other by the adjustable screw-stop *n*.

To the extremity of the lever L is attached a slotted adjustable standard, *p*, carrying a wheel, *q*, with a sharp serrated edge. Upon the same shaft with said wheel *q* is a ratchet-wheel, *r*, actuated by a hook-shaped pawl, *s*, attached to the extremity of the type-wheel shaft *f*. A roller, *t*, of hard rubber or other suitable material, is mounted upon a spring-axle, *u*, in such a manner as to be pressed firmly against the serrated edge of the wheel *q*. A ribbon of paper (not shown in the drawings) may be made to pass horizontally across the lever L and beneath the slotted presser Q, (shown in plan in Fig. 5,) the edge of said paper passing between the serrated wheel *q* and the roller *t* in such a manner that the rotation of the wheel *q* will cause the ribbon to be drawn forward from right to left. The slotted presser Q serves to keep the paper from coming in contact with any portion of the type-wheel, except the letter of which the impression is desired. The two electro-magnets E and M are placed in the same electrical circuit, the connections being arranged as shown in Fig. 3.

The manner in which the above-described apparatus is actuated by means of electric currents is as follows: If a momentary current of electricity be sent from the positive pole of a battery through the electro-magnets E and M, its tendency would be to magnetize the pole N′ of the electro-magnet E "north" and the pole N″ "south;" but as both poles were previously north by the inductive influence of the permanent magnet N S, the effect of this current is to strengthen the north magnetism of N' and to weaken or entirely destroy that of N''. The armature C is therefore attracted to N' with double force, and remains on that side after the cessation of the current, being still attracted by the pole N', whose distance from C is now much less than that of N''. If, now, a momentary negative current is sent, this effect is reversed. The pole N'' in turn attracts the armature, and it moves to that side, remaining until the polarity of the exciting-current is again changed. Thus by transmitting through the helices of the electro-magnet E a rapidly-alternating series of short positive and negative currents, it will readily be understood that the armature C and its attachments may be caused to vibrate to and fro with great rapidity, causing a correspondingly-rapid revolution of the ratchet-wheel H and the type-wheel T, and that the latter may readily be brought to any required position simply by transmitting in succession the requisite number of alternate positive and negative currents through the electro-magnet E. These alternate currents of short duration necessarily traverse the coils of the electro-magnet M, which is included in the same circuit, but the armature of the latter is not affected by them. The reason of this is that a polarized or permanently magnetic armature responds much more promptly to the attraction of an electro-magnet than a non-polarized or neutral armature, other conditions being the same, and therefore the polarized armature C of the magnet E responds perfectly to the short alternate currents, while the more sluggish non-polarized or neutral armature l of the magnet M remains at rest. In order, therefore, to print an impression of any desired character upon the type-wheel, a succession of alternate positive and negative currents is sent through the wire 1 2 3, Figs. 1 and 3, of such short duration as not to affect in any manner the neutral armature l of the electro-magnet M, while, by the action of the polarized armature C of the electro-magnet E, the type-wheel T may be revolved until the desired character upon its circumference is brought opposite the impression-lever L. The duration of the final current is then prolonged, the effect of which prolongation is to cause the type-wheel to be firmly locked in its position, (the pawl h or h' being wedged between the point of the stop i or i' and a tooth of the wheel H,) and to allow sufficient time for the neutral armature l of the electro-magnet M to act, which raises the lever L, and brings the paper ribbon in contact with the type upon the wheel T, the same having been previously inked by the fountain-roller I. The armature l being of soft iron and neutral, it is immaterial, so far as the result is concerned, whether the prolonged terminal current is positive or negative, as it responds with equal certainty in either case. When the attraction of the electro-magnet M ceases, the lever L falls back to its original position. At the same time the hooked pawl s catches a tooth of the ratchet-wheel r, and causes it, together with the wheel q, to revolve a short distance, thus drawing the paper ribbon forward and leaving a clear space in readiness for the next impression. A click, x, prevents the ratchet-wheel r, and consequently the wheel q, from revolving in the opposite direction. The downward movement of the lever L may be assisted by a retracting-spring, if necessary.

It will be understood from the above description that this apparatus is actuated entirely by electro-magnetic power derived from the battery at the transmitting-station without the assistance of local or secondary batteries, or of mechanical power derived from any source other than the said battery at the said transmitting-station, and that any required number of such apparatus may be placed at various points included in the same electric circuit, and operated simultaneously in unison by the action of a single battery placed at the transmitting-station. This will be more clearly understood by reference to Fig. 6, where we have given a skeleton diagram illustrating an arrangement of instruments in connection with a main battery and circuit-breaker, whereby an operator can at one point form a connection with a main battery, so as to complete an electric circuit in such manner that the current of said battery shall pass through as many instruments on a main line unprovided with local batteries as desired, and record simultaneously in printed characters at each instrument the same message. For instance, at a point lettered X, there may be located a circuit-breaker of any suitable construction, and at the point lettered Y a main battery of sufficient power, or in lieu thereof a number of small main batteries, located at such point or elsewhere in the main circuit that a current may be caused to pass from the main battery or batteries through the electro-magnets of instruments I II III, &c.; hence it will be understood without further explanation that a communication may be printed simultaneously at as many different stations as may be desired without the use of local batteries or of mechanism—such, for instance, as weights or springs—for operating each instrument. In such cases the action of such local batteries or mechanism is simply controlled by the action of the main electrical circuit.

It is obvious that another electro-magnet can be placed in the same circuit for effecting other useful purposes—such as striking a bell to call attention, &c.—which may be actuated by increasing the strength of the electric current which operates the printing mechanism.

We do not confine ourselves to the particular form and arrangement of parts shown in the drawings. There are numerous and well-known means of producing the vibratory movement of a lever by the use of alternate positive and negative currents, in combination with a permanent and an electro magnet acting upon each other, and of applying the same to the movement of a type-wheel. Neither do we wish to confine ourselves to any particular method of producing or transmitting alternate positive and negative currents for the purpose specified, as there are many well-known appliances for these purposes, which have heretofore been used in connection with other printing-instruments, and may be employed in like manner with advantage in connection with our improved apparatus.

We are aware that others have heretofore employed a polarized electro-magnet and a neutral electro-magnet in the same circuit, one to control the rotation of the type-wheel by short impulses and the other the operation of the press mechanism by strengthening the short impulses. Our invention, however, is different from the foregoing, in that the press mechanism is operated by prolonging rather than by strengthening an impulse, thus enabling the dispensing of extra battery to effect printing.

We claim as our invention—

1. The combination of a polarized electro-magnet whose armature is operated by alternate positive and negative currents of short duration with a neutral electro-magnet placed in the same circuit whose armature communicates its power directly to the printing-lever and is actuated by prolonged impulses of either polarity, and a type-wheel actuated or controlled by said polarized electro-magnet, substantially as and for the purpose described.

2. The combination of a polarized electro-magnet whose armature is operated by alternate positive and negative currents with a neutral electro-magnet placed in the same circuit whose armature is actuated by prolonged impulses of either polarity, a type-wheel actuated or controlled by said polarized electro-magnet, and a press mechanism actuated or controlled by said neutral electro-magnet, the whole being arranged for operating a printing-telegraph by first moving the type-wheel into any required position by the action of the alternate positive and negative currents of short and uniform duration, and then locking the type-wheel in such position, and at the same time causing the printing to be effected by prolonging the duration of the current last sent irrespective of its polarity, substantially as described.

3. A type-wheel actuated or controlled by the to-and-fro movements of a polarized armature under the influence of alternate positive and negative currents of short duration, in combination with an impression device actuated or controlled by a neutral armature which is under the direct magnetic influence of the same alternate positive and negative currents of short duration, but which is not actuated thereby, when the arrangement is such that the type-wheel is locked at any required character, and the neutral armature brought into action to effect the printing of such character by one of the said alternate currents when sufficiently prolonged, whether positive or negative.

4. The combination of the safety-stops *d d'*, with the stops *i i'*, escapement-pallets *h h'*, and the armature-lever D, substantially as and for the purpose specified.

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7 Sheets—Sheet 1

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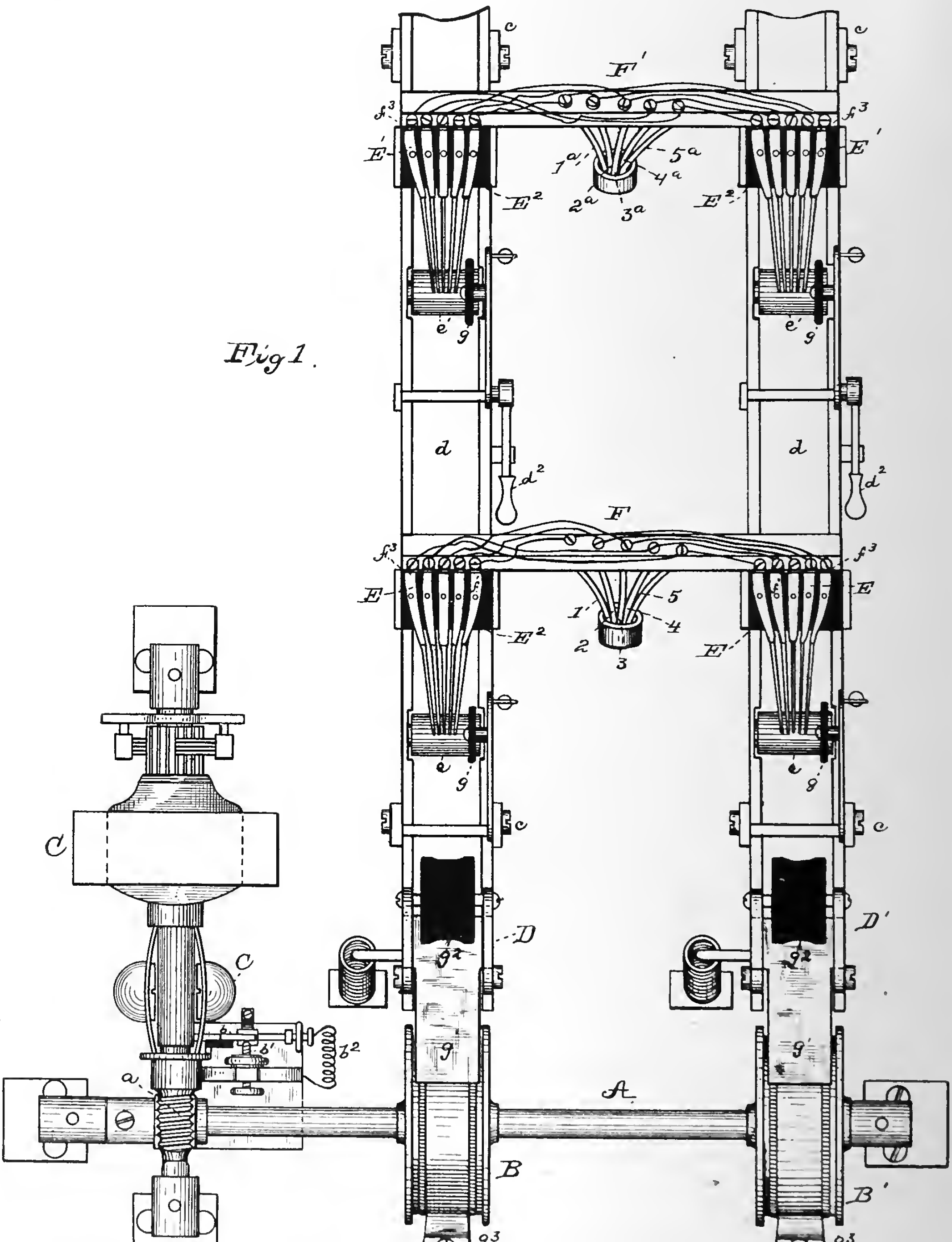
CHEMICAL STOCK QUOTATION TELEGRAPH.

No. 314,115.

Patented Mar. 17, 1885.

Fig 1.



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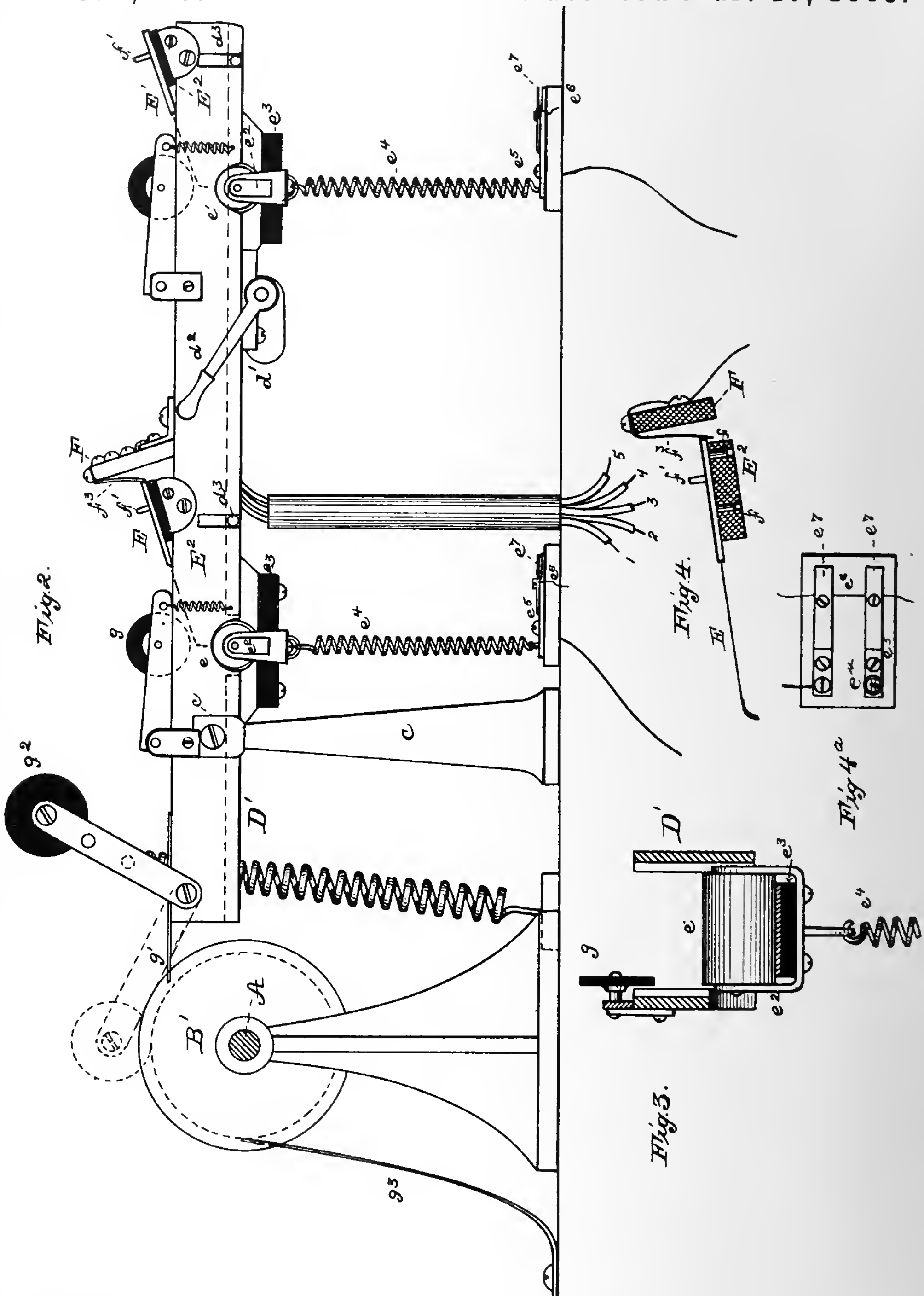

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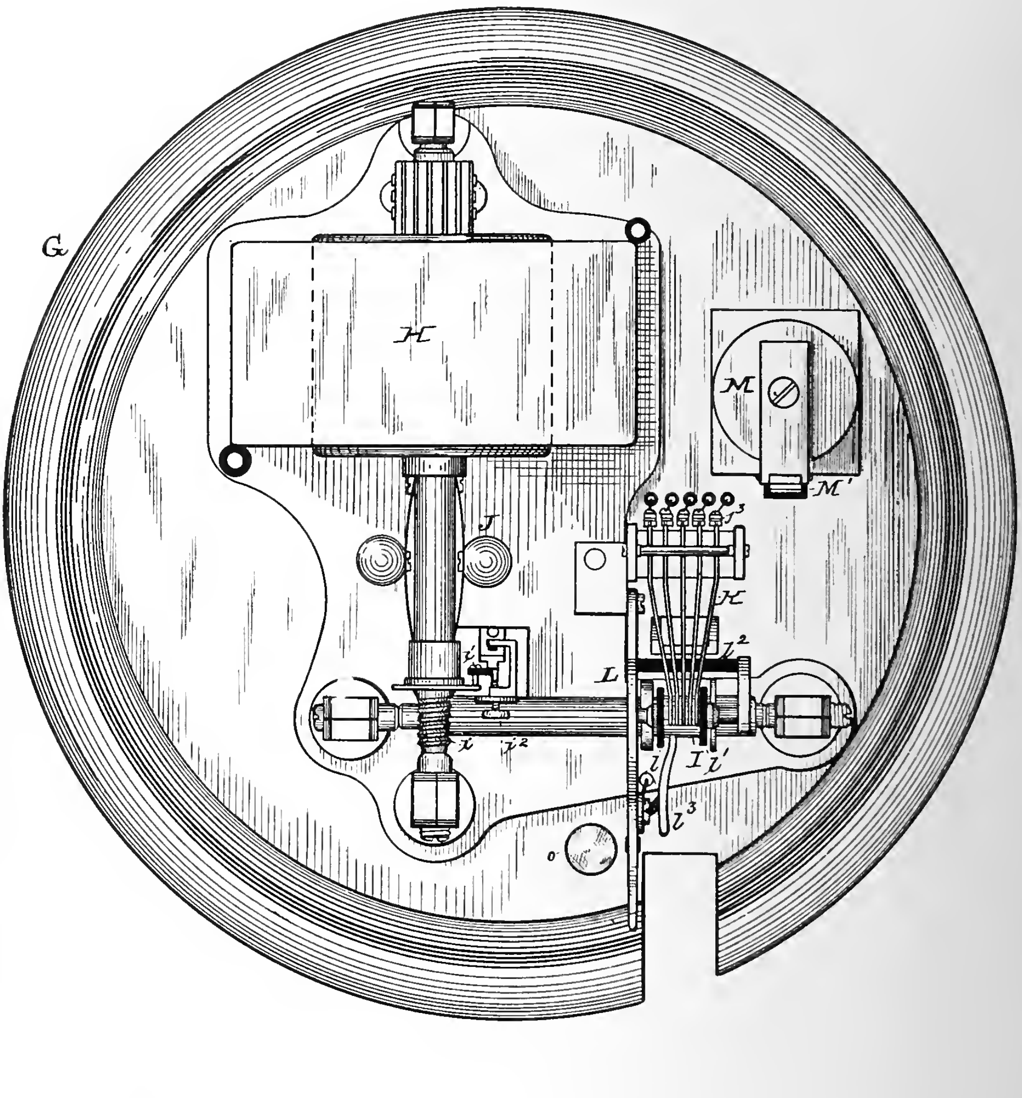
Fig. 5.



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No. 314,115. Patented Mar. 17, 1885.

Fig. 6.

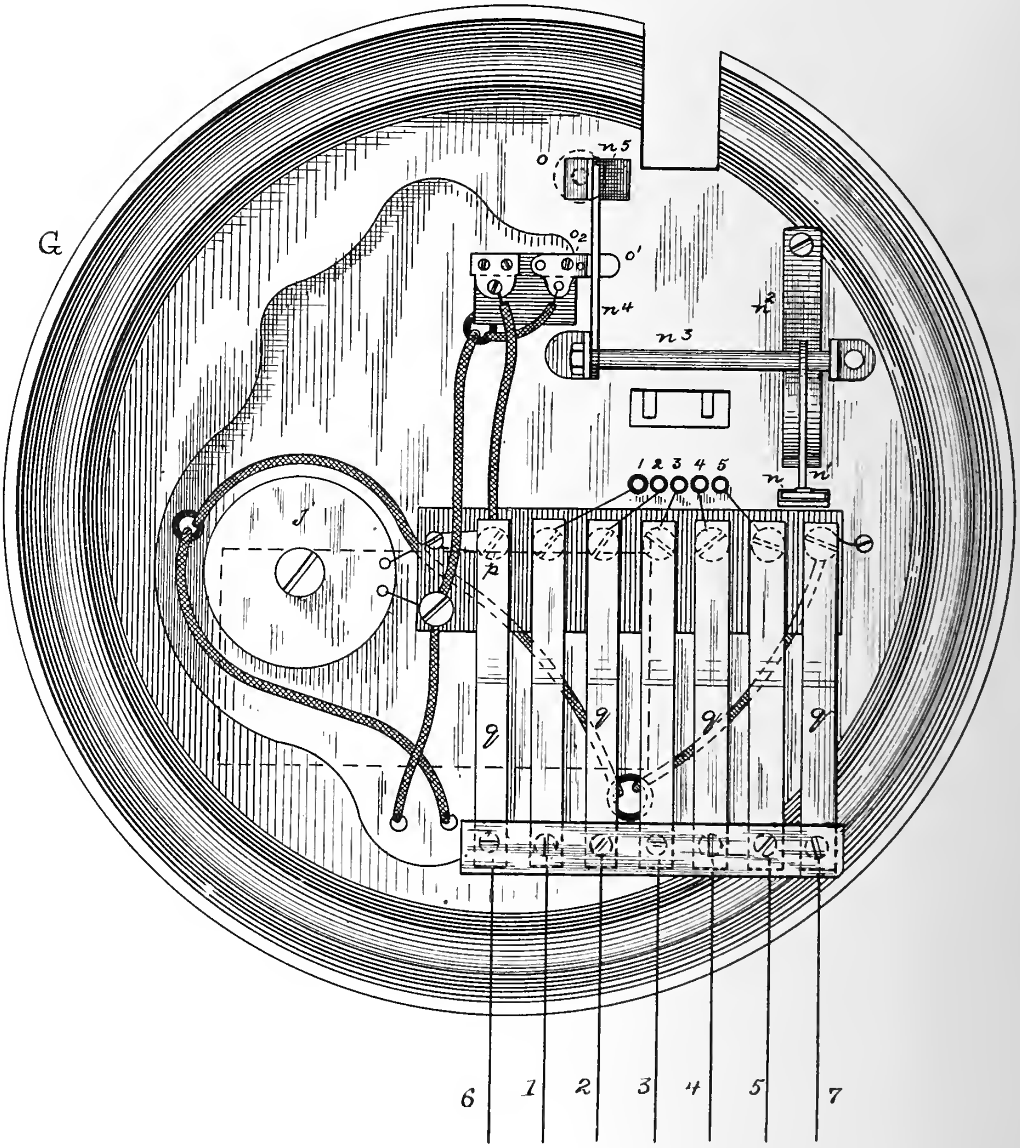

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Fig. 7.

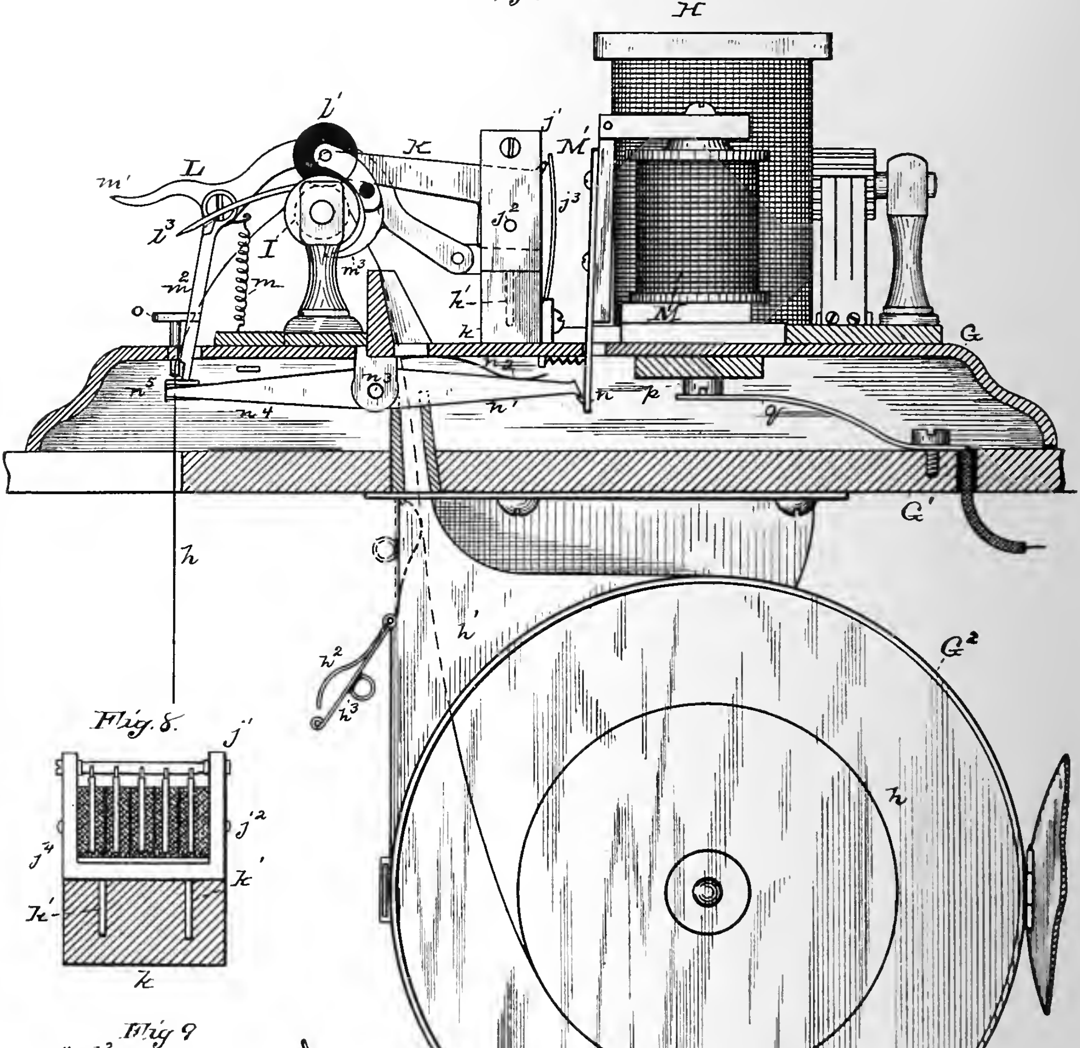

Fig. 9

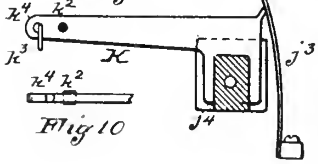

Fig. 10

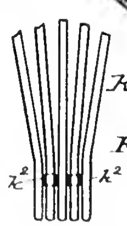

Fig. 11.

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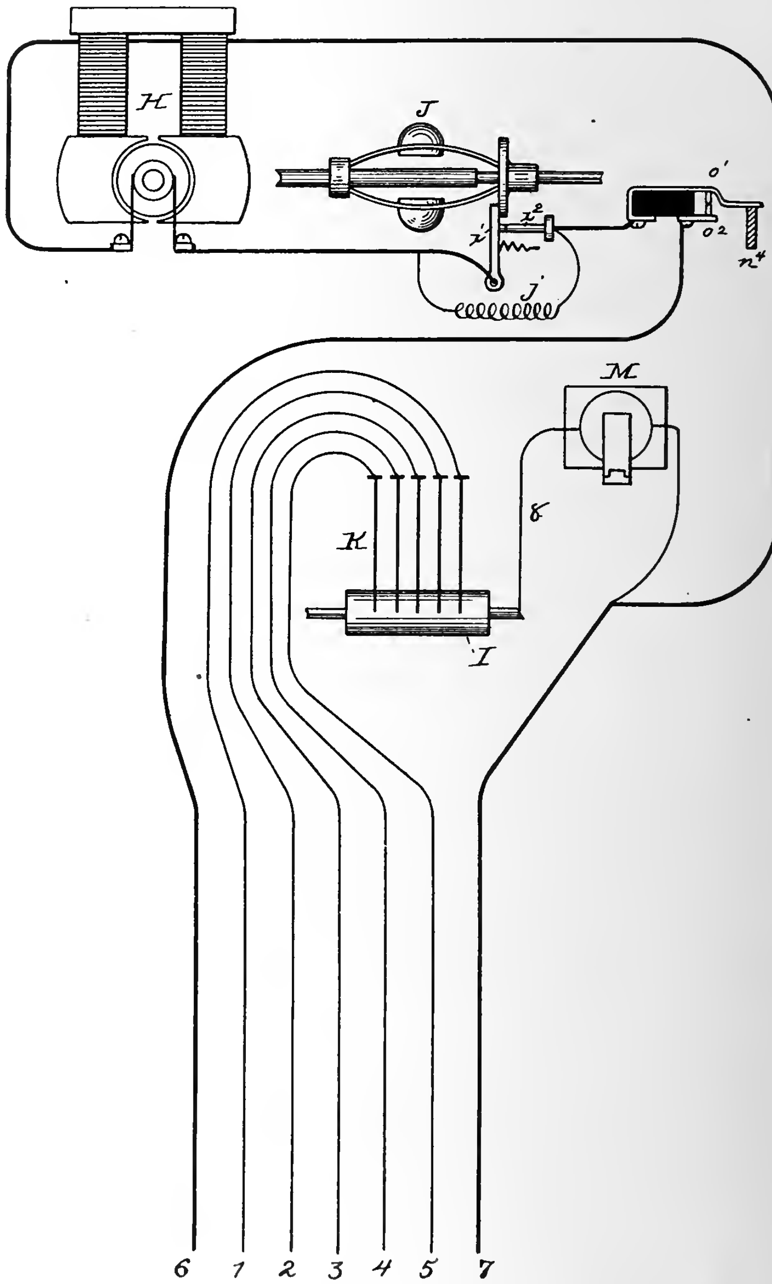
CHEMICAL STOCK QUOTATION TELEGRAPH.

No. 314,115. Patented Mar. 17, 1885.

Fig. 12.



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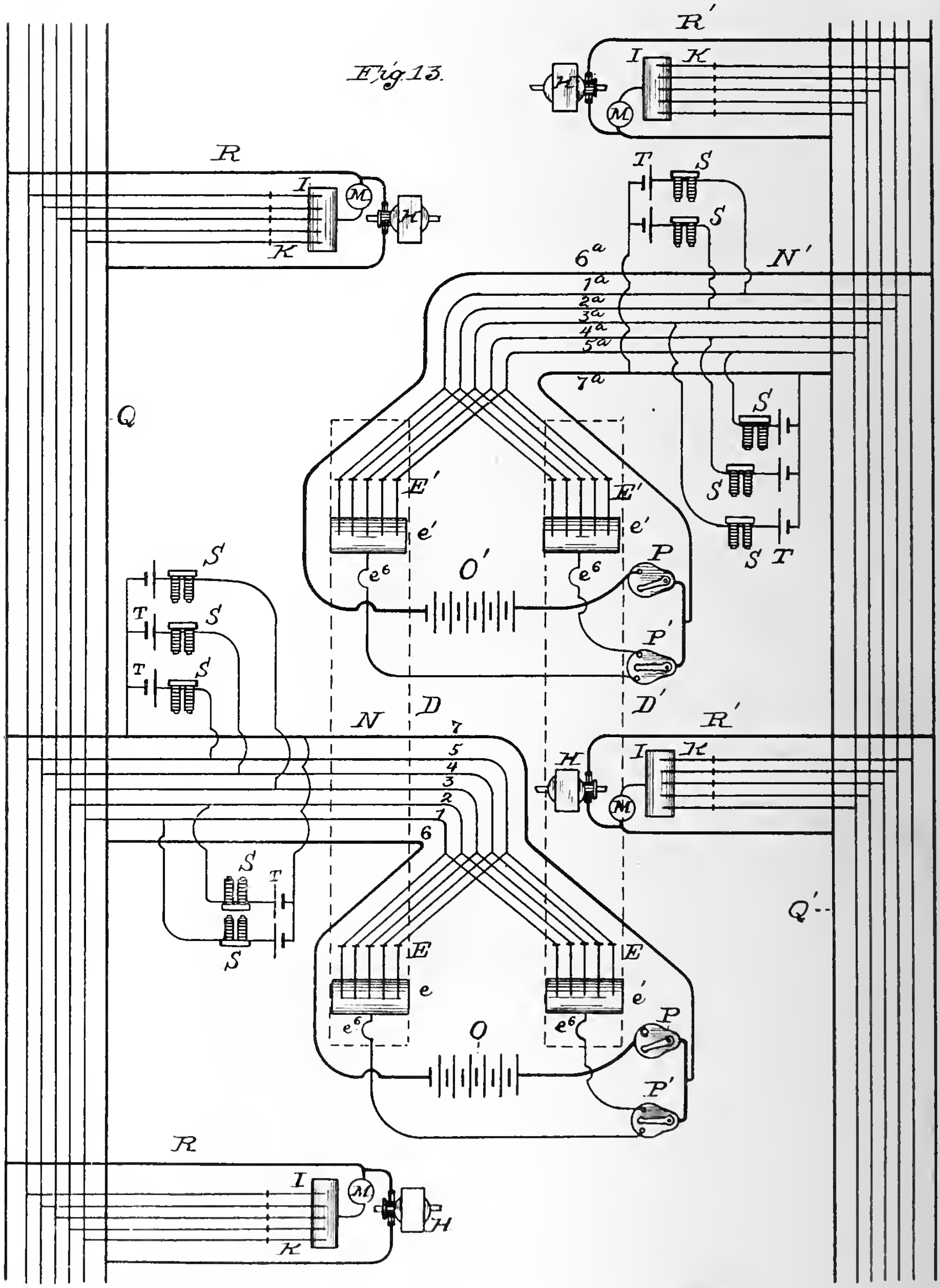

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UNITED STATES PATENT OFFICE.

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CHEMICAL STOCK QUOTATION TELEGRAPH.

SPECIFICATION forming part of Letters Patent No. 314,115, dated March 17, 1885.

Application filed March 19, 1884. (No model.)

To all whom it may concern:

Be it known that we, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, and PATRICK KENNY, of New York, in the county and State of New York, have invented a certain new and useful Improvement in Automatic Telegraphs, (Case No. 620,) of which the following is a specification.

The object we have in view is to produce a system of automatic telegraphy, and suitable instruments and connections therefor, designed to supplant the present stock-printing telegraphs, which system will operate correctly and accurately, with much greater rapidity than the stock-printing telegraphs now in use, and will have advantages of greater simplicity, durability, ease of repair, and a complete independence of the receivers. This we accomplish by utilizing for this purpose the principle of the chemical telegraph, and by such changes in construction and arrangement of instruments and connections and in manner of operation as we have found necessary and desirable to meet the different conditions of the new end sought.

In the accompanying drawings, forming a part hereof, Figure 1 is a top view of the transmitter; Fig. 2, a side elevation of the same; Fig. 3, a vertical cross-section through one of the transmitting-rollers; Fig. 4, a section through the support of a transmitting-stylus, showing circuit-connection; Fig. 4[a], a top view of one of the fusible-wire safety-catches; Fig. 5, a top view of the receiver; Fig. 6, a bottom view of the same and the circuit-springs; Fig. 7, a partial vertical section and elevation of the receiver; Fig. 8, an elevation from the rear of the receiving-pens, the supporting-block being in section; Fig. 9, a side elevation of one of the pens, its insulating pivot-block being in section; Fig. 10, a view on a larger scale of the end of said pen from its under side; Fig. 11, an enlarged view of the front ends of one set of receiving-pens; Fig. 12, a diagrammatic view showing the connections within a receiver; Fig. 13, a diagrammatic view showing the connections of the system between the transmitter and the receiver.

With reference more especially to Figs. 1 to 4, inclusive, the transmitter, by the preferred method, is operated by means of strips of paper perforated with Roman letters and Arabic numerals. These are perforated by means of an Edison perforator, such as has been used for Roman-letter telegraphs. The transmitter has two sets of transmitting devices for each line, so that the transmission can be made continuous, one set being in operation while a perforated strip is being adjusted to the other set. The transmitter is also constructed for transmitting from the same strip over two or more lines simultaneously, the transmitting devices of the two or more lines being arranged in the same trough or paper-way, and the strip being drawn under all the transmitting styluses by a single feeding device. The perforated strip is left with an imperforate end of sufficient length to extend under all the styluses to the feeding device.

A is a horizontal shaft, which operates the feeding-wheels of the one or more transmitters. It is shown in Fig. 1 as working the feeding-wheels B B′ of one transmitter. This shaft is rotated by any suitable power, electrical or mechanical. A continuously-wound electro-dynamic motor, C, is preferably used for the purpose, its armature-shaft having a worm, *a*, engaging with a worm-wheel on the shaft A. This motor may be operated from any source of electrical energy. It is provided with a ball-governor, C′, located upon its shaft, which governor acts upon a spring-lever, *b*, tending to separate it from an adjustable contact, *b′*. The motor-circuit passes through *b* and *b′*, and by the separation of these parts such circuit is broken. A resistance, b^2, may be located in a shunt around the break to reduce the spark. By means of the governor controlling the motor-circuit the speed of the motor and of the feeding-wheels rotated by it will be kept uniform. The speed at which the governor will break the circuit can be varied by adjusting the contact *b′*. It is evident that the regulation of the motor speed and its adjustment can be performed in any other known way. By this adjustment and a similar adjustment at the receivers, to be hereinafter described, the speed of the transmitter and the receivers can be given the proper relation, so that the letters and figures produced by the receivers will be of the desired size. With a definite speed at the receivers the size lengthwise of the strip of the letters produced by them will be inversely proportional to the speed of the transmitter. The size of such letters can be increased by reducing the speed at the transmitter, and reduced by increasing the transmitter's speed.

From the feeding-wheels B B′ extend two horizontal troughs or paper-ways, D D′, the sides of which form guides for properly directing the perforated strips of paper. The troughs are supported by forked standards *c*, and they have movable bottom plates, *d*, which rest when lowered upon such standards. Each trough-bottom is raised by a wiper, d', worked by a handle, d^2, and is guided by pins d^3, working in slots in the sides of the trough.

Mounted upon each bottom *d*, but insulated therefrom, are two or more transmitting-rollers, *e e′*. These are held by straps e^2, secured to insulation e^3, holding the rollers out of contact with other metal parts. Such straps are shown in Figs. 2 and 3. Springs e^4 connect the straps with circuit-terminal plates e^5, and serve also to draw the bottom plate downwardly. Between each plate e^5 and the circuit-wire is a fusible-wire safety-catch, e^6, held by springs e^7 to protect the small stylus and pen-wires, as will be explained further on.

Two or more sets of transmitting styluses, E E′, are mounted in each of the troughs D D′. Each set is carried by an insulating-block, E^2, which is secured to the sides of the trough, and is inclined so that the styluses project down into the trough with their forward ends directly over the center of a transmitting-roller. Each stylus is a spring with a stiff shank, and has on the under side of its shank two pins, *f*, which enter holes in the block E^2 and serve to hold the stylus in place. A pin, f', on the upper side of each stylus-shank permits the stylus to be readily removed or secured in position by means of pliers. It will thus be seen that the styluses can be readily removed for cleaning or sharpening and others put in their places without delay. The number of styluses in each set depends upon the number of lines of perforations in the strip of paper. Five of such lines of perforations have been found most desirable for the purpose, and hence five styluses to each set are shown. The set of styluses E in trough D is directly opposite the set E in trough D′, and the sets E′ E′ are similarly situated.

Bars F F′ extend across both troughs just back of the two sets of styluses. These bars carry circuit-springs f^3, which project downwardly and bear against the shanks of the styluses, each bar carrying the circuit-springs of two sets of styluses—the similar sets in the two troughs. These springs form removable circuit-connections for the styluses, the act of placing a stylus in position bringing it into contact with a spring. The springs on the bars are connected to the five conductors of a cable, such conductors being indicated by the numbers 1 2 3 4 5 and 1^a 2^a 3^a 4^a 5^a. Each cable is connected with or forms a line to which is connected the pens of a number of receiving-instruments.

The transmitting-styluses of each set rest above the center of a transmitting-roller; but when the trough-bottom is depressed the roller drops clear of the stylus-points. In the elevated position of the trough-bottom the transmitting-roller forces the strip of paper up against the points of the styluses. A spring-pressing wheel, *g*, above each transmitting-roller, presses the paper down upon the roller, causing the roller to be rotated by the movement of the paper, so as to present a clear contact-surface to the stylus points when they drop through the perforations. A spring-pressing plate, g', directs the paper strip from each trough upon the feeding wheel. A spring-roller, g^2, presses the strip upon each feeding-wheel above its center, causing the wheel, which has serrated portions, to draw the strip without slipping, while a stripping-plate, g^3, prevents the paper from sticking to the wheel and following around to the under side of the same. A strip of perforated paper with a long imperforated end is drawn under the stylus-points of one trough, while its bottom is depressed and is passed over the feeding-roller. The trough-bottom is then raised, and the pressing-roller g^2 thrown into the position shown in dotted lines. The feeding-wheel draws the strip of paper, and the matter denoted by the perforations is sent out upon the two or more lines connected with the transmitter. While a strip is passing through one trough one is being placed in the other trough, and the trough-bottom is raised. When the strip of the first trough is exhausted, the roller g^2 of the second trough is thrown down, starting that strip. In this way little or no time will be lost by intervals in transmission.

It is evident that more than two lines could be connected with each transmitter. It is also evident that the shaft A can be used to work the feeding-wheels of more than one transmitter.

While we prefer the construction of transmitter shown, it is evident that for the purpose of carrying out the more general objects of our system the transmitter may be varied in many respects.

Instead of having the styluses close circuit directly by dropping through the perforations upon a contact-surface, it is evident that this movement can be utilized to close and open the circuit at other points, as described in our application (No. 47,216) upon fac-simile telegraphs, and that with this last form of circuit controller, instead of using perforations in the paper, depressions may be employed, as described in said application, and instead of using a non conducting material like paper with perforations to permit the points to drop through to metal, a metal surface may be employed with the letters marked thereon in insulating-ink; or our transmitter may be based upon the well-known principle of using type, with the surface of which the stylus-points make contact.

With reference more especially to Figs. 5 to 12, inclusive, the receiver has a base, G, carrying the parts and covered, as usual in stock-printers, by a glass case. (Not shown.) This base rests on a suitable stand, G′.

Beneath the stand is a circular box, G^2, containing a coil, h, of chemically-prepared paper. The solution used to prepare the paper is preferably ferrid-cyanide of potassium, the receiving-pens having points of iron. This box has a side door for closing it tight, and an upwardly-extending throat, h', through which the paper strip passes to the receiving-roller of the instrument, the strip being restrained therein by a spring, h^2, located upon a pivoted flap, h^3.

Upon the base G is mounted an electro-dynamic motor, H. This machine has a continuously-wound armature-bobbin and a Pacinotti commutator, so that it will start from any position when its circuit is closed.

The armature-shaft of the motor is provided with a worm, i, which engages a worm-wheel on a shaft at right angles thereto, carrying the receiving-roller I.

The motor-shaft carries a centrifugal governor, J, which acts to separate a spring-lever contact, i', from an adjustable contact, i^2. The speed at which the governor will separate the contacts i' i^2 depends upon the adjustment of the contact i^2, and the contacts being in the motor-circuit the speed of the motor, and hence of the receiving-roller I, will be made regular by the governor, and this speed can be changed by adjusting the screw i^2.

As has already been explained, the size of the letters and figures (lengthwise of the strip) produced by the receiver is inversely proportional to the speed of the transmitter. The reverse is true of the speed of the receiver, the size of the letters and figures being directly proportional to speed of the receiving-roller; hence the size of the letters and figures produced by the receiver may be varied by adjusting the screw i^2. This adjustment will be utilized to bring the receivers into proper relation with the transmitter, so as to give the letters and figures the most desirable size.

All the receivers can be given the same speed independent of the difference in electro-motive force existing upon the line at the receivers by reason of their location at different distances from the source of electrical energy. This is done by adjusting the governor-screws of all the receivers to such an extent that the electro-motive force at the receiver farthest from the source of electrical energy will be sufficient to drive the motor of that receiver up to the governing point. This insures the action of all the receiver-governors and a uniform speed of the receiver-motors; or the adjustment can be utilized, if desired, to produce letters of different sizes at the receivers. As described in connection with the transmitter-motor, it is evident that the regulation of the speed of the receiver-motors and their adjustment can be effected in any other known way.

A resistance, j, is located in a shunt around the contacts i' i^2 to reduce the spark.

K are the receiving-pens, five in number, which are plates arranged on edge and pivoted in a U-shaped frame, j', by a pin, j^2, the pens being thrown forward upon the receiving-roller by separate springs j^3, which form removable circuit-connections for such pens. Each pen has a forked shank, as shown in Fig. 9, and this shank is set in a slot in the center of a block, j^4, of rubber or other suitable insulation. The pivot-pin j^2 passes through the solid portion of all five blocks, j^4, which are mounted thereon side by side, but are free to turn independently. The frame j' is mounted upon a block, k, rising from the base G, the frame being held removably upon the block by pins k', which enter holes in said block. The frame j' can be lifted from the block k, and by doing so the pens can be readily removed from the instrument. This feature of removability is an important one, since it enables the pens to be taken out for cleaning and repair, which should be done frequently, while another set can be as easily placed in the instrument, so that there need be no stoppage of the instrument for repair. The simple act of placing the frame j' upon the block k completes the circuit-connections through the springs j^3, and the pens have a separate pivotal spring action, so as to conform independently to any irregularity in the thickness of the paper. The pens are brought close together at the forward ends, where, to prevent a cross-connection between the pens, the second and fourth pens are provided with small blocks k^2 of insulation, projecting on each side. The pens also have removable iron wearing-points k^3, which are inserted in slots k^4, one side of each slot being made concave, as shown in Fig. 10, or the parts being otherwise formed to lock the points in place. This feature of the removable pen-points is one which simplifies and cheapens repairs.

The strip of paper h is pressed upon the receiving-roller, so as to be advanced thereby by two pressing-wheels, l l', which are carried by an arm, L, pivoted to a block rising from the base. The pressing-wheel farthest removed from arm L is carried by an insulating-pin, l^2, which passes under the pens K. The arm L also carries a finger, l^3, for guiding the paper and preventing it from curling up in front of the pen-points. The arm L is drawn downwardly by a spring, m, attached to base G, while it may be raised by a finger-piece, m'. A pivoted arm, m^2, Fig. 7, projects downwardly from the arm L through a slot in the base, and has a shoulder on its lower end, which catches on the edge of the slot and holds the arm L up after it is once raised. A curved finger, m^3, attached to arm L, projects under the shaft of the receiving-roller and strikes such shaft when the arm L is raised, preventing the arm L from being elevated to an unnecessary extent. The effect of raising the arm L is to raise the pens and also the pressing-rollers from the paper strip, releasing such strip from the drawing action of the receiving-roller. If the paper strip should break or the roll of paper give out, it is desirable that the pens should be raised from the receiving-roller to break the pen-circuits and the motor-circuit opened. This is done automatically by means of an electro-magnet, M, whose armature M′ is not attracted with sufficient force to overcome its retractor, except when there is an abnormal flow of current, which will occur when the resistance of the paper is removed from the pen-circuits by the dropping of the pens directly upon the receiving-roller.

The armature M′ has a latch end, n, extending through the base, and this engages the beveled end of a horizontal arm, n', pressed downwardly by a spring, n^2. This arm is connected with the end of a spindle, n^3, the other end of which has attached to it an arm, n^4, carrying a plate, n^5, at its outer extremity, upon which rests the lower end of arm m^2. The movement of armature M′ by magnet M releases arm n', which is pressed downwardly by its spring n^2 and raises arm n^4, elevating the arm L and lifting the pens and pressing-wheels from the receiving-roller. A thumb-piece, o, is used to reset the parts. The arm n^4 in its upward movement also separates contact-points on spring-plates o' o^2, and such contacts being in the motor-circuit said circuit is thereby broken. Instead of having special contacts for this purpose, it is evident that the movement could be utilized to separate the governor contacts i' and i^2, opening the motor-circuit at these latter points.

Mounted upon a block of insulation on the under side of the base G are seven screws, p, Fig. 6, to which the connections of the receiver are made. Seven springs, q, secured upon the top of stand G′, make contact with the heads of screws p when the receiver is set in position upon the stand. The springs q are plate-springs arranged horizontally upon the stand G′. The receiver-base is given the correct position upon the stand by suitable studs, (not shown,) so that the simple act of placing the receiver upon the stand will bring the screws p into contact with the proper springs q and complete the circuit-connections. This feature is one of novelty in receivers for stock-telegraphy, the series arrangement of the instruments heretofore used rendering it impracticable or undesirable. The seven screws of the cable are connected with springs q, the wires 1, 2, 3, 4, and 5 being the pen-wires, 6 the motor-wire, and 7 the common return for the pen and motor circuits.

The circuits within a receiver are shown more particularly in Fig. 12. The wires 1, 2, 3, 4, and 5 run directly to the pens, and from the receiving-roller a connection, 8, is made with the return-wire 7 through magnet M. Wire 6 runs to break-points o' o^2, break-points i' i^2, and through armature and field of motor to return-wire 7.

The general arrangement of the system is shown in Fig. 13, to which reference is now particularly made. The dotted lines represent the troughs or paper-ways D D′ of the transmitter, in which are the transmitting-rollers e e' and styluses E E′. From the two opposite sets of styluses E extend five wires, 1 2 3 4 5, and with these are joined the receiver-motor wire 6 and the common return 7. These seven wires are joined into a cable, N. From the two opposite sets of styluses E′ extend five wires, 1^a 2^a 3^a 4^a 5^a, with which are joined motor-wire 6^a and return 7^a, all forming a cable, N′.

It is evident that the common-return wire 7 or 7^a may be substituted by ground-connections.

The cables N and N′ are supplied by two separate batteries, O O′. At one end each battery is connected to the motor-wire of the cable, while at its other end it is connected with the contact-point of a switch, P. A double-point switch, P′, has its two contacts connected with the two transmitting-rollers of the cable, (through springs e^4, plates e^5, and safety-catches e^6,) while the switch-levers of the two switches are connected together and with the return-wire. The motors of the receivers connected with either cable can be set in motion by closing switch P, after which the circuits to transmitting-rollers of either trough can be closed by closing switch P′ on one point or the other.

The cables N and N′ may form the main line to which the receivers are connected; but since the arrangement is a multiple-arc one it is preferred that such cables should be used as feeders and extend to the centers of main lines Q Q′, from which the receiver-circuits R R′ will be taken. By the use of feeders the difference in the drop of electro-motive force at the receivers of each line will be much less, and the receivers can be readily made to run uniformly by adjustment of the governor-points, as before explained. The feeders for the purpose of saving in expense of conductors are preferably of higher resistance than the mains from the point of connection of the feeders therewith to the ends, and hence the main drop in electro-motive force will be upon the feeders; but since this drop does not effect the relative drop at the receivers (there being no receiving-instruments connected with such feeders) the drop upon the feeders can be made as great as desired, while that upon the main lines must be within the practical limits of adjustment of all the motors to a uniform speed.

Each receiver is located at the end of a cable, R or R′, in its own multiple-arc circuit, and hence is independent of all the other receivers, and can be provided with circuit-opening devices, which in their operation will not affect any of the other receivers. This arrangement of the receivers in multiple arc is a novel feature in stock-telegraphy and one that is especially adapted for chemical-receivers. In addition to other advantages, it reduces the number of wires which it is necessary to carry into a building, since if the instruments were in a series it would be necessary to carry at least twelve wires into a building. The multiple-arc arrangement also permits of the ready attachment of additional receivers within the capacity of the line-wires.

As indicated in the diagrammatic views, Figs. 12 and 13, the motor-wire and the return-wire are of larger size than the pen-wires, for the reason that a small current only is sufficient for recording purposes, while a larger current is used in running the motors. The motor and return wires are intended to be made large enough to carry the entire current of the battery without heating injuriously; but for economy in cost and size of cable the pen-wires are so much smaller that if a short circuit should occur with one of them the pen-wire might be heated injuriously or fused. Hence a fusible-wire safety-catch properly proportioned to protect the pen-wires is located in the single wire between the battery and each transmitting-roller. This is shown in Figs. 2 and 4[a], and has been already described.

To prevent tailings and make the marks produced by the receiver clear and sharp, we arrange electro-magnets S in separate cross-circuits between the five pen-wires and the common return of each cable, as shown in Fig. 13. These multiple-arc circuits are connected with the wires of the cable at the transmitting-office and between the transmitter and the receivers. The effect of the magnets is to discharge when the pen-circuits are broken, sending reverse currents of high tension through such circuits. These currents tend, with the solution of ferrid-cyanide of potassium, to produce a white mark instead of a blue one upon the paper, and hence the blue marks are made clear and sharp.

We have found that when no current is flowing through the pen-circuits there is an action set up between the iron pen-points and the solution of the paper strip, and it seems also that by reason of the nearness together of the pen-points in the receivers the current tends to pass from the points of active pens along the surface of the paper to the points of inactive pens, causing all the pens to mark. To overcome these difficulties we place in the same cross-circuits in which the magnets are located batteries T, which are constantly in connection with the pen-circuits, and are arranged to send currents through such circuits in the reverse direction to the currents of the main battery. These batteries T are weaker than the main battery, and hence do not interfere with the transmission of the characters. The current from T, however, flows over the pen-wires when not active, and tends to make a white mark on the paper, so that the tendency to mark blue, which exists when no current is flowing, will be overcome. The tendency of the main current to pass to inactive pen-points is also counteracted.

It will be noticed that the chemical-receivers are under control from the transmitting-office, and are worked by current received therefrom, the receiver-motors upon any line being operated by the line-battery and being stopped and started by means of the switch P.

Since the pen and motor circuits are independent circuits, it is evident that a separate battery or other source of electrical energy located at the transmitting-office could be used to work the motor-circuit; but we prefer the arrangement shown.

What we claim as our invention is—

1. In automatic telegraphs, the combination, with a suitable transmitter and a chemical-receiver, of an electric motor operating the receiver and worked directly and entirely by current from the transmitting-office, substantially as set forth.

2. In automatic telegraphs, the combination, with a suitable transmitter and a chemical-receiver, of an electric motor operating the receiver, worked directly and entirely by current from the transmitting-office, and a switch at the transmitting-office for controlling the circuit of the motor, substantially as set forth.

3. In automatic telegraphs, the combination, with a suitable transmitter, of a chemical-receiver, an electric motor operating the receiver, separate pen and motor circuits from the transmitter to the receiver, a common return for all the circuits, and switches at the transmitting-office for controlling the pen and motor circuits, substantially as set forth.

4. In automatic telegraphs, the combination, with a suitable transmitter, of a line extending therefrom and two or more automatic receivers connected in multiple arc with the line, and operated directly and entirely by the line-current, substantially as set forth.

5. In automatic telegraphs, the combination, with a suitable transmitter, of a line extending therefrom, and two or more chemical-receivers connected in multiple arc with the line, and operated directly and entirely by the line-current, substantially as set forth.

6. In automatic telegraphs, the combination, with a suitable transmitter, of a line extending therefrom and including pen-wires and a separate motor-wire, and two or more chemical-receivers operated by separate electric motors, such receivers being connected in mutiple arc with the line, substantially as set forth.

7. In automatic telegraphs, the combination, with a transmitter, a line, and two or more receivers connected in multiple arc with said line, of a feeder extending from the transmitter to the center of the line, substantially as set forth.

8. In automatic telegraphs, the combination, with a suitable transmitter, a line in-

cluding pen-wires and a separate motor-wire, chemical-receivers operated by separate electric motors and connected in multiple arc with the line, and a feeder extending from the transmitter to the center of the line, substantially as set forth.

9. In automatic telegraphs, the combination, with a transmitter, a line therefrom to receivers, including small pen-wires and a larger motor-wire capable of carrying without injury the entire battery-current, of a safety-catch for protecting the small pen-wires, substantially as set forth.

10. In automatic telegraphs, the combination, with a transmitter having several independent transmitting styluses, from which run separate pen-wires, and a battery connected by a single conductor with the transmitting-roller, of a safety-catch for protecting the pen-wires located in the conductor common to all the styluses, substantially as set forth.

11. In automatic chemical telegraphs, the combination, with a number of independent line pen-wires and instruments for transmitting and receiving Roman letters, of magnets located in cross-circuits between such pen wires, and a common return for preventing tailings, substantially as set forth.

12. In automatic chemical telegraphs, the combination, with a number of independent line pen-wires and instruments for transmitting and receiving Roman letters, of a number of batteries for sending currents upon the separate pen-wires reverse in direction to the main battery-current, such batteries being located in cross circuits between the pen-wires and a common return, and serving to prevent the marking of inactive pens, substantially as set forth.

13. In automatic chemical telegraphs, the combination, with a number of independent line pen-wires and instruments for transmitting and receiving Roman letters, of electro-magnets and reverse-current batteries located in cross-circuits between the several pen-wires and a common return, substantially as set forth.

14. In automatic telegraphs, the combination, with a suitable transmitter, of a chemical-receiver operated by an electric motor receiving current from the transmitting-office, and a governor for automatically governing the speed of said receiver motor, to maintain a uniform size of the characters, substantially as set forth.

15. In automatic telegraphs, the combination, with a suitable transmitter, of a chemical-receiver operated by an electric motor receiving current from the transmitting-office, and an adjustable governor for automatically governing the speed of the motor, substantially as set forth.

16. In automatic telegraphs, the combination, with a suitable transmitter operated by an electric motor, of a chemical receiver operated by an electric motor receiving current from the transmitting office, and adjustable governors for adjusting and controlling the relative speeds of said transmitter and receiver motors, whereby the desired size of characters will be produced by the receiver, substantially as set forth.

17. In automatic telegraphs, a chemical-receiver operated by an electric motor, in combination with a circuit-controller for automatically opening the motor-circuit when there is an abnormal flow of current, substantially as set forth.

18. In automatic telegraphs, the combination, with a chemical-receiver, of an electro-magnet located in the pen circuit, and a circuit-controller operated or controlled by such electro-magnet for opening the pen-circuit when there is an abnormal flow of current therethrough, substantially as set forth.

19. In automatic telegraphs, the combination, with a chemical-receiver, of a lifter for automatically raising the pens from the receiving roller when there is an abnormal flow of current through the pen-circuit, substantially as set forth.

20. In automatic telegraphs, the combination, with a chemical-receiver operated by an electric motor, of an electro-magnet in the pen-circuit and a lifter operated or controlled by such electro-magnet and acting, when there is an abnormal flow of current in the pen-circuit, to raise the pens from the receiving roller and to open the motor-circuit, substantially as set forth.

21. In automatic telegraphs, the combination, with a chemical-receiver operated by an electric motor, of an electro magnet located in the pen-circuit and moving its armature only when there is an abnormal flow of current, a spring-lever released by the movement of the armature, connections with such spring-lever for raising the pens from the receiving-roller and opening the motor-circuit, and a thumb-piece for resetting the parts, substantially as set forth.

22. In chemical-receivers for automatic telegraphs, the combination, with the pivoted pens, of an arm carrying the pressing-roller, having a finger passing under the pens for raising the pens and pressing-rollers simultaneously, substantially as set forth.

23. In chemical-receivers for automatic telegraphs, the combination of a number of pens insulated from each other and mounted together in a frame removable from a suitable support, whereby the pens can be removed bodily from the instrument, substantially as set forth.

24. In chemical-receivers for automatic telegraphs, the combination of a number of pens insulated from each other and mounted in a frame held upon a support by engaging parts, whereby the pens can be removed bodily by simply raising the frame from the support, substantially as set forth.

25. In chemical-receivers for automatic telegraphs, the combination of a number of pens held removably upon a suitable support, and

separate springs pressing against the shanks of said pens, but not secured thereto, for maintaining circuit-connections with such pens and permitting of their ready removal and replacement, substantially as set forth.

26. In chemical-receivers for automatic telegraphs, the combination of a number of receiving-pens mounted at their shanks upon separating insulation, said pens being brought close together at their ends and carrying insulating-studs to insure their electrical separation, substantially as set forth.

27. In chemical-receivers for automatic telegraphs, the receiving-pens having removable points, held by friction in dovetail grooves, substantially as set forth.

28. In automatic telegraphy, the combination, with a suitable support, to which the line-wires run, carrying terminals of such line-wires, of an automatic receiver having circuit-terminals engaging with the terminals of the support and completing the circuits by the act of setting the receiver upon the support, substantially as set forth.

29. In automatic telegraphy, the combination of a number of automatic receivers arranged in multiple arc, each carrying circuit-terminals, with supports for such receivers, to which the line-wires run, carrying terminals of such line-wires engaging the terminals of the receivers, and completing the circuits by the act of setting the receivers in position upon the supports, substantially as set forth.

30. In transmitters for automatic telegraphs, the combination of two troughs or paper-ways, each containing two or more sets of transmitting-styluses connected to different lines, the opposite styluses of the two troughs being connected to the same line, substantially as set forth.

31. In transmitters for automatic telegraphs, the combination, with feeding devices, of a loose transmitting-roller separate from the feeding devices, transmitting-styluses resting on the roller, and a spring-pressing wheel for pressing the traveling strip on the roller to turn said roller, substantially as set forth.

32. In transmitters for automatic telegraphs, the combination, with a feeding-wheel, of a trough or paper-way having a movable bottom, carrying one or more transmitting-rollers, and a lifter for raising said trough-bottom to bring the transmitting-rollers into contact with the transmitting-styluses, substantially as set forth.

33. In transmitters for automatic telegraphs, the independent transmitting-styluses removably held upon a support by frictionally-engaging parts, whereby they can be lifted from position, substantially as set forth.

34. In transmitters for automatic telegraphs, the combination, with the removable styluses, of springs pressing upon the shanks of said styluses, but not secured thereto, said springs permitting of the removal and replacement of the styluses, and maintaining circuit-connection therewith when in position, substantially as set forth.

35. In transmitters for automatic telegraphs, the combination, with two or more feeding-wheels and two or more troughs or paper-ways, of independent spring-rollers for pressing the strips of the troughs separately upon the feeding-wheels, substantially as set forth.

This specification signed and witnessed this 9th day of February, 1884.

THOS. A. EDISON.
PATRICK KENNY.

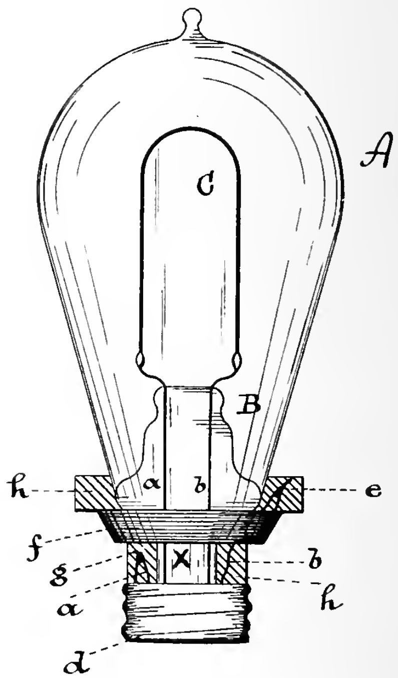
Witnesses:
A. W. KIDDLE,
E. C. ROWLAND.

(No Model.)

T. A. EDISON.

INCANDESCENT ELECTRIC LAMP.

No. 317,631. Patented May 12, 1885.



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UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, ASSIGNOR TO THE EDISON ELECTRIC LIGHT COMPANY, OF NEW YORK, N. Y.

INCANDESCENT ELECTRIC LAMP.

SPECIFICATION forming part of Letters Patent No. 317,631, dated May 12, 1885.

Application filed November 29, 1881. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Electric Lamps, (Case No. 374,) of which the following is a specification.

When it is intended that an incandescing electric lamp shall be readily removable from or replaceable in its socket or support, and the connection through the lamp from the socket is automatically completed or broken by the act of placing in or removing from position, it is necessary that the lamp be provided with a base, in or upon which are secured contact-plates, forming terminals of the wires leading into the lamp and to the incandescing conductor. Such bases have hitherto been made of several pieces of metal or of wood, or of wood and metal, secured to the lamp by a greater or less quantity of wax or cement.

The object of this invention is to provide the incandescing electric lamp with a base of simpler and cheaper construction; to which end it consists in a base formed upon the neck of the lamp entirely of an insulating plastic material, to which are secured, preferably in the process of manufacture, the necessary contact-plates, such plates being joined together and held upon the neck of the lamp-globe by the plastic material. These contact-plates are preferably in different horizontal planes, and one is a screw-ring, the location of the plates in different horizontal planes permitting the lamp to be revolved while the base is entering a socket without short-circuiting the socket.

In the drawing is shown a lamp and the contact as rings in elevation, while the portion of the base seen is in section.

A is the exhausted globe inclosing the carbon filament C, secured to the leading-in wires *a b*, which pass through and are sealed into the supporting-tube B, whose lower end projects beyond the globe A as a tube, *x*. The contacts upon the base are here shown as rings *f d*, located in different horizontal planes, the latter being screw-threaded to fit a corresponding screw-threaded seat in the socket; but it is evident that these contacts may be of any suitable size or form, and that the invention herein is in no wise dependent upon any particular size or shape of the contacts.

h is the base proper, which is formed in one piece directly upon the neck and bottom of the lamp by molding therein in proper shape a suitable quantity of insulating plastic material. A convenient method of doing this is shown in my prior application, No. 31,651, filed May 31, 1881, which is briefly as follows: To *d* a wire, *g*, is attached, and to *f* a wire, *e*. *g* is twisted to the leading-in wire *a*, and *e* to *b*. The contacts are then placed within a mold, the neck of the lamp inserted and held in position, and the space between the contacts and the wire filled with the plastic material. The latter having hardened the lamp-neck is withdrawn from the mold.

The contact-plates, it will be seen, are joined together and supported upon the neck of the lamp by the hardened plastic material. The method is given as typical only, as it is evident that the invention may be carried into effect in many other ways and without the use of a mold at all.

I do not claim herein the method of molding the base directly upon the lamp, nor the mold therefor, as such forms the subject-matter of the application hereinbefore noted; but

What I do claim is—

1. In an incandescing electric lamp, the combination, with the glass inclosing-globe and the neck thereof, of contact-plates joined together and held upon the neck of the lamp by plastic material, substantially as set forth.

2. In an incandescing electric lamp, the combination, with the glass inclosing-globe and the neck thereof, of contact-plates located in different horizontal planes, said plates being joined together and held upon the neck of the lamp by plastic material, substantially as set forth.

3. In an incandescing electric lamp, the combination, with the glass inclosing-globe and the neck thereof, of contact-plates, one of which is a screw-ring located in different horizontal planes, said plates being joined together and supported upon the neck of the lamp by plastic material, substantially as set forth.

THOS. A. EDISON.

Witnesses:
PAUL D. DYER,
WM. H. MEADOWCROFT.

(No Model.)

T. A. EDISON.

INCANDESCENT ELECTRIC LAMP.

No. 317,632. Patented May 12, 1885.

Fig 1.

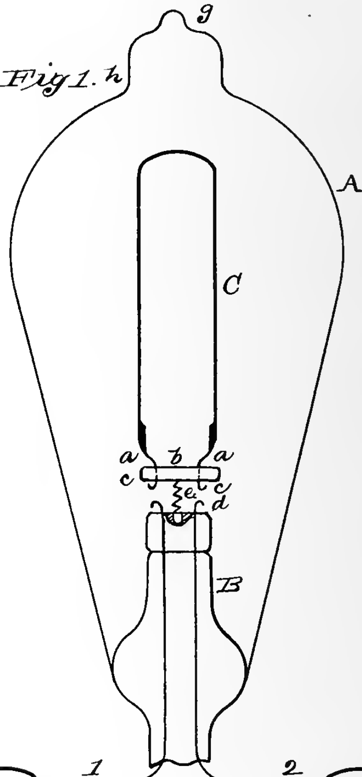


Fig. 2.

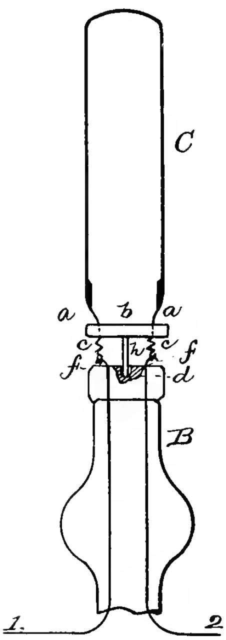


Fig. 3.

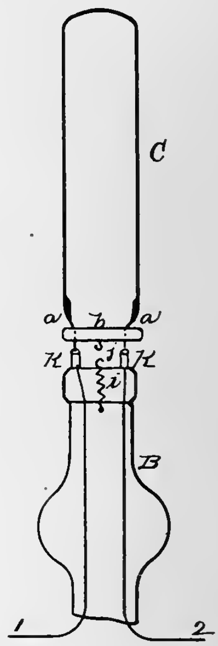


Fig 4.

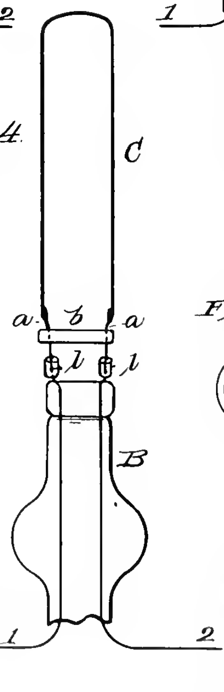


Fig 6

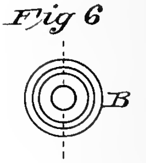
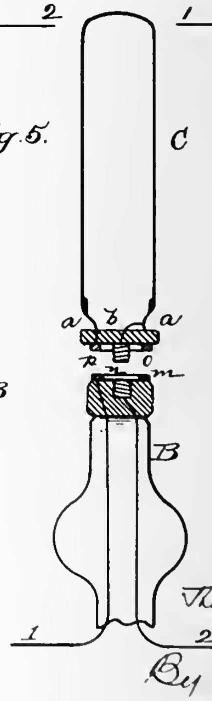


Fig. 5.



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UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, ASSIGNOR TO THE EDISON ELECTRIC LIGHT COMPANY, OF NEW YORK, N. Y.

INCANDESCENT ELECTRIC LAMP.

SPECIFICATION forming part of Letters Patent No. 317 632, dated May 12, 1885.

Application filed November 9, 1882. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Incandescent Electric Lamps, (Case No. 506,) of which the following is a specification.

In the use of incandescing electric lamps it may be sometimes desired after a carbon filament has become broken or worn out to substitute another therefor, using the glass and metallic portions of the lamp over again with the new filament.

The object of my invention is to render the process of substitution as simple and convenient as possible; and to this end the invention consists, principally, in making removable connections between the carbon and the leading-in wires of the lamp, such connections being so formed that good electrical contact as well as rigid and durable mechanical connections will be maintained, and the operations of connecting and disconnecting will be simple and convenient. Preferably, I make the connection by forming the ends of the leading-in wires into hooks and attaching small wires to the ends of the carbon, the ends of which are formed into corresponding hooks; or eyes may be used instead of hooks in one case or the other. Springs should be used in connection with the wire-support and the filament to keep the hooks or hooks and eyes in close contact with each other. Instead of this I may attach to the end of each leading-in wire a split tube of metal, the ends of the short wires attached to the carbon being pressed down into the tubes, such ends being bent out through the splits and the carbon held thus securely, but so as to be readily withdrawn; or a hook may be placed at the end of a spring projecting above the glass wire-support of the lamp, and a corresponding hook be attached to the bottom of an insulating piece, (preferably of glass,) through which pass the short wires attached to the carbon. The ends of the leading-in wires would be attached to metal tubes projecting up from the wire-support, and the ends of the wires attached to the carbon will enter these tubes, fitting closely therein.

Instead of using hooks and springs I may place on the top of the wire support a platinum ring, and set in the center of said support, within the ring, a screw-threaded platinum thimble. Short wires are attached to the carbon, as above, and a glass disk extends across supporting such wires. A platinum ring and a screw-threaded platinum plug are attached to the lower side of said glass disk, one of the wires attached to the carbon being connected with the ring and the other with the plug. The plug is screwed into the thimble on the wire-support, the glass disk being held by a suitable tool for this purpose, whereby circuit is completed through the filament. With all these forms the projection at the top of the globe must be of such diameter that when its top is removed an opening will be left of sufficient size to allow the withdrawal of the old carbon and admission of a new one.

The above may be better understood by reference to the drawings, in which Figures 1, 2, 3, 4, and 5 represent different forms of my invention, and Fig. 6 a top view of the glass wire-support of Fig. 5.

Like letters refer to corresponding parts in all these figures.

In Fig. 1, A is the inclosing-globe; B, the inner tube or wire-support, through which pass the leading in wires 1 2; and C the flexible carbon filament. Short wires *a a* are connected with the ends of the filament, and such wires pass through a glass piece or disk, *b*, their ends being formed into hooks *c c*.

In the solid end portion of the inner tube, B, is formed a hole or socket, *d*, and a spring, *e*, is attached to the piece *d* immediately above such hole or socket. The ends of the leading-in wires 1 2 are formed into hooks *f f*. Originally, of course, the filament is attached to the inner stem, B, the hooks *c c* and *f f* being connected, and the springs *e* entering the hole *d*, and such stem is passed through the bottom of the globe and fused to said globe, the globe then being exhausted from the top and sealed off at *g*.

The globe is constructed, as shown, with a projection, *h*, of sufficient diameter to permit the carbon filament to pass through it, and terminating in a tip, *g*. If it is desired to substitute a new filament for the old one, the tip g is broken off and the air allowed to enter the globe. The glass is then cut away from the upper part of projection h, so that an aperture is left, through which a suitable tool may be passed to grasp the glass piece b. Such piece b being pressed down, the hooks can be disengaged and the filament removed. The new filament, provided with the hooked wires a a and glass piece b, is then placed in the globe from above, the spring e entering the hole d, and being compressed therein until the hooks are connected, when the tool is removed, and the tension of the spring holds the hook in good contact. A glass tube should then be fused to the globe at g, through which the air can be exhausted, such tube then being sealed off in the usual manner.

In the form illustrated in Fig. 2 the wires a a themselves are formed into springs, and a pin, h, extending downwardly from disk b, enters the hole or socket d. The operation is of course the same.

In Fig. 3 a spring, i, is attached to the side of the stem B, and a hook, j, to the disk b. Metal tubes k k extend up from stem B, and the ends of the wires a a fit within such tubes, the tension of the spring keeping the wires in good contact with the tubes.

In Fig. 4 split metal tubes l l are attached to the leading-in wires, and the wires a a entering such tubes are bent out through the splits and held securely. By grasping the piece b the filament may be lifted directly out.

In the form illustrated in Figs. 5 and 6 the top of stem B is provided with a platinum ring, m, and a screw-threaded platinum thimble, n. The glass disk b has a platinum ring, o, and a screw-threaded platinum plug, p, attached to its under side.

The short wires a a attached to the filament are connected, respectively, with the ring o and plug p, and the leading-in wires 1 2 are connected, respectively, with ring m and thimble n. The plug p is screwed into thimble n, and the rings m and o are thus brought into contact.

It will be observed that in all forms of the removable connection the filament is held in a definite position relatively to the other parts of the lamp, no matter in what position said lamp may be placed.

What I claim is—

1. In an incandescing electric lamp, the combination, with the incandescing conductor, of an insulating piece attached to said conductor and metallic terminals supported by said insulating piece connected with said filament, and removably connected with the leading-in wires of the lamp, substantially as set forth.

2. The combination, with the incandescing conductor of an electric lamp and metallic terminals secured to said conductor and the leading-in wires of said lamp, of removable connections between said conductor-terminals and said wires within the lamp-globe, and a spring or springs whose tension acts to maintain electrical contact at such connections, substantially as set forth.

3. In an incandescing electric lamp, the combination, with the leading-in wires having their ends formed into hooks, of the incandescing conductor having corresponding hooks attached to its ends, and a spring or springs for maintaining electrical contact between the two pairs of hooks within the lamp-globe, substantially as set forth.

This specification signed and witnessed this 26th day of October, 1882.

THOS. A. EDISON.

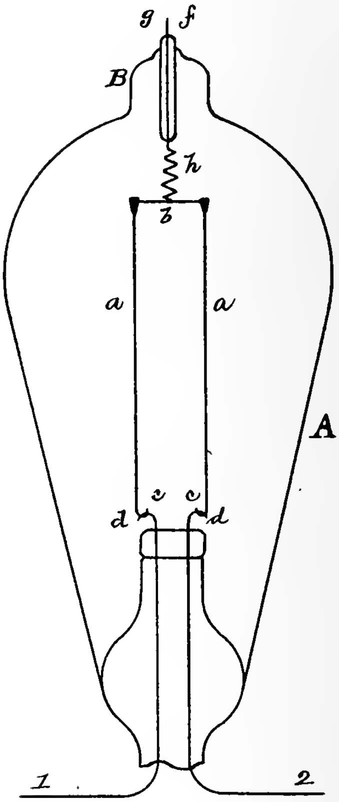
Witnesses:
WM. H. MEADOWCROFT,
H. W. SEELY.

(No Model.)

T. A. EDISON.

INCANDESCENT ELECTRIC LAMP.

No. 317,633. Patented May 12, 1885.



ATTEST:

E. C. Rowland

H. W. Kiddle

INVENTOR:

Thomas A. Edison

By Richd N. Dyer

Atty

United States Patent Office.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, ASSIGNOR TO THE EDISON ELECTRIC LIGHT COMPANY, OF NEW YORK, N. Y.

INCANDESCENT ELECTRIC LAMP.

SPECIFICATION forming part of Letters Patent No. 317,633, dated May 12, 1885.

Application filed November 9, 1882. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Incandescent Electric Lamps, (Case No. 507,) of which the following is a specification.

In my application No. 506 (Serial No. 76,378) I have set forth various means by which the flexible carbon filament of an incandescing electric lamp may be removably attached to the leading-in wires. The object I now have in view is to provide, in connection with such removable connections, means for compensating for the expansion and contraction caused by the heating and cooling of the filament, so as to prevent any bending or breaking of such filament. I prefer to accomplish this by attaching to the filament a spiral spring whose tension is in the same direction as the expansion and contraction of the filament, and such spring being also firmly attached to the glass of the lamp-globe, so that when the filament expands the spring will contract, and when the filament contracts the spring will lengthen.

My invention is illustrated in the annexed drawing, in which the figure is an elevation of a lamp embodying the invention.

The incandescing conductor consists of two straight filaments of carbon, *a a*, connected by a wire, *b*, at their upper ends. To the other end of each is attached a hook, *c*. The ends of the leading-in wires 1 2 are formed into corresponding hooks, *d d*. The filament is inclosed in the glass vacuum-chamber A, at whose top is the projection B, of sufficient diameter to allow the incandescing conductor to pass through it when the glass is cut or otherwise removed from the top of said projection.

A glass tube, *f*, is sealed in the top of the globe, and a platinum wire, *g*, is sealed in said tube. The wire *g* terminates in a spring, *h*, which is attached to the wire *b*. Such spring serves to keep the hooks in good electrical and mechanical contact, to keep the carbon upright, and to compensate for the expansion and contraction of the carbon.

What I claim is—

1. In an incandescing electric lamp, the combination, with the carbon filament, of removable connections with the leading-in wires and a tension-spring drawing upon such filament, to compensate for the expansion and contraction of the filament, substantially as set forth.

2. In an incandescing electric lamp, the combination, with the straight carbon filaments connected by a wire, of the tension-spring attached to said wire and sealed in the glass of the inclosing-globe, substantially as set forth.

3. In an incandescing electric lamp, the combination, with the straight carbon filaments connected by a wire, of the tension-spring attached to said wire and sealed in the glass of the inclosing-globe, and removable connections between said filaments and the leading-in wires, substantially as set forth.

This specification signed and witnessed this 26th day of October, 1882.

THOS. A. EDISON.

Witnesses:

WM. H. MEADOWCROFT,
H. W. SEELY.

(No Model.)

T. A. EDISON.

COMMUTATOR FOR DYNAMO ELECTRIC MACHINES.

No. 328,572. Patented Oct. 20, 1885.

Fig. 1.

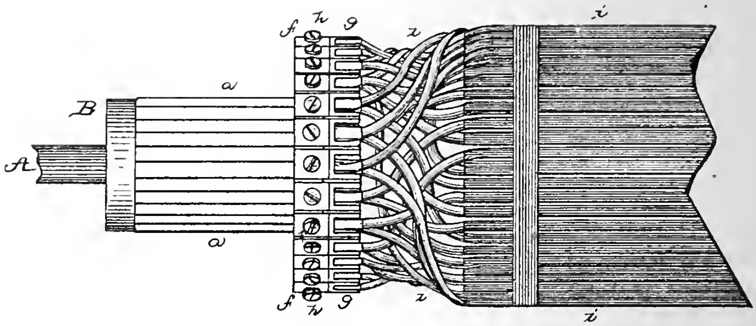


Fig. 2.

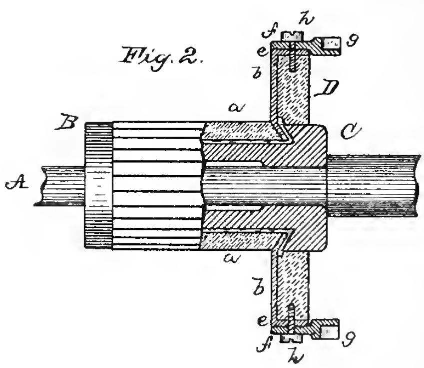


Fig. 3.

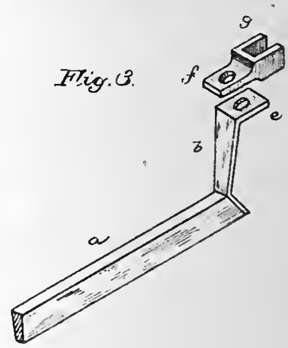
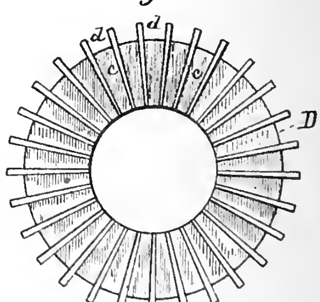


Fig. 4.



ATTEST:

E. C. Rowland

H. W. Seely

INVENTOR:

Thomas A. Edison,

By Rich'd N. Dyer

Att'y

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

COMMUTATOR FOR DYNAMO-ELECTRIC MACHINES.

SPECIFICATION forming part of Letters Patent No. 328,572, dated October 20, 1885.

Application filed June 29, 1883. Serial No 99,556. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Dynamo-Electric Machines, (Case No. 580,) of which the following is a specification.

The object of this invention is to provide secure, good, and durable connections between the coils upon the armature of a dynamo-electric machine and the conducting-strips upon the commutator of the machine, which, while durable, secure, and effective, both mechanically and electrically, shall be removable, so that the commutator can be removed when worn out without any melting of solder; and my invention consists in the novel devices and combinations of devices employed by me in accomplishing this object, as hereinafter described and claimed.

My invention is illustrated in the annexed drawings, in which Figure 1 is a view in elevation of the commutator and the end of the armature of a dynamo-electric machine, showing the connecting devices; Fig. 2, a sectional view of the connecting devices and a portion of the commutator; Fig. 3, an enlarged perspective view of the connections to one commutator-bar, and Fig. 4 an elevation of the insulating-disk which supports and separates the connections.

A is the armature-shaft of the machine, and B is the commutator, consisting of an inner cylinder, C, provided with grooves, in which are placed the commutator-bars *a a*, separated from each other and from the cylinder by mica insulation, as set forth in another application made by me. The inner ends of these bars are beveled, as shown, and to these beveled ends are brazed the metal strips *b b*.

A disk, D, of insulating material, preferably vulcanized fiber, is placed upon the inner end of cylinder C, and serves to support all the connecting devices. Said disk is provided with grooves *c* in its face and grooves *d* in its periphery. In the face-grooves *c* are placed the strips *b*, which are thus held securely and insulated from each other. Their ends also are well secured, being turned obliquely and brazed between the beveled ends of the commutator-bars *a* and the beveled ends of the grooves upon the cylinder C. The ends of the strips *b* are turned at right angles, and the bent portions *e* are inserted in the grooves *d* in the periphery of the disk D.

The intermediate connecting-pieces each consist of a flat portion, *f*, which is placed upon the part *e* in the groove *d*, and a box or cup, *g*, or other device capable of holding solder, into which terminal of the armature-coils are brought and soldered. The contacting surfaces of *e* and *f* are gold-plated, to make good electrical connection, and the two pieces are secured together by screws *h*, which enter the fiber disk D. These screws are preferably of iron or steel, and are also plated with the same metal as the other contact-surfaces.

The wire coils *i i* are wound longitudinally upon the armature. Each coil is composed of a number of wires. The end of a coil is brought to a box, *g*, from one side of the armature, and the opposite end of the coil next in position is brought from the other side to the same box. The first end of said next coil is brought to the next box, and the opposite end of the coil next to this is brought to the same box, and so on. Thus all the coils are connected longitudinally together, forming a single continuous coil, connected at intervals to the commutator-strips *a*. The two ends brought into a box are securely soldered therein, a good electrical and mechanical connection being thus provided.

To remove the commutator-cylinder, the screws *h* are withdrawn, when the cylinder and connecting-strips can be withdrawn from the shaft without disturbing the armature-connections. A new cylinder can then be placed on the shaft and the connecting-strips screwed together.

It will be seen that all the connections made from the coils to the commutator-strips are good and secure, and that all the parts are rigidly held in position.

What I claim is—

1. The combination, with the conducting-strips rising from the commutator-bars and turned at right angles, of the connecting-pieces removably secured thereto and permanently secured to the armature-coils, substantially as set forth.

2. The intermediate connecting-pieces, pro-

vided with boxes or cups, in which the armature-conductors are secured, substantially as set forth.

3. The combination, with the commutator-bars placed in grooves in a cylinder, of the conducting-strips secured between said bars and the ends of said grooves, substantially as set forth.

4. The combination, with the commutator-bars having beveled ends, and the beveled ends of the grooves, of the oblique ends of the conducting-strips secured between them, substantially as set forth.

5. The combination, with the strips rising from the commutator-bars, of the insulating-disk having grooves in its face, in which said strips are held, substantially as set forth.

6. The combination, with the devices connecting the armature-coils with the strips rising from the commutator-bars, of the insulating-disk having grooves in its periphery, in which such devices are held, substantially as set forth.

7. The combination, with devices, substantially such as described, connecting the armature-coils with the commutator-bars, of the insulating-disk having face grooves and edge grooves, in which such devices are held, substantially as set forth.

8. The combination, with the conducting-strips rising from the commutator-bars and turned at right angles, of the intermediate connecting-pieces attached to said rising strips, said intermediate pieces being provided with boxes or cups, in which the armature-coils are secured, substantially as set forth.

This specification signed and witnessed this 25th day of June, 1883.

THOS. A. EDISON.

Witnesses:

H. W. SEELY,

EDWARD H. PYATT.

(No Model.)

T. A. EDISON.

SYSTEM OF ELECTRIC LIGHTING.

No. 328,573. Patented Oct. 20, 1885.

Fig 1.

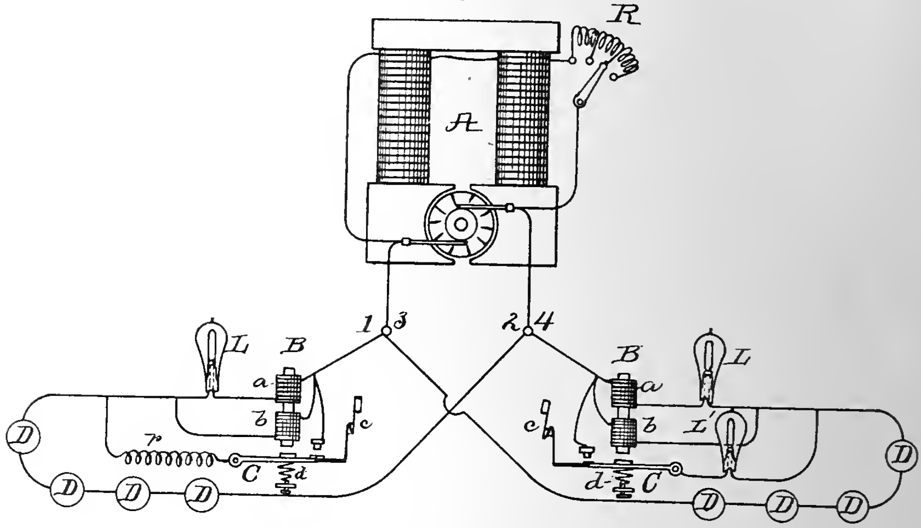


Fig 2.

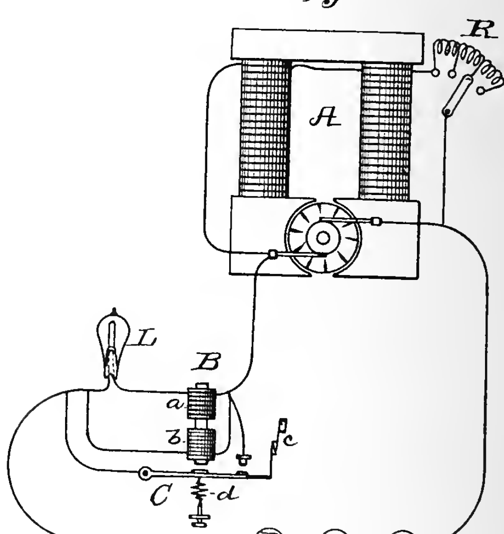


Fig 4.

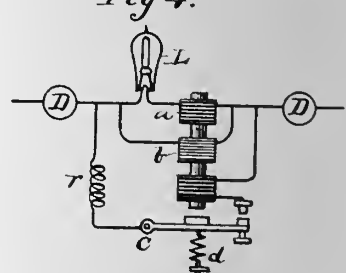
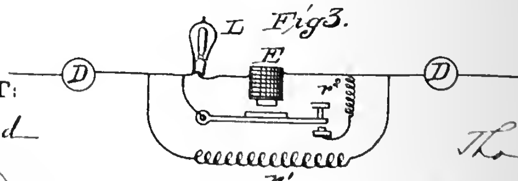


Fig 3.



ATTEST:

E. C. Rowland

Paul D. Dyer.

INVENTOR:

Thomas A. Edison

By Rich'd N. Dyer

Atty.

United States Patent Office.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

SYSTEM OF ELECTRIC LIGHTING.

SPECIFICATION forming part of Letters Patent No. 328,573, dated October 20, 1885.

Application filed October 2, 1884. Serial No. 144,514. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a certain new and useful Improvement in Systems of Electric Lighting, (Case No. 630,) of which the following is a specification.

The object I have in view is to utilize incandescing electric lamps upon high-tension circuits for street-lighting, or for other purposes where great economy in conductors is desirable and a high-tension current is not objectionable.

My invention relates, first, to the arrangement of the incandescing electric lamps in series in a high-tension circuit, with peculiar automatic cut-out mechanisms for the lamps, which maintain the continuity of the circuit when the carbon conductor of a lamp breaks; and, second, to the arrangement for a system of several circuits, all the circuits being taken from a common source of supply, and means being provided for maintaining constant the relative resistances of the several circuits.

With regard to the first part of my invention, I employ at each lamp of the series in the circuit an electro-magnetic cut-out with a localizing shunt-circuit around the lamp, which is constantly closed to prevent the action of all the cut-outs when one acts. I may use a differential cut-out, the localizing shunt forming the high-resistance coils of the magnet. The differential cut-out is a differentially-wound electro-magnet or solenoid, one set of coils being directly in the line in series with the lamps and the other set of coils being in a constantly-closed shunt (the localizing circuit) around the particular lamp the mechanism is designed to cut out. This magnet or solenoid acts upon an armature or core, closing, when the lamp-carbon breaks, a shunt around the broken lamp. The shunt is maintained in any of the known ways by a mechanical lock—such as a spring-catch or trigger—or by an electrical lock, throwing into circuit coarse-wire coils, which maintain the magnetism and hold the shunt closed. In these general respects the differential automatic cut-out for an incandescing electric lamp does not differ, except in its application, from similar mechanisms used in connection with arc-lamps; but an automatic cut-out for incandescing electric lamps depending for its proper operation upon other conditions than the similar mechanism for arc-lamps, the construction and adjustment of the devices are necessarily different. In an arc-light cut-out the cut-out may operate when the arc becomes abnormally long, and while there is still current in both sets of coils of the differential magnet or solenoid; but in my cut-out for incandescing electric lamps the operation is designed to take place only when the lamp-carbon is broken and there is a total cessation of current in one set of the differential coils. The incandescing carbon conductor of the lamp changes its resistance rapidly under changes in temperature, the lowering of the temperature producing an increase in its resistance. This may occur at any time by the flickering of the lamps from any cause—such as the cutting out of a lamp—or the temperature of each lamp may be decreased and the resistance increased when the load is too great for the dynamo or dynamos supplying the current. It is evident, also, that this peculiar property of the incandescing carbon conductors might cause all the cut-outs to act when the dynamo is first started up. To overcome these difficulties I make the retracting-spring of sufficient strength and strain it to the proper point, so that the armature or core will not be moved, except upon a complete cessation of the current through that set of coils of the differential magnet or solenoid which is in the line. The shunt-circuit which is closed by this cut-out mechanism may include another lamp, or a resistance in other form equal to the broken lamp, or where the current is regulated at the source of supply this shunt will have practically no resistance at all.

The localizing shunt-circuit, which is constantly closed around each lamp, instead of including one set of coils of the differential magnet, may be a simple resistance. The cut-out will then be a magnet whose armature-lever closes the cut-out shunt at its back point. The parts will be constructed and adjusted so that the magnet will attract the armature and keep the shunt open when there is any current in the magnet, and will not permit the shunt to close or remain closed except upon a total cessation of current in the magnet-coils.

In carrying out the second part of my invention I provide a source of electrical supply composed of one or more dynamo-electric machines, the machines (if more than one) being connected to common or omnibus conductors in the station. The machine (or each machine, if more than one is employed) is provided with means, either manual or automatic, for varying the current generated by it. This is preferably an adjustable resistance in the field-magnet circuit of the machine, which is a derived circuit taken from the armature of the machine. From this common source of supply is run two or more lighting-circuits, each containing a number of incandescing electric lamps having cut-out mechanisms. In a system of this character it is essential that the relative resistances of the several circuits taken from the common source of supply should be maintained, so that the current will be properly distributed between the two or more circuits, and each will receive the right number of ampères of current to maintain the lamps at normal incandescence. This may be done in several ways, all of which come within the scope of the broad invention hereinafter claimed. The cut-out for each lamp may be arranged to throw in an equivalent resistance, whether another lamp or not; or the regulation can be performed by throwing resistances into the circuits at the central station. The last way is covered specifically by an application for patent of even date herewith, Serial No. 144,545, and hence is not claimed herein, except as it comes within the scope of the broad invention hereinafter claimed.

The circuits, instead of being simple circuits, may be compensating circuits—a construction which is also covered specifically by an application of even date herewith, Serial No. 144,546.

In the accompanying drawings, forming a part hereof, Figure 1 is a view, principally in diagram and partially developed, illustrating a system embodying my invention; Fig. 2, a similar view of a dynamo-electric machine and a single circuit supplied thereby; Fig. 3, a view of a modified form of cut-out, and Fig. 4 a view of the cut-out showing electrical lock.

A is a dynamo-electric machine, having its field-circuit derived from its armature and including an adjustable resistance, R. This machine supplies incandescing electric lamps L D, arranged in series.

B is a differentially-wound electro-magnet, forming the operating element of the cut-out at each lamp. This magnet has one set of coils, a, located in the line in series with all the lamps, while its other set of coils, b, is in a shunt constantly closed around the lamp and forming a localizing circuit for the cut-out.

The armature-lever C closes a shunt-circuit around the lamp, and this circuit is held closed by a spring-lock, c, Figs. 1 and 2, or by an electrical lock formed by magnet-coils c' in the shunt-circuit, Fig. 4. The retracting-spring d of the armature-lever is adjusted to produce the effect described. The shunt closed by lever C may have practically no resistance, as in Fig. 2, or it may include a resistance, r, equal to a lamp or an extra lamp, L', Fig. 1.

The circles D are intended to represent lamps and cut-outs, one being developed for each circuit.

In Fig. 3 the cut-out is composed of a magnet, E, in series with all the lamps, and a constantly-closed shunt-circuit around the lamp and magnet containing a resistance, r'. The magnet E keeps the cut-out shunt open while L is burning, no change in resistance of L, due to changes in temperature, serving to weaken E enough to close the cut-out shunt.

In starting up the plant the cut-out shunts will be opened, provided the resistance r or lamp L' of Fig. 1 is used, otherwise a small resistance, r^2, in the cut-out shunt is employed to give magnet E sufficient force to open said cut-out shunt.

In Fig. 1 two circuits, 1 2 and 3 4, are taken from the same machine, and the relative resistances of the circuits are maintained by the operation which takes place at the cut-outs, resistances equal to the lamps cut out or other lamps being thrown into circuit as the lamps break.

What I claim is—

1. The combination, with incandescing electric lamps arranged in series, of automatic cut-out mechanisms for the several separate lamps, (including a localizing constantly-closed shunt around each lamp,) maintaining the continuity of the circuit as the incandescing conductors of the lamps break, substantially as set forth.

2. The combination, with incandescing electric lamps arranged in series, of differentially-wound magnets or solenoids closing shunt-circuits around the lamps as they are broken, one set of coils of each differential magnet or solenoid being in the main circuit and the other set of coils being in a constantly-closed shunt around the lamp, and mechanical or electrical locks for holding the shunts closed, substantially as set forth.

3. The combination, with an incandescing electric lamp, of a magnet in series therewith controlling a cut-out shunt, and constructed and adjusted, substantially as described, to permit the same to be closed only after a total cessation of current in the coils of said magnet, and not being affected by changes in resistance of the incandescing conductor, and a constantly-closed shunt-circuit around said lamp, and magnet for localizing the cut-out, substantially as set forth.

4. The combination, with an incandescing electric lamp, of a differentially-wound magnet or solenoid having one set of coils in series therewith and the other set in a constantly-closed shunt around said lamp and the first set, an armature or core and retractor acting to close a shunt around the lamp, said parts being constructed and adjusted to act only upon a complete cessation of current in the set of coils in series with the lamp, and not to be

affected by changes in resistance of the incandescing conductor, substantially as set forth.

5. The combination, with an incandescing electric lamp, of a differentially-wound magnet or solenoid having one set of coils in series therewith and the other set in a constantly-closed shunt around said lamp and the first set, an armature or core and retractor acting to close a shunt around the lamp, and a mechanical or electrical lock for keeping said shunt closed, the parts being constructed and adjusted to act only upon a complete cessation of current in the set of coils in series with the lamp, and not to be affected by changes in resistance of the incandescing conductor, substantially as set forth.

This specification signed and witnessed this 12th day of September, 1884.

THOS. A. EDISON.

Witnesses:

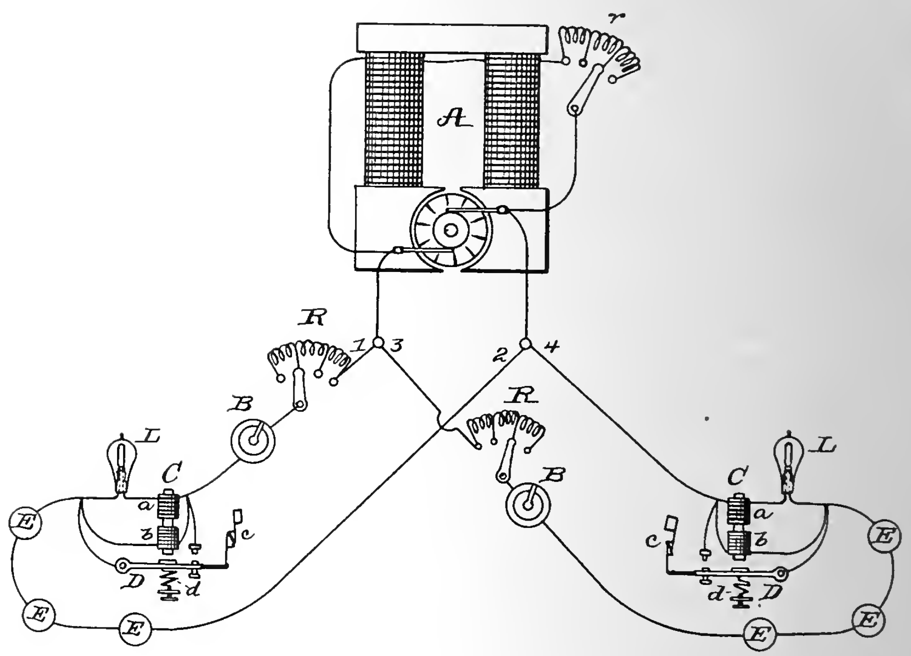
WM. H. MEADOWCROFT,
PAUL D. DYER.

(No Model.)

T. A. EDISON.

SYSTEM OF ELECTRIC LIGHTING.

No. 328,574. Patented Oct. 20, 1885.



ATTEST:
E. C. Rowland
Paul D. Dyer

INVENTOR:
Thomas A. Edison
By Rich^d N. Dyer
Atty.

United States Patent Office.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

SYSTEM OF ELECTRIC LIGHTING.

SPECIFICATION forming part of Letters Patent No. 328,574, dated October 20, 1885.

Application filed October 2, 1884. Serial No. 144,545. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a certain new and useful Improvement in Systems of Electric Lighting, (Case No. 631,) of which the following is a specification.

The object I have in view is to utilize incandescing electric lamps upon high-tension circuits for street-lighting, or for other purposes where great economy in conductors is desirable and a high-tension current is not objectionable.

My present invention relates to a simple and efficient arrangement for accomplishing that end.

In carrying out my invention I take from a common source of electrical supply two or more circuits, each containing a number of incandescing electric lamps arranged in series. Each lamp is provided with an automatic cut-out mechanism which closes a shunt of practically no resistance around the lamp when the incandescing conductor of the lamp breaks. The cut-out mechanism is not affected by changes in resistance of the incandescing conductor, due to changes in temperature, and if a differential cut-out, it has a mechanical or electrical lock for holding the shunt closed. The two or more lamp-circuits must have their relative resistances maintained constant, in order that the lamps may all have the same incandescence. This I accomplish by throwing resistance into the separate circuits in the station. Each circuit at the source of supply is provided with an ampère indicator and a manually-operated adjustable resistance; or these parts may be supplanted by an automatic apparatus throwing resistance into the circuit to maintain a constant flow of current. This automatic apparatus may be such as is shown in my Patent No. 287,524, the pressure-magnet B of that patent being wound of low resistance and located directly in the line, while the adjustable resistance will be arranged to be thrown into and out of the line. The source of supply is composed of one or more dynamo-electric machines, the machines (if more than one) being connected together to common or omnibus conductors in the station. The machine (or each machine, if more than one is employed) has its field-magnet located in a circuit derived from its armature, and in this circuit is located a manually or automatically operated adjustable resistance for controlling the generative capacity of the supply common to the two or more lamp-circuits.

The circuits, instead of being simple circuits, may be compensating circuits, such as are described in an application of even date herewith, Serial No. 144,546.

In the accompanying drawing, forming a part hereof, the figure is an illustration, principally in diagram, of a system embodying my invention.

A is a dynamo-electric machine, having its field-magnet in a circuit derived from its armature, and including an adjustable resistance, *r*. From this machine are taken circuits 1 2 and 3 4, each including within the station an adjustable resistance, R, which may be in the form of lamps, or be a wire resistance, and an ampère indicator, B. Each circuit has incandescing electric lamps L E arranged in series therein. Each lamp has a cut-out, which may be composed of a differentially-wound magnet, C, having coils *a* in series with the lamp and coils *b* in a shunt around the lamp. The armature-lever D closes a shunt of practically no resistance around the lamp, and this shunt, when closed, is locked by a spring-lock, *c*.

The retracting-spring *d* is given such a construction and adjustment that the armature is not moved until there is a total cessation of current in the coils *a*, and hence the cut-out is not affected by changes in the resistance of the incandescing lamp conductor, due to changes of temperature in such conductor; or the cut-out may be a simple magnet in the line, and a constantly-closed shunt of high resistance around the lamp and magnet for localizing the cut-out, as described in my application No. 630, Serial No. 144,544, of even date herewith. With this form of cut-out the cut-out shunt would have a small resistance, sufficient to enable the magnet to open the cut-out shunt in starting up; but its resistance would still be low.

The circles E are intended to represent lamps and cut-outs, one set of these parts being developed in each circuit.

What I claim is—

1. The combination, with a common source

of supply, of two or more circuits therefrom, incandescing electric lamps in series in each circuit, automatic cut-out mechanisms closing shunt-circuits of low or practically no resistance around the lamps as they break, and an adjustable resistance in each circuit at or near the source of supply for maintaining constant the relative resistances of the two or more lamp-circuits, substantially as set forth.

2. The combination, with a common source of supply, of two or more circuits therefrom, incandescing electric lamps in series in each circuit, automatic cut-out mechanisms closing shunt circuits of low or practically no resistance around the lamps as they break, an adjustable resistance in each circuit at or near the source of supply, and an ampère indicator in each circuit at that point, substantially as set forth.

3. The combination, with one or more dynamo-electric machines forming a common source of supply, of adjustable resistances for regulating the generative capacity of the machine or machines, two or more circuits from such source of supply, incandescing electric lamps in series in each circuit, automatic cut-out mechanisms closing shunt-circuits of low or practically no resistance around the lamps as they break, and an adjustable resistance in each circuit at or near the source of supply, substantially as set forth.

4. The combination, with one or more dynamo-electric machines forming a common source of supply, of the field-magnet coils of the machine (or of each machine) located in a circuit derived from its armature, adjustable resistances for regulating the generative capacity of the machine or machines, two or more circuits from such source of supply, incandescing electric lamps in series in each circuit, automatic cut-out mechanisms closing shunt-circuits of low or practically no resistance around the lamps as they break, and an adjustable resistance in each circuit at or near the source of supply, substantially as set forth.

This specification signed and witnessed this 12th day of September, 1884.

THOS. A. EDISON.

Witnesses:
WM. H. MEADOWCROFT,
PAUL D. DYER.

(No Model.)

T. A. EDISON.

SYSTEM OF ELECTRIC LIGHTING.

No. 328,575. Patented Oct. 20, 1885.

Fig 1.

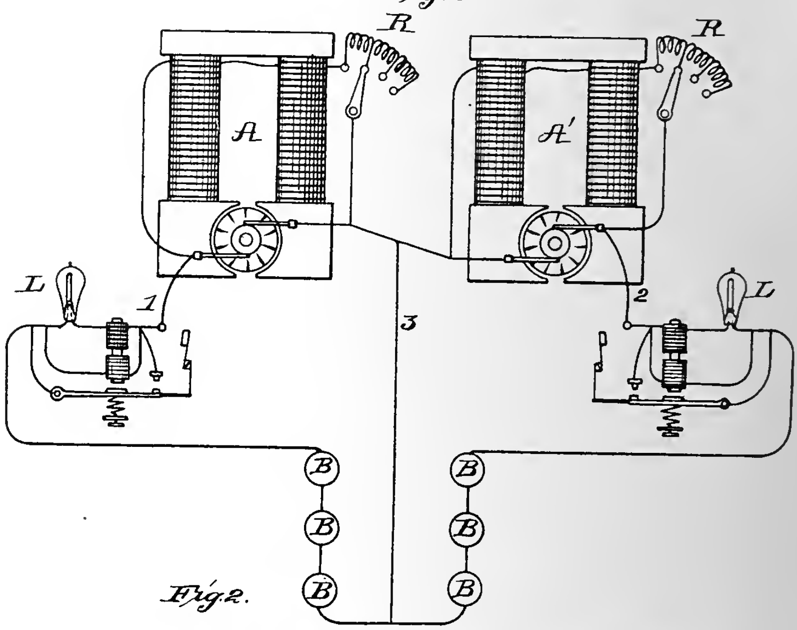
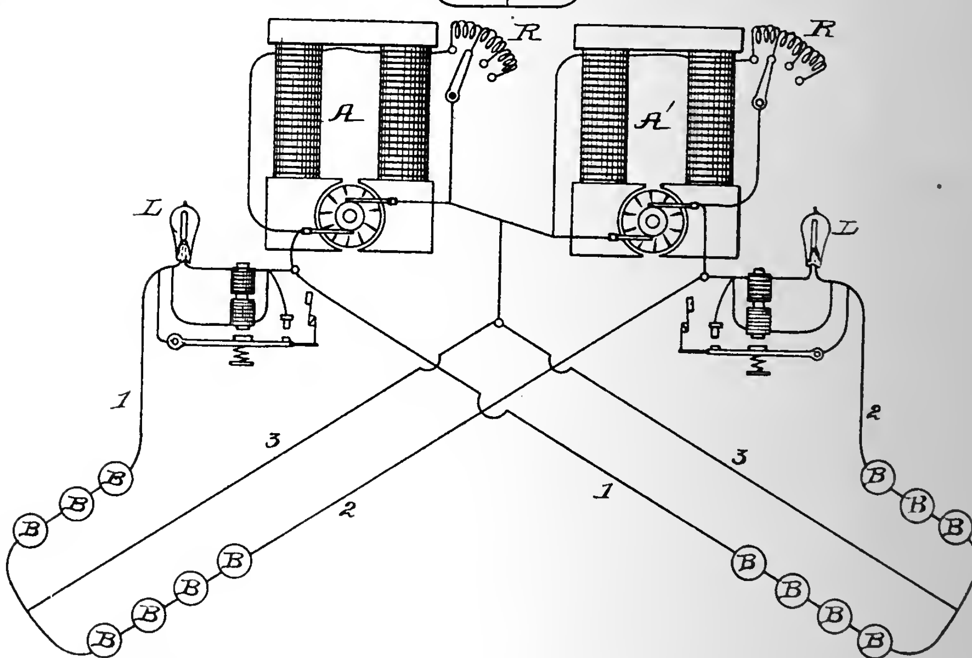


Fig.2.



ATTEST:

E. C. Rowland

Paul D. Dyer.

INVENTOR:

Thomas A. Edison,

By Rich^d N. Dyer

Atty.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

SYSTEM OF ELECTRIC LIGHTING.

SPECIFICATION forming part of Letters Patent No. 328,575, dated October 20, 1885.

Application filed October 2, 1884. Serial No. 144,546. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a certain new and useful Improvement in Systems of Electrical Lighting, (Case No. 632,) of which the following is a specification.

The object I have in view is to combine in a series system of electric lighting by incandescence the advantage of small conductors resulting from the use of high-tension currents with an independence of circuits taken from a common source of supply. This I accomplish by using a divided source of electrical supply, such as two dynamo-electric machines having their armatures connected together in series. From this source of supply are taken three conductors, two conductors—the positive and negative—being taken from the outer terminals of the two machines, and the third conductor—the neutral or compensating conductor—from a point between the two machines. These three conductors are run out the desired distance, and are connected together at their outermost ends. The positive and negative conductors include each a number of incandescing electric lamps located in series with one another. These lamps are provided with cut-out mechanisms, which are not affected by changes in resistance of the incandescing conductor due to changes in temperature, but only act when the lamps break.

The two dynamo-electric machines are adapted to be regulated independently, each machine having its field-magnet coils located in a derived circuit from its armature, and in each field-circuit is located a manually or automatically adjusted resistance.

The three conductors form two circuits, which, while taken from a common source of electrical energy, are independent, in that the cutting out of a translating device on one side of the neutral or compensating conductor does not affect the translating devices on the other side, the central compensating-conductor becoming a positive or negative conductor if the current on one side or the other predominates, or becoming neutral if the two sides balance. When two or more of such compound circuits (each composed of two independent circuits) are taken from the same source of electrical supply, as I design to do, the relative resistances of the several compound circuits may be maintained constant by adjustable resistances, or otherwise, as explained in two applications of even date herewith, Nos. 144,544 and 144,545.

In the accompanying drawings, forming a part hereof, Figure 1 is a view, principally diagrammatic, illustrating a system having one compound circuit; and Fig. 2, a similar view showing two compound circuits taken from a common source of supply.

A A′ are dynamo-electric machines having their armatures connected in series. Each machine has its field-magnet coils in a circuit derived from its armature, and adjustable resistance R is located in each field-circuit to regulate the machines independently.

1 and 2 are positive and negative conductors, and 3 the neutral or compensating conductor. These three conductors form a compound circuit, in each side of which are arranged in series a number of incandescing electric lamps, L B.

Each lamp has an automatic cut-out mechanism for closing a shunt around the lamp when its carbon conductor is broken, and not until then. As described fully in the applications referred to, this cut-out acts only when the lamp-carbon breaks, and is not affected by changes in resistance of the incandescing conductor due to changes in its temperature.

The circles B represent lamps with cut-outs, one lamp only being developed in each circuit. In Fig. 2 two of such compound circuits are shown as taken from the same source of supply.

What I claim is—

1. The combination, with a divided source of electrical energy, of a compound or three-wire circuit extending therefrom, incandescing electric lamps located in series in each side of the circuit, and cut-out mechanisms for the separate lamps, substantially as set forth.

2. The combination, with a divided source of electrical energy, the parts of which are independently regulatable, of a compound or three-wire circuit extending therefrom, incandescing electric lamps located in series in each side of the circuit, and cut-out mechanisms for the separate lamps, substantially as set forth.

3. The combination, with a divided source of electrical energy, of two or more compound or three-wire circuits taken therefrom, incandescing electric lamps located in series in each side of said compound circuits, and cut-out mechanisms for the separate lamps, substantially as set forth.

This specification signed and witnessed this 12th day of September, 1884.

THOS. A. EDISON.

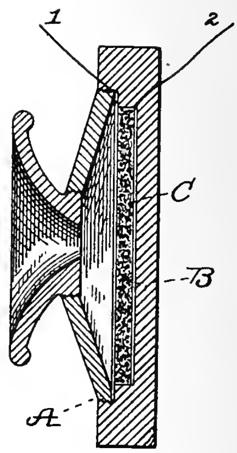
Witnesses:
WM. H. MEADOWCROFT,
PAUL D. DYER.

(No Model.)

T. A. EDISON.

TELEPHONE.

No. 329,030. Patented Oct. 27, 1885.



ATTEST:

E. C. Rowland

T. G. Greene Jr.

INVENTOR.

Thomas A. Edison

By Dyer & Seely

Attys.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

TELEPHONE.

SPECIFICATION forming part of Letters Patent No. 329,030, dated October 27, 1885

Application filed December 15, 1884. Serial No. 150,344. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Telephones, (Case No. 636,) of which the following is a specification.

In the use of loose granulated carbon or other divided conducting material in telephones such material is liable to shift its position and become packed, and the instrument be thereby made to fail in its operation. This renders it necessary to fix the position of such instruments, which is not desirable, and even when their position is fixed the difficulty is not wholly overcome, since external vibrations serve to produce the same result. I have found, however, that by coating to the minimum extent the carbon or other granules with an adhesive substance—such as an oil or other viscous material—the effectiveness of the instrument is not injured, and the granules will retain their relative positions without packing. This discovery is applicable to any form of telephone in which granulated carbon or other material is used, and hence I wish it understood that my invention is not limited to any particular construction of instrument.

In the accompanying drawing, to which reference is now made, there is shown, for illustration, a sectional view of a conventional form of telephone.

A is a metal diaphragm, between which and a metal back plate, B, is located a body, C, of loose granules of carbon or other conducting material. These granules are coated with an adhesive substance, as already explained. The circuit-connections 1 2 are made with the diaphragm and back plate, the body of granulated carbon or other material being interpolated in the circuit between those parts.

What I claim is—

1. A telephone having in circuit a body of granulated material, the granules being coated with an adhesive substance, substantially as set forth.

2. A telephone having in circuit a body of granulated carbon, the carbon granules being coated with an adhesive substance, substantially as set forth.

This specification signed and witnessed this 3d day of December, 1884.

THOMAS A. EDISON.

Witnesses:

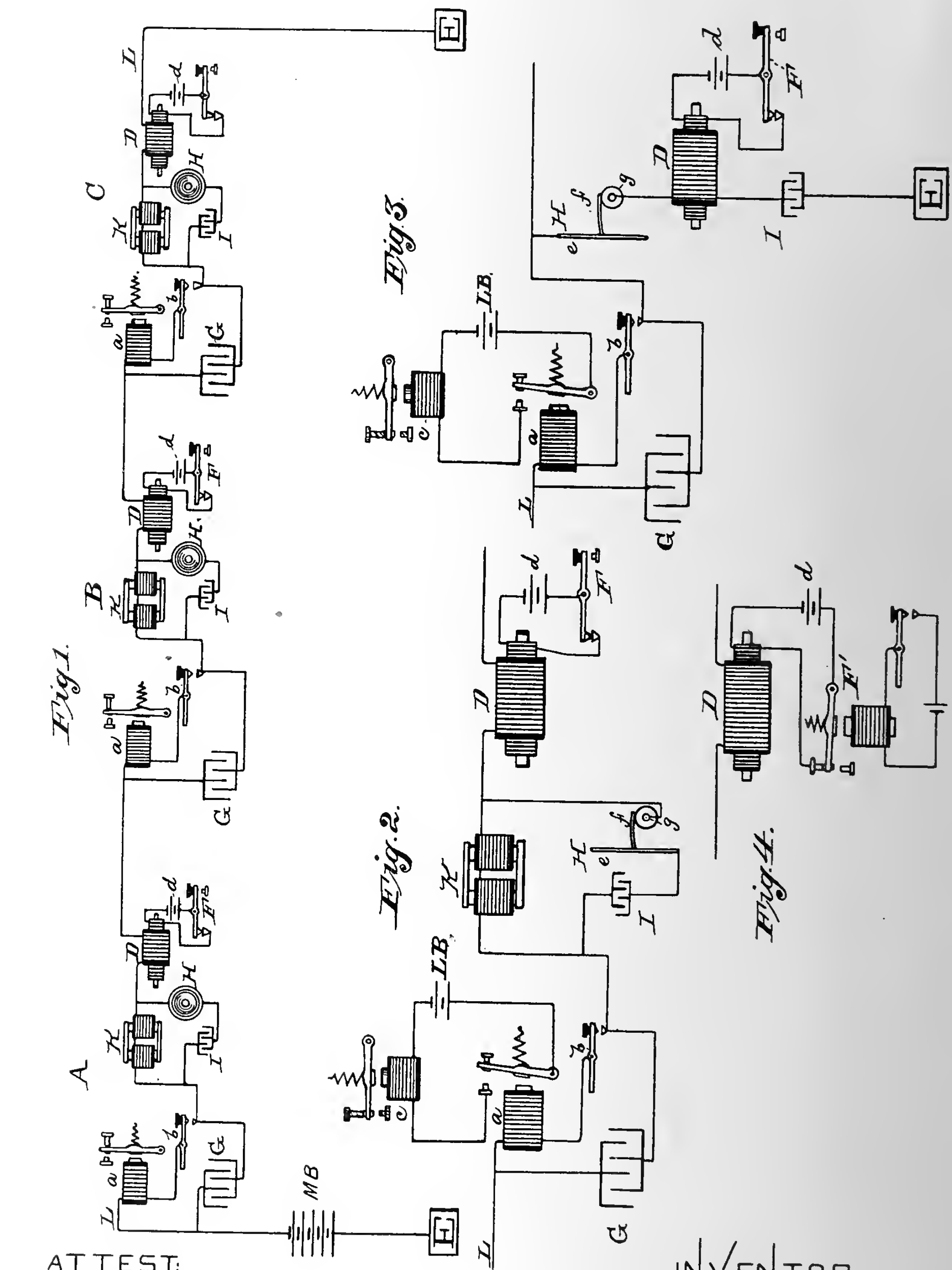
THOS. G. GREENE, Jr.,
EDW. C. ROWLAND.

(No Model.)

T. A. EDISON.

TELEGRAPHY.

No. 333,289. Patented Dec. 29, 1885.



ATTEST:
E. C. Rowland.
F. W. Kiddle.

INVENTOR:
Thomas A. Edison
By Dyer & Seely.
Attys

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

TELEGRAPHY.

SPECIFICATION forming part of Letters Patent No. 333,289, dated December 29, 1885.

Application filed May 8, 1885. Serial No. 164,856. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Telegraphy, (Case No. 648,) of which the following is a specification.

The object I have in view is to increase the capacity of telegraph-lines in a simple and practical manner by the production of instruments and connections permitting the transmission of two sets of Morse signals back and forth over the line at the same time without interfering one with the other, and not only between terminal offices, but between a terminal office and any intermediate office, or between intermediate offices alone.

The invention is especially applicable to local lines or to lines having several offices upon them, to which it can be applied at small expense, each office upon the line being provided with instruments for transmitting and receiving a second set of signals, and with devices for making the two sets of signals independent, and for insuring against their interference. Not only is the capacity of the telegraph-lines doubled, but the delays occasioned on lines with several offices by the interfering of two or more operators in their attempts to gain possession of the line are diminished.

In the accompanying drawings, forming a part hereof, Figure 1 is a view in diagram of a line with three offices embodying my invention; Fig. 2, a view on a larger scale of the apparatus for one office; Fig. 3, a view of the apparatus for one office, with a modified arrangement of parts; and Fig. 4, a view of a further modification.

Like letters denote corresponding parts in all the figures.

The line L L is grounded at its ends, and has the usual main battery, M B. The three offices A B C have each the ordinary set of Morse instruments, of which are shown in Fig. 1 the relay *a* and key *b*. In Figs. 2 and 3 the Morse sounders *c* and local batteries L B are shown. With these ordinary Morse instruments telegraphing is carried on by Morse signals in the usual way.

At each office is a device working independent of the main battery and acting to induce in the line impulses of high tension. This device is composed of an induction-coil, D, the secondary circuit of which may be located directly in line, as shown in Figs. 1 and 2. The primary circuit of this coil includes a battery, *d*, and a back-point key, F; or, in place of key F, a back-point sounder, F′, worked by a key and local battery, may be used, as shown in Fig. 4.

The ordinary Morse key, *b*, is shunted by a condenser, G, so that the line will be always closed for the induced currents. This condenser, also, preferably shunts the relay, for a purpose that will be presently set forth. To receive these induced currents there is provided at each office a diaphragm-sounder, H′, which is preferably, as shown in Figs. 2 and 3, constructed upon the principle of the electro-motograph, a diaphragm, *e*, being kept under tension by a spring, *f*, held by friction upon a revolving chalk cylinder, *g*. The chalk cylinder is rotated continually by a motor, electric or mechanical, and the circuit is closed through the spring and cylinder. This construction of instrument is a well-known telephone receiver of my invention, and hence does not require further description here.

For my diaphragm-sounder a magneto-electric telephone or other form of telephone-receiver may be used. The diaphragm-sounder at each office is preferably located in circuit with a condenser, I, and this circuit is preferably a shunt around a resistance located in the line, as shown in Figs. 1 and 2, which resistance is preferably an electro-magnet, K. The circuit at each office, including diaphragm-sounder H and condenser I, instead of being a shunt around a magnet in line, may be a grounded earth-connection or "leak to earth," as shown in Fig. 3, and the secondary circuit of the induction-coil D, instead of being directly in line, may be in a condenser-circuit, whether that circuit is a shunt around a magnet in line or a leak to earth. By the manipulation of keys F (or the working of sounders F′) signals are thrown upon the line in the form of momentary and sharply-defined waves, which are responded to only by the diaphragm-sounders, the regular Morse relays not acting quick enough to respond to these waves. The regular Morse keys being shunted by condensers, the line is always closed to the high-tension induced currents, and since such condensers have what is equivalent to a low resistance on the instant of closing circuit, it will be seen that a free path is always provided for the momentary impulses of induction. By extending these condenser-shunts to include the relays as well as the keys a desirable result is obtained, in that the counter electro motive force set up by the relay-magnet effectively stops the passage of the induced impulses by way of the key and relay, and makes the condenser-circuit practically the only one closed to these impulses. The effect of this action is to make the induction-circuit of practically the same resistance, whether the regular Morse keys are open or closed. An additional advantage flows from the fact that the induced impulses are not absorbed by the relays, and the induction-signals are made more distinct for that reason. The condenser-shunts are, however, practically open circuits for the quantity-currents used to operate the relays for the regular Morse signals, the condensers becoming fully charged and of very high resistance in less time than is required for the relays to act.

By locating the diaphragm-sounders in the circuit of condensers I such sounders are not affected to the extent of a disturbance of signals by the regular line quantity-currents. To obtain this result, however, even with the diaphragm-sounders in condenser-circuits, I have found that the capacity of the condensers must be definitely fixed. It has been ascertained by me that the loudness of sound in the diaphragm-sounder is within certain limits quite independent of the capacity of the condenser I, while the disturbing effect of the regular Morse signals in the diaphragm-sounder increases with the capacity of such condenser I; hence I reduce the capacity of that condenser below the point of disturbance by the regular Morse signals. On the other hand, I find that the disturbing effect of the regular Morse signals on the diaphragm-sounders is diminished as the capacity of the condenser G around the keys and relays is increased; hence I make these condensers G of large capacity—say several microfarads each—while condensers I have a small capacity—say a fractional part of a microfarad each.

When each diaphragm-sounder and its condenser are located in a shunt around a resistance in the form of a magnet, K, in line, the reverse action of the condenser and magnet will make the condenser-shunt the only path practically closed to the induced currents and the line the only path closed to the regular quantity-line currents, as before explained, with respect to the relation of condensers G and the Morse relays.

The induced impulses thrown by the induction coil D upon the line are produced by a source of energy (the batteay d) independent of the main batteries. These impulses are practically the same whether the regular Morse keys are open or closed. By arranging the key F so that the downstroke will open the primary circuit and the upstroke will close that circ it the signal for the downstroke of the key will be louder than for the upstroke, since when the primary circuit is closed it absorbs to a certain ex nt the induction, and the impulse in secondary is weaker than when the primary is opened. The back-point sounder, worked by key and local battery, operates the same way. This difference in the down and up strokes of key is an important one, since if the two signals required to mark the interval of time denoting a dot or dash were the same the receiving-operator might be frequently confused by mistaking the last signal of a dot or dash for the first signal of the next succeeding dot or dash, and get what is called in telegrapher's parlance the "back-stroke."

The instrument and devices described make a complete system of Morse telegraphy, whereby over one line may be transmitted back and forth two sets of Morse signals produced by different sources of energy independent of each other as to loudness, and also as to interference in the receiving-instruments.

What I claim is—

1. In telegraphs, the combination, with two or more sets of Morse telegraph-instruments, consisting each of an ordinary relay and a signaling-key, a source of electrical energy for operating the same, and shunt-circuits to keep the line constantly closed at the signaling-keys, of two or more other sets of telegraph-instruments, each composed of a Morse signal-transmitter having a separate source of electrical energy and throwing momentary and sharply-defined impulses upon the line, and a diaphragm-sounder responding to such momentary impulses, whereby two sets of Morse signals can be transmitted and received simultaneously without interference, substantially as set forth.

2. In telegraphs, the combination, with two or more sets of Morse telegraph-instruments, consisting each of an ordinary relay and a signaling-key, a source of electrical energy for operating the same, and shunt-circuits to keep the line constantly closed at the signaling-keys, of two or more other sets of telegraph-instruments, each composed of a Morse signal-transmitter having a separate source of electrical energy and throwing momentary and sharply-defined impulses upon the line, and a diaphragm-sounder responding to such momentary impulses and located in a shunt from the line, whereby two sets of Morse signals can be transmitted and received simultaneously without interference, substantially as set forth.

3. In telegraphs, the combination, with a telegraph-line, Morse telegraph-instruments, consisting of relays and signaling-keys, and a source of electrical energy for operating the same, of an induction-coil having its secondary circuit in connection with line, a separate source of electrical energy, and a Morse sig-

nal-transmitting device in the primary circuit of such coil, and a diaphragm-sounder responding to the induction impulses, substant[illegible]lly as set forth.

4. In a system of Morse telegraphy, the combination, with a telegra[illegible]h-line and Morse instruments, of a diaphragm-sounder and a signal-transmitter transmitting momentary and sharply-defined waves producing alternately varying signals at the diaphragm-sounder, substantially as set forth,

5. In a system of Morse telegraphy, the combination, for the transmission and reception of Morse signals, of a telegraph-line, an induction-coil having secondary connected with the line, a Morse signal-transmitter in primary producing alternately-varying signals in secondary, and a diaphragm-sounder receiving the induced impulses, substantially as set forth.

6. The combination, with a telegraph-line, Morse telegraph-instruments, and a source of electrical energy for operating the same, of an induction-coil having secondary connected with the line, a Morse signal-transmitter in primary producing alternately-varying signals in secondary, and a diaphragm-sounder receiving the induced impulses, substantially as set forth.

7. The combination, with a telegraph-line, of a diaphragm-sounder responding to induced impulses, a transmitting induction coil having secondary connected with line, a battery in primary circuit, and a key controlling said primary circuit, said key being arranged to open the primary circuit on the downstroke, substantially as set forth.

8. In telegraphs, the combination, with two or more sets of Morse telegraph-instruments, consisting each of an ordinary relay and a signaling-key, a source of electrical energy for operating the same, and shunt-circuits to keep the line constantly closed at the signaling-keys, of two or more other sets of telegraph-instruments, each composed of a Morse signal-transmitter having a separate source of electrical energy, and throwing momentary and sharply-defined impulses upon the line, and a diaphragm-sounder responding to such momentary impulses, and located in a condenser-circuit connected with such line, whereby two sets of Morse signals can be transmitted and received simultaneously without interference, substantially as set forth.

9, The combination, with a telegraph-line and Morse telegraph-instruments, of condensers located in shunts around the Morse keys, and diaphragm-sounders connected in condenser-circuits with said line, the key-condensers being of greater capacity than the sounder-condensers, and the relative capacity of the condensers being such that the disturbance of the diaphragm-sounders by the regular Morse signals is prevented, substantially as set forth.

10. The combination, with a telegraph-line, of a diaphragm-sounder receiving Morse signals produced by momentary and sharply-defined waves, resistance in line around which said diaphragm-sounder is shunted, and a condenser in said shunt-circuit, substantially as set forth.

11. The combination, with a telegraph-line, of a diaphragm-sounder receiving Morse signals produced by momentary and sharply-defined waves, an electro-magnet resistance in line around which said diaphragm-sounder is shunted, and a condenser in said shunt-circuit, substantially as set forth.

12. The combination, with a telegraph-line, of a number of sets of instruments directly in the line-circuit, each set consisting of an ordinary relay and signaling-key, and a condenser shunting both the relay and key, and several sets of other and independent instruments connected with or in said line, consisting of a transmitting device for sending momentary and sharply-defined waves, a diaphragm-sounder shunted around a resistance or magnet in the line, and a condenser in said shunt-circuit, substantially as set forth.

This specification signed and witnessed this 27th day of April, 1885.

THOS. A. EDISON.

Witnesses:

A. W. KIDDLE,

E. C. ROWLAND.

(No Model.) 2 Sheets—Sheet 1.

T. A. EDISON.

DUPLEX TELEGRAPHY.

No. 333,290. Patented Dec. 29, 1885.

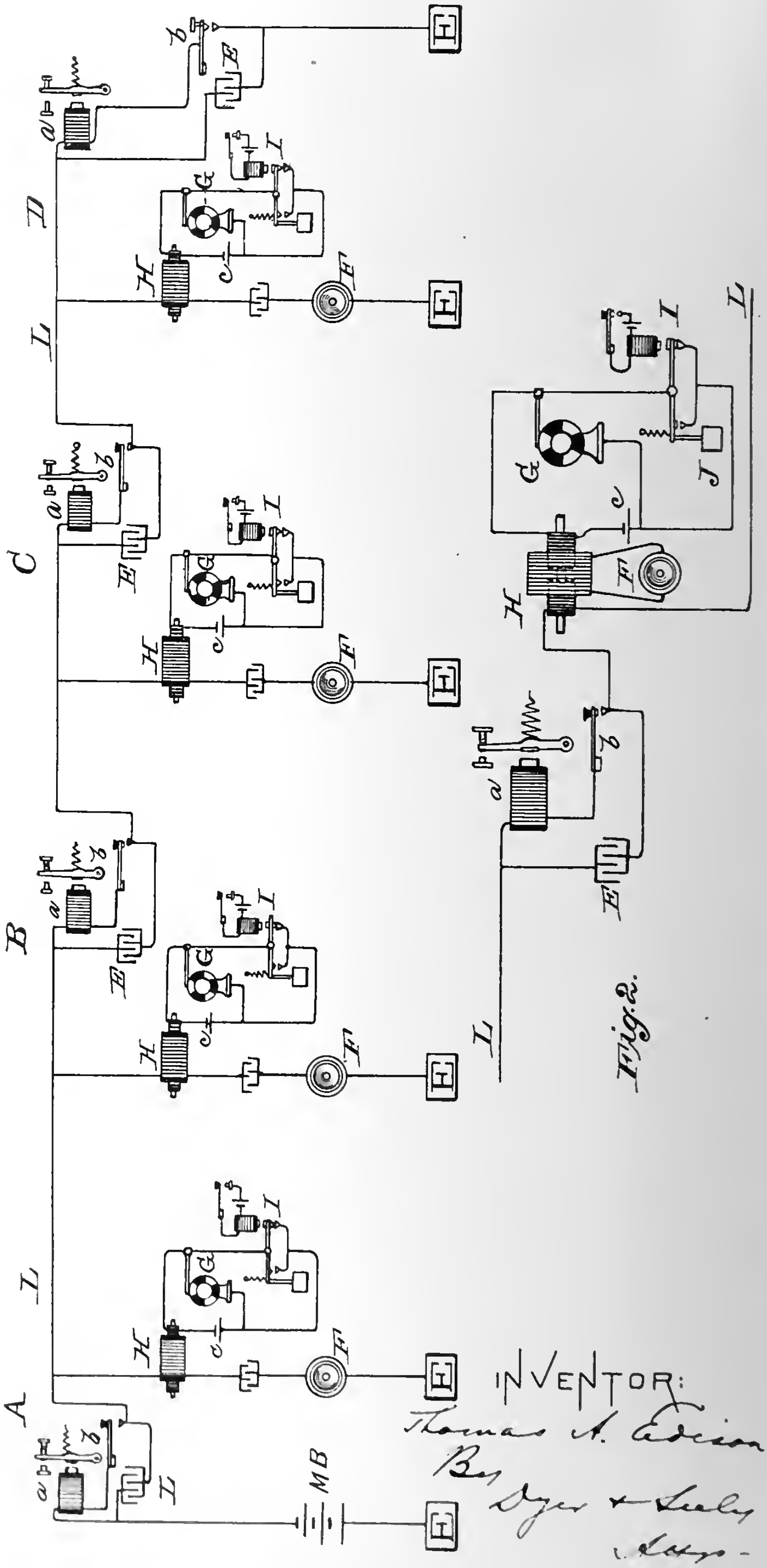


Fig. 1.

Fig. 2.

ATTEST:
E. C. Rowland
H. W. Kiddle

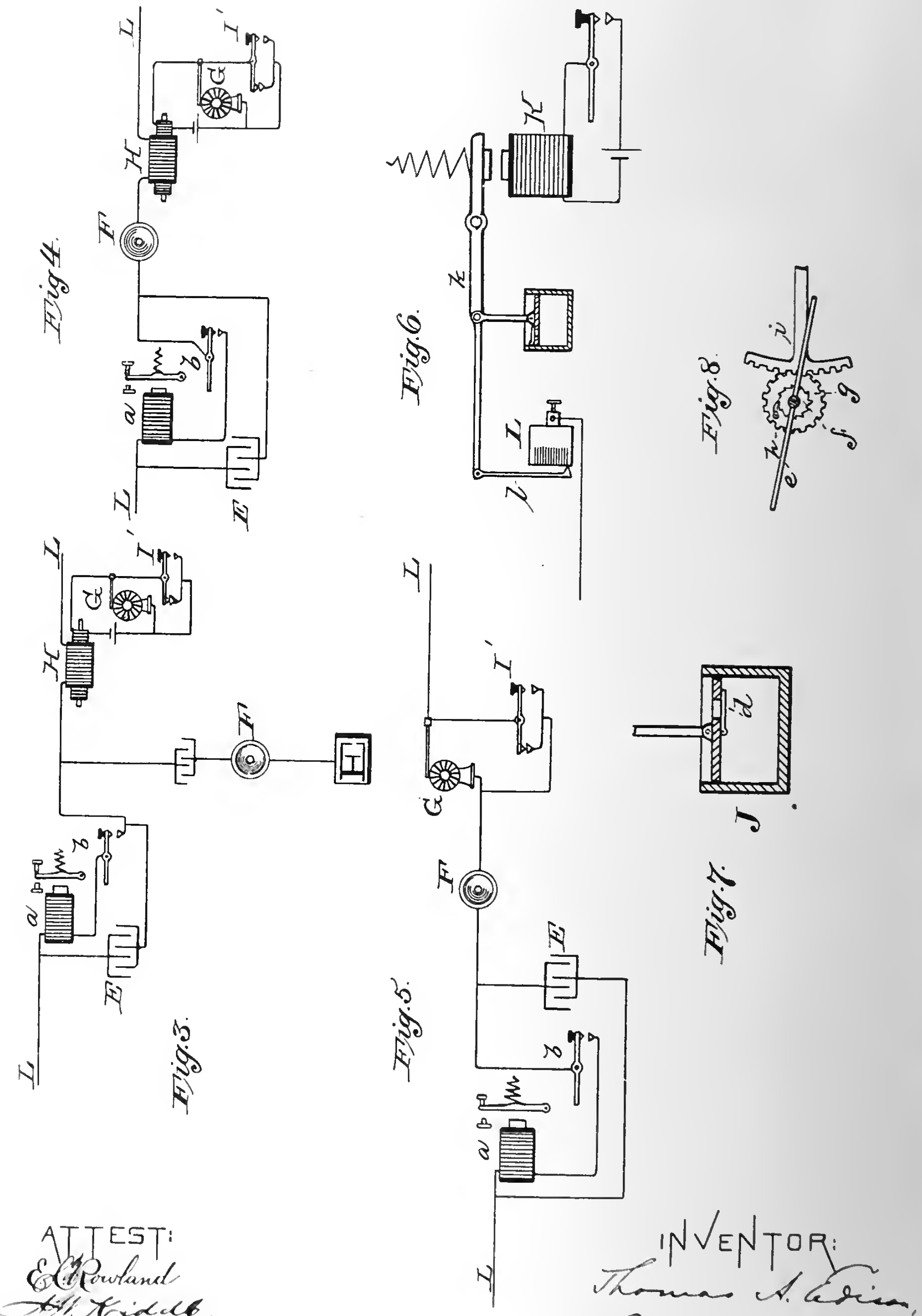
INVENTOR:
Thomas A. Edison
By Dyer & Seely
Attys.

(No Model.) 2 Sheets—Sheet 2.

T. A. EDISON.

DUPLEX TELEGRAPHY.

No. 333,290. Patented Dec. 29, 1885.



ATTEST:
E. C. Rowland
H. W. Kiddle.

INVENTOR:
Thomas A. Edison,
By Dyer & Seely
Attys.

Correction in Letters Patent No. 333,290.

It is hereby certified that in Letters Patent No. 333,290, granted December 29, 1885, upon the application of Thomas A. Edison, of Menlo Park, New Jersey, the title of the invention was erroneously written and printed "Duplex Telegraphy," whereas the said title should have been written and printed *Telegraphy;* and that the said Letters Patent should be read with this correction therein to make the same conform to the record of the case in the Patent Office.

Signed, countersigned, and sealed this 26th day of January, A. D. 1886.

[SEAL.]

H. L. MULDROW,
Acting Secretary of the Interior.

Countersigned:
M. V. MONTGOMERY,
Commissioner of Patents.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

DUPLEX TELEGRAPHY.

SPECIFICATION forming part of Letters Patent No. 333,290, dated December 29, 1885.

Application filed May 8, 1885. Serial No. 164,857. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Telegraphy, (Case No. 649,) of which the following is a specification.

The object I have in view is to increase the capacity of telegraph-lines in a simple and practical manner by the production of instruments and connections permitting the transmission of two sets of Morse signals back and forth over the line at the same time without interfering one with the other, and not only between terminal offices, but between a terminal office and any intermediate office, or between intermediate offices alone.

The invention is especially applicable to local lines, or to lines having several offices upon them, to which it can be applied at small expense, each office upon the line being provided with instruments for transmitting and receiving a second set of signals, and with devices for making the two sets of signals independent and for insuring against their interference. Not only is the capacity of the telegraph-lines doubled, but the delays occasioned on lines with several offices by the interfering of two or more operators in their attempts to gain possession of the line are diminished.

The general objects before stated are fully accomplished by apparatus described and claimed in my application No. 648.

The present invention is an improvement upon that apparatus, and relates more particularly to a peculiar transmitter for producing the momentary and sharply-defined waves to which the diaphragm-sounder responds, and also to the manner of connecting the diaphragm-sounder to the line.

In the accompanying drawings, forming a part hereof, Figure 1 is a view in diagram of a line with four offices; Fig. 2, a separate view in diagram of the arrangement for one office; Figs. 3, 4, and 5, views similar to Fig. 2 of modified arrangements; Fig. 6, a view of a further modification of the transmitter; Fig. 7, a sectional view of a dash-pot for varying alternate signals, and Fig. 8 a view of another device for the same purpose.

Like letters denote corresponding parts in all the figures.

The line L L is grounded at its ends, and has the usual main battery, M B. The four offices A B C D have each the ordinary set of Morse instruments, composed of a relay, *a*, and key *b* in line, the former working a sounder (not shown) in the circuit of a local battery. With these ordinary Morse instruments telegraphing is carried on by Morse signals in the usual way. At each office the set of Morse instruments (the relay and key) or the key alone is shunted by a condenser, E, which keeps the line closed constantly to signals produced by momentary and sharply-defined waves, which are received on diaphragm-sounders F, located one at each office, at which there is also located a transmitter for producing such waves. This transmitter is an instrument constructed to make and break circuit with great rapidity, so as to send for each signal a large number of such momentary and sharply-defined waves. It may be constructed in a variety of ways. The form I prefer is a rapidly-revolving circuit-controller, G, kept in motion by a suitable electrical or mechanical motor. This circuit-controller may be placed directly in line, as shown in Fig. 5; but I prefer to place it in the primary circuit of an induction-coil, H, the secondary circuit of which is directly in the line, as shown in Figs. 2, 3, and 4 or is in a condenser-circuit connected with the line, as shown in Fig. 1. This condenser-circuit may be a ground-connection from line or a shunt around a resistance or magnet in line.

In the primary circuit of H is a battery, *c*, and in a shunt around the revolving circuit-controller G is a sounder, I, with both its front and back points connected in circuit and operated by a key and local battery, as shown in Figs. 1 and 2.

In place of a sounder, a key, I', Figs. 3, 4, and 5, may be employed, connected to close circuit at front and back points. Normally, the sounder or key closes this shunt at its back contact, and the revolution of the circuit-controller does not affect the induction-coil. The movement of the sounder-lever (or the key) first breaks this shunt at its back point and then closes it at its front point. During this interval, while the shunt-circuit is open the circuit-controller produces a series of waves in the primary of the induction-coil, and the secondary of such coil throws upon the line a large number of momentary and sharply-defined waves. The return movement of the sounder-lever or the key first opens and then closes the shunt-circuit, producing the same result as in the forward movement. The momentary and sharply-defined waves do not work the relays, but are responded to by the diaphragm-sounders, and are translated by them into sound, the intervals between the signals representing dots and dashes. The number of waves transmitted for each signal is sufficiently great to make a corresponding number of air-waves audible, and hence the sound is transmitted electrically instead of being produced by a mechanical blow, which is the result of a single electrical impulse, as at an ordinary Morse sounder.

To make the signal different for the down and up stroke of key, I connect the lever of sounder I with a dash pot, J, the plunger of which has a valve, *d*, opening in one direction, Fig. 7, so that the sounder-lever will have a quicker movement in one direction than the other. This movement is preferably made quicker on the upstroke of key, causing the second signal marking the interval denoting a dot or dash to be weaker or shorter or of different tone from the first signal. This prevents confusion in receiving.

Instead of a dash-pot with valved flanges for varying alternate signals, the device shown in Fig. 8 can be used. This consists of a retarding-fan, *e*, secured to a spindle with ratchet-wheel, *f*. The cog-wheel *g*, loose on the same spindle, has a pawl, *h*, which engages with ratchet-wheel *f*. The sounder-lever has on its end a toothed sector, *i*, engaging with wheel *g*. The movement of the sounder-lever in one direction will turn the fan. In the other direction, the wheel *g* turns free of the ratchet-wheel *f*.

My transmitter may be constructed as shown in Fig. 6. A magnet, K, worked by a key and local battery, operates a lever, *k*, which is extended the required distance to get the necessary movement. At its end it carries a finger, *l*, playing over the surface of a contact-block, L. This contact-block has its face composed of a large number (preferably fifty or more) of thin plates separated by insulation. This block L and the lever *k* are connected in circuit, preferably in the primary of induction-coil H, and the movement of *k* causes the circuit to be made and broken rapidly, throwing upon the line momentary and sharply-defined waves. A dash-pot or the fan-regulator is attached to lever *k* to vary alternate signals.

The diaphragm-sounders F may be any form of telephone-receiver.

I prefer to use my electro-motograph receiver, although a magneto-electric or other telephone-receiver can be employed.

The diaphragm sounders may be located directly in line, Figs. 4 and 5, or in condenser-circuits connected with line, Figs. 1 and 3; but I prefer the arrangement shown in Fig. 2, wherein the diaphragm-sounder is located in the tertiary circuit of induction-coil H, and is operated by induction from the line.

What I claim is—

1. In a system of Morse telegraphy, the combination, with ordinary Morse telegraph-instruments shunted to keep the line constantly closed to momentary and sharply-defined waves, of diaphragm sounders and transmitters transmitting Morse signals electrically by throwing upon the line for each signal a large number of momentary and sharply-defined waves, which do not work the Morse relays, but are responded to by the diaphragm sounders, substantially as set forth.

2. In a system of Morse telegraphy, the combination, with a diaphragm-sounder, of a transmitter consisting of a circuit-breaker and a controlling key, the former being constructed to make and break circuit rapidly a large number of times for each movement of the controlling-key, substantially as set forth.

3. In a system of Morse telegraphy, the combination, with a diaphragm sounder, of a transmitter consisting of a circuit-breaker and a controlling-key, the former being constructed to make and break circuit rapidly a large number of times for each movement of the controlling-key, and means for retarding the movement of the transmitter in one direction, so as to vary alternate signals, substantially as set forth.

4. In a system of Morse telegraphy, the combination, with a diaphragm-sounder, of a transmitter composed of a revolving circuit-controller, and a shunt around the same controlled by a key, substantially as set forth.

5. In a system of Morse telegraphy, the combination, with a diaphragm-sounder, of an induction-coil with secondary in line, and a transmitter in the primary of such coil, consisting of a circuit-breaker and a controlling-key, the former being constructed to make and break such primary circuit rapidly a large number of times for each movement of the controlling-key, substantially as set forth.

6. In a system of Morse telegraphy, the combination, with ordinary Morse telegraph-instruments shunted to keep the line constantly closed to momentary and shaply-defined waves, of a transmitter of such waves, and a diaphragm-sounder responding to such waves and connected inductively with the line, substantially as set forth.

This specification signed and witnessed this 30th day of April, 1885.

THOMAS A. EDISON.

Witnesses:

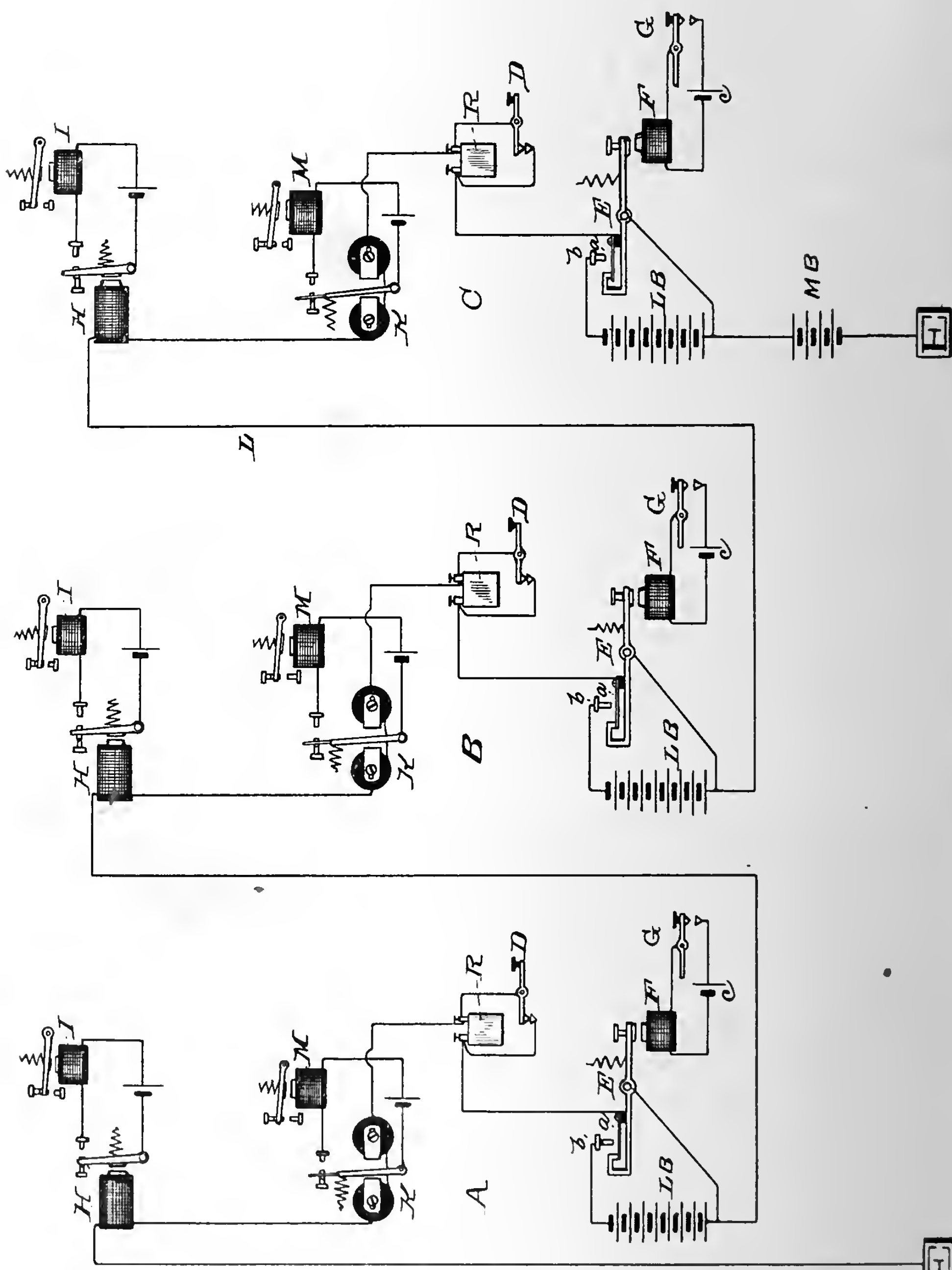
RICHD. N. DYER,
A. W. KIDDLE.

(No Model.)

T. A. EDISON.

WAY STATION QUADRUPLEX TELEGRAPH.

No. 333,291. Patented Dec. 29, 1885.



ATTEST:
E. C. Rowland
H. W. Riddle

INVENTOR:
Thomas A. Edison
By Dyer & Seely
Attys

Correction in Letters Patent No. 333,291.

It is hereby certified that in Letters Patent No. 333,291, granted December 29, 1885, upon the application of Thomas A. Edison, of Menlo Park, New Jersey, the title of the invention was erroneously written and printed "Way Station Quadruplex Telegraph," whereas the said title should have been written and printed *Telegraphy;* and that the said Letters Patent should be read with this correction therein to make the same conform to the record of the case in the Patent Office.

Signed, countersigned, and sealed this 26th day of January, A. D. 1886.

[SEAL.]

H. L. MULDROW,
Acting Secretary of the Interior.

Countersigned:
M. V. MONTGOMERY,
Commissioner of Patents.

United States Patent Office.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

WAY-STATION QUADRUPLEX TELEGRAPH.

SPECIFICATION forming part of Letters Patent No. 333,291, dated December 29, 1885.

Application filed May 16, 1885. Serial No. 165,703. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Telegraphy, (Case No. 650,) of which the following is a specification.

The object I have in view is to increase the capacity of local telegraph-lines, or those lines having one or more way-stations in addition to the terminal stations, by the production of apparatus by means of which two sets of independent and non-interfering Morse signals can be sent back and forth over the line between terminal stations, or terminal and way-stations, or way-stations alone.

In carrying out my invention I employ for receiving-instruments at each terminal and way-station an ordinary non-polarized relay, which acts by changes in the strength of current without regard to its polarity, and a polarized relay acting by changes in the polarity of current without regard to its strength. The line is provided with a constant current from a main battery of, say, sixteen cells, which is decreased by the manipulation of a Morse key at each station, such keys normally short-circuiting a large resistance (say five thousand ohms) and throwing such resistance into line when depressed. The non-polarized relays close sounder-circuits at their back points. To reverse the polarity of the constant line-current, I provide at each terminal and way-station a battery which has twice the number of cells as the main battery, and which is thrown into circuit reverse to and opposing the main battery. This local battery is normally out of circuit, and when thrown in neutralizes the current of main battery and produces a current of opposite polarity equal to the normal current of the main battery. By these means it will be seen the line-current can be reversed at any station, whether way or terminal, thus operating the polarized relays.

In the accompanying drawing, forming a part hereof, the figure represents two terminal stations and a way-station having apparatus embodying my invention.

L L is a line grounded at its ends, as usual, and A, B, and C are terminal and way stations upon said line.

M B is the main battery, composed, for illustration, of sixteen cells. These are shown located at the terminal office C with zinc to line, in which case the terminal station A at the other end of the line would have no main battery; but this battery may be divided between the terminal stations or located anywhere in the line.

R is a standard resistance-box (say of five thousand ohms) which is located in line at each station. This is shunted normally by a back-point key, D, by depressing which the resistance is thrown into circuit.

At each station there is a local battery, L B, having twice the number of cells as the main battery. The line passes through a circuit-preserving lever, E, and spring *a*, carried thereby on a block of insulation, which spring closes circuit normally, as usual, by making contact with the hook end of lever; and the local battery is located between the line connection of lever E and the contact *b*. The lever E is worked by a magnet, F, controlled by a key, G, and local battery *c*. Normally, the battery L B at each station is out of circuit, as shown in the drawing. By closing key G magnet F moves lever E forward until spring *a* strikes contact *b*, and is forced away from the hook end of the lever. This throws the battery L B into circuit with carbon to line, overcoming main battery M B and producing a current on line equal to the normal current of M B, but of opposite polarity.

H is a non-polarized relay at each station, its armature-lever being normally on the front contact, and controlling at its back contact the circuit of sounder I. At each station is also a polarized relay, K, controlling circuit of sounder M at its front contact. When current of M B is on line, the armatures of the polarized relays are not moved. The reversal of the current, by throwing in and out a battery, L B, works the polarized relays without changing strength of currents, and hence without affecting the non-polarized relays and independently of any decrease or increase of current produced by throwing a resistance, R, into and out of circuit, to which decrease and increase of current the non-polarized relays alone will respond.

What I claim is—

1. In a system of Morse telegraphy, the combination, with a telegraph-line, of terminal and way stations, each of such stations hav-

ing a Morse signal-transmitter changing the strength of the line current, and a Morse signal-transmitter reversing the line-current without changing its strength, and receiving-instruments at each station responding separately to such transmitters, substantially as set forth.

2. In a system of Morse telegraphy, the combination, with a telegraph-line, of terminal and way stations, each of such stations having as receiving-instruments a polarized relay and a non-polarized relay, and two Morse signal-transmitting instruments at each terminal and way station, acting one to change the strength of the line-current and the other to reverse such line-current, substantially as set forth.

3. In a system of Morse telegraphy, the combination, with a telegraph-line, of terminal and way stations, a main-line battery constantly in circuit, a local battery at each terminal and way station, having double the power of the main battery, said local battery being normally out of circuit, and a key for each of such local batteries throwing the local battery into circuit reverse to the main battery, whereby the line-current can be reversed at a terminal or way station without changing its strength, substantially as set forth.

4. In a system of Morse telegraphy, the combination, with a telegraph-line, of a main-line battery constantly in circuit, terminal and way stations, each provided with a local battery of double the power of the main battery, normally out of circuit, a key at each station throwing the local battery into and out of circuit reverse to the main battery, thus reversing the line-current without changing its strength, a key at each station varying the strength of the line-current without regard to its polarity, and polarized and non-polarized relays, substantially as set forth.

5. In a system of Morse telegraphy, the combination, with a telegraph-line, of a main-line battery constantly in circuit, two or more stations, each provided with a local battery of double the power of the main battery, normally out of circuit, a key at each station throwing the local battery into and out of circuit reverse to the main battery, thus reversing the line-current without changing its strength, a key at each station varying the strength of the line-current without regard to its polarity by throwing resistance into and out of the line, and polarized and non-polarized relays, substantially as set forth.

This specification signed and witnessed this 6th day of May, 1885.

THOS. A EDISON.

Witnesses:

ALFRED W. KIDDLE,

E. C. ROWLAND.

(No Model.)

T. A. EDISON.

MOLD FOR CARBONIZING.

No. 334,853. Patented Jan. 26, 1886.

Fig. 1.

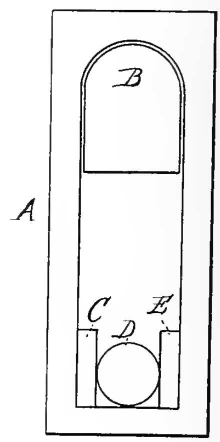


Fig. 2.

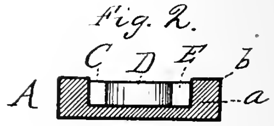


Fig. 3.

WITNESSES:

E. C. Rowland

H. W. Seely

INVENTOR:

Thomas A. Edison,

By Richd. N. Dyer,

Atty.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, ASSIGNOR TO THE EDISON ELECTRIC LIGHT COMPANY, OF NEW YORK, N. Y.

MOLD FOR CARBONIZING.

SPECIFICATION forming part of Letters Patent No. 334,853, dated January 26, 1886.

Application filed August 14, 1882. Serial No. 69,262. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Molds for Carbonizing; and I do hereby declare that the following is a full and exact description of the same, reference being had to the accompanying drawings, and to the letters of reference marked thereon.

The object of the present invention is to produce molds for carbonizing filaments for incandescing conductors for electric lamps, having weights to hold the filaments under strain and permitting contraction, which will be cheaper in construction than the nickel molds heretofore employed, will not be liable to be destroyed by the excessive heat to which the molds are occasionally subjected in carbonizing, and will be efficient in operation, in that they will not absorb gases to a detrimental extent or change in any respect the nature of the carbon filaments.

The object is accomplished by forming the mold of hard carbon—such as gas-retort carbon—which is powdered and mixed with tar or other cementing or binding carbonaceous or carbonizable material. The molds are then formed from this mixture by means of heavy pressure, and are then baked in a suitable oven or retort. Large quantities of the shaped molds are then put into a chamber and heated, and the vapor of a decomposable carbon compound is passed over them, forming a deposit of hard steel-like carbon. This coating of deposited carbon is exceedingly hard and compact, and does not readily absorb gases. It prevents the body of the mold from so doing to any detrimental extent, and reduces and makes even the friction on the surface of the mold, permitting the weights which hold the filament under strain to draw up evenly. The weights used within the mold to hold the filament under strain are preferably constructed with a core of nickel or other heavy element or compound fusible at high temperature only, which core is covered with the mixture of hard carbon and a binding carbonaceous or carbonizable material and baked, after which a coating of hard steel-like carbon may be deposited upon it or not, as desired.

The foregoing will be better understood by reference to the drawings, in which Figure 1 is a top view of the mold; Fig. 2, a cross-section of the same, the weights being shown in elevation; and Fig. 3, a sectional view of one of the weights.

A is the mold, which is shaped like the molds heretofore used by me for holding filaments while being carbonized, it being recessed on one side to receive the filament.

B C D E are the weights for retaining the filament in position and holding it under strain while carbonizing, which weights are also preferably of the shape heretofore employed by me.

The mold is made of a mixture, *a*, composed of powdered hard carbon—such as gas-retort carbon—and a cementing or binding carbonaceous or carbonizable material, for which purpose tar may be used. The mold is formed from this mixture under heavy pressure and then baked, after which it is provided with a coating, *b*, of hard steel-like carbon, which is produced by heating the mold in a suitable chamber and passing over it the vapor of a decomposable compound of carbon.

The weights are constructed with cores, *c*, of nickel or other heavy element or compound fusible only at high temperatures, the cores being covered with a coating, *d*, composed of a mixture of powdered hard carbon and a binding carbonaceous or carbonizable material, after which hard steel-like carbon may be deposited upon the coating *d*; or the weights may be used without such extra coating.

What I claim is—

1. A carbon mold for carbonizing, provided with a deposited coating of hard steel-like carbon, substantially as set forth.

2. The weights for a carbonizing-mold, each constructed with an external carbon covering and a core of heavier material, substantially as set forth.

3. The combination, with a carbonizing-mold constructed of carbon, of carbon-covered weights, substantially as set forth.

This specification signed and witnessed this 7th day of July, 1882.

THOMAS A. EDISON.

Witnesses:
RICHD. N. DYER,
EDWARD H. PYATT.

(No Model.)

T. A. EDISON & S. BERGMANN.

TELEPHONE.

No. 337,254. Patented Mar. 2, 1886.

Fig. 1.

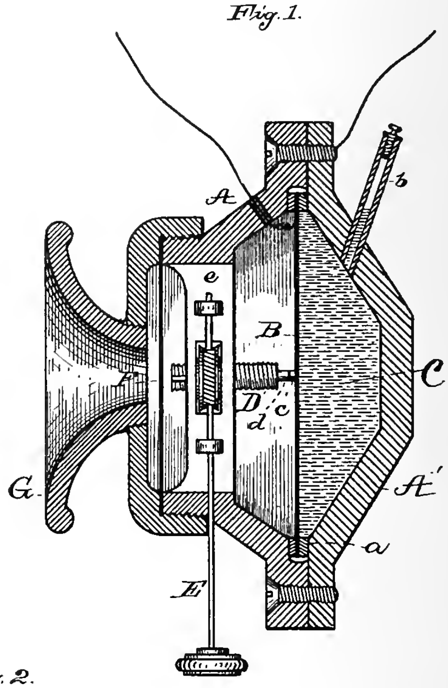


Fig. 2.

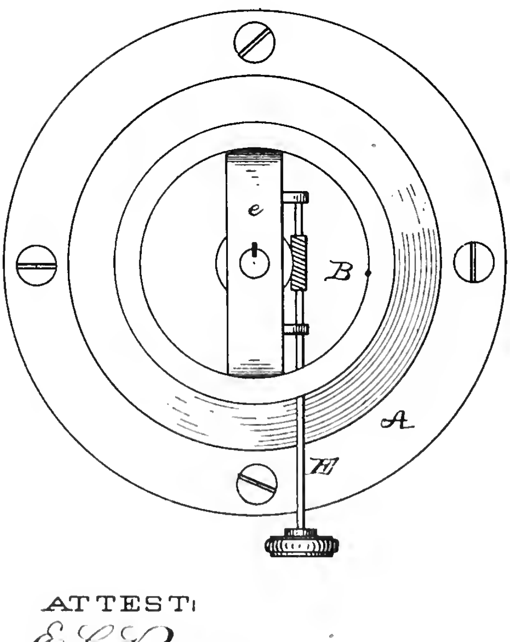
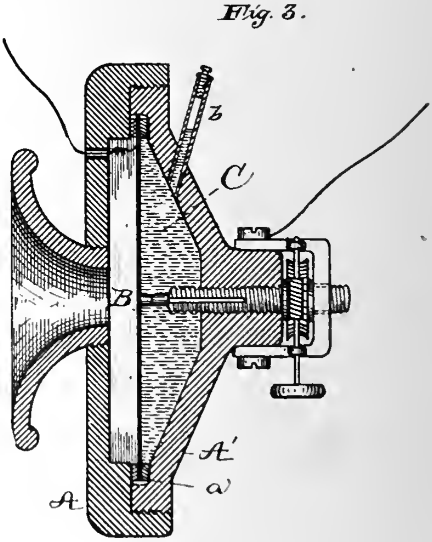


Fig. 3.



ATTEST:

E. C. Rowland

H. W. Seely

INVENTORS:

Thomas A Edison

Sigmund Bergmann

By Rich^d N Dyer Atty.

N. PETERS, Photo-Lithographer, Washington, D. C.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, AND SIGMUND BERGMANN, OF NEW YORK, N. Y.

TELEPHONE.

SPECIFICATION forming part of Letters Patent No. 337,254, dated March 2, 1886.

Application filed November 13, 1883. Serial No. 111,614. (No model.)

To all whom it may concern:

Be it known that we, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, and SIGMUND BERGMANN, of New York, in the county and State of New York, have invented a certain new and useful Improvement in Telephones, of which the following is a specification.

The object of our invention is to produce a telephone-transmitter in which metallic contact-points are effectively employed in the transmission of articulate speech. We accomplish this by the use of a diaphragm, metallic electrodes affected by the movements thereof, and a body of liquid limiting the movement of said diaphragm, and thereby limiting and controlling the separation of the electrodes. The liquid body, by preventing an excessive movement of the diaphragm, prevents the electrodes from moving too far, so that they quickly return to their normal position, and all the sound-vibrations are responded to from the normal position of the electrodes. The liquid body is preferably of oil, but may be of any other liquid—mercury, for instance. We prefer to place the body of liquid behind the diaphragm, between it and the rigid inclosing-case of the instrument, and the electrodes on the side of the diaphragm opposite the liquid that is between the diaphragm and the mouth-piece. One of said electrodes is preferably carried directly by said diaphragm and the other supported rigidly from the case of the instrument. An outer protecting-diaphragm may be employed at the mouth-piece, if desired.

In the accompanying drawings, forming a part hereof, Figure 1 is a vertical section of a telephone-transmitter embodying our invention; Fig. 2, a front elevation of the instrument with the mouth-piece removed, and Fig. 3 a vertical section of a modified form of transmitter.

A A′ are the two parts of a suitable case, preferably of metal, within which is held the diaphragm B. This diaphragm is clamped between packing-rings *a*, by which it is insulated from the case, and by which a closed chamber, C, is formed back of the diaphragm. The chamber C is filled with a liquid through the tube *b*, which is closed so as to seal the liquid within the instrument, preventing escape or evaporation. The contact-points are located, preferably, outside of the liquid, as shown in Fig. 1. A platinum contact-point, *c*, is carried by the front of the diaphragm, and against it bears a contact-point, *d*, of platinum, carried by a screw, D. This screw is supported rigidly in the bridge *e* within the front A of the case, and is adjusted by spindle E. To close up the telephone and prevent the saliva from reaching the contact-points, a second diaphragm, F, may be employed, held in place by the mouth-piece G. In the transmitter shown in Fig. 3, the contact-points being within the chamber C and protected thereby, there is no need of the second diaphragm. The electrical connections, it will be seen, are made so as to bring the contacts into the circuit, one with the case and the other with the diaphragm; but it will be understood that if a diaphragm of insulating material such as mica is used, instead of one of metal, as shown, one connection will run directly to the contact-point carried by the diaphragm.

We are aware that it has been proposed to provide a telephone-transmitter having carbon electrodes with a hydrostatic column pressing the electrodes together and toward the diaphragm; but the movement of the diaphragm in a direction to separate the contacts would not be limited by such a construction.

We are also aware that battery-telephones have been proposed wherein the diaphragm would form one plate of a galvanic battery and would be separated from the other battery-plate by the exciting-liquid, the distance between the battery-plates being varied by the movements of the diaphragm.

What we claim is—

1. In a telephone-transmitter, the combination, with a diaphragm and electrodes controlled thereby, of a body of liquid connected with and limiting the movement of said diaphragm, substantially as set forth.

2. In a telephone-transmitter, the combination, with a diaphragm and metallic electrodes controlled thereby, of a body of liquid connected with and limiting the movement of said diaphragm, substantially as set forth.

3. In a telephone-transmitter, the combina-

tion, with a diaphragm and electrodes in direct contact controlled thereby, of a body of liquid behind said diaphragm and covering the active surface thereof, substantially as set forth.

4. In a telephone-transmitter, the combination of a diaphragm, a body of liquid behind said diaphragm, and two electrodes, one of which is carried by said diaphragm on the side opposite the liquid, substantially as set forth.

5. In a telephone-transmitter, the combination of a diaphragm, a body of liquid behind said diaphragm, and two electrodes on the opposite side of the diaphragm from the liquid, one carried by said diaphragm, the other independent thereof, substantially as set forth.

6. In a telephone-transmitter, the combination of a diaphragm, a body of liquid behind it, electrodes affected by said diaphragm situated between the diaphragm and mouth-piece, and an outer diaphragm protecting the electrodes, substantially as set forth.

7. In a telephone-transmitter, the combination, with a diaphragm and electrodes in direct contact controlled thereby, of a body of liquid held between said diaphragm and a closed rigid case, substantially as set forth.

This specification signed and witnessed this 10th day of November, A. D. 1883.

THOMAS A. EDISON.
SIGMUND BERGMANN.

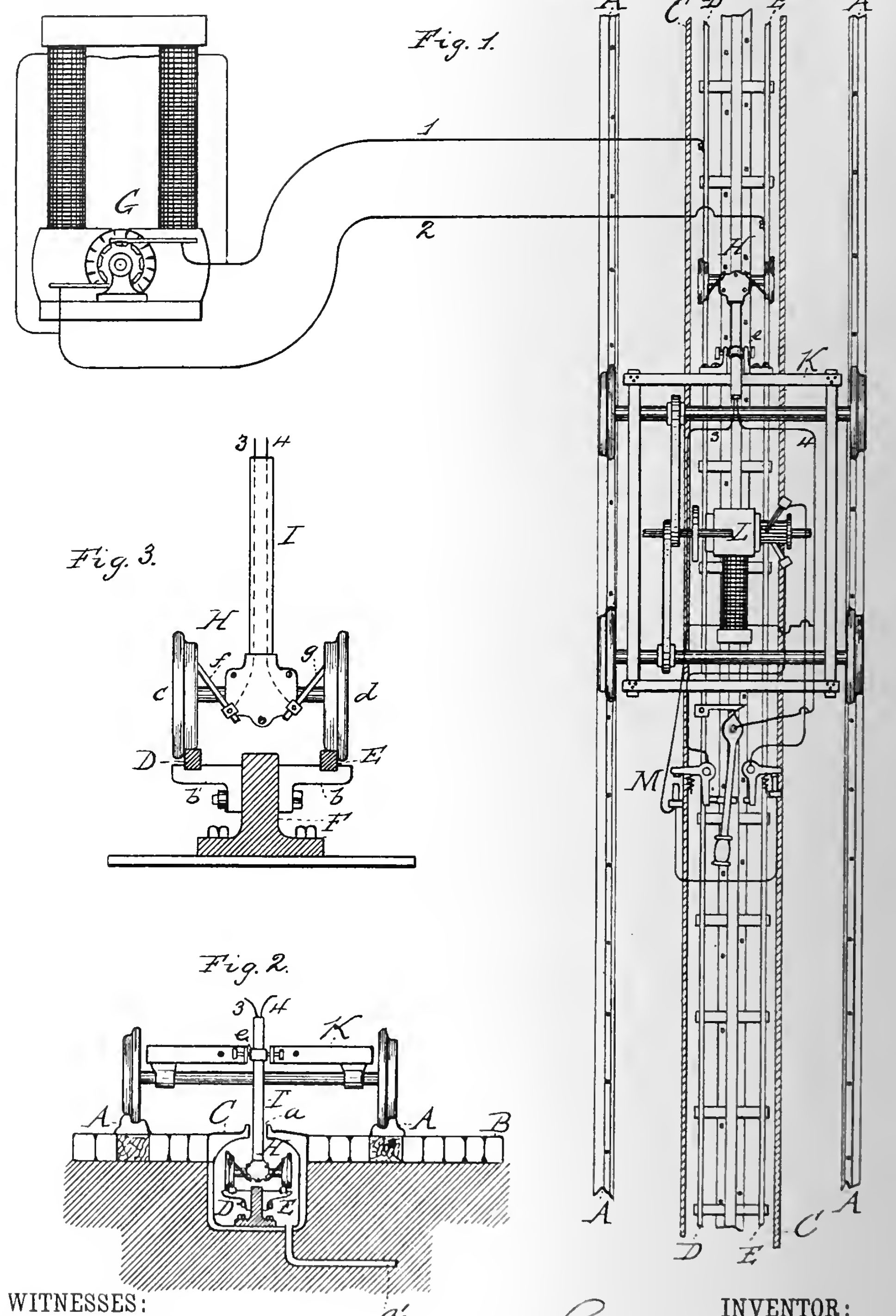
Witnesses:
P. H. KLEIN, Jr.,
RICHD. N. DYER.

(No Model.)

T. A. EDISON.

ELECTRIC RAILWAY.

No. 339,278. Patented Apr. 6, 1886.



WITNESSES:

E. C. Rowland

H. W. Seely

INVENTOR:

Thomas A. Edison,

By Richd. N. Dyer, Atty.

United States Patent Office.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, ASSIGNOR TO THE EDISON ELECTRIC LIGHT COMPANY, OF NEW YORK, N. Y.

ELECTRIC RAILWAY.

SPECIFICATION forming part of Letters Patent No. 339,278, dated April 6, 1886.

Application filed August 14, 1882. Serial No. 69,266. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Electric Railways, (Case No. 468;) and I do hereby declare that the following is a full and exact description of the same, reference being had to the accompanying drawings, and to the letters of reference marked thereon.

The object of the present invention is to produce simple and efficient means for operating street-railroads by electricity, wherein it is essential that there should be no obstruction projecting above the surface of the pavement, and that there should be two continuous metallic conductors for carrying the current to and from the motors of the various cars, having good electrical joints, and forming practically a continuous and integral metallic circuit, and wherein, further, it is desirable that such conductors should be concealed from sight and wholly protected from accidental external contact, and should, further, be independent of the rails, so that such rails can be taken up and replaced or the track otherwise repaired without breaking the circuit or becoming liable to form a short circuit.

The object is accomplished by providing each track of a street-railroad with a suitable tube or way, constructed preferably of metal, and located centrally between the rails. This tube rises only to the surface of the pavement, or slightly above the same, and has a continuous longitudinal slot in its top at the center thereof. Within the sunken tube are two continuous parallel conductors insulated from each other and forming rails, upon which travels a truck or small wheeled carriage having an arm projecting upwardly through the slot of the tube and attached to the car. Each car is provided with such a contact-truck. The two continuous conductors are connected with the dynamo or magneto electric machine or machines which supply the electrical energy for operating the motors mounted upon the cars. The wheels of each contact-truck have their rims insulated from their hubs, or they are otherwise insulated from each other. They conduct current from and to the conducting-rails upon which they travel, and have contact brushes or springs bearing upon them and supported by the body of the truck, which brushes are connected with two conductors leading up through the arm attached to the car. From this arm the conductors run to the field and armature circuits of the electro-dynamic motor, such circuits being preferably independent multiple-arc circuits, and provided with suitable circuit-controllers for making and breaking the circuits at will. In the armature-circuit is located a current-reversing device, as described in my application No. 61,955, by the manipulation of which the direction of the current through the coils of the armature can be reversed and the car made to travel forward or backward at will without disturbing the commutator-brushes of the motor. An adjustable resistance may also be located in the field-circuit, or any other device be provided in the field or armature circuit or in the circuit common to both the field and armature coils, for changing the rate of speed as desired without disturbing the commutator-brushes of the motor, as described in my application No. 68,645. The revolving armature of the motor is connected with one or more axles of the car by speed-reducing connections, so that the motor can run at high speed, and an endless belt, rope, chain, or other flexible connection (one or more) is used as part of the connections in order to permit the car to move on its springs without affecting the running of the motor, as described in my application No. 68,649. A friction-clutch is also preferably used to throw the armature into and out of connection with the axle or axles, so that the car can be stopped without stopping the motor, as described in my application No. 68,649.

The foregoing will be better understood by reference to the drawings, in which Figure 1 is a view, partly diagrammatic, of a street-railroad, and connections for working the same by means of electrical energy, the parts of the car illustrated being shown, for clearness, somewhat separated, and the slotted tube being in horizontal section; Fig. 2, a vertical section through the road-bed, with the car in end elevation, and Fig. 3, a vertical section, on a somewhat larger scale, of the continuous concealed conductors and support.

A A are the rails of one track of a street-railroad, and B represents the pavement of the street. In the center of the track is the continous sunken tube C, constructed preferably of metal, and having the continuous narrow slot *a*, extending along the center of its top. This tube rises to the surface only of the pavement, or slightly above, the lips of the slot projecting preferably above the body of the tube. The tube C may have pipes *a'*, at intervals connected with the sewer, for carrying off the water.

D E are two continuous metallic conductors, which are supported within the tube C, parallel with each other, by brackets *b* of insulating material, secured to a longitudinal support, F, rising from the bottom of the tube C. This support may be a line of T-beams, as shown.

The conductors D E are connected with the conductors 1 2, leading from the dynamo or magneto electric machine or machines G, which supply the current.

H is a truck having wheels *c d*, which travel upon the conductors D E, and carry the current from and to such conductors. These wheels *c d* have their rims insulated from their hubs; or the wheel or wheels on one side of the truck are insulated in any other way from those on the other side, as described in my application No. 61,955. The truck is provided with an arm, I, projecting upwardly through the slot *a* of the tube C, and attached to the frame K of the car by a pivoted joint, *e*, or other loose joint, permitting of independent vertical movement of the car-frame and contact-truck.

Contact brushes or springs *f g* are carried by the truck H, and bear upon the wheels *c d*. These brushes *f g* are connected with insulated conductors 3 4, running through the arm I, and protected thereby from contact with the tube C at the sides of the slot *a*.

L is the electro-dynamic motor, mounted upon the car and connected with an axle or axles of the car through a flexible connection and a friction-clutch, as described in my applications before referred to. The armature and field coils of the motor are preferably in multiple-arc circuits from 3 4, a suitable current-reverser, such as shown at M, being located in the armature-circuit, and a device for varying the speed being also used, if desired, as described in my applications before referred to.

What I claim is—

1. In an electrical railroad, the combination, with the parallel conductors inclosed within and concealed by a sunken slotted tube, of a car, a contact-truck attached to the car and having wheels traveling upon such parallel conductors, and connections from the wheels of the contact-truck to the motor on the car, substantially as set forth.

2. In an electrical railroad, the combination, with the parallel conductors inclosed within and concealed by a sunken slotted tube, of a contact-truck, an arm extending from such contact-truck to the car, and insulated conductors inclosed within such arm and protected thereby from contact with the sides of the slot, substantially as set forth.

3. In an electrical railroad, the combination, with the parallel conductors inclosed within and concealed by a sunken slotted tube, of a contact-truck riding upon such conductors, and an arm from such truck attached to the car by a pivoted or loose joint and permitting of an independent movement of the car and contact-truck, substantially as set forth.

This specification signed and witnessed this 7th day of July, 1882.

THOMAS A. EDISON.

Witnesses:

RICHD. N. DYER,

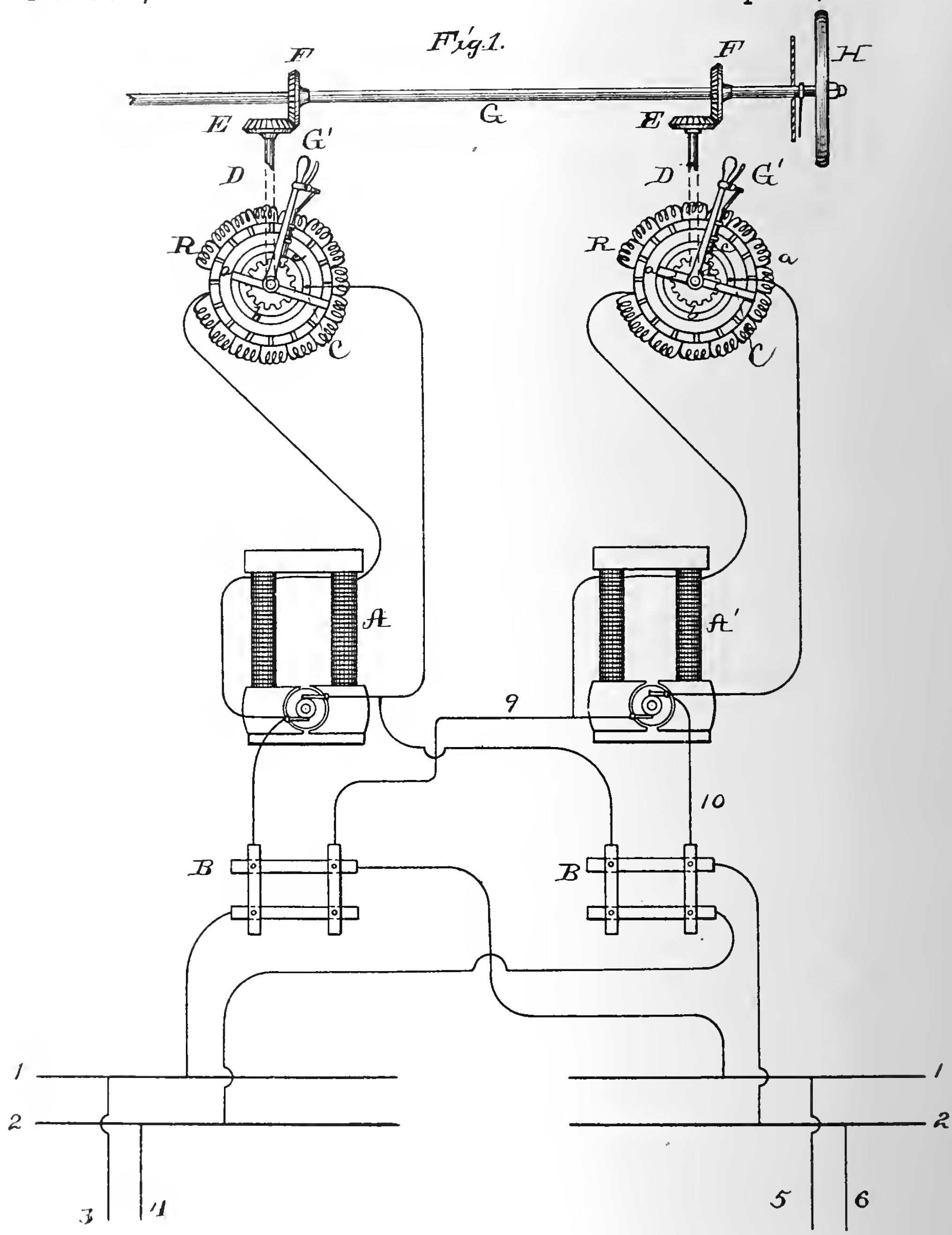
EDWARD H. PYATT.

(No Model.) 2 Sheets—Sheet 1.

T. A. EDISON.

SYSTEM OF ELECTRICAL DISTRIBUTION.

No. 339,279. Patented Apr. 6, 1886.



WITNESSES:
E. C. Rowland
F. W. Biddle

INVENTOR:
Thomas A. Edison,
By Rich'd N. Dyer
Atty.

N. PETERS, Photo-Lithographer, Washington, D.C.

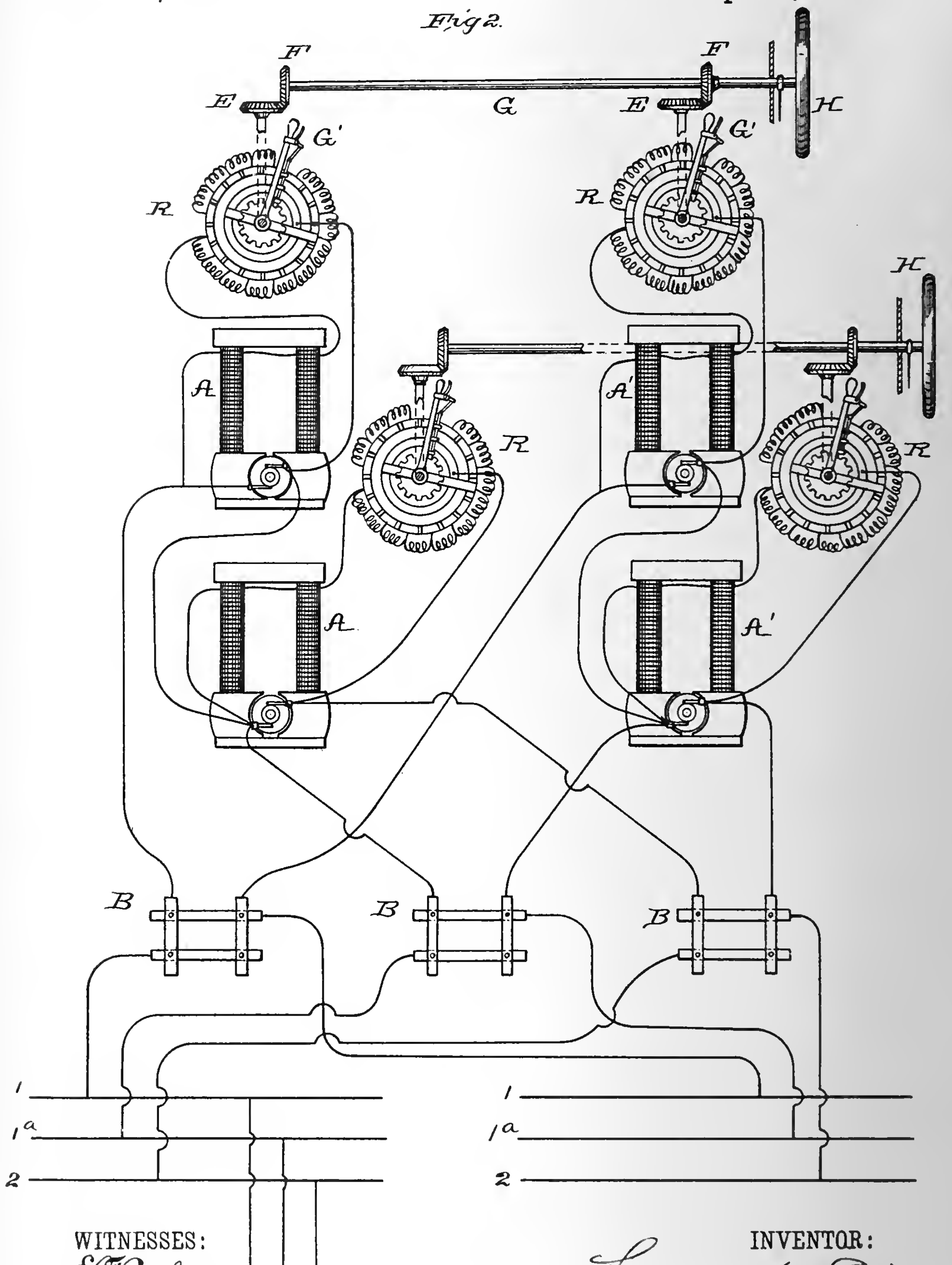
(No Model.) 2 Sheets—Sheet 2.

T. A. EDISON.

SYSTEM OF ELECTRICAL DISTRIBUTION.

No. 339,279. Patented Apr. 6, 1886.

Fig 2.



WITNESSES:

E. F. Rowland

A. W. Kiddle

INVENTOR:

Thomas A. Edison,

By Rich^d. N. Dyer

Atty.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

SYSTEM OF ELECTRICAL DISTRIBUTION.

SPECIFICATION forming part of Letters Patent No. 339,279, dated April 6, 1886.

Application filed April 5, 1884. Serial No. 126,803. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Systems of Electrical Distribution, (Case No. 618,) of which the following is a specification.

This invention relates to the regulation of the current supplied to the translating devices in a system of electrical distribution, in which such devices are connected with a system of intersecting and connected main conductors, which are joined to the source of supply by feeding-circuits, and is intended as an improvement upon the method of regulation set forth in the patent granted to C. S. Bradley, No. 291,141, dated January 1, 1884. In that patent the several dynamo-electric machines or series of such machines at the central station or source of supply are connected independently with the feeding-circuits, and so arranged that any machine may be thrown into connection with any feeder, or a number of feeders may be supplied from any required number of dynamo-electric machines, each machine or series being also provided with means for regulating its electro-motive force independently of the others, whereby current may be supplied to each part of the district according to the number of translating devices there in circuit, and the "pressure" is maintained the same at all parts of the district, all the translating devices receiving the same current. Thus, if the number of translating devices in any part of the system is increased, the electro-motive force of the generator or generators connected to the feeder which terminates nearest to such point is increased; or, if the increase is very great, one or more additional generators are attached to such feeder.

My improvement upon this system consists in providing means whereby all the generators in circuit can be regulated simultaneously, in addition to their independent regulation, so that the current in all the feeders, and therefore that supplied to all the translating devices in the district, can be raised and lowered at the same time. I prefer to use for this purpose the apparatus set forth in my Patent No. 281,349, dated July 17, 1883, with an additional device which allows the regulator-arms to be readily adjusted independently.

My invention is illustrated in the annexed drawings, in which Figure 1 is a diagram illustrating its application to an ordinary multiple-arc system, while Fig. 2 shows it in connection with my three-wire or compensating system.

Referring first to Fig. 1, A A′ are dynamo-electric machines, and 1 2 are the common conductors at the central station, from which extend the feeding-circuits 3 4 and 5 6. These, it is understood, are connected at different points to the system of intersecting and properly connected positive and negative main conductors, on which the lamps, motors, or other translating devices are arranged in multiple arc. The generators are connected in multiple arc to the conductors through the switch-boards B B, which are so connected that each generator may, by the insertion of the proper plugs connecting intersecting bars, be connected with either feeding-circuit or either generator to both feeders, or both feeders to a single generator.

In the field-circuit of each machine is a resistance, R, adjustable by means of the arm C, in contact with plates a and metal ring b, so that by turning the arm more or less of the resistance-coils are thrown into circuit. From each arm C a spindle, D, (which for convenience of illustration is shown partly in dotted lines,) extends to a bevel-wheel, E. These bevel-wheels engage with corresponding bevel-wheels, F, on the shaft G, which is provided with a hand-wheel, H, for turning it. By turning the shaft all the resistances are adjusted simultaneously and to the same extent. Each resistance is also provided with means for moving the adjusting-arm independently of the common shaft. Such means consist of the arm G′, which is locked at the position to which it is adjusted by the catch c and ratchet d.

The generators are respectively connected to the feeders, and their electro-motive force adjusted by separately regulating their field-resistances until each feeder receives the right proportion of current. Then, in order to regulate the current to all the feeders and all the translating devices in the district, the resistances are all adjusted simultaneously.

In Fig. 2 an additional compensating-conductor, 1ˣ, is employed in each circuit.

The generators are connected in series of two each, A A and A′ A′. A system of this character is set forth in my Patent No. 274,290, dated March 20, 1883. The switch-board connections are made for each series the same as for the single machines of Fig. 1, one or more series being connected to each feeder, as desired.

To regulate the electro-motive force of one series, the resistance in the field-circuit of one machine or those of both machines of that series are adjusted, while by adjusting both resistances of one of the connected sets of resistances, or, if necessary, of both such connected sets, the regulation of both series is effected.

It is evident that each series of generators in Fig. 2 is the equivalent of a single generator of Fig. 1.

What I claim is—

1. The combination, in a system of electrical distribution, of two or more feeding-circuits for supplying current to the translating devices, two or more independent generators, means for connecting said generators separately with said feeders, means for separately regulating each generator, and means for simultaneously regulating all said generators, substantially as set forth.

2. In a system of electrical distribution, the combination of the two or more feeding-circuits supplying current to different parts of the district, two or more independent generators, means for connecting each generator separately with the feeders, an adjustable resistance in the field-circuit of each generator, means for adjusting each resistance separately, and means for adjusting all said resistances simultaneously, substantially as set forth.

3. The combination of two or more dynamo-electric machines, an adjustable resistance in the field-circuit of each machine, means for adjusting all said resistances simultaneously, and means for adjusting each resistance separately, substantially as set forth.

This specification signed and witnessed this 8th day of February, 1884.

THOS. A. EDISON.

Witnesses:

A. W. KIDDLE,

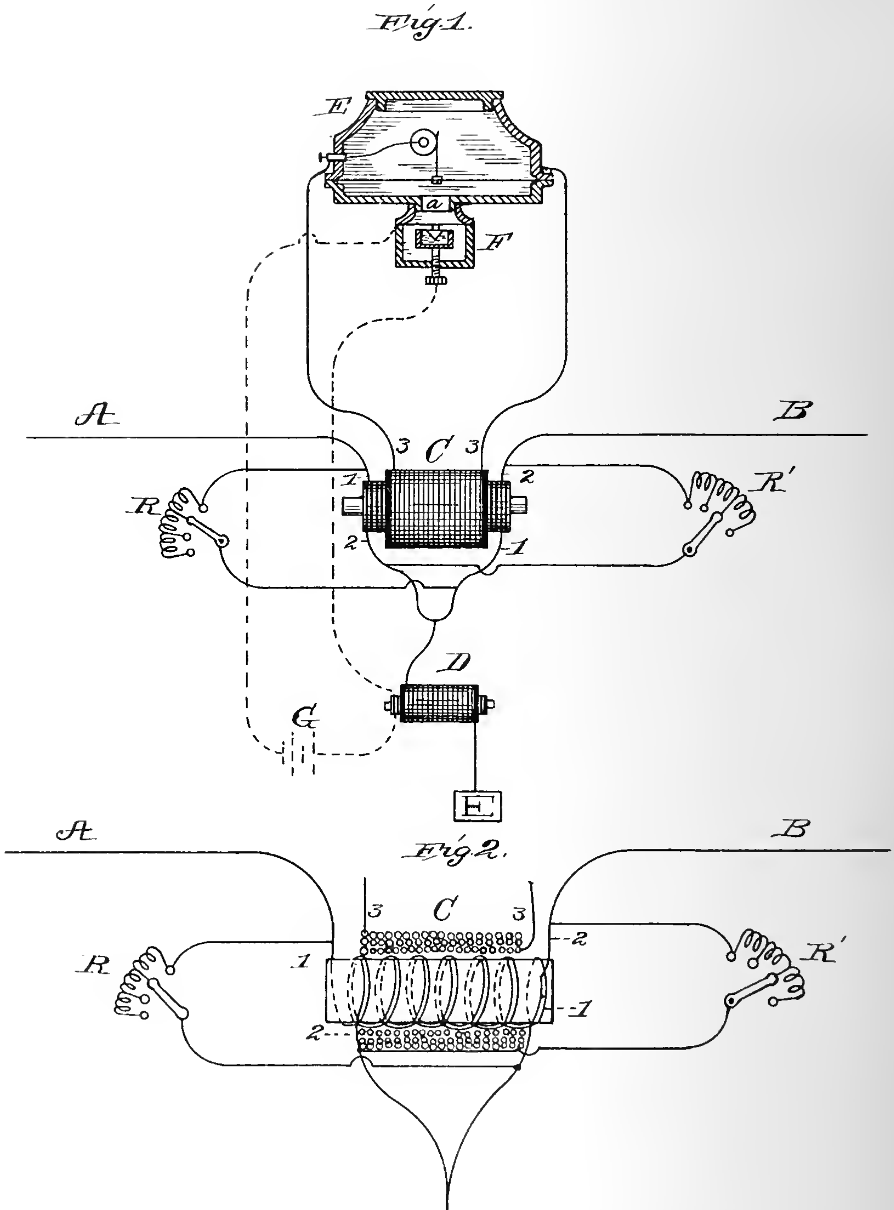
E. C. ROWLAND.

(No Model.)

T. A. EDISON.

TELEPHONIC REPEATER.

No. 340,707. Patented Apr. 27, 1886.



ATTEST:

E. C. Rowland

J. G. Greene Jr.

INVENTOR:

Thomas A. Edison

By Dyer & Seely

Attys

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

TELEPHONIC REPEATER.

SPECIFICATION forming part of Letters Patent No. 340,707, dated April 27, 1886.

Application filed December 15, 1884. Serial No. 150,347. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Telephone-Repeaters, (Case No. 639,) of which the following is a specification.

The object I have in view is to produce a telephone-repeater for relaying telephone undulations from either of two lines to the other, which will operate without the use of switches for changing the line and local circuits in the relay apparatus, and will at the same time produce clear articulation free from the confusion produced by the reciprocal action of the repeating-instruments.

A further object is to produce an arrangement whereby a single combined receiver and transmitter can be used to relay in either direction without the use of switching apparatus, and also to provide means whereby my devices for relaying in either direction without switches can be used effectively with connected lines of widely-different resistances.

The invention will be better understood by reference to the accompanying drawings, in which Figure 1 is a view principally in diagram of a telephone-repeater embodying my invention, and Fig. 2 a view in detail of the receiving induction-coil.

A and B are two telephone-lines, which are connected with different circuits 1 2 of the induction-coil C. The induction-circuits 1 and 2 are formed of wire wound together upon the core, the lines A B being connected at opposite ends of the core to the two circuits, so as to oppose each other in their inductive action. The other ends of the induction-circuits 1 2 are connected together and through the secondary of induction-coil D to earth. The induction-coil C has a third circuit, 3, in which is located the receiver E. This is an electro-motograph receiver, the chalk-cylinder of which is kept rotating constantly by any suitable means. F is a telephone-transmitter of any suitable construction. Its case is connected with the receiver-case by a channel, *a*, with closed walls. The transmitter is in circuit with primary of D and with a battery, G.

In speaking over either line the current-undulations will pass through 1 or 2 of C, and to earth through secondary of D, the greater resistance of the other line preventing any action in the other circuit (2 or 1) of C. The electro-motograph receiver will be operated by induction, and will throw sound-waves through channel *a* onto the transmitter-diaphragm. The transmitter acting through primary of D the induced undulations in secondary of D will pass out through both 1 and 2 of C upon both lines. The induction in C will be neutralized, and the reaction upon the receiver prevented.

For working connected lines of widely-different resistances adjustable resistances R and R′ are used for balancing the lines, which resistances are located in shunts around coils 1 and 2 of induction coil C. By adjusting these resistances the action of the induction in the coils 1 and 2 can be made equal, so that the inductive action from repeating-coil D will be neutralized in receiving-coil C.

What I claim is—

1. In a telephone-repeater, the combination, with two telephone-lines, of a receiving induction-coil having two opposing primary circuits and a repeating induction-coil whose secondary circuit is connected with both the primary circuits of the receiving induction-coil, substantially as set forth.

2. In a telephone-repeater, the combination, with two telephone-lines, of a receiving induction-coil having two opposing primary circuits, a repeating induction-coil whose secondary is in circuit with both said primary circuits, and a repeating telephone-receiver operated by induction from the receiving induction-coil, substantially as set forth.

3. In a telephone-repeater, the combination, with two telephone-lines, of a receiving induction-coil having two opposing primary circuits connected with said lines, a repeating telephone-receiver in the secondary circuit of such receiving-coil, a transmitting induction-coil having its secondary in circuit with the opposing circuits of the receiving induction-coil, and a repeating telephone-transmitter worked by the receiver and located in the primary circuit of the repeating induction-coil, substantially as set forth.

4. In a telephone-repeater, the combination, with two telephone-lines, of a receiving induc-

tion-coil having two opposing primary circuits, a repeating induction-coil whose secondary circuit is connected with both said primary circuits, and resistances for balancing the lines, substantially as set forth.

5. In a telephone-repeater, the combination, with two telephone-lines, of a receiving induction-coil having two opposing primary circuits, a repeating induction-coil whose secondary circuit is connected with both said primary circuits, and resistances located in shunts around such opposing primary circuits for balancing the lines, substantially as set forth.

This specification signed and witnessed this 9th day of December, 1884.

THOS. A EDISON.

Witnesses:
WM. H. MEADOWCROFT,
THOS. G. GREENE, Jr.

(No Model.) 2 Sheets—Sheet 1.

T. A. EDISON.

ELECTRICAL SIGNALING APPARATUS.

No. 340,708. Patented Apr. 27, 1886.

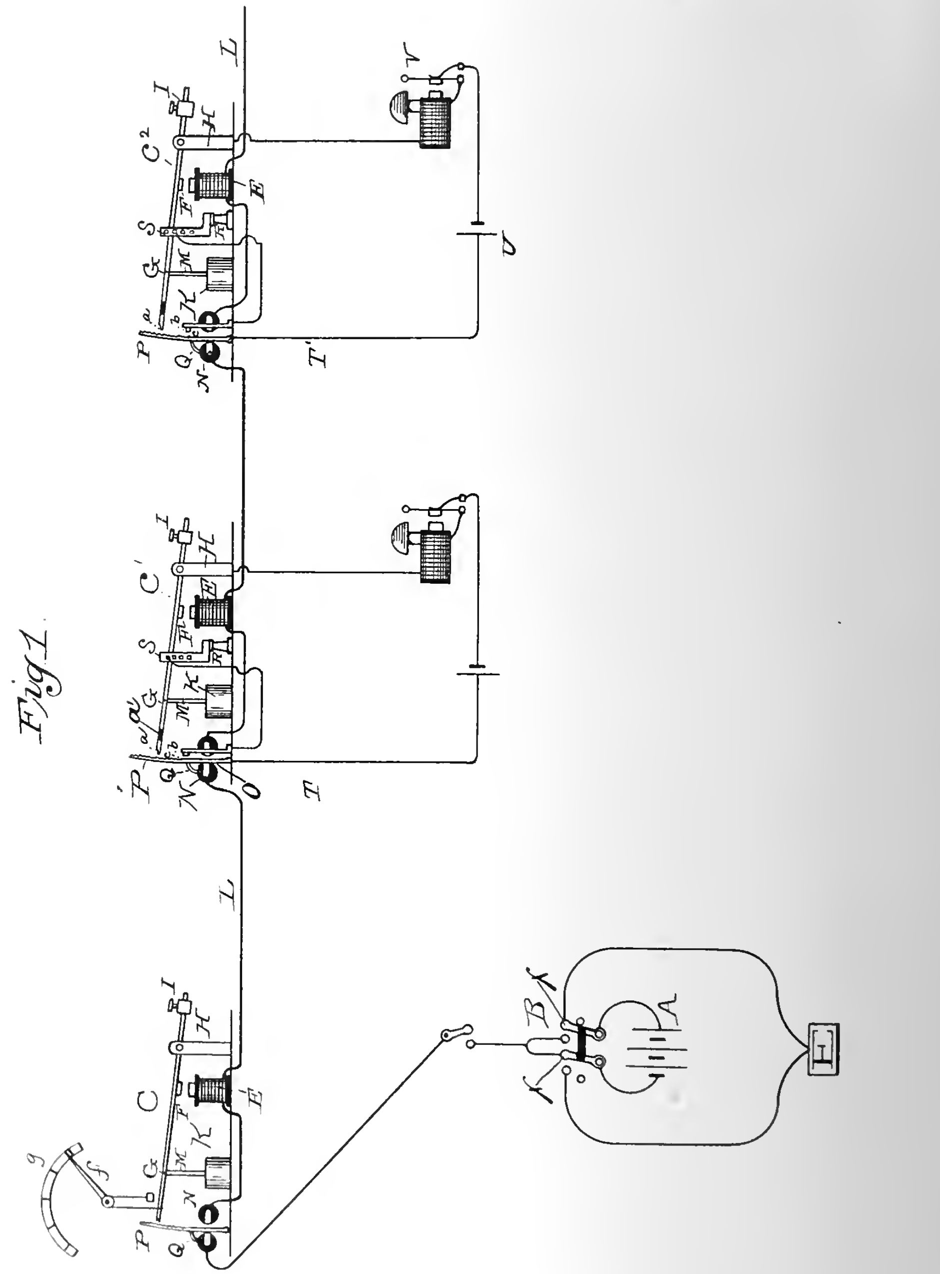


Fig. 1.

ATTEST
E. C. Rowland
M. W. Riddell

INVENTOR:
Thomas A. Edison
By Dyer and Seely
Attys

(No Model.)

2 Sheets—Sheet 2.

T. A. EDISON.

ELECTRICAL SIGNALING APPARATUS.

No. 340,708.

Patented Apr. 27, 1886.

Fig. 2.

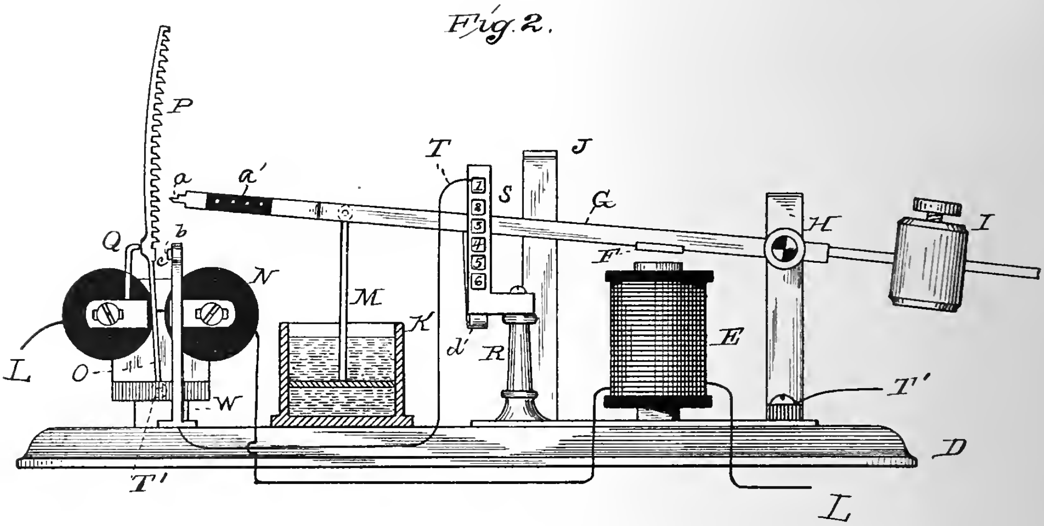
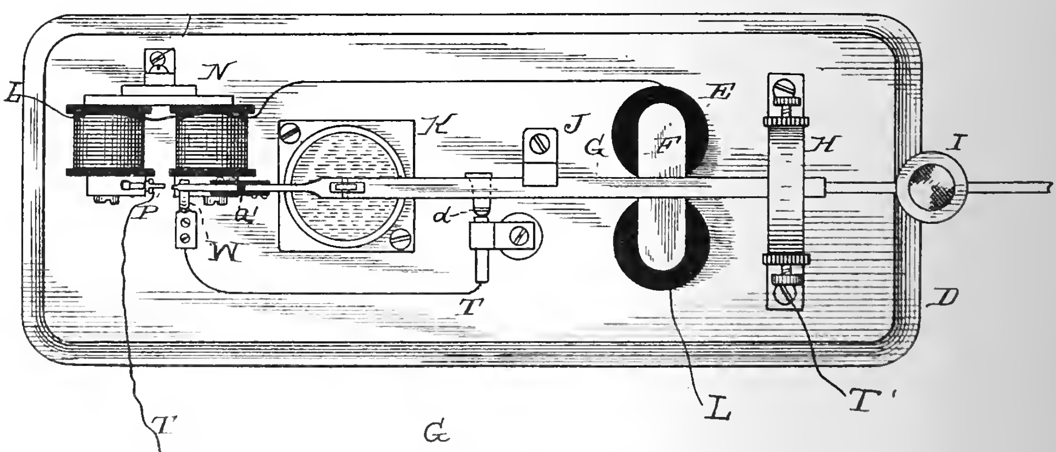


Fig. 3.



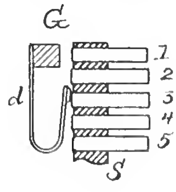


Fig. 4.

ATTEST:

E. C. Rowland

T. G. Greene Jr.

INVENTOR:

Thomas A. Edison

By Dyer & Seely

Attys.

N. PETERS, Photo-Lithographer, Washington, D.C.

United States Patent Office.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

ELECTRICAL SIGNALING APPARATUS.

SPECIFICATION forming part of Letters Patent No. 340,708, dated April 27, 1886.

Application filed January 12, 1885. Serial No. 152,622. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Electrical Signaling Apparatus, (Case No. 641,) of which the following is a specification.

My invention relates to electrical signaling apparatus by means of which signals of any character may be communicated from a central office or other place to any one of a number of receiving or indicating instruments on the same line without affecting any of the other instruments, and particularly my invention relates to that form of apparatus set forth in my application No. 640, (Serial No. 152,621,) in which several main-line instruments are employed, each controlling a local circuit and each consisting of two parts separately controlled by the current from the signaling-station, one of which brings the local-circuit contacts into position for closing circuit, after which the other acts to close the circuit.

In my present invention the means for first bringing the local contacts into position are mechanical means, set in operation by the main-line current, giving all the local-circuit controllers the same movement, while the second part of the apparatus acts to stop the movement of all said circuit-controllers and close the right local signaling-circuit at the proper determined point of such movement.

My invention is illustrated in the accompanying drawings, in which Figure 1 is a diagram of a signaling system embodying said invention; Fig. 2, an elevation of one of the main-line instruments; Fig. 3, a top view of the same, and Fig. 4 a view of the local-circuit contacts.

A is the line-battery at the signaling-station. L is the line, and B is a circuit breaker and reverser therein.

C C′ C² are the main-line signaling-instruments. Instrument C is at the signaling-station, and by means of it the operator can determine the condition of the other instruments. Each of these instruments is mounted upon a suitable base, D, and consists of an electro-magnet, E, whose armature F carries an arm, G, pivoted at H, and balanced by a weight, I. J is a stop for said arm, and K is a dash-pot, and M a plunger for retarding the movement of the arm.

N is a polarized relay, between whose poles plays the pivoted arm O, whose upper part is a toothed bar, P. Q is a back stop for said arm.

At the end of arm G is a tooth, *a*, which engages with the teeth of P when arm O is attracted in that direction. An interposed insulating-section, *a′*, removes the end of the arm G from the circuit.

A standard, R, supports an insulating strip or block, S, which carries a series of contacts, 1 2 3, &c., there being as many of these numbered contacts as there are instruments on the line. These contacts pass through the strip S.

Metal post W carries a contact, *b*, situated opposite the contact-surface *c* of arm O.

Arm G carries a contact-spring, *d*, which moves up and down the series of contacts 1 2, &c.

The local circuit, which includes local battery U and electric bell V, or other suitable audible or visual indicator, is as follows when closed: from contact 1 (or in another instrument from that contact of the series with which the circuit is connected, as already explained) by wire T to post W, contacts *b c*, arm O, wire T′, through the bell and battery to standard H, arm G, and spring *d*, bearing on the contacts. Normally, however, this circuit is open at 1 *d* and at *b c*, the weight I bringing the spring *d* above all the numbered contacts.

The operation of these devices is as follows: When the arms of the switch B are on the points *f f*, the line is open and the signaling-instruments in the line are in the normal condition just described. Moving the switch into the position illustrated closes the line and energizes all the magnets E, which attract their armatures and cause them to move down, carrying the arms G to their lowest point. The polarized relays N are so arrranged that with the current in this direction the arms P are held back against the stops Q. The line is then opened by bringing the reverser-arms to their middle contacts. The magnets E are demagnetized and the weights I move the arms G slowly back, the movement being retarded by the dash-pots. The instrument C at the signaling-station performs the same movement as the others, and being provided with a scale, *g*, and pointer *f*, the movements are shown enlarged upon such scale, and thus the position of all the armature-levers G is constantly indicated to the operator. When the armature-levers reach such a point that each contact-spring is on the contact corresponding in number to the signaling-instrument which it is desired to affect, the operator throws over his reversing-switch to the other side and reverses the line-current, thus reversing the attraction of the polarized relay, which throws the arm O over and closes circuit at *b c*, and the tooth *a* engages with the teeth of bar B, and holds the local circuit closed at 1 *d* and *b c* until the signal is completed by the bell V, or such other signaling or indicating device as may be substituted therefor. Then, by again reversing the switch, the polarized relay draws the bar P away from the arm and unlocks it, and by breaking the line the arms are all restored to their original positions.

To affect any other instrument, the moving contact-arms are stopped at the proper point to close its local circuit.

Another way in which the instruments may be operated is to close the line through the magnets, and as the arms move down operate the polarized relay, and so stop and lock them at the proper predetermined point to operate the signal, after which, the circuit being broken, the arms are brought back again above the series of contacts.

What I claim is—

1. In electrical signaling apparatus, two or more line-instruments, each comprising a moving contact and a stationary contact of a local signaling-circuit, all said stationary contacts being situated differently relative to the moving contacts, and mechanical means controlled from the signaling-station for setting said moving contacts in motion, in combination with means at the signaling-station for stopping the movement of said contacts at any determined point to close the desired local circuit, substantially as set forth.

2. In electrical signaling apparatus, two or more instruments, each controlling a local circuit and each comprising an electro-magnet in the main line, a contact-arm moved by said magnet and connected with the local circuit, means for retarding the movement of said arms, a stationary local-circuit contact, all said stationary contacts being situated differently relative to said moving contact-arms, and a polarized relay in the line for stopping the movement of said contact-arms at any determined point to close the desired local circuit, in combination with a line-circuit breaker and reverser at the signaling-station, substantially as set forth.

3. In an electrical signaling apparatus, two or more signaling-instruments, each comprising a local-circuit contact having, when set in motion, a continuous retarded movement, electro-magnetically controlled means affected by the line-current for setting the same in motion, a stationary local-circuit contact, all said stationary contacts being situated differently relative to said moving contacts, and an electro-magnetic device in the line for stopping the movement of said moving contact and closing the local circuit when the desired stationary contact is reached, in combination with means at the signaling-station for affecting first the devices setting the contacts in motion and then the devices stopping the same, substantially as set forth.

This specification signed and witnessed this 19th day of December, 1884.

THOS. A. EDISON.

Witnesses:

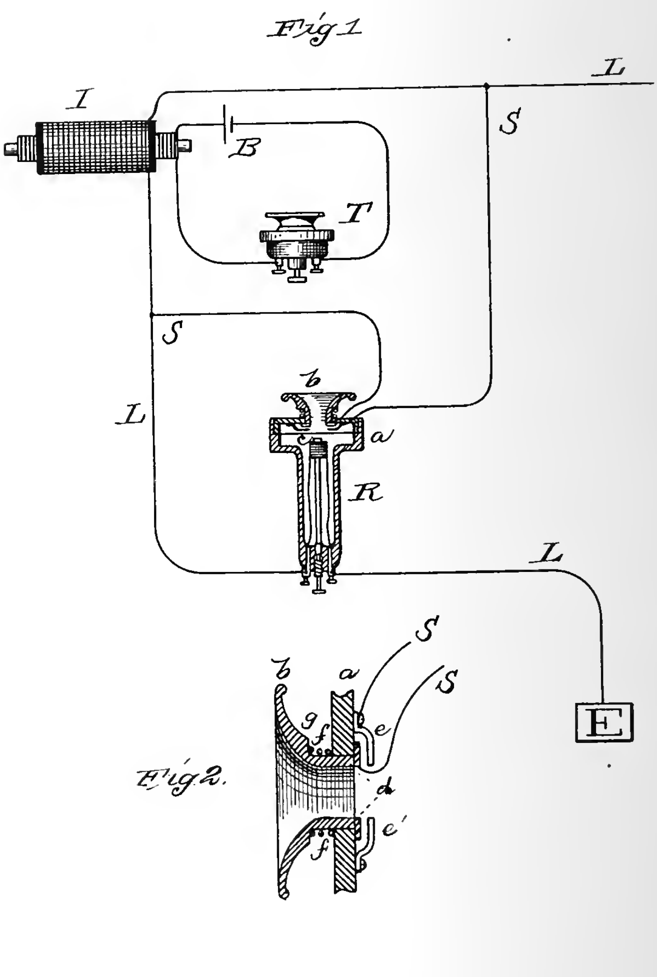
WM. H. MEADOWCROFT,
T. G. GREENE, Jr.

(No Model.)

T. A. EDISON & E. T. GILLILAND.

TELEPHONE CIRCUIT.

No. 340,709. Patented Apr. 27, 1886.



ATTEST:
E. C. Rowland
H. W. Kiddle.

INVENTORS.
Thomas A. Edison
Ezra T. Gilliland
By Dyer & Seely
Attys

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, AND EZRA T. GILLILAND OF BOSTON, MASSACHUSETTS.

TELEPHONE-CIRCUIT.

SPECIFICATION forming part of Letters Patent No. 340,709, dated April 27, 1886.

Application filed October 14, 1885. Serial No. 179,864. (No model.)

To all whom it may concern:

Be it known that we, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, and EZRA T. GILLILAND, of Boston, in the county of Suffolk and State of Massachusetts, have invented a certain new and useful Improvement in Telephone-Circuits, of which the following is a specification.

Heretofore in the use of telephone-receivers, difficulty has been experienced from the secondary of the induction-coil of the transmitter of the same instrument being in circuit with the receiver. The extra currents induced in the wire of the coil have been found to reduced the volume of sound received very materially.

The object of our invention is to overcome this difficulty, and to this end we provide means whereby the induction-coil may be cut out of circuit when the receiver is in use and restored to the circuit when the transmitter is to be used. Such means consist of a low-resistance shunt from the line around the induction-coil and a circuit-controller in said shunt, said circuit-controller being mounted upon the receiver.

In the preferred form of our invention the circuit-controller is operated by pressure upon the ear-piece of the receiver. Such ear-piece is supported loosely, and is provided with a contact-piece, to which a wire of the shunt is connected; and within the case of the instrument is placed an opposing contact-piece, to which the other shunt-wire is connected. If the ear-piece is pressed against the ear of the user, these contacts are pressed together against the force of a counteracting spring with which the ear-piece is provided. Circuit is thus closed from the line around the induction-coil. When the user wishes to use this transmitter, he removes the pressure from the ear-piece and the spring forces the contacts apart, so that the circuit to the line is again through the induction-coil. The receiver may be so arranged that the ear-piece pushes into the case, or so that a portion of the case pushes into the ear-piece to close the shunt.

Instead of using the loose ear-piece to actuate the circuit-controller, we may in some cases employ a simple push-button, mounted on the receiver, so it can be readily operated when the instrument is held in the hand.

Our invention is illustrated in the accompanying drawings, in which Figure 1 is a diagram of a telephone and its connections embodying the preferred form of our invention. Fig. 2 is a section of the ear-piece of the receiver thereof.

T is any suitable transmitter, and B is the battery in the primary circuit of induction-coil I.

L is the line including the secondary of the induction-coil.

R is any suitable receiver, of which *a* is the inclosing-case; *b*, the ear-piece, and *c* the diaphragm. The neck of the ear-piece *b* passes through an opening in the case, and is free to move back and forth therein. At its inner end within the case the ear-piece carries a metal ring, *d*. Inside the case, attached to the front wall thereof, is the metal contact *e*, to which is connected a wire of the shunt S S from the line around the induction-coil I. A corresponding metal piece, *e'*, is also attached to the case, to keep the ear-piece straight when it is pressed in. The other wire of shunt S S is connected with ring *d*. Outside the case, around the neck of the ear-piece, is placed a coiled spring, *f*, between the shoulder *g* and the case.

In using the receiver, if the sound is not loud enough, the user simply presses the receiver more closely against his ear, which brings the ring *d* against *e e'*, and closes S S around the induction-coil. When he is through listening, he removes the pressure and the spring *f* throws the ear-piece back to its normal position, breaking the shunt and making the line ready for the use of the transmitter. Preferably the wires S S and the line-wires are all run together to the receiver in a four-ply cord.

What we claim is—

1. The combination, with a telephone transmitter and receiver and an induction-coil in the line, of a shunt around the induction-coil

and a circuit-controller in said shunt carried by the receiver, substantially as set forth.

2. The combination, with a telephone-transmitter and its induction-coil, of the receiver having a loose ear-piece and a shunt-circuit around the induction-coil controlled by the movement of said ear-piece, substantially as set forth.

This specification signed and witnessed this 2d day of January, 1885.

THOMAS A. EDSON.
EZRA T. GILLILAND.

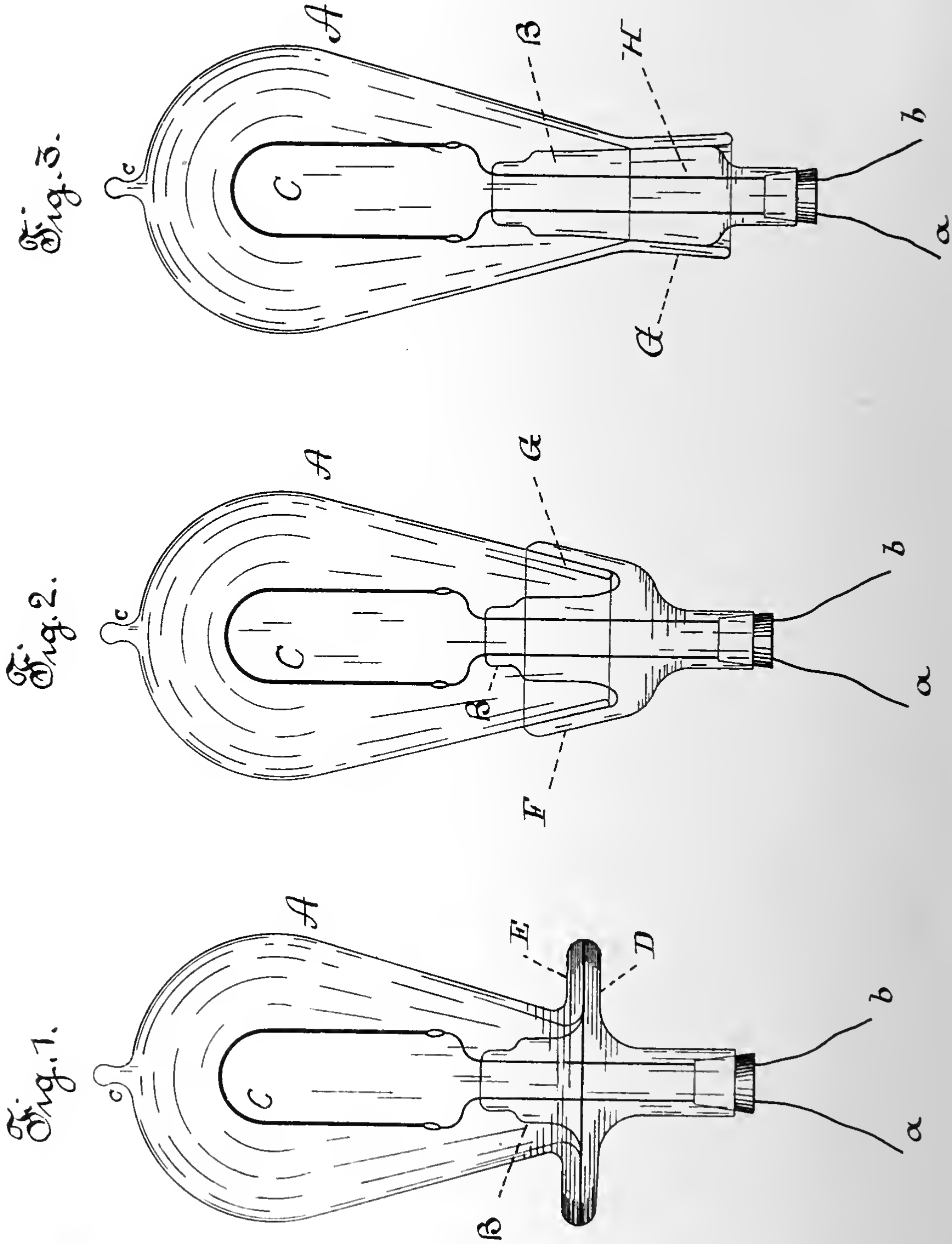
Witnesses:
JOHN C. TOMLINSON,
FRANK E. DONOHOE.

(No Model.)

T. A. EDISON.

INCANDESCENT ELECTRIC LAMP.

No. 341,644. Patented May 11, 1886.



Attest:

O. D. Mott

H. W. Seely

Inventor:

T. A. Edison

per

Dyer & Wilber

Attys.

N. PETERS, Photo-Lithographer, Washington, D. C.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, ASSIGNOR TO THE EDISON ELECTRIC LIGHT COMPANY, OF NEW YORK, N. Y.

INCANDESCENT ELECTRIC LAMP.

SPECIFICATION forming part of Letters Patent No. 341,644, dated May 11, 1886.

Application filed May 31, 1881. Serial No. 34,652. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Electric Lamps; and I do hereby declare that the following is a full and exact description of the same, reference being had to the accompanying drawings, and to the letters of reference marked thereon.

The object I have in view is to produce a simple method and means for sealing incandescent electric lamps, so that when the carbons are destroyed the lamps can be taken apart, supplied with new carbons, and again exhausted and sealed at a less cost than the first expense of manufacture. This I accomplish by providing the glass-support for the filament of each lamp with a sufficiently large ground surface with which fits closely a ground surface of similar size on the globe or bulb, one or both of the surfaces being, if necessary, first covered with a viscous substance, which fills the interstices and makes an air-tight joint. The lamp is exhausted, as usual, and the pressure of the atmosphere holds the surfaces together, the viscid substance requiring no packing to hold it in place.

As just stated, the lamp is made in two glass parts secured together by a ground glass joint aided by atmospheric pressure. The wires leading to the incandescing conductor are sealed into one of the glass parts of the lamp by the fusion of the glass around and upon such wires. For the incandescing conductor there is employed a carbon filament—viz., a conductor of carbon of filamentary size and having consequently a high resistance, which permits of the use of small leading-in wires, which can be successfully sealed into the glass without danger of breaking the seal at such points.

The lamp-globe, it will be understood, is exhausted by connection with suitable vacuum apparatus, and is "sealed off" from connection with the vacuum apparatus by the fusion of a glass tube extending from one glass part of the lamp.

The lamp produced is separate from the vacuum apparatus, and has each of its two glass parts formed of a continuous glass piece by the fusion of the glass, the only point in the glass globe where the glass is not fused into one piece being at the ground surfaces where the two parts meet.

In the drawings, Figure 1 is an elevation of one form of the lamp embodying my invention, and Figs. 2 and 3 elevations of other forms.

A is the glass globe or bulb. B is the glass-support for the filament; *a b*, the leading-in wires, and C the incandescing carbon filament.

In Fig. 1 the glass-support B is shown as provided with a solid horizontal flange, D, which is ground on its upper surface, while the bulb A, at its lower end, is turned outwardly to form a horizontal flange, E, which is ground on its under surface and fits closely the upper surface of the flange D. Before the bulb A is exhausted the carbon is inserted into the same and the ground surfaces of flanges D E brought together, one or both of such surfaces being first rubbed with a viscid substance—such as bird-lime, paraffine, or liquid rubber or grease. The bulb is then exhausted, as usual, and sealed off at *c* by the fusion of the glass.

In Fig. 2 the glass-support has an upturned cup-flange, F, and the lower end, G, of the bulb is fitted inside of the same, the meeting surfaces being ground. A viscid substance is used in the joint, as before explained. The end, G, of the bulb may be fitted over the cup F, if desired.

In Fig. 3 the lower end, G, of the bulb is fitted over the tapering body H of the glass-support. When the carbon is broken the globe may be used over again. It is opened by breaking off the sealing-teat *c*, allowing the air to rush into the vacuum. The globe can then be separated at the joint. A new exhausting-tube is sealed on where *c* is broken off, a new carbon filament is connected with the wires, and the globe is exhausted and again sealed.

What I claim is—

1. A separate incandescent electric lamp consisting of an exhausted glass inclosing-chamber made in two parts, each of which is formed of a continuous glass piece by the fusion of the glass, the two parts being provided with ground meeting or junction surfaces aided in their adhesion by atmospheric pressure,

and an incandescing carbon filament secured to leading-in wires passing through one of the parts and sealed by fusion into the glass thereof, substantially as set forth.

2. A separate incandescent electric lamp consisting of an exhausted glass inclosing-chamber made in two parts, each of which is formed of a continuous glass piece by the fusion of the glass, the two parts being provided with ground meeting or junction surfaces covered with a viscid substance and aided in their adhesion by atmospheric pressure, and an incandescing carbon filament secured to leading-in wires passing through one of the parts and sealed by fusion into the glass thereof, substantially as set forth.

3. A separate incandescent electric lamp consisting of an exhausted glass inclosing-chamber made in two parts, each of which is formed of a continuous glass piece by the fusion of the glass, the two parts being provided with ground meeting or junction surfaces aided in their adhesion by atmospheric pressure, and one of such parts having the sealing-teat *c*, and an incandescing carbon filament secured to leading-in wires passing through one of the parts and sealed by fusion into the glass thereof, substantially as set forth.

This specification signed and witnessed this 20th day of May, 1881.

THOMAS A. EDISON.

Witnesses:

RICHD. N. DYER,

H. W. SEELY.

(No Model.)

T. A. EDISON.

INCANDESCING ELECTRIC LAMP.

No. 341,839. Patented May 11, 1886.

Fig. 1.

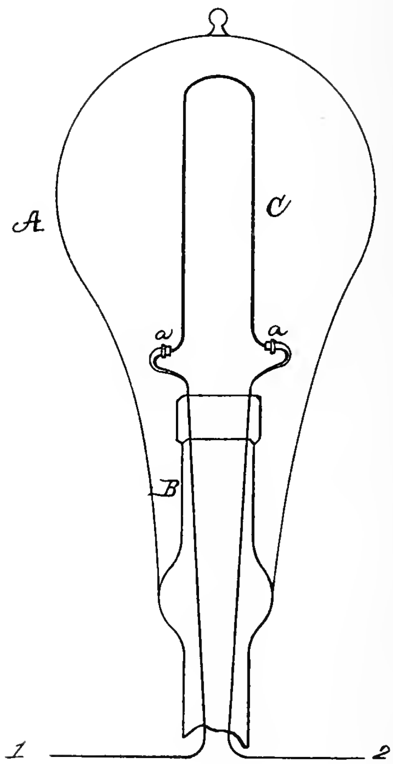
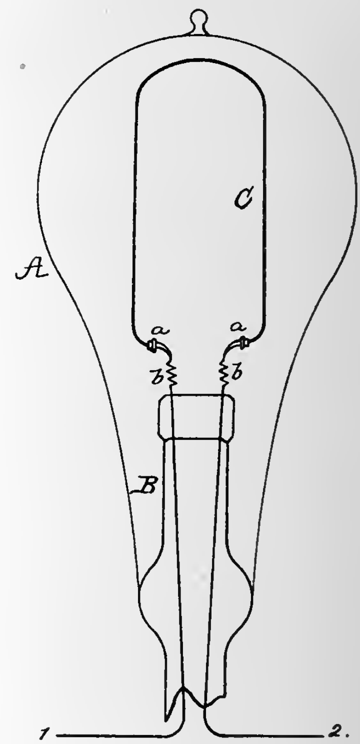


Fig. 2.



ATTEST

E. C. Rowland

H. W. Seely

INVENTOR

Thomas A. Edison,

By Richd. N. Dyer,

Atty.

N. PETERS, Photo-Lithographer, Washington, D.C.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

INCANDESCING ELECTRIC LAMP.

SPECIFICATION forming part of Letters Patent No. 341,839, dated May 11, 1886.

Application filed May 14, 1883. Serial No. 91,892. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Incandescing Electric Lamps, (Case No. 563,) of which the following is a specification.

The object of this invention is to increase the durability in use of incandescing electric lamps by allowing the flexible carbon incandescing conductor to expand freely, and by providing a clamp for joining the carbon to the leading-in wires which shall not readily be injuriously affected by the heat of the electrical carrying of the filament. Such electrical carrying or transferring of carbon takes place from the negative side of the carbon to the positive clamp, and such clamp, therefore, becomes intensely heated.

I accomplish the first-named object by bending the ends of the filament in a horizontal direction—that is, perpendicularly to the sides of the filament, either inwardly or outwardly—and employing expansible leading-in wires attached thereto, which permit an expansion and contraction of the straight sides of the filament; and the second-named object is attained by making the positive clamp, or both clamps, of such form that a mass of metal greater than is necessary for clamping is at the point nearest the heated portion of the conductor, so that the greatest heat is applied to such a mass of metal as is not likely to be fused thereby. The clamp which I prefer to use is made by flattening the larger end of a tapered wire, which may be the platinum leading-in wire or a short copper or other wire attached thereto, and bending it into a cylinder around an end of the filament. A washer or wedge is used to clamp the cylinder tightly upon the carbon. While it is necessary only that the positive clamp be formed in this way, I prefer to make both clamps alike, because in use changes may occur in the direction in which the current is passed through the lamp. The expansibility of the leading-in wires is secured by making them of spiral form. It is evident that this form of clamp can be used in connection with the filament having bent ends and spiral wires, or without them, and also that the filament with bent ends could be employed without the spiral wires, or the spiral wires without the bent filament.

My invention is illustrated in the annexed drawings, in which Figure 1 is a view of a lamp showing the filament bent outwardly and without the spiral leading-in wires, and Fig. 2 a view of a lamp with the ends of the filament bent inwardly and provided with spiral leading-in wires.

A is the inclosing-globe, and B the inner stem or wire support, of an incandescing electric lamp. C is the flexible carbon filament.

In Fig. 1 the filament C is bent outwardly near its ends, and in Fig. 2 the ends are bent inwardly. The leading-in wires 1 2 are flattened and taper outwardly near their ends, and are bent into a cylindrical form around the filament, as shown in my application No. 91,955. A ring or washer, *a*, is placed around the cylinder, and clamps it closely against the filament.

In Fig. 2 the leading-in wires within the globe are formed into spirals *b b*. The bent form of the filament and the spirals of the leading-in wires readily permit the longitudinal expansion and contraction of the carbon under the various temperatures to which it is subjected in use. The bent wires of Fig. 1, being flattened as described, are also flexible, and permit the filament to expand without injury.

A mass of metal is employed in the clamps larger than that necessary merely for clamping, and so large as not to be readily affected by the heat of the incandescent particles which are continually transferred to it.

What I claim is—

1. The flexible carbon filament of an incandescing electric lamp, formed as an arch or loop with straight or approximately straight sides, and having a single bend near each end in a direction perpendicular to its sides, substantially as set forth.

2. In an incandescing electric lamp, the combination, with the filament bent horizontally near its ends, of the continuous expansible leading-in wires attached thereto, substantially as and for the purpose set forth.

3. In an incandescing electric lamp, the gradually-enlarged leading in wires, substantially as set forth.

4. In an incandescing electric lamp, the lead-

ing-in wires having their greatest mass of metal at their ends, such ends being flattened and formed into clamps for the incandescing conductor, substantially as set forth.

5. In an incandescing electric lamp, the combination, with the filament having horizontally-bent ends, of the spiral gradually-enlarged leading-in wires formed into clamps for holding said filament, substantially as set forth.

This specification signed and witnessed this 8th day of May, 1883.

THOS. A. EDISON.

Witnesses:
WM. H. MEADOWCROFT,
H. W. SEELY.

(No Model.) 2 Sheets—Sheet 1.

T. A. EDISON.

SYSTEM OF ELECTRICAL DISTRIBUTION.

No. 343,017. Patented June 1, 1886.

Fig. 1.

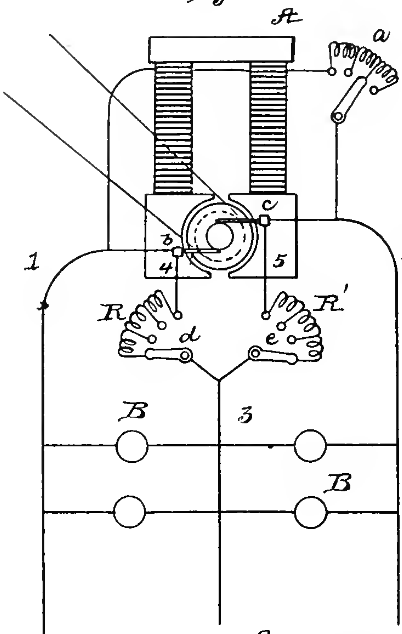


Fig. 2.

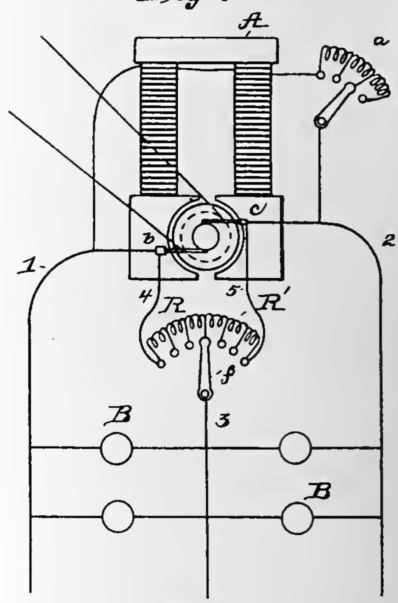


Fig. 3.

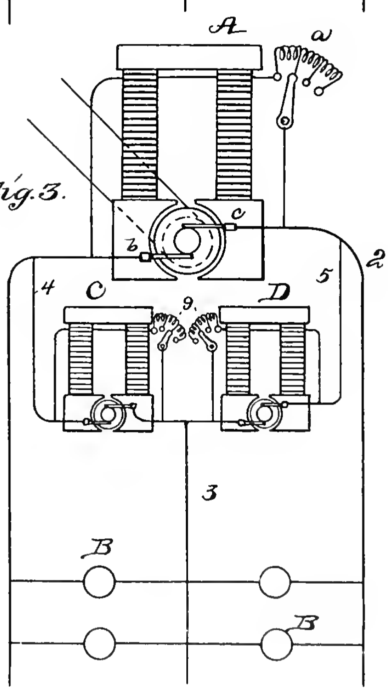
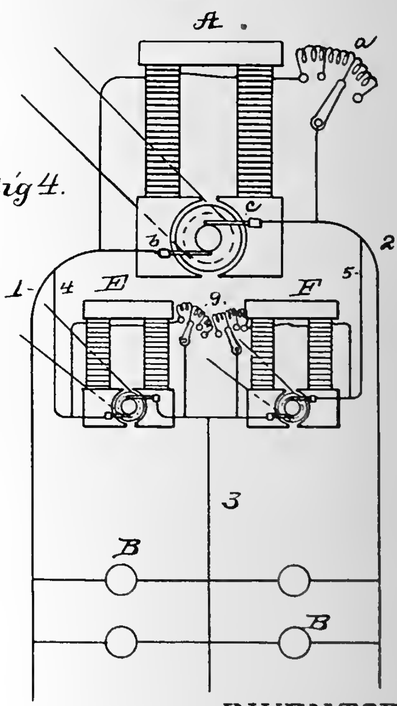


Fig. 4.



ATTEST:

INVENTOR:

Thomas A Edison,

By Richd N. Dyer

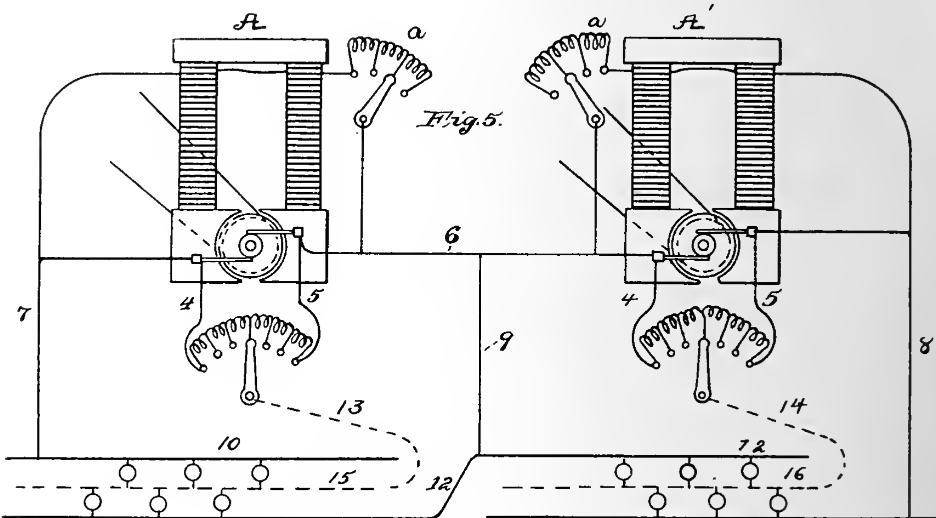
Atty.

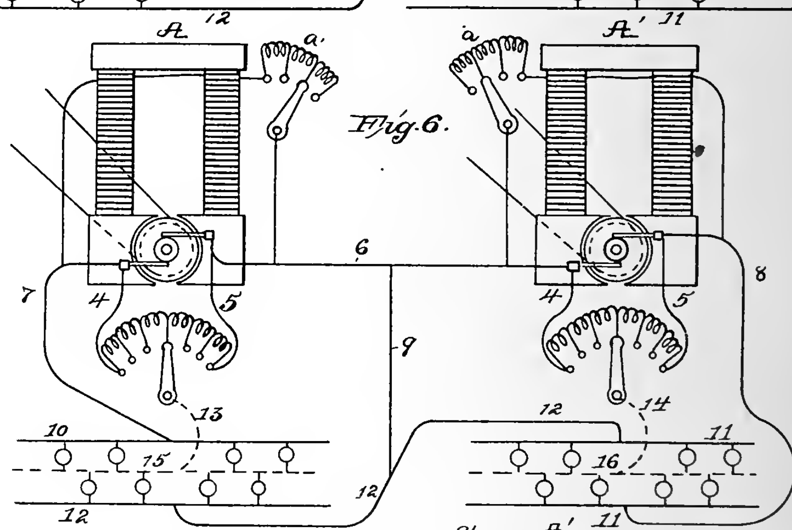
(No Model.) 2 Sheets—Sheet 2.

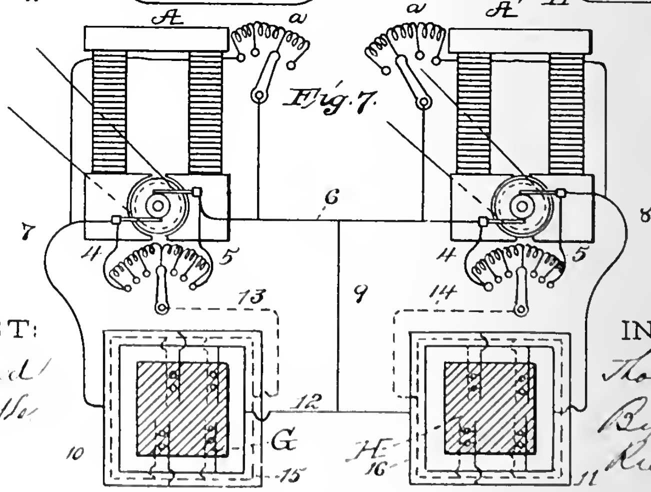
T. A. EDISON.

SYSTEM OF ELECTRICAL DISTRIBUTION.

No. 343,017. Patented June 1, 1886.







ATTEST:
E. C. Rowland
A. W. Kiddle

INVENTOR:
Thomas A. Edison
By
Rich^d N. Dyer
Atty.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

SYSTEM OF ELECTRICAL DISTRIBUTION.

SPECIFICATION forming part of Letters Patent No. 343,017, dated June 1, 1886.

Application filed August 7, 1884. Serial No. 139,962. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a certain new and useful Improvement in Systems of Electrical Distribution, (Case 629,) of which the following is a specification.

The invention relates to compensating systems of electrical distribution wherein a divided source of electrical energy is employed, from which extend two main conductors and one or more intermediate compensating-conductors, as set forth in my Patent No. 274,290.

The object I have in view is to reduce the number of dynamos necessary for such a system, and this I do by dividing the electromotive force and current of a dynamo external to the same by means of resistances or their equivalents for this purpose—small motors or dynamos.

The invention is especially applicable to small and extended installations where it is desirable to use currents of high tension and four or more divisions of the system, although it is also useful in a compensating system of two divisions.

The invention consists in the method and apparatus employed for carrying this system into effect, broadly, and in some details hereinafter pointed out, and also in a special arrangement of the conductors of a compensating system having four or more divisions.

In the accompanying drawings, forming a part hereof, Figure 1 is a view, principally in diagram, showing the division of the electromotive force and current of a dynamo by means of resistances; Fig. 2, a similar view showing a different arrangement of the resistances; Fig. 3, a similar view illustrating the accomplishment of the division by means of small motors; Fig. 4, a similar view with small dynamos substituted for the motors; Fig. 5, a view, principally in diagram, of a system of four divisions; Fig. 6, a similar view showing a somewhat different arrangement of the conductors; and Fig. 7 a view, principally in diagram, illustrating the application of the system to a town.

With reference to Figs. 1 to 4, inclusive, A is a dynamo-electric machine having means for varying its generative capacity, which is preferably an adjustable resistance, *a*, in its field-circuit. From the commutator-brushes *b c* of A extend main conductors 1 2, between which and a compensating-conductor, 3, are arranged in multiple-arc incandescing electric lamps or other translating devices, B. The brushes *b c* are connected externally to the machine by a bridge or shunt circuit, 4 5, to the central portion of which is connected the compensating-conductor 3. The bridge-circuit 4 5 contains resistances R R′, Figs. 1 and 2, located one on each side of the connection of the compensating-conductor therewith. These are preferably adjustable independently by contact-arms *d e*, as shown in Fig. 1, although the compensating-conductor 3 may be connected to a single contact-arm, *f*, Fig. 2, which increases one resistance as it decreases the other. This adjustment or variation of the forces of the two sides of the bridge-circuit with relation to each other is used to bring the two divisions of the system into balance. The total electro-motive force is varied by adjusting the strength of the field-magnet of dynamo A.

In my patent referred to is shown and described means for taking the three conductors of a compensating system from one dynamo, such means being a third commutator-brush; but practical considerations make that method undesirable, it having objections which are overcome by the external bridge-circuit.

Instead of the adjustable resistances R R′, small electro-dynamic motors C D, Fig. 3, or small auxiliary dynamo-electric machines E F, Fig. 4, may be used in the two sides of the bridge-circuit 4 5. The counter or direct forces of the motors or generators can be varied independently in any suitable way. Adjustable resistances *g* in the field-magnet circuits are shown for this purpose. This system of dividing the electro-motive force and current of a dynamo by an external bridge-circuit has especial advantages in a compensating system of four or more divisions.

A system with four divisions is shown in Figs. 5, 6, and 7. Two dynamos, A A′, are connected in series by conductor 6, and have main conductors 7 8 extending from their outside brushes, and a compensating-conductor, 9, extending from conductor 6 between the dynamos. These are feeders running to the centers or ends of main conductors 10 11 12. Each machine A A′ has an independent field-circuit with an adjustable resistance, a, for varying the generative capacity of the machine. Each machine also has a bridge-circuit, 4 5, and conductors 13 14 extend from the centers of these bridge-circuits to mains 15 16. Conductors 13 14 are also feeders, and each of these, as well as each of the feeders 7, 8, and 9, may be in one part running to a suitable point upon the mains, or in two or more parts connected at different points to the mains to equalize the distribution of current.

As shown in Figs. 5, 6, and 7, the system is composed of two compensating systems or sections each of two divisions, the two sections being connected in series by conductor 12.

I prefer to divide a town or locality to be supplied with current into two sections, and in each to run three mains, from which the house-circuits will be taken. The conductors of the two sections are connected in series, and proper feeders run from the station thereto.

In Fig. 7 the squares G H represent two sections of a town or locality with conductors arranged in this manner.

What I claim is—

1. The combination, with a dynamo-electric machine, of a bridge-circuit connecting its commutator-brushes externally to the machine, conductors extending from the ends and center of such bridge-circuit, and translating devices arranged in multiple arc in the circuits thus formed, substantially as set forth.

2. The combination, with a dynamo-electric machine, of a bridge-circuit connecting its commutator-brushes externally to the machine, conductors extending from the ends and center of the bridge-circuit, such bridge-circuit being arranged for varying the relative forces existing on opposite sides of such central connection, and translating devices arranged in multiple arc in the circuits thus formed, substantially as set forth.

3. The combination, with a dynamo-electric machine, of a bridge-circuit connecting its commutator-brushes externally to the machine, conductors extending from the ends and center of the bridge-circuit, such bridge-circuit being arranged for an independent and separate adjustment of the forces existing on opposite sides of such central connection, and translating devices arranged in multiple arc in the circuits thus formed, substantially as set forth.

4. In a system of electrical distribution, the combination with two or more dynamo-electric machines connected in series, a bridge-circuit across the brushes of each machine, and conductors extending from the ends and centers of such bridge-circuits to translating devices, substantially as set forth.

5. In a system of electrical distribution, the combination, with two or more dynamo-electric machines connected in series, each being adapted for independent regulation or adjustment of its generative capacity, a bridge-circuit across the brushes of each machine, and conductors extending from the ends and centers of such bridge-circuits to translating devices, each bridge-circuit being arranged for varying the relative forces existing on opposite sides of the central connection therewith, substantially as set forth.

6. A compensating system of electrical distribution of four or more divisions, having one dynamo-electric machine for every two divisions, the current and electro-motive force of each machine being divided between the two divisions, substantially as set forth.

7. A compensating system of electrical distribution of four or more divisions, divided into sections of two divisions each, such sections being connected in series, substantially as set forth.

8. In a compensating system of electrical distribution of four or more divisions, a town or locality divided into two or more sections, each containing conductors for two divisions, such sections being connected in series, substantially as set forth.

This specification signed and witnessed this 27th day of June, 1884.

THOS. A. EDISON.

Witnesses:
ALFRED W. KIDDLE,
BENJAMIN F. CARD.

(No Model.) 2 Sheets—Sheet 1.

T. A. EDISON.

ELECTRICAL SIGNALING APPARATUS.

No. 347,097. Patented Aug. 10, 1886.

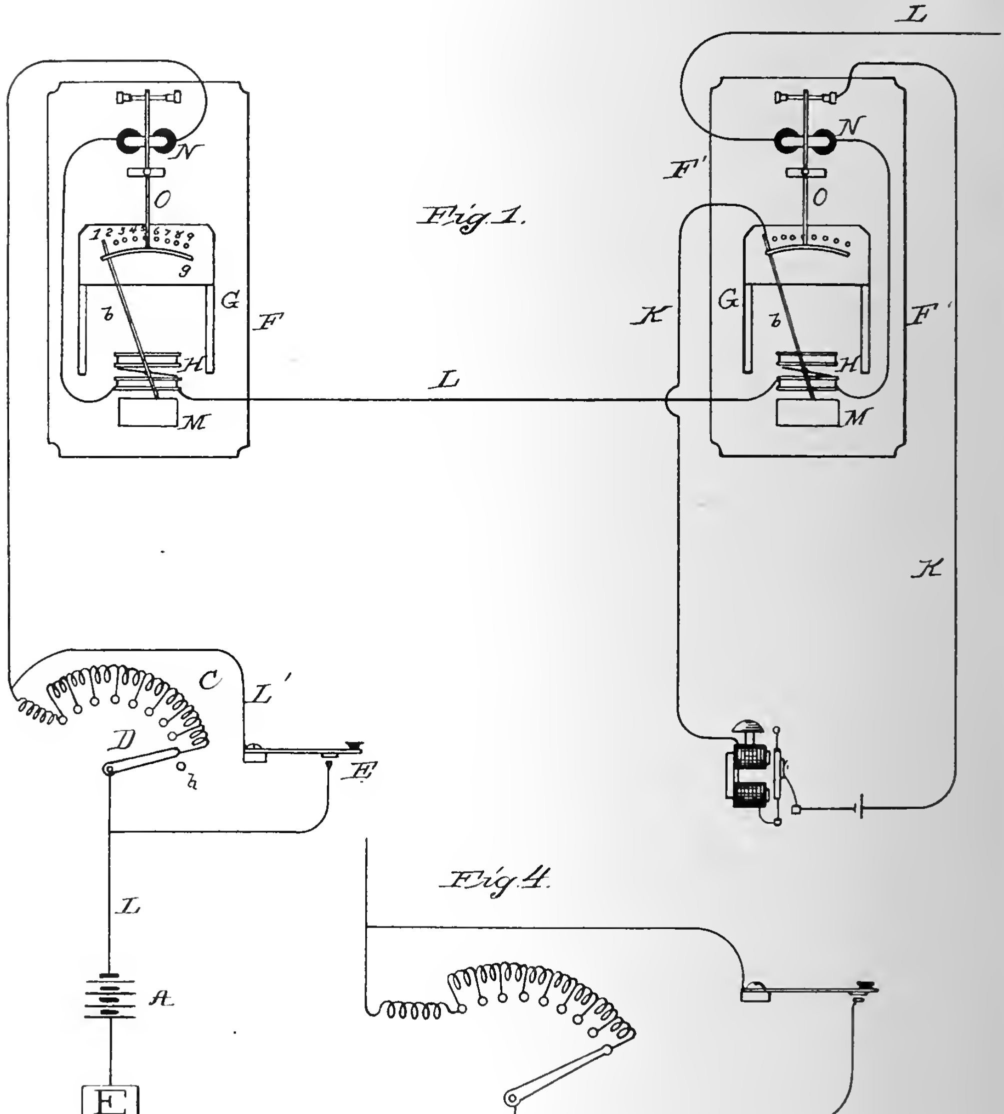


Fig. 1.

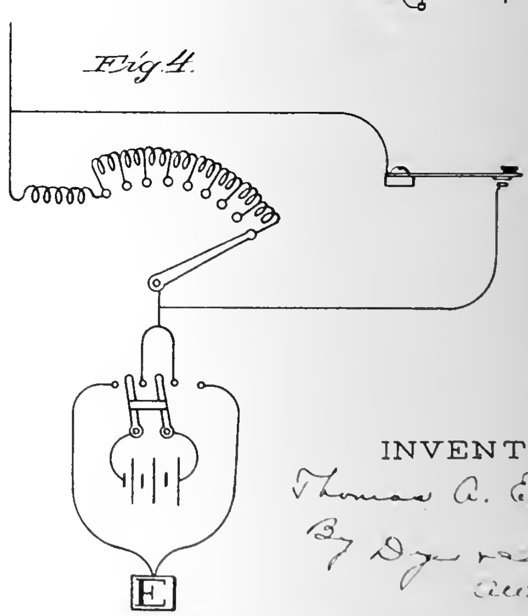


Fig. 4.

ATTEST:
E. C. Rowland
I. G. Greene Jr

INVENTOR:
Thomas A. Edison
By Dyer & Seely
Attys

(No Model.) 2 Sheets—Sheet 2.

T. A. EDISON.

ELECTRICAL SIGNALING APPARATUS.

No. 347,097. Patented Aug. 10, 1886.

Fig. 2.

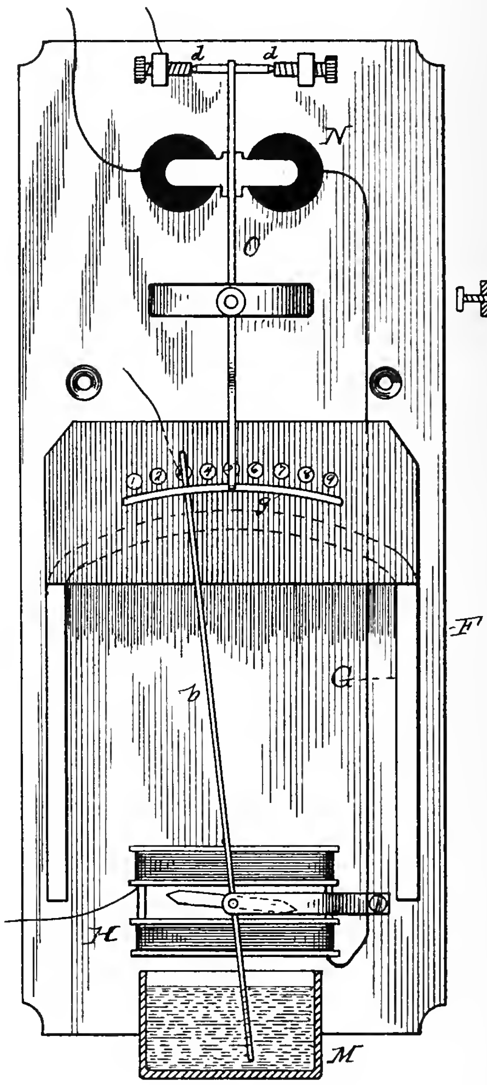
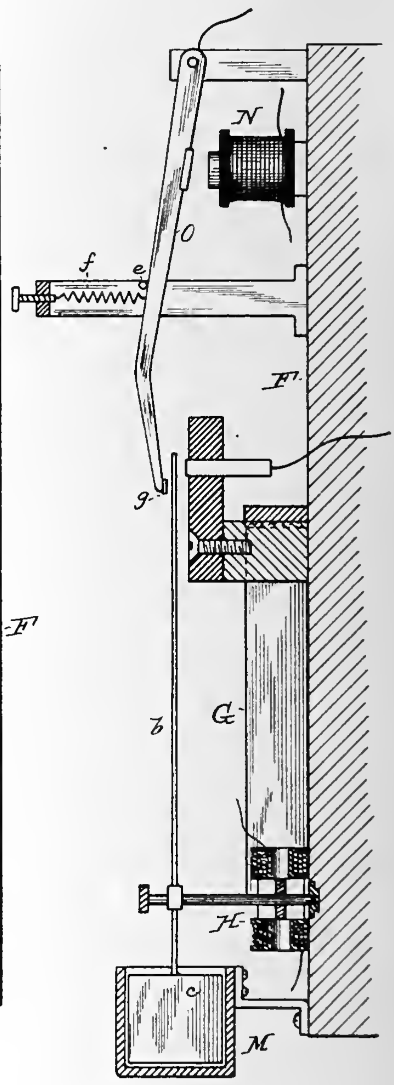


Fig. 3.



ATTEST:
E. C. Rowland
T. G. Greene Jr.

INVENTOR:
Thomas A. Edison
By Dyer & Seely
Attys.

United States Patent Office.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

ELECTRICAL SIGNALING APPARATUS.

SPECIFICATION forming part of Letters Patent No. 347,097, dated August 10, 1886.

Application filed January 12, 1885. Serial No. 152,621. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Electrical Signaling Apparatus, (Case No. 640,) of which the following is a specification.

My invention relates to apparatus by means of which signals of any character may be communicated from a central office or other place to any one of a number of receiving or indicating instruments on the same line without affecting any of the other instruments.

In carrying out my invention I provide at each point to which the signals are to be communicated a circuit-closing device in the main line, which controls a local circuit in which a local battery and a suitable audible or visual indicator is placed. All the circuit-controllers in the line are affected by a current from the signaling station to the same extent; but the local circuits are all differently arranged relatively to said circuit-closers, so that one current is required to cause the closing of one local circuit and a different amount of current to cause the closing of each of the others.

The apparatus which I prefer to use for controlling a local circuit consists of a galvanometer whose needle plays in front of a series of contacts and whose coils are in the line. The local circuit, including the signal-indicator, extends from one of the contacts of the series and includes also the pivoted armature of an electro-magnet whose coils are in the line, and this armature carries a contact arc or blade so situated and of such length that it is always in position to come in contact with the galvanometer-needle if it is attracted by its magnet. Normally, however, it is held back from such contact by a strong spring. At the signaling station apparatus, preferably an adjustable resistance is provided for sending a variable current upon the line. A certain current being sent, all the galvanometer-needles of the system are moved opposite the same contact of each of the series of local-circuit contacts—namely, opposite that contact to which the local circuit of the particular station to which the signal is to be communicated is connected. A stronger current is then sent over the line by short-circuiting the whole resistance, or in any other suitable manner, sufficient to cause all the main-line magnets to attract their armatures, which then strike all the galvanometer-needles and bring them all against the opposite contacts, thus closing through the armature-lever and the end of the galvanometer-needle the desired local circuit, and no other. This mode of closing a circuit through a galvanometer-needle by making contact at the end of it, instead of having a permanent connection to its pivot, is an important feature of my invention, because it does not interfere with the adjustment and delicate operation of the instrument, as such connections have done as have heretofore been used, and because it allows of the transmission of a heavier current than such former connections. Any suitable answer-back device may be provided by which the local operators or subscribers may communicate with the signaling station.

My invention may be more readily understood by reference to the accompanying drawings, in which Figure 1 is a diagram of a signaling system embodying my invention; Fig. 2, an elevation of one of the main-line-circuit controllers; Fig. 3, a vertical section of the same, and Fig. 4 a diagram of the arrangements at the signaling station for a modification of the invention.

A is the line-battery at the signaling station.

L is the main line.

C is a series of resistance-coils, having a pivoted arm, D, for throwing more or less of them into circuit. A shunt, L', is made around the resistance C, provided with a circuit-controlling key, E.

F F' are the line-instruments which control the local circuits. At F, however, no local circuit is shown, this being intended as an instrument by which the signaling operator at the station may determine the condition of the other instruments. As many instruments F' may be placed on the line as desired.

Each of said instruments is constructed and arranged as follows: G is the permanent magnet of a galvanometer, and H H are the coils thereof included in the main circuit L. The pivoted needle *a* carries the pointer or index arm *b*. Arm *b* plays in front of a series of contacts, 1 2 3, &c., arranged upon an insulating-piece, I, carried by magnet G. As shown, these contacts pass through piece I, and the connections to them are made at the other side. At each instrument a local circuit, K, extends from one of the contacts 1 2, &c. At instrument No. 1, for instance, this local circuit extends from contact 1, and at instrument No. 2 from contact 2, and so on, there being as many contacts preferably at each instrument as there are instruments in the line. Instead of this, each instrument may have only one contact, all the contacts being placed in different positions relative to the arm *b*. It is preferred, however, to make all the instruments alike, and in installing the system to connect the local circuit of each to the proper contact. Each arm *b* carries at its lower end a fan-blade, *c*, moving in a vessel, M, containing a liquid, for retarding the movement of the arm, or any other suitable retarding device may be employed instead.

N is an electro-magnet whose coils are in the line. It has an armature-lever, O, pivoted at *d d* and normally held away from the magnet against a stop, *e*, by an adjustable retracting-spring, *f*. At its free end lever O carries a curved metal bar, *g*, which hangs outside and away from the index-arm *b*. Lever O is preferably of the bent form shown, so that its free end is brought near the index-arm. The other terminal of the local circuit K is brought to the lever O.

The operation of these devices is as follows, referring to Fig. 1 especially: The operator at the signaling station desires to signal the subscriber No. 1, whose instrument is at F'. He moves lever D away from the stop *h*—the circuit having previously been open—and closes the circuit, as shown, through the whole resistance C. The galvanometer-needles and index-arms are so arranged that when no current is passing in the coils the index-arm is thrown off to one side of the series of numbered contacts. The current which passes when the whole resistance C is in circuit is sufficient to move the needle so as to bring each of the index-arms of the system opposite contact 1 of its instrument, and they will all remain in that position so long as that current is passing. The operator, however, now immediately closes the key E, which short-circuits the whole resistance C, and throws such a current upon the line as to cause the magnets N to move their armatures, the retracting-springs *f* of the armatures being of such strength as to hold the armatures against the attraction due to any current which can flow when any part of resistance C is in circuit. The contact-bars *g*, carried by the armature-levers, are all thus brought against the index-arms *b*, and these being long and flexible are pressed down against contacts 1. This evidently has no effect except at the proper instrument in which the local circuit is connected to contact 1. Here such local circuit is closed, and local battery rings the bell P, or any other indicating or signaling device placed in such local circuit is affected. The fan *c* or other retarding device prevents the needle from moving quickly away from the contact when the resistance C is short-circuited, retaining it in front of the contact until the armature-lever forces it against the same. To affect any other instrument, the arm D is moved to another division of the resistance C, so that current enough will flow to move the index-arms opposite the right contacts. By means of the instrument F, placed at the station, which is affected simultaneously with the other instruments, the operator can see when the index-arms have reached the right positions. Such instrument may, however, be dispensed with, the resistance-contacts being graduated to correspond with the local-circuit contacts, so that the operator can tell where the index-arms are by the position of the resistance-arms. The galvanometers may be arranged so that their arms will stand normally at the middle of the scale, and will move one way for a current of one polarity and the other way for an opposite current. The arrangement at the signaling station in this case is that shown in Fig. 4. A circuit-reverser, R, is connected with the battery, and the whole of the resistance C is normally in the line, the current then given to the line being such as to maintain all the galvanometer-arms at the middle position on the series of contacts. The current being in one direction, the galvanometer-arms move over the contacts on one side of it a distance determined by the amount of resistance C in circuit, as before. On reversing the current at R the arms will move in the other direction from the center over the contacts on that side according to the amount of resistance as before. The operation of the magnet N is the same as above described.

It is evident that any number of lines each having a suitable number of signaling devices may extend from the same signaling station.

What I claim is—

1. In a circuit-controller, the combination of two contacts, a galvanometer-arm adapted to enter between said contacts, and means for forcing the contacts together upon said arm, substantially as set forth.

2. In a circuit-controller, the combination of a series of contacts, a galvanometer-arm playing in front of said contacts, and a movable contact adapted to force said galvanometer-arm against such contact of the series as it may stand opposite, substantially as set forth.

3. In an electrically-controlled circuit closer, the combination of a series of contacts, a galvanometer in the controlling-circuit whose arm plays in front of said contacts, an electro-magnet in the controlling-circuit, and a movable armature therefor, carrying a contact adapted when the magnet is energized to force the galvanometer-arm against such contact of the series as it may stand opposite, said magnet being adapted to move its armature only with a stronger current than that which affects the galvanometer, substantially as set forth.

4. In electrical signaling apparatus, the combination of a galvanometer in the main

line whose arm plays before a contact of the local signaling-circuit, the signaling-circuit including a pivoted armature-lever carrying the other local-circuit contact situated before said galvanometer-arm, an electro-magnet controlling said armature-lever, means at the signaling station for affecting said galvanometer-arm, and means also at the signaling station for energizing said electro-magnet, substantially as set forth.

5. In an electrical signaling apparatus, the combination of two or more main-line instruments, each comprising a galvanometer whose arm moves before a local-circuit contact, all said contacts being situated differently relative to said arms, and an electro-magnet also in the main line, having an armature-lever carrying a local-circuit contact situated before said galvanometer-arm, said magnet being adapted to move its armature only on a stronger current than that which affects the galvanometer with an adjustable resistance at the signaling station, and a shunt around said resistance provided with a circuit-controller, substantially as set forth.

This specification signed and witnessed this 19th day of December, 1884.

THOS. A. EDISON.

Witnesses:

WM. H. MEADOWCROFT,

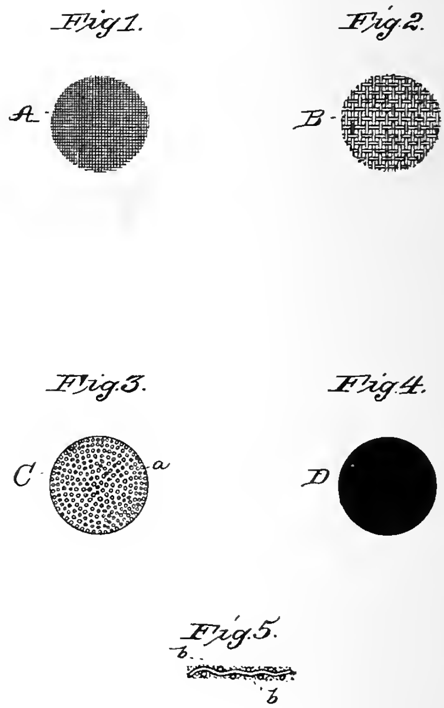
T. G. GREENE, Jr.

(No Model.)

T. A. EDISON.

ELECTRODE FOR TELEPHONE TRANSMITTERS.

* No. 348,114. Patented Aug. 24, 1886.



ATTEST

E. C. Rowland

INVENTOR:

Thomas A. Edison

UNITED STATES PATENT OFFICE

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

ELECTRODE FOR TELEPHONE-TRANSMITTERS.

SPECIFICATION forming part of Letters Patent No. 348,114, dated August 24, 1886.

Application filed October 14, 1885. Serial No. 179,869. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a certain new and useful Improvement in Electrodes for Telephone-Transmitters, of which the following is a specification.

This invention relates to the carbon electrodes or buttons for telephone-transmitters; and its object is to increase the effectiveness in use of such electrodes.

The carbon button of my invention consists of a base of textile or woven fabric (or of a certain equivalent material, hereinafter described) whose meshes are filled or impregnated and whose surfaces are covered with lamp-black, plumbago, or carbon in any other suitable form. The fabric may be fine wire-gauze, or any material woven from animal or vegetable fiber. I prefer to use veiling or other cloth of a similar texture. A flat piece of the material chosen, of the proper size for the carbon button, and usually of circular form, is laid upon a quantity of the powdered carbon, and more of the carbon is then placed upon the flat piece. Pressure is then applied in any suitable manner to the carbon and fabric, and the carbon is thus forced into the meshes or interstices of the fabric and fills the same, so that the fabric is thoroughly impregnated with the carbon and is covered on each side with a layer of carbon. For some forms of carbon a suitable glutinous or sticky material is employed to unite the carbon particles. With lamp-black, however, no such thing is required. I have found that carbon buttons of this character are more effective in use than those composed wholly of carbon, and I think the reason for this is that at those parts of the button where the carbon lies upon the threads or wires of the fabric the surface is higher than at those parts where it is forced into the meshes between the threads, and therefore the surface of the button is provided with a great number of minute raised contact parts, whereby better contact is attained with the opposing surface than where the button has a perfectly-flat surface.

I prefer the fabric of animal or vegetable fiber to the metal gauze, because the wires of the latter are smooth and slippery and do not retain the carbon upon their surfaces under pressure, like the threads of the former.

Instead of the textile fabric I may employ a disk of thin paper perforated with a large number of small holes so thickly that its structure is similar to that of a woven fabric. This evidently may be considered the equivalent of the textile fabric. The carbon is pressed into the apertures and remains upon the surface of the intermediate paper in the same manner as above described.

The base of textile fabric, or its equivalent, holds the carbon together, so that the whole forms an integral structure.

My invention is illustrated in the accompanying drawings, in which Figure 1 represents a piece of animal or vegetable fabric for the base of a carbon button; Fig. 2, a piece of wire-gauze for the same purpose; Fig. 3, a piece of perforated paper for the same purpose; Fig. 4, a complete carbon button, and Fig. 5 is an exaggerated sectional view of such carbon button.

A is a circular disk cut from a piece of veiling or similar fabric; B, a disk of wire-gauze; C, a disk of paper closely perforated with a large number of minute apertures, *a*. The piece of one or another material is placed between layers of carbon, and the whole is pressed into an integral structure, as above set forth.

The carbon *b*, covering the fabric and filling its interstices, is shown in an exaggerated manner in Fig. 5, and the complete carbon button D is seen in Fig. 4.

In my Patent No. 203,015, of April 30, 1878, is set forth a carbon electrode composed of a number of fibers, each separately covered with carbon and all rolled into a wad or tuft. My present invention, however, provides a better construction, inasmuch as it produces a flat button, which is more convenient in use and can be substituted in any ordinary telephone for the usual carbon button, and does not require a binding to hold it together. The present method of manufacture also is much more simple and economical than that required to produce the article set forth in the patent referred to.

What I claim is—

1. An electrode for a telephone-transmitter, consisting of a flat piece of textile fabric, or

its equivalent, impregnated and covered with carbon, substantially as set forth.

2. An electrode for a telephone-transmitter, consisting of a flat piece of animal or vegetable fabric, or its equivalent, impregnated and covered with carbon, substantially as set forth.

3. An electrode for a telephone-transmitter, consisting of a flat piece of veiling impregnated and covered with carbon, substantially as set forth.

4. An electrode for a telephone-transmitter, consisting of a flat piece of textile fabric, or its equivalent, impregnated and covered with lamp-black, substantially as set forth.

5. The method herein described of forming an electrode for a telephone-transmitter, consisting in placing a piece of textile fabric between layers of carbon and pressing the whole together.

This specification signed and witnessed this 12th day of January, 1885.

THOS. A. EDISON.

Witnesses:

A. W. KIDDLE,

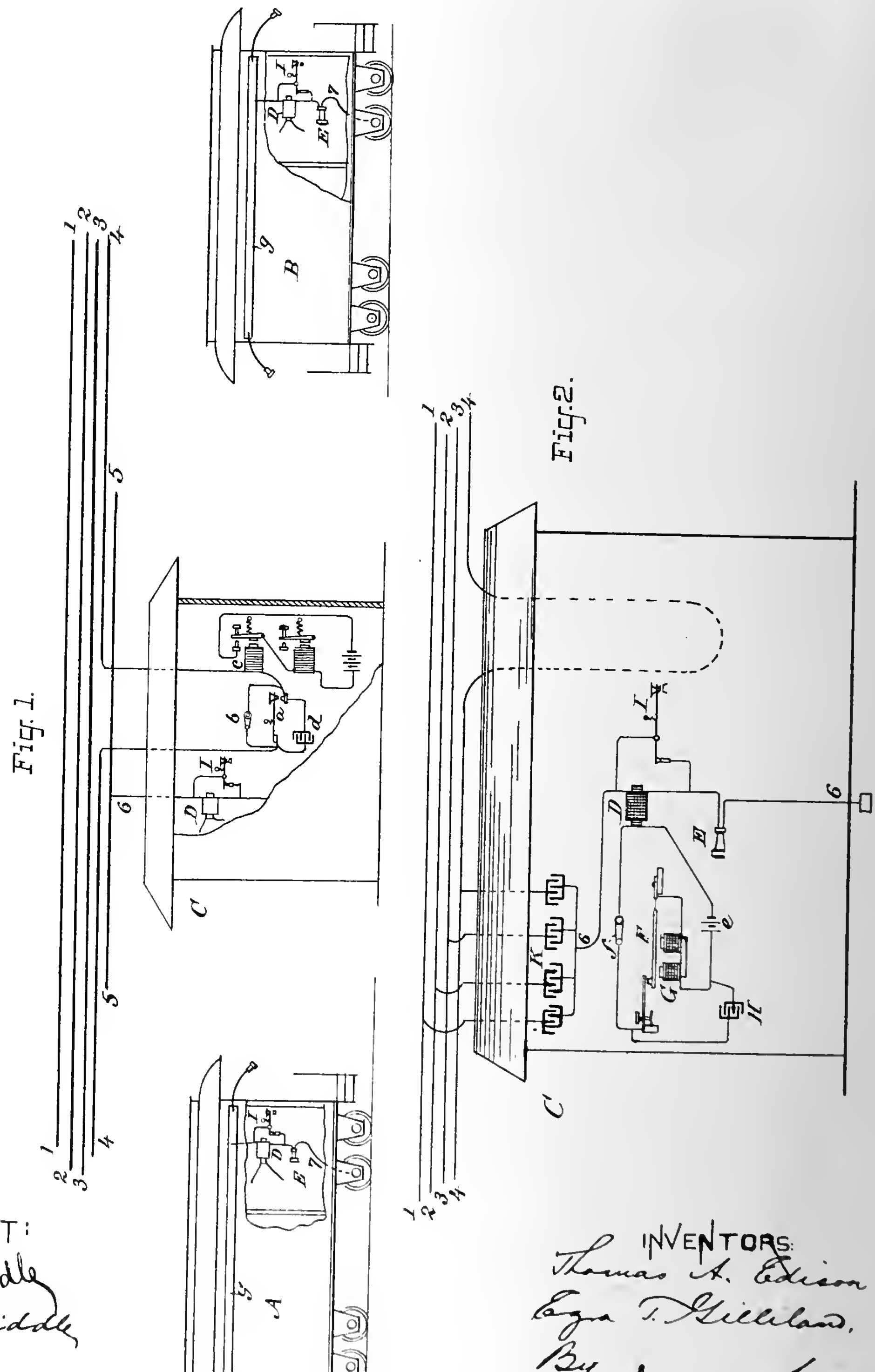
E. C. ROWLAND.

(No Model.)

T. A. EDISON & E. T. GILLILAND.

SYSTEM OF RAILWAY SIGNALING.

No. 350,234. Patented Oct. 5, 1886.



ATTEST:
J. A. Hurdle
A. W. Kiddle

INVENTORS:
Thomas A. Edison
Ezra T. Gilliland.
By Dyer & Seely
Attys

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, AND EZRA T. GILLILAND, OF BOSTON, MASSACHUSETTS, ASSIGNORS TO THE RAILWAY TELEGRAPH AND TELEPHONE COMPANY.

SYSTEM OF RAILWAY SIGNALING.

SPECIFICATION forming part of Letters Patent No. 350,234, dated October 5, 1886.

Application filed April 7, 1885. Serial No. 161,438. (No model.)

To all whom it may concern:

Be it known that we, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, and EZRA T. GILLILAND, of Boston, in the county of Suffolk and State of Massachusetts, have invented a certain new and useful Improvement in Systems of Railway Signaling, (Case B,) of which the following is a specification.

The object we have in view is to utilize the ordinary telegraph-wires extending along a railroad for the line of an inductive signaling apparatus for reciprocal signaling between stations and trains and between trains without interference between the two classes of signals. The numerous wires running along trunk railway lines would give a large inductive surface, which is a point of great advantage in inductive apparatus operating by condenser action upon the principle of static induction.

In carrying out our invention we connect at each signaling station each of the passing telegraph-wires (or each of as large a number as desired) with a condenser in the station. The condensers on their other sides are all connected together and with a circuit extending to ground. In this circuit are arranged our signal transmitting and receiving devices, which are preferably for the receiving device, a telephone, and for the transmitting device, a musical vibrator and an induction-coil. The Morse keys upon the telegraph-wires are all shunted by condensers to increase the clearness of the telegraph-signals. Instead of connecting the wires to condensers in each station, the transmitting and receiving devices in station may be connected with a wire or wires run for a greater or less distance upon the telegraph-poles in proximity with the telegraph-wires, but not connected therewith. Each train has its cars equipped with inductive strips coupled together and connected with receiving and transmitting devices similar to those used in the stations, such devices being included in a circuit between the inductive strips and the ground.

In the accompanying drawings, forming a part hereof, Figure 1 is a view, principally in diagram, of a signaling system embodying our invention, the signaling-instruments not being developed; and Fig. 2, a view of a station, showing a modified condenser arrangement, the signaling-instruments being shown.

A and B are cars of two trains, and C is a station.

1 2 3 4 are telegraph-wires running along the line of the road. Wire 4 is looped into station and has the regular instruments for Morse telegraphy. There are shown a Morse key, *a*, and switch *b*, and a relay, *c*, controlling local sounder-circuit. The key *a* is shunted by a condenser, *d*. Running a short distance with the telegraph-wires 1 2 3 4 is a condenser-wire, 5, Fig. 1. This is connected with wire 6, running through the station to ground. Within the station this wire has connected with it signal transmitting and receiving devices, which are particularly described and claimed in our application (Case A) of even date herewith. They consist of an induction-coil, D, the secondary of which is of high resistance—say one thousand ohms—and is located in line of wire 6, in which is also the high-resistance receiving-telephone E. The primary of D includes a local battery, *e*, vibrating musical reed F, opening and closing circuit, a magnet, G, acting on the reed, and a simple switch, *f*. The contact-points at which the musical reed opens and closes circuit are shunted by a condenser, H. The secondary of induction-coil is short circuited by the normal position of a key, I, by depressing which the short circuit is broken. These parts are shown in Fig. 2, and their operation is fully explained in the application referred to.

The cars A B have external inductive strips *g*, insulated from car, and connected with ground by a wire, 7, extending through the car to a truck. This wire has connected with it the signal transmitting and receiving devices described, and shown in Fig. 2.

Instead of using a condenser wire or strip, 5, external to station, the telegraph-wires 1 2 3 4 may be connected with condensers K in station, Fig. 2, which, on their other sides, are coupled together and form the upper terminal of wire 6.

The telegraph-wires are, as usual, grounded lines.

The trains and stations, as will be understood by the foregoing, are connected with this line by condensers arranged in multiple arc. The system of signaling is by dots and dashes, as explained in the application referred to; but the high-resistance telephone-receivers are capable of receiving through the condensers static impulses, which are not sufficient to work the Morse instruments.

The condensers, which shunt the Morse keys, form for the high-tension impulses of induction a constantly-closed circuit, so that the railway signaling is not interfered with by the working of the Morse keys in telegraphing.

The broad invention of utilizing a number of telegraph-wires collectively as the line for the inductive railway-signals is not claimed herein, but will be embodied in another application for patent.

What we claim is—

1. In railway inductive signaling apparatus, the combination, with one or more telegraph-wires and their instruments, of a train having railway signaling, transmitting, and receiving instruments operating to transmit and receive signals produced by induction impulses, and acting inductively upon and from the telegraph wire or wires, a station having transmitting and receiving instruments for such induction railway-signals, and shunts around the telegraph-keys to maintain a closed line-circuit for the induction railway-signals, substantially as set forth.

2. In railway inductive signaling apparatus, the combination, with one or more telegraph-wires and their instruments, of a train having railway signaling, transmitting, and receiving instruments operating to transmit and receive signals produced by induction impulses, and acting inductively upon and from the telegraph wire or wires, a station having transmitting and receiving instruments for such induction railway-signals, and condenser-shunts around the telegraph-keys to maintain a closed line circuit for the induction railway-signals, substantially as set forth.

3. In railway inductive signaling apparatus, the combination, with several telegraph-wires and their instruments, of a train having railway signaling, transmitting, and receiving instruments operating to transmit and receive signals produced by induction impulses and acting inductively upon and from the telegraph-wires collectively, a station having transmitting and receiving instruments for such induction railway-signals, and shunts around the telegraph-keys to maintain a closed line-circuit for the induction railway-signals, substantially as set forth.

4. In railway inductive signaling apparatus, the combination, with several telegraph-wires and their instruments, of a train having railway signaling, transmitting, and receiving instruments operating to transmit and receive signals produced by induction impulses, and acting inductively upon and from the telegraph-wires collectively, a station having transmitting and receiving instruments for such induction railway-signals, and condenser-shunts around the telegraph-keys to maintain a closed line-circuit for the induction railway-signals, substantially as set forth.

5. In railway inductive signaling apparatus, the combination, with several telegraph-wires and their instruments, of trains and stations having railway signaling-instruments operating inductively upon and from such telegraph-wires collectively, and condensers in shunts around the telegraph-keys, substantially as set forth.

6. In railway inductive signaling apparatus, the combination, with several telegraph-wires and their instruments, of trains and stations having railway signaling-instruments connected in multiple arc with such telegraph-wires by condensing-surfaces, and condensers in shunts around the telegraph-keys, substantially as set forth.

7. The combination, with the series of telegraph wires or circuits used for ordinary purposes, of a series of condensers connected individually with one set of poles to said wires, and having their other or opposite poles joined together and connected to the apparatus at the fixed station of a railway-telegraph, substantially as set forth.

This specification signed and witnessed by the said EDISON on the 27th day of March, 1885, and by the said GILLILAND on the 28th day of March, 1885.

THOMAS A. EDISON.
EZRA T. GILLILAND.

Witnesses as to signature of T. A. Edison:
A. W. KIDDLE,
E. C. ROWLAND.

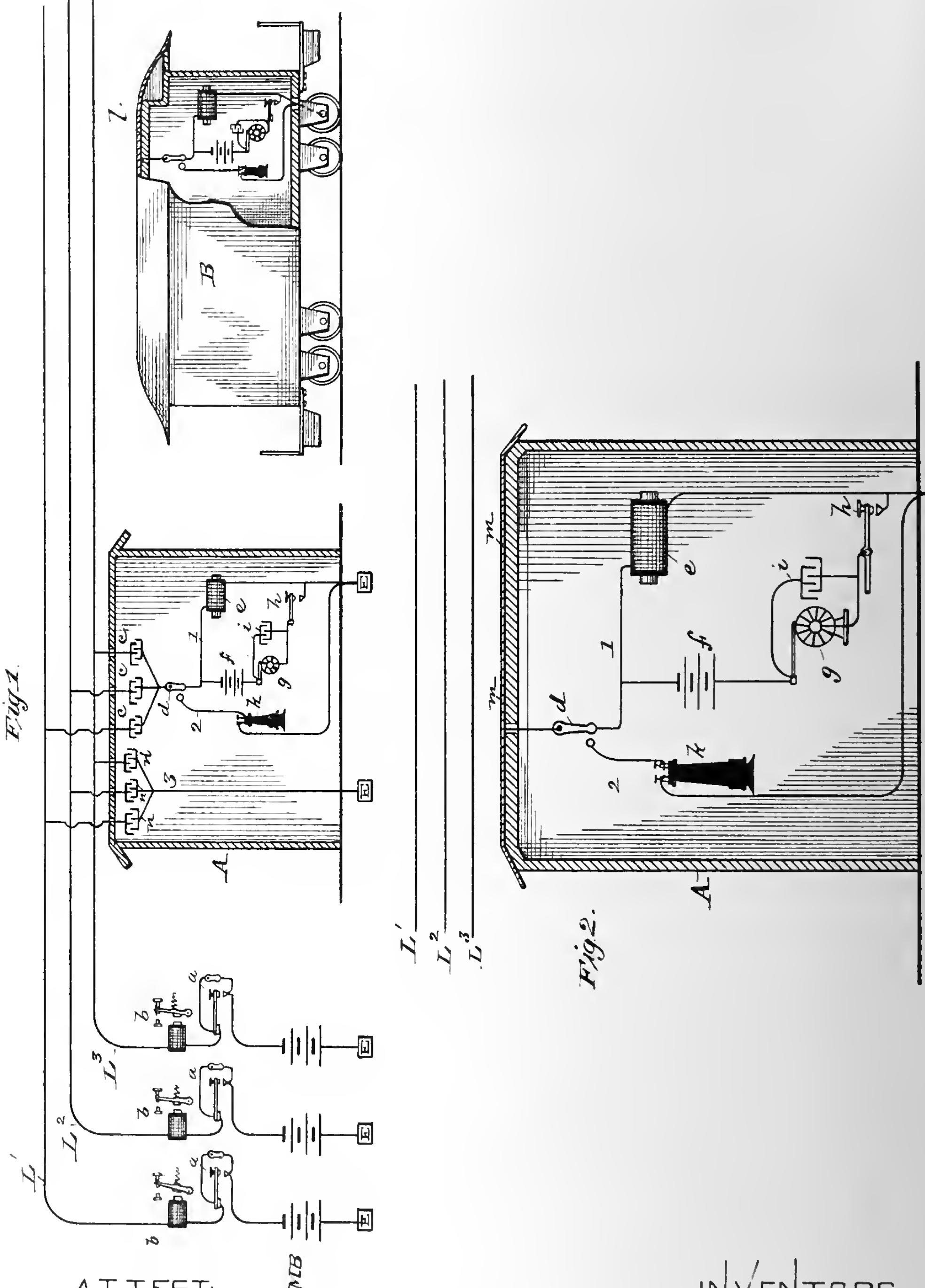
Witnesses as to signature of E. T. Gilliland:
GEO. WILLIS PIERCE.
THOS. D. LOCKWOOD.

(No Model.)

T. A. EDISON & E. T. GILLILAND.

RAILWAY TELEGRAPHY.

No. 350,235. Patented Oct. 5, 1886.



ATTEST:

E. C. Rowland
C. H. Liddle

INVENTORS:

Thomas A. Edison
Ezra T. Gilliland
By Dyer & Seely
Attys

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, AND EZRA T. GILLILAND, OF BOSTON, MASSACHUSETTS.

RAILWAY-TELEGRAPHY.

SPECIFICATION forming part of Letters Patent No. 350,235, dated October 5, 1886.

Application filed January 13, 1886. Serial No. 188,418. (No model.)

To all whom it may concern:

Be it known that we, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, and EZRA T. GILLILAND, of Boston, in the county of Suffolk and State of Massachusetts, have invented a certain new and useful Improvement in Systems of Railway-Signaling, of which the following is a specification.

Our invention relates to systems for signaling with moving railway-trains by induction between the trains and a line-wire—such as described in patent of William Wiley Smith, No. 247,127.

The principal object we have in view is to utilize the ordinary telegraph-wires extending along a railway collectively as the line for the inductive railway signaling apparatus without interfering with the use of such lines for general telegraphing purposes, so as to avoid the expense of constructing a special line for the railway-signals and to take advantage of the large inductive surface afforded by the numerous telegraph-wires, which is a point of great practical importance.

A further object is to provide means for keeping the telegraph-lines constantly closed for the railway-signals without the necessity of shunting the signaling-keys in the terminal or main telegraph-office.

Another feature of invention is an improved combination and arrangement of parts forming more efficient transmitting and receiving apparatus for the railway-signals.

In the accompanying drawings, forming a part hereof, Figure 1 is a view, principally in diagram, of a signaling system embodying our invention; and Fig. 2 is a similar view of a modified station arrangement.

L' L^2 L^3 represent telegraph-wires running along the railway, of which A is a station, and B a moving car forming part of a train. The ordinary telegraph-instruments at the terminal office are alone shown, the wires being through or trunk wires. These instruments are signaling-keys *a* and relays *b*. The usual main battery M B for each line is also shown.

At the railway-station A the several telegraph-wires are connected with separate condensers, *c*, which are connected together on their other sides. A switch, *d*, at one point connects this latter side of the condenser with a wire, 1, running to earth through an electromagnet, *e*. This magnet is shunted by a battery, *f*, a revolving circuit-breaker, *g*, and a signaling-key, *h*, the revolving circuit-breaker *g* being shunted by a condenser, *i*. Circuit-breaker *g*, whose surface is broken at intervals by insulation, is kept revolving by a suitable motor, electrical or mechanical, while signals are being transmitted. By closing key *h* circuit-breaker *g* will cause the rapid charging and discharging of magnet *e*, throwing sharp induction impulses upon wire 1 and through condenser *c* to line-wires. These impulses produce a sound in all the diaphragm sounders or receivers, whether in stations or on trains, which sound is continued as long as key *h* is closed, and ceases when key *h* is opened. The railway-signals formed by these sounds may be composed of Morse signals, or of a code of numerical or other signals. Condenser *i* serves to sharpen the impulses and to absorb the sparks which might otherwise be produced at breaker *g*. A wire, 2, runs from another point of switch *d* to ground, including a diaphragm sounder or receiver, *k*, which may be similar in construction to any ordinary telephone-receiver. Switch *d* is thrown to the right for transmitting, and to the left for receiving, the receiving or transmitting wire being kept open when the other is in use.

Upon the car B, and preferably upon a car of every train upon the road, is similar transmitting and receiving apparatus connected between the insulated metal roof *l* of the car, forming a condensing-surface and an axle thereof, forming a ground connection through the wheels of car and the rails upon which they travel.

Instead of condensers *c* in station, the metallic roof *m* of station, should it have one, may be utilized as condensing-surface, as shown in Fig. 2.

Signaling can be carried on between station and moving train by the apparatus described, the telegraph-wires being used collectively as the signaling-line and being connected inductively both with the train and station. Two trains can also communicate, as will be well understood. The railway-signals being formed of short sharp induction-impulses of high tension, the telegraph-relays are too sluggish to respond to them, while the comparatively-low tension, gradual, and prolonged waves produced by the ordinary Morse signaling-keys do not disturb the diaphragm-sounders when arranged as shown and described.

To keep the telegraph-lines constantly closed for the railway-signals, the ordinary Morse keys at terminal and way offices may be shunted by condensers or high resistances, as described in our application Serial No. 161,438; but we have found that with a number of telegraph-wires one or more lines will always be closed to carry railway-signals, although they may be all in operation for telegraphing, and hence it is not necessary to shunt the telegraph-keys, although it is desirable to do so in order to secure the full benefit of the inductive surface afforded by all the wires collectively. A way of doing this for the keys of the terminal office outside the telegraph-office itself is shown in Fig. 1. A ground-connection, 3, is made from all the wires through condensers n, such connection being located between the connection of railway-station signaling apparatus with the lines and the terminal telegraph-office.

What we claim is—

1. In railway inductive signaling apparatus, the combination, with a number of telegraph-wires and their instruments, of a train having railway signaling, transmitting, and receiving instruments operating to transmit and receive signals produced by induction impulses, and acting inductively upon and from the telegraph-wires collectively, and a station having transmitting and receiving instruments for such induction railway-signals, substantially as set forth.

2. In railway inductive signaling apparatus, the combination, with a number of telegraph-wires and their instruments, of a train having railway signaling, transmitting, and receiving instruments operating to transmit and receive signals produced by induction impulses, and acting inductively upon and from the telegraph-wires collectively, and a station having transmitting and receiving instruments for such induction railway-signals, also acting inductively upon and from the telegraph-wires collectively, substantially as set forth.

3. In railway inductive signaling apparatus, the combination, with the line therefor composed of one or more telegraph-wires having ordinary Morse instruments at a terminal office beyond the railway signaling office, of a ground-connection from such telegraph wire or wires between the terminal telegraph-instruments and the railway-station signaling apparatus, such ground-connection acting to shunt for the railway-signals the breaks formed by the Morse keys at the terminal telegraph-office, substantially as set forth.

4. In railway inductive signaling apparatus, the combination, with the line therefor composed of one or more telegraph-wires having ordinary Morse instruments at a terminal office beyond the railway signaling office, of a condenser, ground-connection from such telegraph wire or wires between the terminal telegraph-instruments and the railway-station signaling apparatus, such ground-connection acting to shunt for the railway-signals the breaks formed by the Morse keys at the terminal telegraph-office, substantially as set forth.

5. In railway inductive signaling apparatus, the combination, for transmitting signals, of a magnet, a shunt around such magnet, including a battery, a revolving circuit breaker and a key, and a condenser shunting such circuit-breaker, substantially as set forth.

This specification signed and witnessed this 28th day of December, 1885.

THOMAS A. EDISON.
EZRA T. GILLILAND.

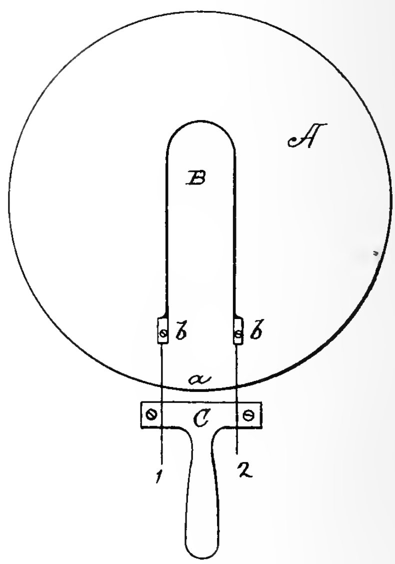
Witnesses:
A. W. KIDDLE,
E. C. ROWLAND.

(No Model.)

T. A. EDISON.

ELECTRIC LAMP.

No. 351,855. Patented Nov. 2, 1886.



Witnesses:

S. W. Mott

J. A. Payne

Inventor:

T. A. Edison.

by Dyer & Wilber

Attorneys.

N. PETERS, Photo-Lithographer, Washington, D. C.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, ASSIGNOR TO THE EDISON ELECTRIC LIGHT COMPANY, OF NEW YORK, N. Y.

ELECTRIC LAMP.

SPECIFICATION forming part of Letters Patent No. 351,855, dated November 2, 1886.

Application filed August 27, 1880. Serial No. 16,061. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a certain new and useful Improvement in Incandescent Electric Lamps, (Case No. 244,) of which the following is a specification.

The object of my invention is to provide a simple and cheap form of incandescent electric lamp. Such lamps have usually been made by me in two glass parts, an outer globe and an inner tube or stem which supports the wires to which the carbon is attached, such wires being sealed in the tube or stem and such tube or stem being sealed in an opening at the lower end of the globe.

In the construction which constitutes the present invention I dispense with the inner stem or wire support, and seal the glass of the inclosing-globe directly upon the wires themselves, such wires being made strong enough to support the carbon without any other support.

The carbon is a loop with its ends brought together, so that the leading-in wires attached thereto will be quite close together and parallel with each other. The carbon may thus be introduced through an opening in one side of the globe, and this single opening can then be closed by the fusion of the glass upon both of the leading-in wires.

My invention is illustrated in the accompanying drawing.

A is the glass inclosing-globe. 1 2 are the parallel leading-in wires, and B is the loop-shaped carbon filament clamped or otherwise secured to said wires at *b b*. The globe is originally formed with an opening at its lower side. To introduce the carbon and wires into this opening I prefer to employ the handle or support C, to which the wires are temporarily attached at the proper distance apart, and the handle being held by the operator the carbon and wires are passed into the globe, after which the opening in the globe is closed around and upon the wires by the application of heat to the glass, whereby the glass is melted and sealed. The globe A is exhausted from the top and sealed off in the usual manner. After the wires are secured in the globe, they are detached from the handle C, and they may be connected with the supplying-circuit in any suitable manner.

What I claim is—

1. In an incandescent electric lamp, the combination of an exhausted glass inclosing-globe and a carbon filament within the same secured to metallic wires, said globe being sealed directly upon said wires, substantially as set forth.

2. In an incandescent electric lamp, the combination of an exhausted glass inclosing-globe and a loop-shaped carbon filament within the same, having its ends secured to parallel metallic wires, said globe being sealed on one side thereof directly upon such wires, substantially as set forth.

3. The method of manufacturing an incandescent electric lamp, consisting in attaching the carbon filament to the leading-in wires, inserting the same in a glass globe and sealing said globe directly upon said wires, substantially as set forth.

This specification signed and witnessed this 11th day of August, 1880.

THOS. A. EDISON.

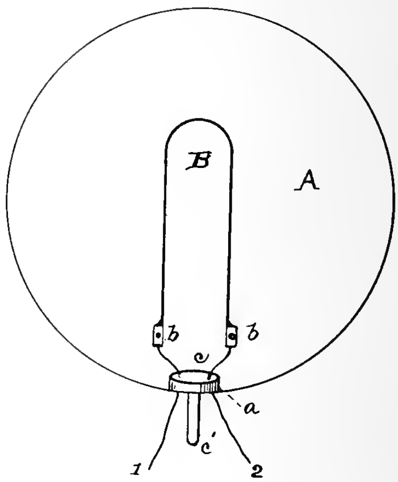
Witnesses:
WM. CARMAN,
OTTO A. MOSES.

(No Model.)

T. A. EDISON.

INCANDESCENT ELECTRIC LAMP.

No. 351,856. Patented Nov. 2, 1886.



ATTEST:
E. C. Rowland.
Wm. Pelzer.

INVENTOR:
Thomas A. Edison,
By Dyer & Seely,
Attys.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY.

INCANDESCENT ELECTRIC LAMP.

SPECIFICATION forming part of Letters Patent No. 351,856, dated November 2, 1886.

Application filed October 5, 1886. Serial No. 215,342. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Incandescent Electric Lamps, (Case No. 679,) of which the following is a specification.

The electric lamp which I generally prefer to use is one in which the carbon filament is inclosed in a hermetically-sealed exhausted glass globe, made in two parts of glass hermetically joined together, the lower part of the globe being fashioned into a neck, so that it may be readily placed in a suitable holder or socket, as more fully described in Letters Patent of the United States No. 230,255, granted to me. In some locations, however, may be desired a simple lamp capable of being suspended or swung, divested of all parts not necessary, in order that it may be cheaply made.

The object of this invention is to furnish such a lamp; and to that end it consists in the features more particularly set forth and claimed.

The accompanying drawing represents such a lamp.

A is the glass inclosing-globe, preferably made round, but with an aperture left at the point *a*.

B is the carbon filament, attached to clamps *b b*, on the terminals of the metallic conductors 1 2.

c is a glass disk, in which are sealed the conductors 1 2. It may or may not be provided with a handle of glass, *c'*.

The wires 1 2 being sealed in the disk and the carbon properly attached, the disk is passed into the globe through the aperture, the edges of which are then hermetically sealed upon the disk. The globe is exhausted and sealed off in the usual manner, or as described in my Patent No. 230,255, before referred to, and the result is an exhausted hermetically-sealed lamp, with the inclosing-chamber made in two glass parts hermetically joined together without the tubular inside stem or part of said patent, and of simpler construction than the lamp described in said patent.

What I claim is—

The incandescent electric lamp having, in combination, a glass inclosing-globe composed of the glass chamber and disk hermetically joined together, the incandescing conductor inclosed within such globe, and the metallic conductors leading to such incandescing conductor and passing through and sealed into the glass disk, substantially as set forth.

This specification signed and witnessed this 30th day of September, 1886.

THOS. A. EDISON.

Witnesses:

RICHD. N. DYER,

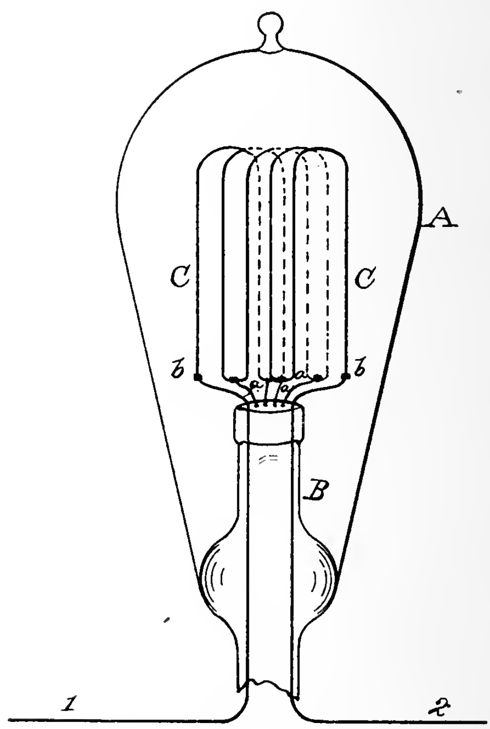
WM. PELZER.

(No Model.)

T. A. EDISON.

INCANDESCENT ELECTRIC LAMP.

No. 353,783. Patented Dec. 7, 1886.



ATTEST:
E. C. Rowland
H. W. Seely

INVENTOR:
Thomas A. Edison,
By Rich^d. N. Dyer,
Att'y.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, ASSIGNOR TO THE EDISON ELECTRIC LIGHT COMPANY, OF NEW YORK, N. Y.

INCANDESCENT ELECTRIC LAMP.

SPECIFICATION forming part of Letters Patent No. 353,783, dated December 7, 1886.

Application filed November 9, 1882. Serial No. 76,384. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Incandescing Electric Lamps, (Case No. 512,) of which the following is a specification.

In the manufacture of incandescing electric lamps it may be sometimes desired to construct a lamp of exceedingly high resistance. A convenient way of doing this is to take a considerable length of very fine fiber—such as flax, ramie, or similar vegetable material—and coil or loop it into a compact shape and then carbonize it, the material forming upon carbonization an exceedingly fine flexible filament of carbon. The coils or loops are of course at some distance apart. In a lamp of this kind it is desirable that intermediate supports should be provided for the coils or loops between the leading-in wires, as otherwise such coils or loops would bend and get out of shape and perhaps touch each other.

My invention therefore consists in providing intermediate supports for the coils or loops of the fine flexible carbon filament made as described.

My invention is preferably carried out by attaching to the lower portion of each coil or loop, preferably by the electro-deposition of copper, a wire the other end of which is sealed in the glass of the inner stem or wire support of the lamp.

My invention is illustrated in the accompanying drawing, wherein A is the inclosing-globe of an incandescing electric lamp, and B the inner stem or wire support.

C C is the incandescing conductor, consisting of a fine filament of flexible carbon bent into a number of loops, as shown; or the filament might be coiled into compact shape, if desired. The radiating surface and resistance of the filament are so proportioned that the entire filament will give the candle-power desired. Each loop has electroplated to it a wire, *a*, the other end of which is sealed in the glass of stem B, whereby all the loops are supported. The ends *b b* of the filament are electroplated or otherwise attached to the leading-in wires 1 2.

Instead of the arrangement shown a number of loops or coils of flexible carbon may be electroplated or otherwise attached together in series, intermediate supports being provided, as before.

What I claim is—

1. The coiled or looped carbon filament of an incandescent electric lamp provided with intermediate supports for the coils or loops, substantially as set forth.

2. In an incandescent electric lamp, the combination, with the coiled or looped carbon filament, of a number of wires attached to the coils or loops and all sealed in the glass stem of the lamp, substantially as set forth.

3. In an incandescing electric lamp, the long and fine flexible carbon filament made in one piece, in combination with leading-in wires connected to the ends of the same, and intermediate supports, substantially as set forth.

This specification signed and witnessed this 3d day of November, 1882.

THOMAS A. EDISON.

Witnesses:

H. W. SEELY,

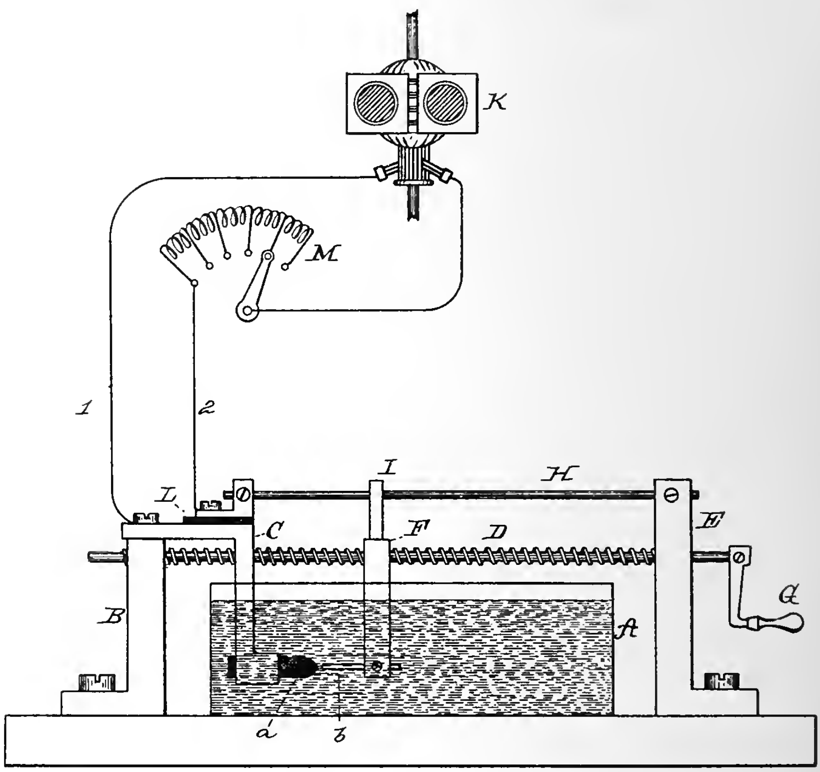
EDWARD H. PYATT.

(No Model.)

T. A. EDISON.

MANUFACTURE OF CARBON CONDUCTORS.

No. 354,310. Patented Dec. 14, 1886.



ATTEST:

E C Rowland,

H W Seely

INVENTOR:

Thomas A. Edison.

By Rich^d N. Dyer,

Atty

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

MANUFACTURE OF CARBON CONDUCTORS.

SPECIFICATION forming part of Letters Patent No. 354,310, dated December 14, 1886.

Application filed April 17, 1883. Serial No. 91,953. (No specimens.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in the Manufacture of Carbon Conductors, (Case No. 556,) of which the following is a specification.

The object of this invention is to produce flexible filaments for incandescing conductors for electric lamps of pure and dense carbon by an artificial process and without the carbonizing of fibrous or other material. By the use of such conductors lamps of high candle-power can be produced. I accomplish this by establishing a voltaic arc between two electrodes immersed in a liquid or gaseous compound of carbon decomposable by heat. One of the electrodes must consist of a piece of carbon, while the other should be a rod or wire of metal, carbon, or any conducting material of small area. Carbon from the liquid or gas will be deposited upon the end of the latter electrode, and said electrode is gradually drawn away as this gradual deposit proceeds, the normal length of the arc being thus maintained.

The negative electrode is preferably of such area that a fine filament is formed. This may be made of any length, and is of such flexibility that it may, if desired, be bent into loops or horseshoe form.

Enlarged ends for clamping may be formed upon this stick by depositing carbon in any suitable manner.

My invention may be carried into effect by the apparatus illustrated in the annexed drawing.

A is a tank or vessel containing a hydrocarbon oil or other liquid carbon compound capable of being decomposed by heat.

A standard, B, supports the arm C, which holds the carbon electrode *a* immersed in the liquid. A screw-threaded rod, D, is supported by the standards B and E, and carries an arm, F, which supports the electrode *b*, which is preferably a small platinum rod, but may be of any metal or conducting material. A handle, G, is provided for turning the screw. A guide-rod, H, extends from one standard to the other, and a guide-fork, I, passes along said rod to keep the electrode in position. The wires 1 2 extend to the electrodes from the poles of a dynamo-electric machine, K; or any other suitable electric generator may be employed.

L is a section of insulating material for preventing a short circuit. An adjustable resistance, M, may be provided for regulating the current supplied to the electrodes.

When the current is set up and the arc established, the heat thereof decomposes the liquid in the vessel, and carbon is deposited upon the electrode *b*.

The screw is turned and the electrode *b* is gradually withdrawn. A thin stick or filament of carbon is thus formed, which, when it has attained the desired length, is broken off from the platinum electrode. Enlarged clamping ends may then be formed upon it in any suitable manner. The carbon thus produced is of a very pure, dense, and homogeneous structure, and is flexible and very suitable for the purpose mentioned.

Instead of the trough containing a hydrocarbon liquid, a vessel may be used through which a decomposable gas is passed, the mechanism for moving the electrode being actuated by a rod passing into the vessel through a stuffing-box.

Instead of the screw motion shown, any suitable automatic mechanism—such as is employed in voltaic-arc lamps—may be employed to maintain a constant arc.

It is evident that by using suitable mechanism for moving the electrode spirals or other shapes of deposited carbon can be formed, and by using electrodes of different areas sticks of different sizes may be produced.

I do not claim herein the product resulting from the process described, this application being limited to the process alone. The product thereof is reserved for a separate application. Neither do I claim herein the above-described apparatus for carrying out my process; but I reserve this also for separate application.

What I claim is—

1. The process of forming incandescing conductors for electric lamps, consisting in decomposing a carbon compound by heat and

causing the carbon set free to deposit in the required form without any axial cone or support.

2. The process of producing carbon sticks or filaments, consisting in establishing a voltaic arc between two electrodes immersed in a liquid or gaseous carbon compound decomposable by heat and maintaining a constant length of the arc, substantially as set forth.

3. The process of producing carbon sticks or filaments, consisting in establishing an arc between a carbon electrode and another electrode immersed in a liquid or gaseous carbon compound decomposable by heat, and gradually removing one electrode away from the other as the stick or filament increases in length by the deposited carbon, substantially as set forth.

This specification signed and witnessed this 6th day of April, 1883.

THOS. A. EDISON.

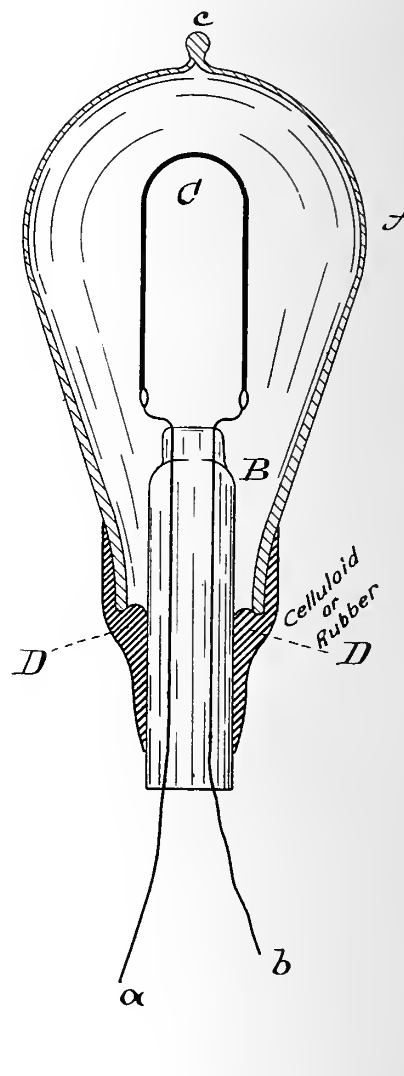
Witnesses:
H. W. SEELEY,
EDWARD H. PYATT.

(No Model.)

T. A. EDISON.

INCANDESCENT ELECTRIC LAMP.

No. 358,599. Patented Mar. 1, 1887.



WITNESSES:

O. D. Mott

J. Ellis Clark

INVENTOR:

T. A. Edison

BY Dyer & Wilber

ATTORNEYS.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, ASSIGNOR TO THE EDISON ELECTRIC LIGHT COMPANY, OF NEW YORK, N. Y.

INCANDESCENT ELECTRIC LAMP.

SPECIFICATION forming part of Letters Patent No. 358,599, dated March 1, 1887.

Application filed November 28, 1881. Serial No. 46,754. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Incandescing Electric Lamps, (Case No. 363;) and I do hereby declare that the following is a full and exact description of the same, reference being had to the accompanying drawing and to the letters of reference marked thereon.

The object I have in view is to produce a simple and efficient means for joining the two glass parts of an incandescing electric lamp, so that when the carbon breaks said parts can be readily separated and used again.

In carrying out my invention I support the bulb or globe and unite the same with the tubular wire-support before the globe is exhausted, by means of a cement or other material or substance which is sufficiently plastic to permit of its being molded or formed upon the parts at the joint or is capable of being made plastic by heat or otherwise, and which hardens or can be hardened when in position, so as to hold the parts firmly together, and which, further, is of such nature that it will adhere to the glass surfaces of the two parts of the lamp and will form an air-tight joint. For this purpose I prefer to use celluloid or rubber, either of which can be applied in a plastic condition and molded over the joint around the bottom of the globe and then hardened, the celluloid being hardened by exposure and the rubber by vulcanization.

The drawing represents in vertical section a lamp constructed in this manner.

A is the glass inclosing bulb or globe.

B is the tubular glass wire and carbon support.

C is the incandescing conductor, (preferably a filament of carbon,) and *a b* are the leading-in wires.

D represents the joint between the globe and wire-support, which is molded or formed of celluloid or rubber applied in a soft or plastic condition, and, if rubber it will, then be vulcanized.

This material is not only applied to form an air-tight joint between the globe and the wire-support, but is made to inclose the bottom edge of the globe, as shown, and forms the only means for uniting the two parts and supporting the globe upon the glass wire-support.

As before stated, other suitable substances or materials could be used instead of celluloid or rubber, such as any resinous cement which will adhere to the surface of the glass parts. After this joint is formed, the globe is exhausted and sealed off at *c*.

What I claim is—

In an incandescent electric lamp, the combination, with the open-mouthed glass globe and the glass wire-support entering centrally the mouth of said globe, of a hardened plastic material applied to the outside both of the wire-support and of the globe, forming an air-tight joint between them, substantially as set forth.

This specification signed and witnessed this 29th day of October, 1881.

THOS. A. EDISON.

Witnesses:

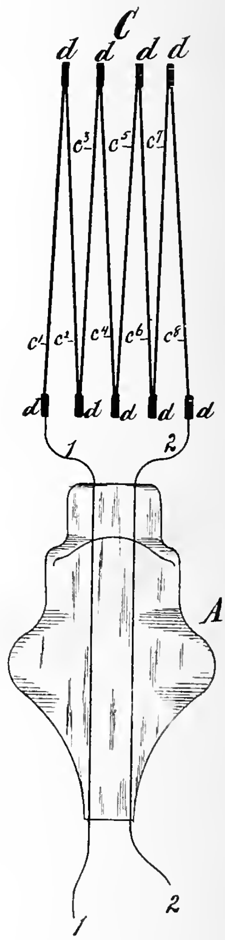
RICHD. N. DYER,
H. W. SEELY.

(No Model.)

T. A. EDISON.

INCANDESCING ELECTRIC LAMP.

No. 358,600. Patented Mar. 1, 1887.



WITNESSES:

Thomas E. Birch.

O. D. Mott

INVENTOR:

T. A. Edison

BY Richd. N. Dyer

ATTORNEY.

United States Patent Office.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, ASSIGNOR TO THE EDISON ELECTRIC LIGHT COMPANY, OF NEW YORK, N. Y.

INCANDESCING ELECTRIC LAMP.

SPECIFICATION forming part of Letters Patent No. 358,600, dated March 1, 1887.

Application filed August 7, 1882. Serial No. 68,610. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Incandescing Electric Lamps, (Case No. 386;) and I do hereby declare that the following is a full and exact description of the same, reference being had to the accompanying drawing, and to the letters of reference marked thereon.

The object I have in view is to produce another way of constructing carbon filaments of high resistance for incandescing electric lamps. This I accomplish by securing together by electroplated joints a number of carbon filaments, the end filaments being electroplated to the leading-in wires of the lamp.

In carrying out my invention I preferably take a natural fiber—such as a wood fiber—and cut into straight pieces or filaments with enlarged ends. These straight filaments are then carbonized without being bent. A number of the straight carbon filaments are then placed parallel with each other, and are secured together, end to end, by mechanical unions—as, for instance, by wrapping with fine wire or with metal foil. These unions are then electroplated, the carbon filaments being kept separated by tissue-paper or other suitable material. After electroplating, the connected carbon filaments are sprung apart, so that they assume a zigzag form, and the end filaments are first mechanically secured to the leading in wires and then electroplated thereto.

The drawing shows the glass wire-support of the incandescing electric lamp, the leading-in wires, and the carbon in elevation.

A represents the glass wire-support, in the upper part of which the leading-in wires 1 2 are sealed.

C is the incandescing carbon conductor of the lamp, composed of straight carbon filaments c' to c^8, inclusive. These filaments have enlarged ends d, which are secured together by electroplated unions, the lower ends of the outer filaments, c' c^8, being electroplated to the leading-in wires.

It is evident that any number of straight carbon filaments (four or more) can be secured together in this way to secure the desired high resistance and form the zigzag carbon.

What I claim is—

1. An incandescing conductor for an electric lamp, composed of two or more carbon filaments joined together by electroplating, substantially as set forth.

2. The combination, in an electric lamp, of two or more carbon filaments joined together by electroplating, and leading-in wires connected with such carbon filaments by electroplated joints, substantially as set forth.

3. The zigzag incandescing conductor for an electric lamp, composed of a number of separate straight carbon filaments joined together at their ends by electroplating, substantially as set forth.

This specification signed and witnessed this 13th day of December, 1881.

THOS. A. EDISON.

Witnesses:
RICHD. N. DYER,
H. W. SEELY.

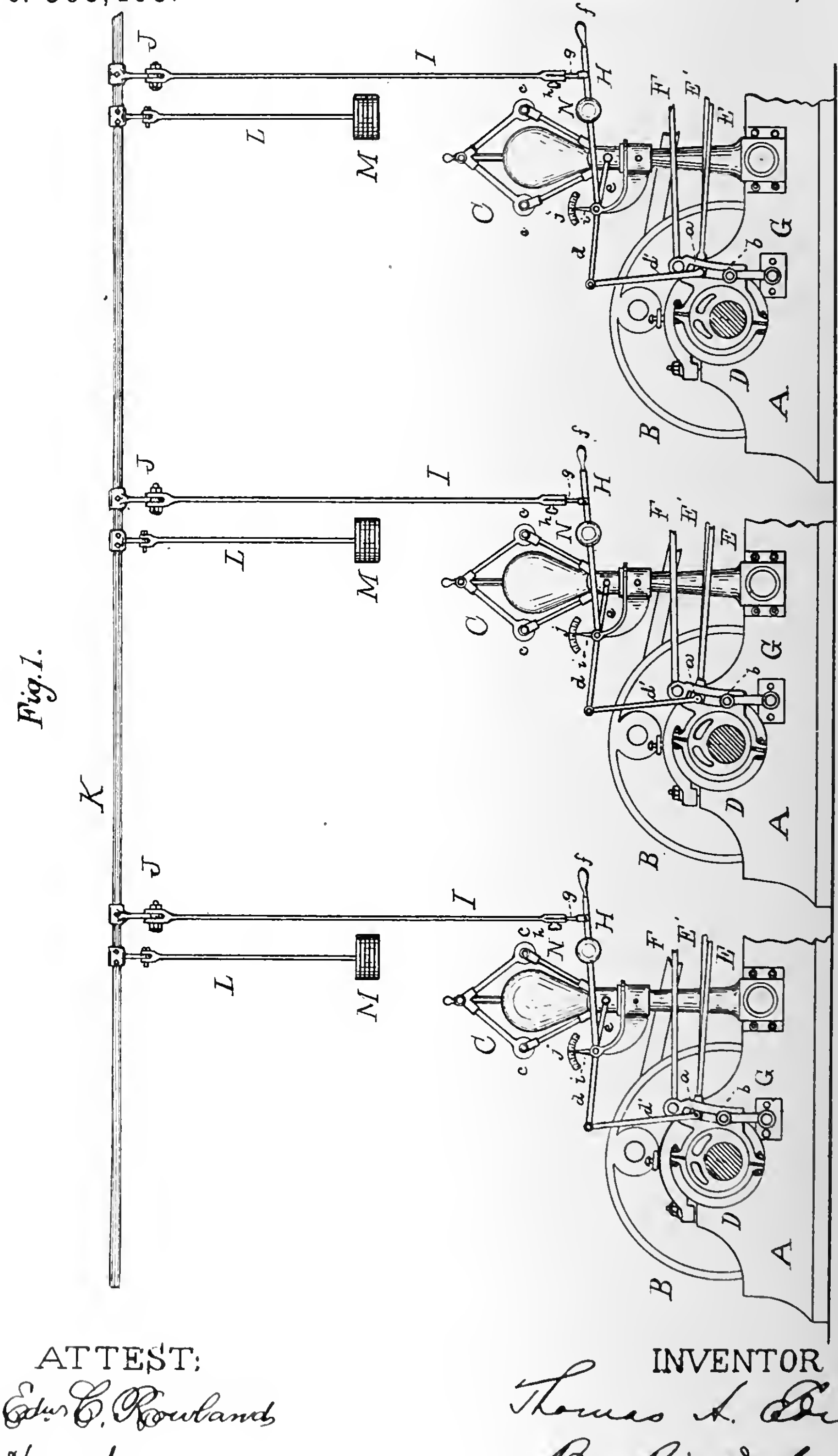
(No Model.) 2 Sheets—Sheet 1.

T. A. EDISON.

VALVE GEAR.

No. 365,465. Patented June 28, 1887.

Fig. 1.



ATTEST:

Edw. C. Rowland

H. W. Seely

INVENTOR

Thomas A. Edison

By Rich^d. N. Dyer

Atty.

N. PETERS, Photo-Lithographer, Washington, D.C.

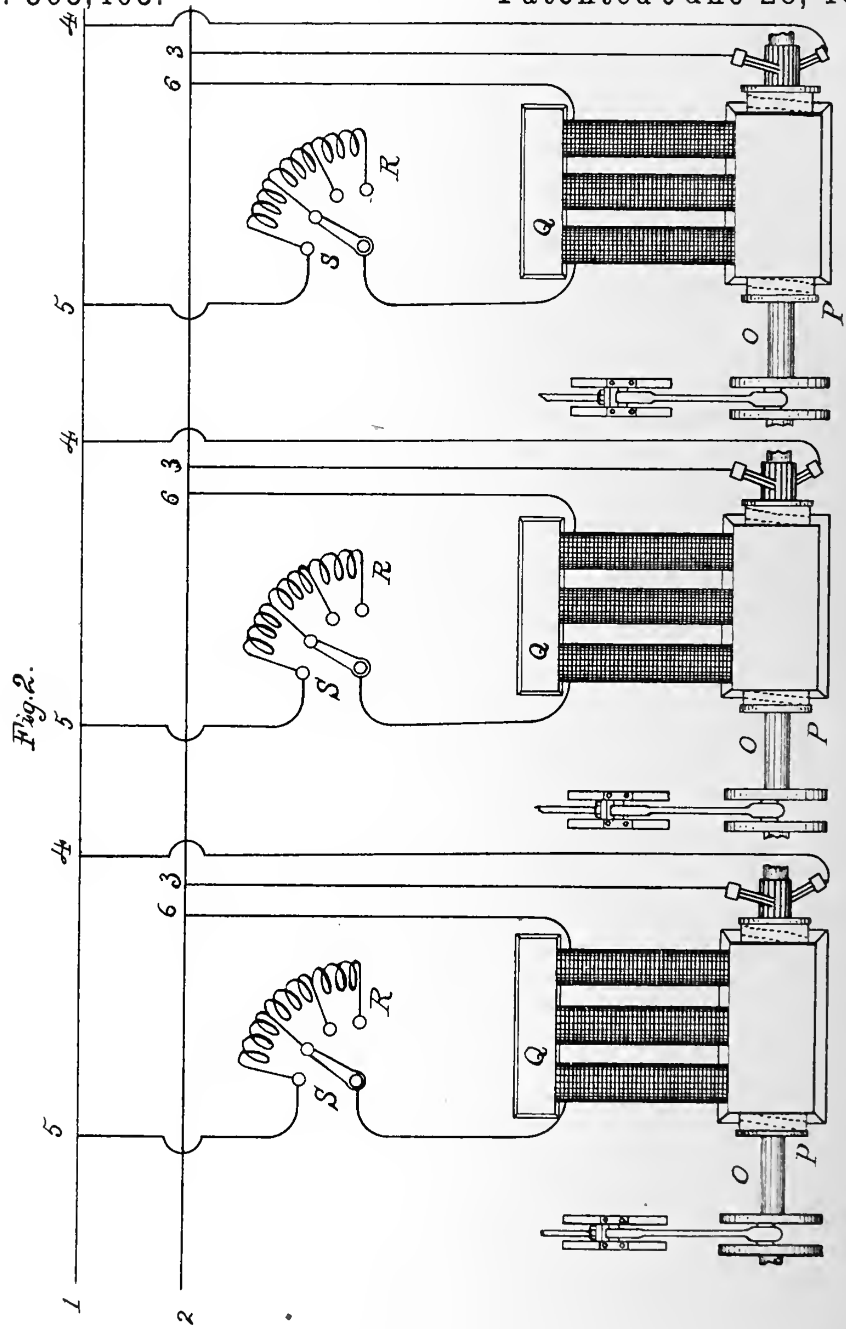
(No Model.)

2 Sheets—Sheet 2.

T. A. EDISON.

VALVE GEAR.

No. 365,465. Patented June 28, 1887.



ATTEST

E. C. Rowland,

W. W. Seely

INVENTOR:

Thomas A. Edison

By Richd. N. Dyer

Atty.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, ASSIGNOR TO THE EDISON ELECTRIC LIGHT COMPANY, OF NEW YORK, N. Y.

VALVE-GEAR.

SPECIFICATION forming part of Letters Patent No. 365,465, dated June 28, 1887.

Application filed October 12, 1882. Serial No. 74,096. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Valve-Gear for Electrical-Generator Engines, (Case No. 488,) of which the following is a specification.

In my system of electrical distribution the dynamo-electric machines which supply current to the translating devices of a district are placed in multiple-arc relation to each other at a central station, each machine being run preferably by a separate steam-engine and the armatures being revolved directly by the engine-shafts, without the interposition of belts or other gearing, when high-speed engines are used; but with slow-speed engines suitable belts or gearing, or both, are used to multiply the speed.

In operating a number of dynamo or magneto electric machines arranged in multiple-arc relation to each other it is necessary that the machines should all produce the same electro-motive force; and in order that they should do this it is necessary that their armatures should all be revolved at the same or practically the same speed. In a multiple-arc arrangement of electrical generators operated by separate steam-engines, the governors of the independent engines having independent movements, or vibrating or jumping to a greater or less extent, the generators must necessarily vary in speed and electro-motive force. This variation in speed and electromotive force results in an action peculiar to the multiple-arc arrangement of the generators, generators having lower speed and electro-motive force being driven as motors by the current from other generators, and this relation being reversed at intervals by the racing of the engines; hence it is generally impossible to operate generators in multiple arc by means of separate independent steam-engines.

The object of this invention is to do away with any difficulty of this kind. I prefer to accomplish this by so connecting the throttle-valve or cut-off mechanisms of all the engines that any variations in the action of such mechanism, produced either by the governor or by hand on one engine, are communicated to all the others, so that if the admission of steam to the chest or cylinder of one engine is varied the same variation is produced in all the other engines of the system. The engines which it is preferred to use are those in which the steam is cut off from the cylinder during a portion of each stroke of the piston, and the time of so cutting off the steam is regulated by a centrifugal or other form of governor; but the invention is equally applicable to engines in which the admission of steam is controlled entirely at the throttle-valve.

In carrying out my invention one or more lines of connected shafting are provided, to which a number of arms are attached, each running to one of the engines and there adjustably and removably connected with the throttle-valve or cut-off mechanism in such manner that a variation in the position of such mechanism on one engine is communicated through said arm to the shaft and thence to the throttle-valve or cut off mechanism of all the other engines connected with said shaft.

The variation of the valve or cut off mechanism may be accomplished solely and automatically by the governors of the engines, or means may be employed at each engine operated by hand for varying the cut-off. Such means may be employed in connection with the governor, or the governor may be used simply as an indicator of speed and the regulation effected solely by hand, a suitable indicating device being employed in connection with the governor, if desired, or the governor may be dispensed with altogether and the regulation accomplished only by hand.

When the speed is regulated by hand, the connecting shafting may be moved directly by a hand-lever, and all the throttle or cut-off mechanisms adjusted simultaneously, or the connection with such shafting at any engine may be moved, moving the shafting and the connection of all the other engines.

Suitable friction devices, with or without counterbalancing-weights or any positive locking device, with or without friction devices or counterbalancing-weights, are used to hold the shafting in any position to which it is moved.

The connection of each engine with the

shafting is made removable, so that any engine can be disconnected therefrom or connected therewith at will. This connection is also made adjustable, in order that each engine can be adjusted to work in unison with the others. Instead of the arrangement described, the regulation may be accomplished automatically by the use of suitable electro-magnetic devices operated by the current generated; but this will form the subject of a separate application.

In the accompanying drawings, Figure 1 is a view in elevation of parts of three engines embodying my invention; and Fig. 2, a plan view and partial diagram representing parts of the engines, the generators driven thereby, and the electrical connections.

A A represent the bed-plates, B B the fly-wheels, and C C the centrifugal governors, of the engines.

D D are the eccentrics which operate the inlet-valves of the cylinder through rods E E', and the exhaust-valves through rods F. (Such valves not being shown.) The rods E E' are connected to the slide-block *a* in the curved slot *b*, and the rod F directly to the eccentric, the eccentric being guided in its movement by the vibrating lever G.

As is well understood, the movement of the governor-balls *c c*, acting through arm *e* and links *d d'*, varies the position of the slide-block *a* in the slot *b*, and thus causes the slide-valves to cut off the steam more or less quickly, according to the rapidity of the revolution of said governor-balls.

As seen in Fig. 2, each engine-shaft O carries the rotating armature P of a dynamo-electric machine having field-magnets Q. These dynamo-electric machines are in multiple-arc relation to each other, each armature P being in a derived circuit, 3 4, from the main circuit 1 2, and the field-magnets Q of each machine being in a derived circuit, 5 6, from said main circuit. Each of the field-circuits 5 6 contains a resistance, R, made adjustable by means of arm S. The object of these adjustable resistances is to regulate the generation of current by the machine for changes in the number of translating devices in circuit in the district supplied by the machines.

To the link *d* of each engine is pivoted a lever, H, terminating in a handle, *f*. From such lever extends upwardly a rod, I. The upper end of rod I is attached to arm J, which extends downwardly and outwardly from the shaft K. It will be seen that the position of the slide-block *a* of an engine is changed by moving the lever H, while at the same time such movement of the lever H produces, through rod I and arm J, a turning of the shaft K, which moves all the other arms J, rods I, and levers H, thus changing the positions of the slide-blocks *a* of all the engines.

From the shaft K extend the arms L downwardly and in an outward direction opposite to that of the arms J. Each arm L carries a weight, M, and such weights assist in the turning of the shaft when an arm J is raised. A weight, N, is placed on each of the levers H to assist in bringing the lever down, and the weights M and N act together to assist in holding the shaft K in any position in which it may be placed; but, as stated, frictional or other suitable devices may be used for so holding the shaft.

A removable and adjustable connection is made, as stated, between each lever H and its rod I. A small rod, *g*, attached to arm H, fits in the end of rod I, and is clamped therein by screw *h*, so that by loosening said screw the connection between the arm H and rod I is severed, and the engine may either remain disconnected or the lever H may be adjusted and the connection again made, whereby each engine is made independently adjustable. This could of course be accomplished in many other ways.

A pointer, *i*, attached to the arm *e*, indicates on a scale, *j*, the extent to which the governor-balls are thrown out, and the lever H is moved in accordance with these indications.

A convenient mode of adjusting all the engines to the same speed is to fix, when all the engines are disconnected from the shafting, by marking the rod I, or by setting a suitable gage or indicator attached to said rod, the point to which the lever H is to be adjusted. When the first engine is connected and adjusted to this point and its cut-off also adjusted to the proper point, the shaft is turned to the proper position, and in connecting the other engines it is necessary only to adjust their rods *g* to the same points on the rods I, when it will be seen that all the cut-offs will be placed similarly to the first one, and all the engines will run at practically the same speed.

In the form of my invention shown in the drawings it will be seen that the cut-off mechanism is operated both by the movement of the governor and by that of the lever H; but it is evident that the arm *e* need not be connected with the link *d*, but only with the pointer *i*, so that the regulation will be accomplished only by the arm H; or the governor might be dispensed with altogether, and a speed-indicator provided elsewhere on the engine; or the governor could be used without the indicator and the speed of the engine noted merely by the eye.

It is also evident that the lever H could be used to alter the position of a throttle-valve, either in connection with a governor or without such governor, all the levers being connected with the shaft K, as before described; or my invention can be employed with any of the cut-off or valve mechanisms now in use.

While, as stated, my invention is especially intended to be applied to multiple-arc arrangements of electrical generators, yet it is equally applicable when such generators are placed in series, all feeding into the same main conductors, for here the same difficulty exists; as, should one machine give a higher electro-motive force than another the latter will be converted into a motor, and the same irregularities will occur as in the multiple-arc arrangement.

I may, if desired, place the armatures of several machines on the shaft of each engine, or by belts or other gearing connect several machines with each engine, all the machines feeding into the same main conductors, and the engines being regulated as just set forth.

It is evident that my invention is applicable to motors other than steam-engines—such as water-wheels, gas-engines, compressed-air engines, &c.—where two or more such motors are used, each operating one or more electrical generators, and all such generators feeding into the same main conductors.

What I claim is—

1. The combination, with two or more engines having centrifugal governors, of connections between such governors causing them to act in unison, substantially as set forth.

2. The combination, with two or more steam-engines, each operating one or more dynamo or magneto electric machines, all of such machines being connected with the same conductors or system of conductors, of a line or lines of connected shafting, and connections from said shafting to the throttle-valve or cut-off mechanism of each engine, whereby variations in such mechanism in one engine are transmitted to the corresponding mechanism of both or all the other engines, substantially as set forth.

3. The combination, with the throttle-valve or cut-off mechanisms of two or more engines and the line or lines of connected shafting, of removable and adjustable connections between them, substantially as set forth.

4. The combination of the valve or cut-off mechanisms of two or more engines, the line or lines of connected shafting, connections between such mechanisms and such shafting, and means for holding such shafting in any position to which it is moved, substantially as set forth.

5. The combination of two or more steam-engines, one or more dynamo or magneto electric machines driven by each of said engines, all such machines being connected in multiple arc, and means for regulating the speed of both or all said engines simultaneously, substantially as set forth.

This specification signed and witnessed this 5th day of October, 1882.

THOS. A. EDISON.

Witnesses:

H. W. SEELY,
E. H. PYATT.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, ASSIGNOR TO THE EDISON ELECTRIC LIGHT COMPANY, OF NEW YORK, N. Y.

FILAMENT FOR INCANDESCENT ELECTRIC LAMPS.

SPECIFICATION forming part of Letters Patent No. 365,509, dated June 28, 1887.

Application filed August 7, 1882. Serial No. 68,654. (No specimens.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Incandescing Conductors for Electric Lamps, (Case No. 440;) and I do hereby declare that the following is a full and exact description of the same.

The object I have in view is to produce a method and material for forming flexible carbon filaments for use as the incandescing conductors of electric lamps which will be suitable for many purposes. This I accomplish by carbonizing an oxidized drying-oil.

The drying-oil is formed into a tough flexible sheet or membrane by drying or baking. The filaments are punched or cut from this sheet and then carbonized by heat under strain and pressure; or the sheet may be first carbonized and the filaments punched or cut from it after carbonization. Instead of first forming the drying-oil into sheets it may be molded directly into filaments, or run out into a long filament and cut into proper lengths before carbonization.

Any drying-oil may be used—such as linseed, cotton-seed, poppy-seed, or nut oil.

To form the drying-oil into sheets, thin polished metallic plates may be coated with it in the form of a liquid as free as possible from gritty and other foreign substances. The plates are then dried or baked until the coating forms a tough flexible sheet or membrane. The metallic plates are then eaten away by an acid, leaving the sheets of oxidized drying-oil free and intact. The filaments are punched or cut from the sheets and are carbonized by heat under strain and pressure; or the sheets may be first carbonized and the filaments punched from them after carbonization.

Plates of other material than metal which is capable of being dissolved by a substance not attacking the oxidized drying-oil may be used to receive the drying-oil. Glass or mica plates could be used for the purpose and be dissolved by hydrofluoric acid, or plates of gelatine may be used and be dissolved by water.

The drying-oil in a solid or semi solid state may be forced out through dies under heat and pressure, or pressure alone, in the form of a long filament or a thin sheet, which is dried or baked.

The long filament may be cut into proper lengths and provided with enlarged ends before carbonization, while the filaments of proper shape and size may be punched or cut from the sheet before or after carbonization.

Carbon filaments formed of carbonized oxidized drying-oil are suitable for use as the incandescing conductors of electric lamps, and are flexible and have a high resistance.

What I claim is—

1. A flexible carbon filament for the incandescing conductor of an electric lamp, formed of carbonized oxidized drying-oil, substantially as set forth.

2. The method of forming flexible carbon filaments for the incandescing conductors of electric lamps, consisting in drying or baking drying-oil and carbonizing the same by heat, the material being reduced to the desired size and shape before or after carbonization, substantially as set forth.

This specification signed and witnessed this 3d day of June, 1882.

THOS. A. EDISON.

Witnesses:

RICHD. N. DYER,

EDWARD H. PYATT.

(No Model.)

2 Sheets—Sheet 1.

T. A. EDISON.

SYSTEM OF ELECTRICAL DISTRIBUTION.

No. 365,978. Patented July 5, 1887.

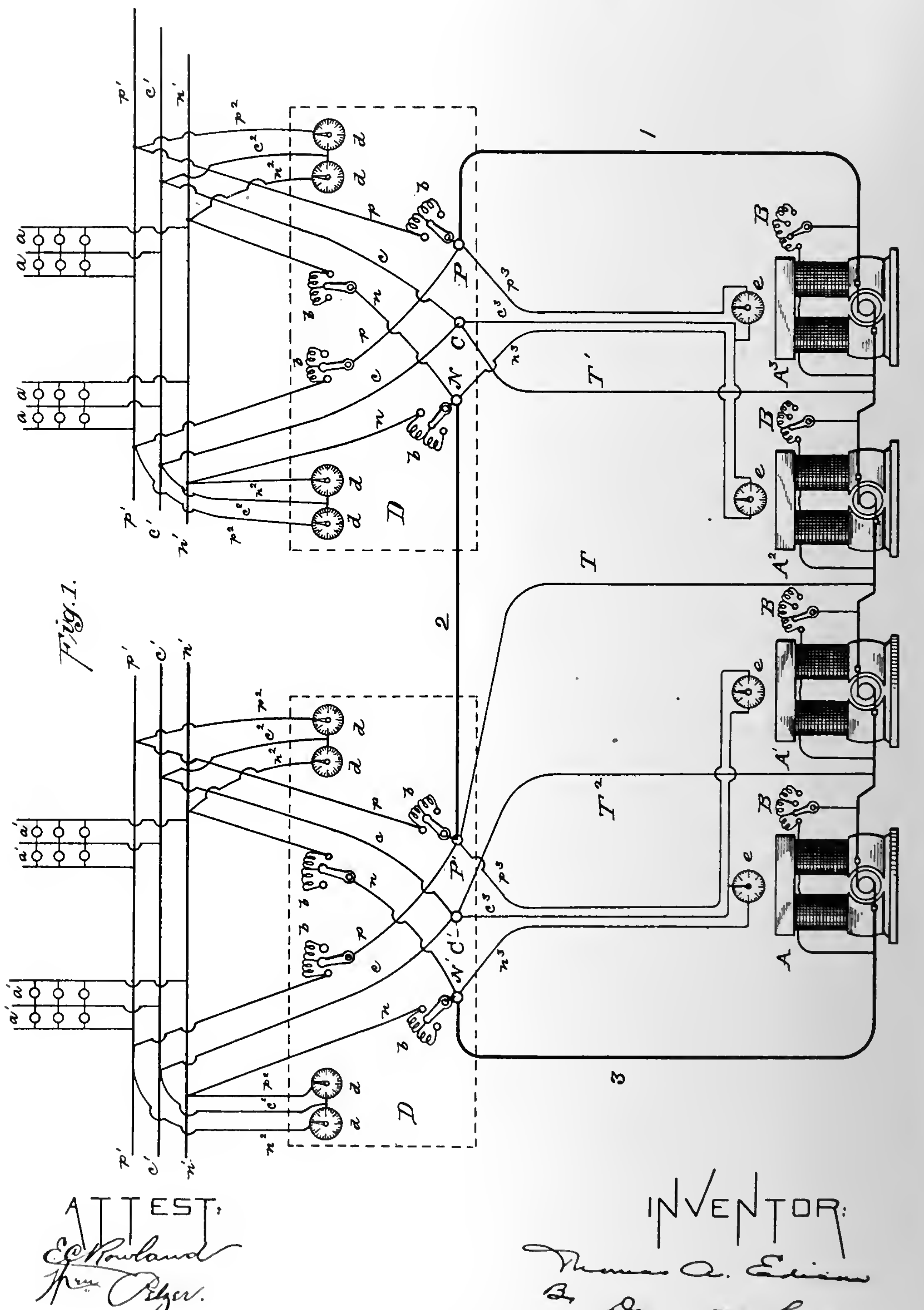


Fig. 1.

ATTEST:
E. C. Rowland
Wm. Pelzer.

INVENTOR:
Thomas A. Edison
By Dyer & Seely
Attys.

(No Model.) 2 Sheets—Sheet 2.

T. A. EDISON.

SYSTEM OF ELECTRICAL DISTRIBUTION.

No. 365,978. Patented July 5, 1887.

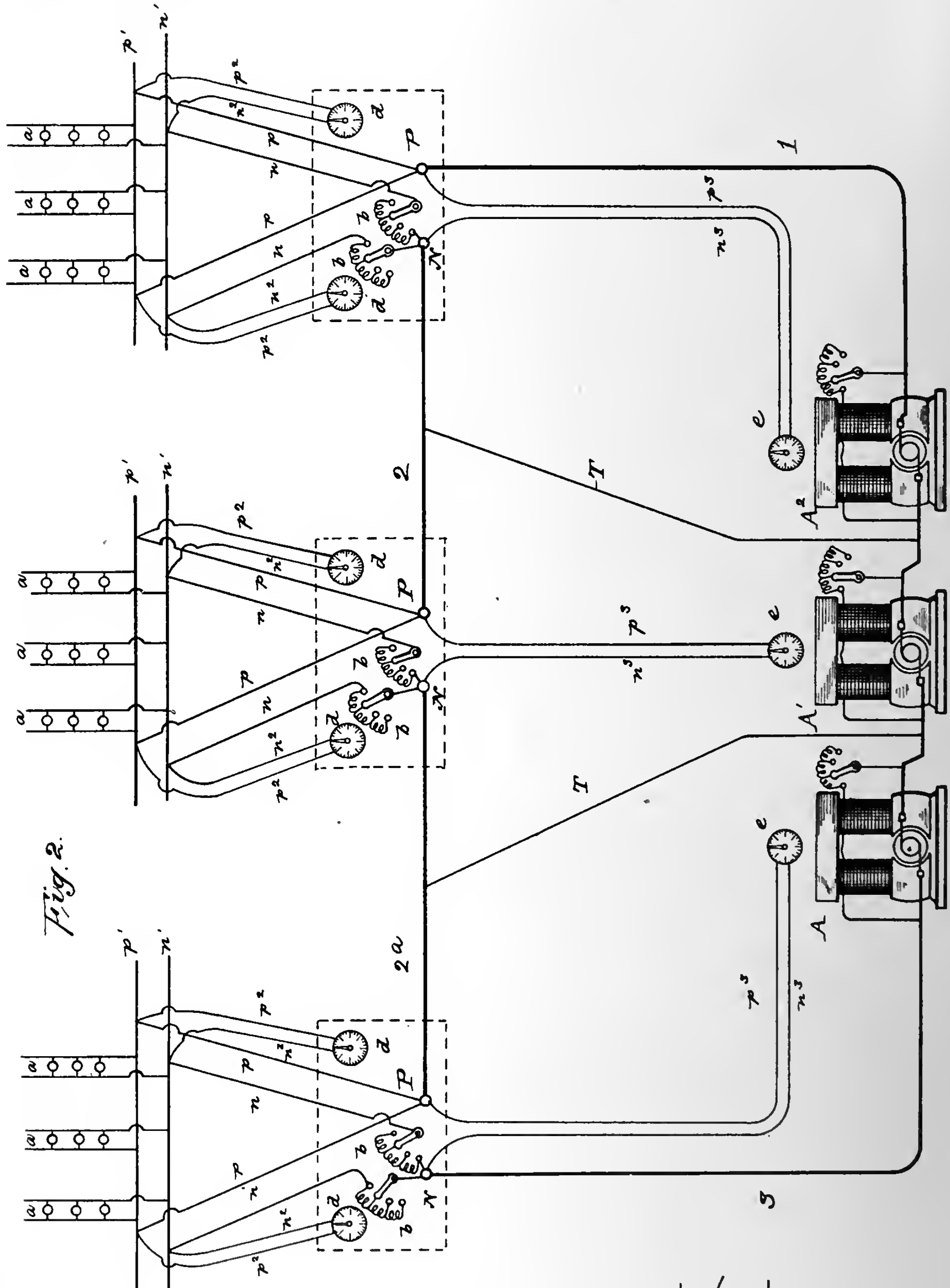


Fig. 2.

ATTEST:

E. C. Rowland

Wm. Pelzer.

INVENTOR:

Thomas A. Edison

By Dyer & Seely

Attys

N. PETERS, Photo-Lithographer, Washington, D. C.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY.

SYSTEM OF ELECTRICAL DISTRIBUTION.

SPECIFICATION forming part of Letters Patent No. 365,978, dated July 5, 1887.

Application filed November 29, 1886. Serial No. 220,125. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Systems of Electrical Distribution, (Case No. 700,) of which the following is a specification.

The object of my invention is to produce a system for the distribution of electricity for lighting and similar purposes, in which currents of high tension may be used, and consequent economy in the metal required for conductors will be attained, which system shall be of a simple and efficient character and readily and conveniently regulable. In accomplishing this object I provide a divided source of electricity of high tension, consisting of two or more dynamo-electric machines connected in series placed at a suitable building at a place where power may be procured conveniently and economically. A circuit extends from this source of power to two or more sub-stations, at each of which a feeding circuit or circuits are taken off, which extend to a district to be supplied with current. All these sub-stations are in series, and from the main circuit-conductor between the stations compensating conductors extend, which are connected with the points of division of the source of supply. At each sub-station suitable indicating and regulating devices are provided, whereby the electrical condition of the circuits extending therefrom is indicated and regulated, and from each sub-station a circuit extends to the main station or source of supply, with which circuits are connected indicating devices, in accordance with whose indications the generators are regulated according to the requirements of the district supplied from each sub-station. I prefer to connect the districts from the sub-stations on the three-wire or compensating system, but I may arrange them as two-wire systems.

My invention is illustrated in the accompanying drawings, in which—

Figure 1 is a diagram of the preferred form, in which the districts are arranged on the three-wire system; and Fig. 2 a diagram of the modified form with each district arranged as a two-wire system.

The invention is particularly applicable to cases where there is a very large area to be lighted or supplied with current from a single source.

Referring, first, more especially to Fig. 1, A, A′, A^2, and A^3 are dynamo-electric machines, all connected in series and situated at a suitable point where the necessary power to operate them can be conveniently and cheaply procured, and which may be for that purpose situated, if necessary, at a considerable distance from the places to be supplied, since the current generated by the series of machines has a high tension and can therefore be economically conveyed by conductors of small mass. Each generator is separately regulable, preferably by means of the adjustable resistances B B, placed in the shunted field-circuit of each machine.

From the terminals of the series of machines a circuit, 1 2 3, extends. D and D′ represent sub-stations to which this circuit extends. The dotted rectangles indicate suitable rooms or places into which the conductors are run, and in which the connections are made and the indicating and regulating devices are placed. In the station D the conductor 1 is brought to a suitable terminal point, P, and from a similar terminal point, N, the conductor 2 extends to the next sub-station. There is also a third terminal point, C. From the sub-station extend two feeding-circuits, *p n c*. There are provided any desired number of such feeding-circuits, according to the extent of and number of translating devices in the district supplied. The conductors *p* extend from terminal P, conductors *n* from terminal N, and conductors *c* from terminal C; and these conductors are all connected, respectively, with positive, negative, and compensating lighting or translation circuit-conductors *p′ n′ c′*, with which the electric lamps or other translating devices *a a* are connected in multiple series, as is now common in the three-wire system of electrical distribution. Each of the feeding-conductors *p n* is provided with an adjustable resistance, *b*, whereby the two sides of the sub-system are regulated to keep the same constant pressure at all points on the lighting-circuits, thereby regulating for unequal distribution or changes in the number of translating devices in circuit in the different parts of the district. This regulation is effected in accordance with the showing of indicators d d, connected across the conductors of three-wire indicating-circuits p^2 n^2 c^2, one of which extends back from the terminals of each feeding-circuit into the sub-station, and which continually show the pressure at the points where the feeders are connected. The sub-station D′ is similarly arranged and equipped, the conductor 2 being carried to the terminal point P′ and the conductor 3 from the main source to the terminal N′, and the feeders extending from terminals P′, N′, and C′, and supplying translating devices a' a', and being provided with indicating and regulating apparatus precisely as explained with reference to the other station. It will be seen that the conductor 2 connects the two districts supplied from the two sub-stations in series with each other and with the generators at the main station. From any point on the conductor 2 between the sub-stations a conductor, T, extends to the middle point of the series of generators, whereby a divided source of electricity is produced, at whose point of division the compensating conductor T is connected. I have shown the conductor T as extending from the terminal point P′ in sub-station D′. The effect is evidently the same as though it were connected anywhere along the line 2 between the sub-stations. It will be usually more convenient to make the connection in the sub-station, as shown.

From the terminal point C in station D a conductor, T′, extends, which is connected between the generators A^2 and A^3—that is, at the middle point of one of the divisions of the source—and from C′ in station D′ a similar conductor, T^2, extends and is connected between generators A and A′, the two divisions of the source being thus themselves divided, or, in other words, the source being thus subdivided into four subdivisions. Thus the two districts form a compensating or three-wire system having a divided source and a compensating conductor, while each district is itself a three-wire system having a divided source and a compensating conductor. The translating devices of the two districts are in multiple series with each other—that is, any two devices a a in series in district D are in series with two translating devices a' a' in district D′. There are therefore four translating devices in series, and hence high-tension currents and small conductors are employed. At the same time all the translating devices are independent. In each sub-system, when the number of devices on the two sides becomes unequal, current flows in one direction or the other on conductors c and T′ or T^2 to maintain the balance, and if the number of devices in one sub-system differs from that in the other the balance is similarly preserved by the compensating conductor T. As stated, the adjustable resistances at the sub-stations are employed to keep a constant pressure at all the feeder terminals, thus regulating for unequal distribution or changes in the number of translating devices in circuit in different parts of the district. Indicating circuits also extend from the sub-stations to the main station, each of which consists of three conductors, p^3 n^3 c^3, including suitable indicators, e e, by means of which the condition of each side of each sub-system is continually shown, and in accordance with which the generators are regulated together or separately to regulate the whole current supplied to the entire system, or that supplied to each sub-system, or that supplied to each side of each sub-system. It is evident that there may be any desired number of sub-stations and districts supplied therefrom, the number of generators at the station being correspondingly increased, so that there will be one or more generators for each side of each sub-system, and conductors being run from between the sub-stations to the points of division, and from the middle terminals of the sub-stations to the points of subdivision of the source. The generators comprising the high-tension source are not necessarily all placed in the same building or at the same place; but they may be placed at two or more different points, they being, however, always connected in series by conductors extending between the different points.

In the above-described system economy is attained not only in conductors, but in other ways also. In the matter of renting or purchasing property for stations, for instance, for the main station may be placed at a distance from the thickly-settled areas to be illuminated, at a point where rents are low or property cheap, while for each of the sub-stations only a small room is necessary, which can be cheaply obtained, it being necessary only to have room enough for the indicators and adjustable resistances. A single attendant is kept at each sub-station, whose only duty is to observe the indicators and adjust the resistances accordingly.

In the modified arrangement shown in Fig. 2 each sub district is arranged as an ordinary two-wire multiple-arc system, although the general system is a compensating system. Three sub-stations, D^2, D^3, and D^4, are shown supplied with high-tension current from a series of three generators, (or three connected sets of generators,) A, A′, and A^2. Conductors 2 and 2^a connect the sub-stations in series. At each sub-station the circuit is broken, as before described, at terminal points P N, and from these terminals the conductors p n of any desired number of feeding-circuits extend to lighting or translating circuits p' n', with which the translating devices a a are connected in multiple arc. The translating devices of the three districts are in series with each other through the conductors 2 and 2^a, there being, as shown, three translating devices in series, or as many as there are sub-stations. Each feeding-circuit p n is provided with an adjustable resistance, b, for regulating the current conducted by it, and indicating-circuits p^2 n^2, including indicators d, extend to the sub-stations, as before. Indicating-circuits p^3 n^3 extend from the sub-stations to the main station and are connected with indicators e, by whose indications the generators are regulated to affect the entire current supplied to each sub-district or that supplied to the entire system. The conductors T extend back from between sub-stations to the points of division of the source to balance the districts, as already explained.

What I claim is—

1. In a system of electrical distribution, the combination of a main station or source of supply, a main circuit extending therefrom, sub-stations at which the main circuit is broken, two or more feeding-circuits extending from the main-circuit terminals at each sub-station, and a system of connected translation-circuits for each sub station, to which both or all the feeding-circuits from that sub-station are connected at different points, substantially as set forth.

2. In a system of electrical distribution, the combination of a main station or source of supply, a main circuit extending therefrom, sub-stations, circuits extending from the main circuit at such sub-stations, translating devices supplied with current by such sub-station circuits, indicating-circuits extending from the main circuit at such sub-stations to indicating devices at the main station, and means at the main station for regulating the main circuit, substantially as set forth.

3. In a system of electrical distribution, the combination of a main station or source of supply, a main circuit extending therefrom, sub-stations at which said main circuit is broken, feeding-circuits extending from the main-circuit terminals at the sub-stations to translation-circuits, through which the main-circuit connections are completed, means for regulating the pressure on each feeding-circuit, and means at the main station or source of supply for regulating the main circuit, substantially as set forth.

4. In a system of electrical distribution, the combination of a main station or source of supply, a main circuit extending therefrom, sub-stations at which said main circuit is broken, feeding-circuits extending from the main-circuit terminals at each sub-station to translation-circuits, through which the main-circuit connections are completed, indicating-circuits extending from the outer terminals of each feeder to its sub-station, indicating devices connected therewith, means for regulating the pressure at each of said feeding-circuits, indicating-circuits extending from the main circuit at the sub-stations to the main station or source of supply, indicating devices connected therewith, and means at the main station for regulating the main circuit, substantially as set forth.

5. In a system of electrical distribution, the combination of a divided source of electricity, a main circuit extending from one terminal to the other of said source, sub-stations at which said main circuit is broken, circuits extending from the main-circuit terminals at said sub-stations, translating devices supplied by said circuits, through which the main circuit is completed, and conductors extending from the main circuit between the sub stations to the points of division of the source of supply, substantially as set forth.

6. In a system of electrical distribution, the combination of a divided source of electricity, a main circuit extending therefrom, sub-stations at which said main circuit is broken, circuits extending from the main-circuit terminals at said sub-stations, translating devices supplied by said circuits, through which the main circuit is completed, conductors extending from the main circuit between the sub-stations to the points of division of the source of supply, and means for separately regulating each division of the source of supply, substantially as set forth.

7. In a system of electrical distribution, the combination of two or more electrical generators connected in series, a main-circuit extending from the terminals of the series, sub-stations at which said main circuit is broken, circuits extending from the main-circuit terminals at said sub-stations, translating devices supplied by said circuits, through which the main circuit is completed, conductors extending from the main circuit between the sub-stations to between the generators, and means for regulating each of said generators, substantially as set forth.

8. In a system of electrical distribution, the combination of a divided source of electricity, a main circuit extending therefrom, sub stations at which the main circuit is broken, feeding-circuits extending from the main-circuit terminals at the sub stations, translation-circuits connected with said feeding-circuits, through which the main circuit is completed, indicating and regulating devices at the sub-stations for said feeding-circuits, conductors extending from the main circuit between the sub-stations to the points of division of the source of supply, and indicating and regulating devices at the main station for each division of the source of supply, substantially as set forth.

9. In a system of electrical distribution, the combination of a main station or source of supply, a main circuit extending therefrom, sub-stations at which the main circuit is broken and connected to suitable terminals, an additional terminal at each sub-station, a circuit composed of positive, negative, and compensating conductors extending, respectively, from the main-circuit terminals and said additional terminal at each sub-station, translating devices in multiple series supplied from said circuits, through which the main circuit is completed, and a conductor extending from each of said additional terminals to a point of

division of the source of supply, substantially as set forth.

10. In a system of electrical distribution, the combination of a source of supply, a main circuit extending therefrom, sub-stations at which said main circuit is broken and connected to suitable terminals, an additional terminal at each sub-station, a circuit composed of positive, negative, and compensating conductors extending, respectively, from said main-circuit terminals and said additional terminal at each sub-station, translating devices in multiple series supplied from said circuits, through which the main circuit is completed, conductors extending from between the sub-stations to points of division of the source of supply, and a conductor extending from each of said additional terminals to a point of subdivision of the source, substantially as set forth.

11. In a system of electrical distribution, the combination of a source of supply, a main circuit extending therefrom, sub-stations at which said main circuit is broken and connected to suitable terminals, an additional terminal at each sub-station, a circuit composed of positive, negative, and compensating conductors extending, respectively, from said main-circuit terminals and said additional terminal at each sub-station, translating devices in multiple series supplied from said circuits, through which the main circuit is completed, conductors extending from between the sub-stations to points of division of the source of supply, and a conductor extending from each of said additional terminals to a point of subdivision of the source, each subdivision of the source being independently regulable, substantially as set forth.

This specification signed and witnessed this 22d day of November, 1886.

THOS. A. EDISON.

Witnesses:

WM. PELZER,

E. C. ROWLAND.

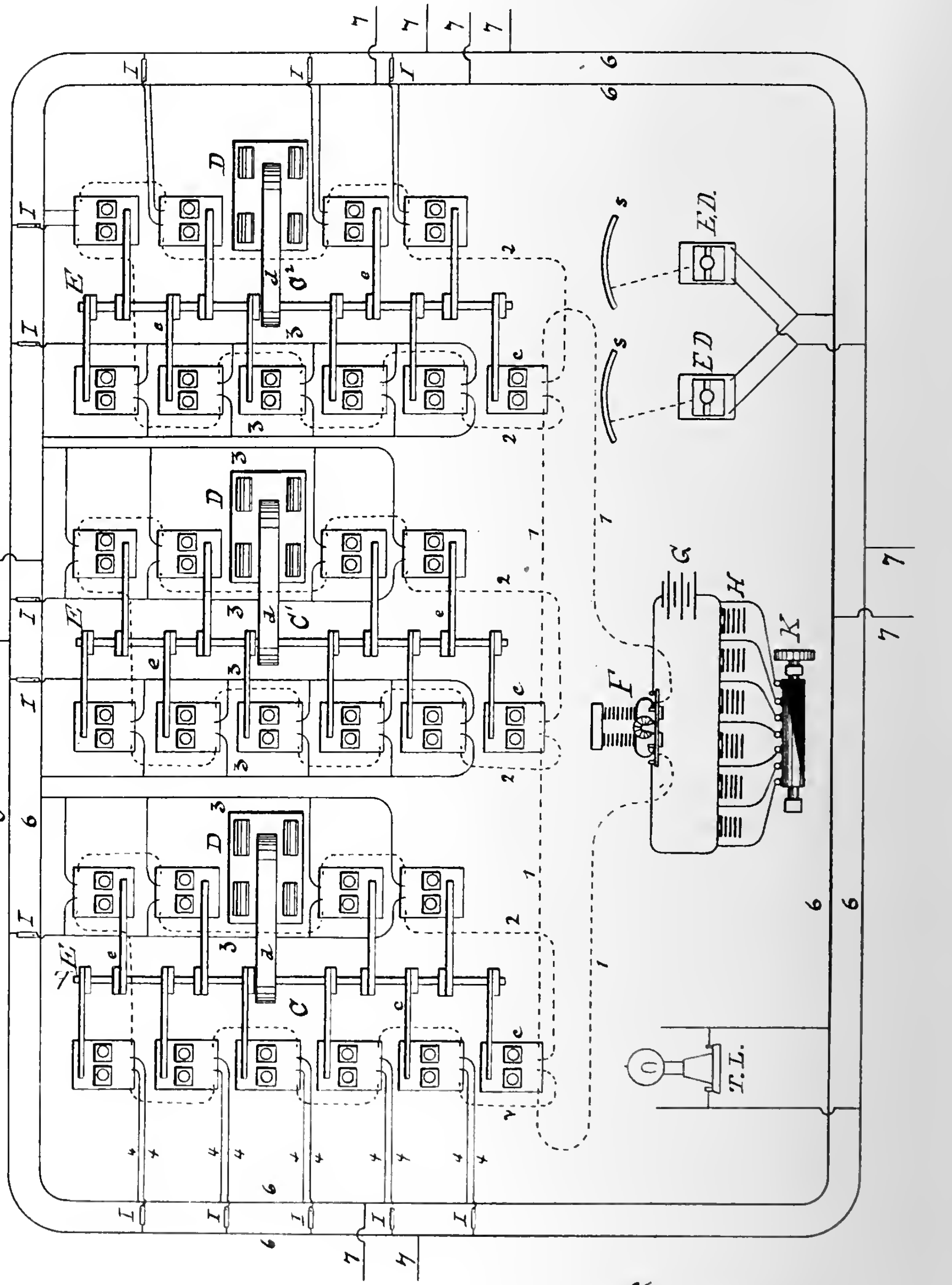
4 Sheets—Sheet 1.

T. A. EDISON.

SYSTEM OF ELECTRICAL DISTRIBUTION.

No. 369,280. Patented Aug. 30, 1887.

Fig. 1.



Attest:

Sam. D. Mott
Jas. A. Payne.

Inventor:

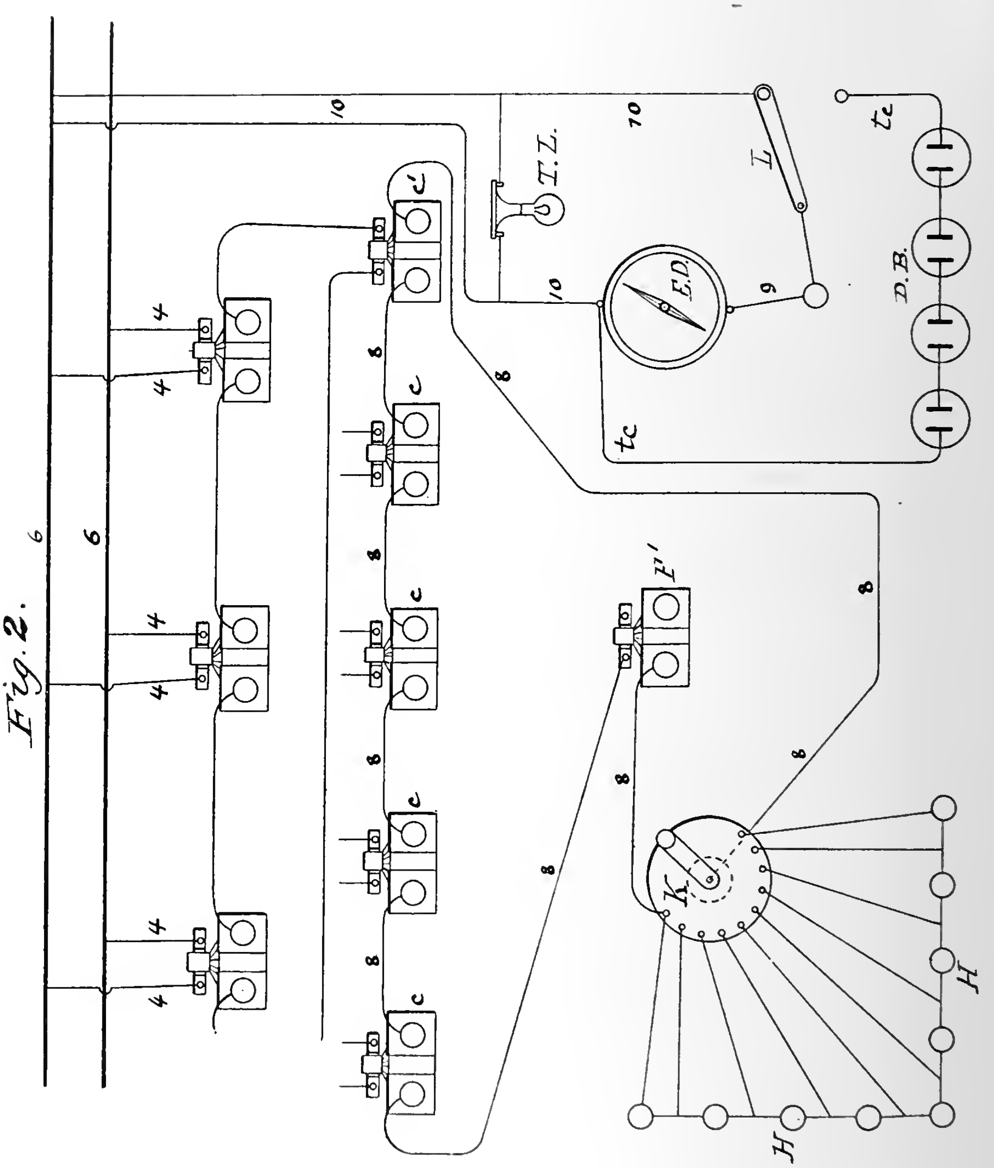
T. A. Edison
per Dyer & Wilber
his Atty's

T. A. EDISON.

SYSTEM OF ELECTRICAL DISTRIBUTION.

No. 369,280. Patented Aug. 30, 1887.

Fig. 2.



Attest:
Sam D. Mott.
Jas. A. Payne

Inventor:
T. A. Edison, per
Dyer & Wilber
his Atty's

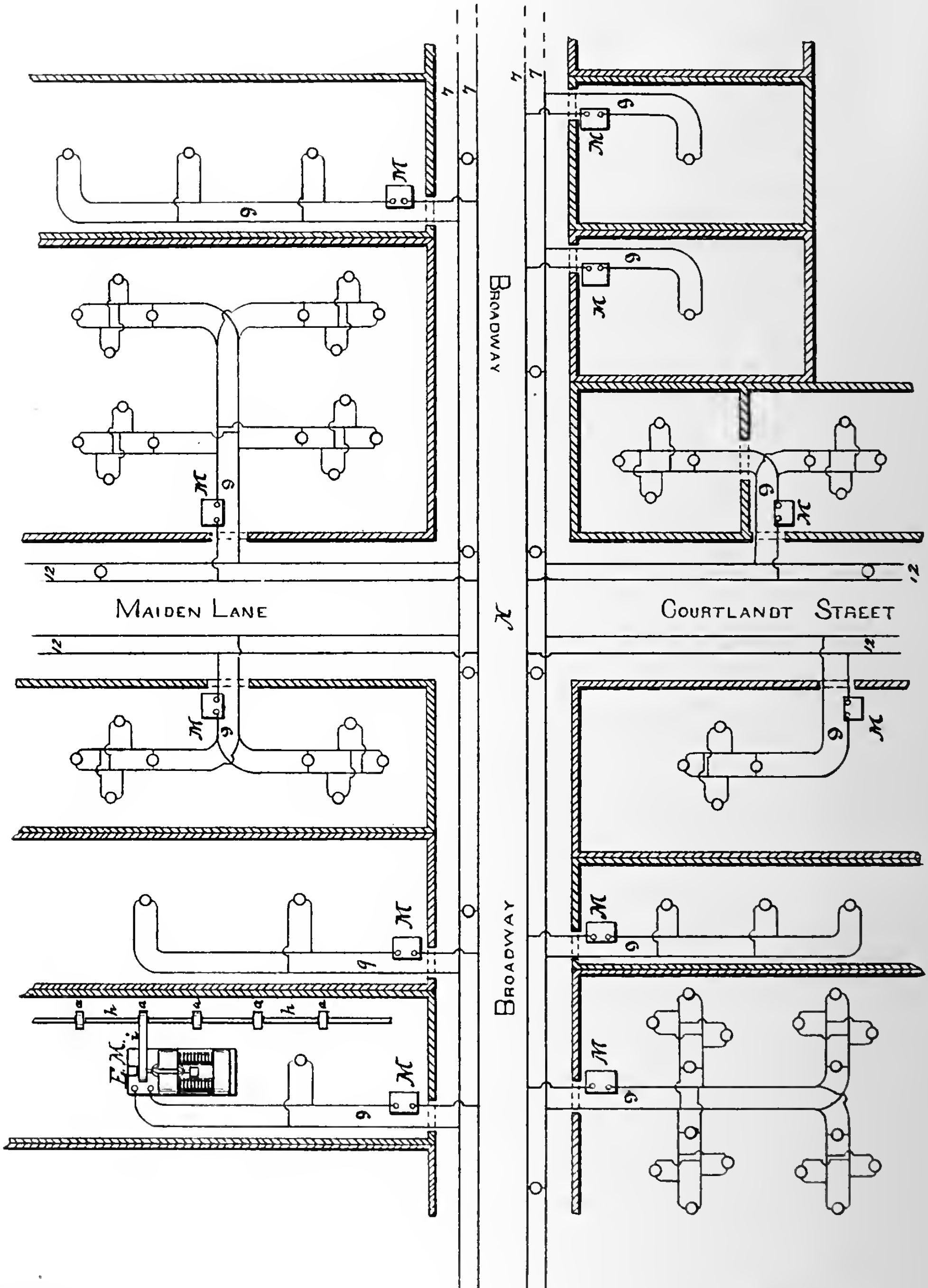
4 Sheets—Sheet 3.

T. A. EDISON.

SYSTEM OF ELECTRICAL DISTRIBUTION.

No. 369,280. Patented Aug. 30, 1887.

Fig. 3.



Witnesses:

Saml. D. Mott.

Jas. A. Payne.

Inventor:

T. A. Edison

per

Dyer & Wilber

Attorneys

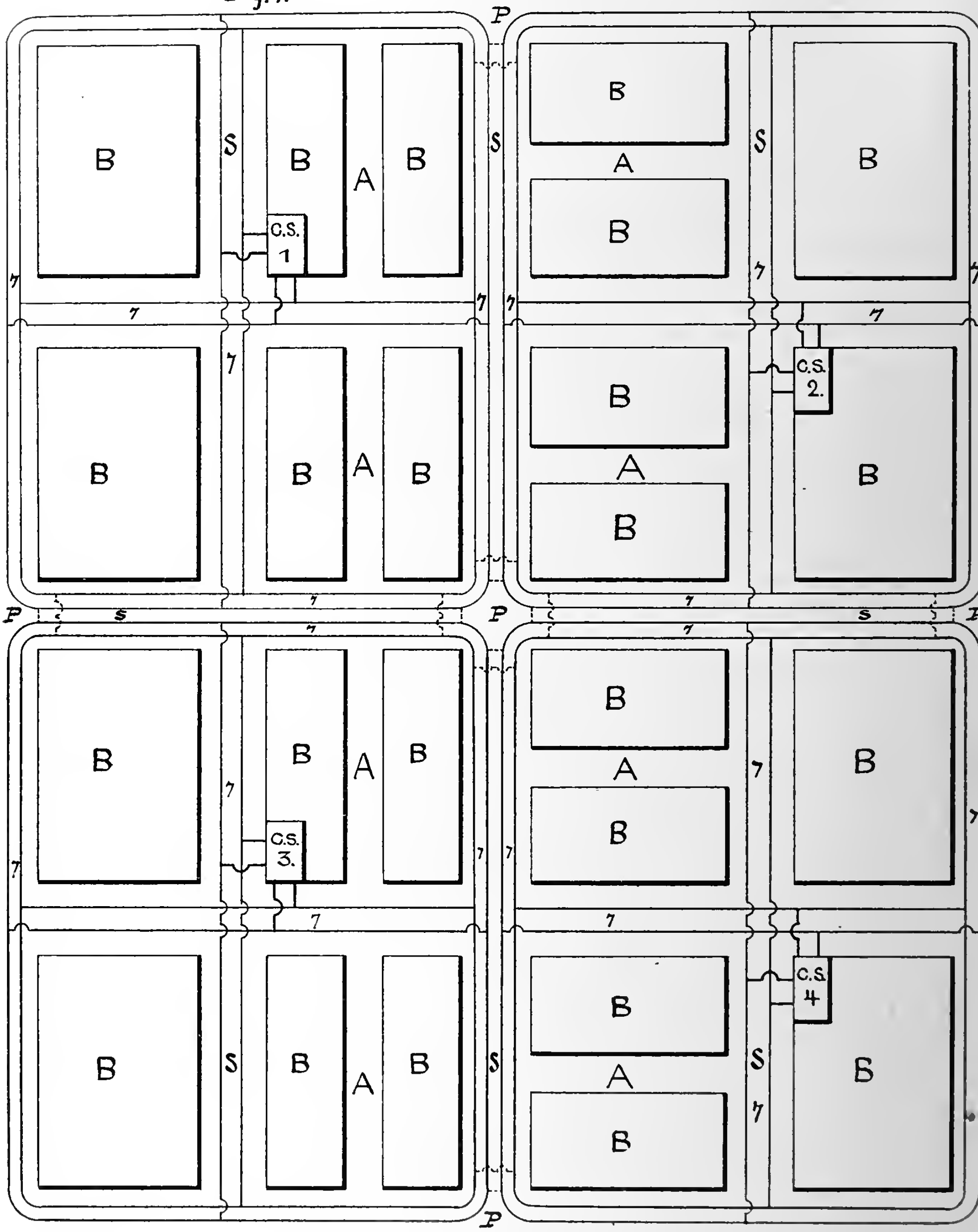
4 Sheets—Sheet 4.

T. A. EDISON.

SYSTEM OF ELECTRICAL DISTRIBUTION.

No. 369,280. Patented Aug. 30, 1887.

Fig. 4.



Attest:

Saml. D. Mott
Jas. A. Payne

Inventor:

T. A. Edison per
Dyer & Wilber
Attys

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE EDISON ELECTRIC LIGHT COMPANY, OF NEW YORK, N. Y.

SYSTEM OF ELECTRICAL DISTRIBUTION.

SPECIFICATION forming part of Letters Patent No. 369,280, dated August 30, 1887.

Application filed February 5, 1880. Serial No. 2,282. Patented in England February 11, 1880, No. 602; in Italy May 10, 1880, No. 11,809; in Belgium May 15, 1880, No. 51,329; in France July 5, 1880, No. 136,399; in Canada July 21, 1880, No. 11,527, and in Austria-Hungary October 5, 1880, No. 30/1837.

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the State of New Jersey, United States of America, have made certain new and useful Improvements in Furnishing Light and Power from Electricity, of which the following is a specification.

The object of this invention is to arrange a system for the generation, supply, and consumption, for either light or power, or both, of electricity, that all the operations connected therewith requiring special care, attention, or knowledge of the art shall be performed for many consumers at central stations, leaving the consumers only the work of turning off or on the supply, as may be desired—in other words, to so contrive means and methods that electricity may be supplied for consumption in a manner analogous to the systems for the supply of gas and water without requiring any greater care or technical knowledge on the part of the consumer than does the use of gas or water, in order that economy, reliability, and safety may be insured.

In carrying the invention into effect, a city, town, village, or locality may form one district, or, if the extent of territory makes it desirable, may be divided into several districts. In each district I provide a central station, at which are grouped a suitable prime motor or several motors, dependent upon the amount to be supplied, generators or means for converting the prime motive force into electricity, and means for determining and regulating the amount of electricity generated and supplied, in order that a constant pressure of electricity (so to speak) may be kept up. The prime motors are any suitable engines, steam or water, and one or a series of two or more is provided, as may be necessary, each of which is provided with its own system of shafting and belting, driving a number of magneto-electric machines, the number actuated by one prime motor being hereinafter termed a "battery."

It is to be noted, as is also shown in previous applications for patents made by me, that I make my field-of-force magnets exceedingly long and of an extremely large mass of metal in proportion to the mass of metal in the revolving armature carrying the generating-coils. The effect of this is to give to the generators field-magnets of great strength, so that currents of the desired high electromotive force can be generated in armatures of low resistance, and the waste of energy in the form of heat in such armatures will be reduced to the minimum. I desire to avoid also the use of generators having the coils of their field-magnets in series with their generating-coils, since this, besides being a defective arrangement with respect to regulation, also increases the internal resistance of the machines, and results in an objectionable waste of energy; hence I prefer to keep the coils of the field-of-force magnets and the generating-coils separate, and that one machine in each battery (which machine may be termed the "battery field-of-force generator") be used to supply the requisite energy to the field-of-force magnets of the other machines in such battery, (which may be termed the "supply-generators.") The coils of the field-of-force magnets are connected as a series or in a multiple arc in one circuit, while the generating-coils of the supply-generators of each battery are all connected in a multiple arc to the main conductors. This arrangement, it is seen, gives great economy, as the per cent. of the entire current generated in each battery absorbed in keeping up the magnetic maximum in the field-of-force magnets when it is furnished by one special machine of the battery, the number given it to feed being properly calculated, being less than when a portion of the current generated in each machine is absorbed in its own field-of-force magnets.

Where a single battery of machines is used, it is preferable, in view of what has been hereinbefore stated, that the current for the coils of the field-of-force magnets of the field-of-force generator of the battery be supplied by a small galvanic battery; but if more than one battery of machines be used the field-of-force generators of all the batteries are fed from one or more prime field-of-force generators connected in a multiple arc or in a series, the field-of-force magnets of the prime field-of-force generator or generators used being kept magnetically saturated by a weak galvanic-battery current, as before set forth. For instance, a weak galvanic current supplies the field-current necessary for one prime field-of-force generator, which in turn feeds the field-of-force magnets of the field-of-force generators of the batteries of twenty or thirty machines, the ultimate effect in the generation of current depending upon (as one important factor) the tension of the galvanic current sent through the field-of-force coils of the prime field-of-force generator. This prime field-of-force generator may, however, be a dynamo-electric machine instead of a magneto-machine, its field of force being kept up by the current generated in the machine instead of by a galvanic current.

At the central station all the supply-generating coils or batteries thereof are connected to conductors on the multiple-arc system, and from these conductors at the station main conductors (which for convenience may be called simply the "mains") connected thereto, also on the multiple-arc system, lead in any and all desired directions for conveying the energy to the points where work, either by translation into light or motive power, is to be done. All of such conductors from the generators at the station to the lamps are made in pairs—one for the outgoing current and the other for the returning current of electricity, the circuits throughout the system being complete or round metallic circuits, the conductors of which are well insulated from each other and from the earth. The use of the earth for one-half of the circuit would largely increase the difficulties arising from the grounding of the conductors or the crossing of the conductors among themselves or with the conductors of other circuits to such an extent that a system so constructed would be impracticable.

In order to give a better understanding of the method of regulating what, for convenience, may be called the "pressure" of the current through the entire system, I will here state that all the devices for translation of electricity into work are arranged on the multiple-arc system, each device being in its own derived circuit, the effect being, in substance, to give each a circuit from the generating source independent of the circuit of all the other devices. As a resultant, it follows that the greater the number of translating devices brought into circuit the less the total resistance of the circuit. For instance, I prefer that my lamps should each be of about one hundred ohms resistance. Then, if one lamp only be in circuit, there is a resistance of one hundred ohms. If another lamp be put in circuit, two circuits, each of one hundred ohms, are provided for the current, making the net total resistance to the current fifty ohms, although the resistance in each derived circuit remains unchanged. This effect is ordinarily opposite to the effect produced by the addition of lamps when they are connected in an ordinary straight circuit, each one then adding to the resistance of the circuit.

The bringing into operation successively of numbers of the devices, and thereby making more paths or circuits for the currents, does not appreciably lessen the pressure or diminish the effect upon the devices in use, the active forces at the central station—viz., prime field-of-force generators and motive power—remaining unchanged until the net resistance of the devices in circuit exterior to the battery of machines is so diminished as to approach in a degree the resistance of the battery and main conductors, it being remembered that as the machines of a battery are connected in multiple arc the net internal resistance of a battery is as many times less than one machine as there are machines in the battery.

To avoid any appreciable variations and insure uniformity, it is essential that any lessening of pressure be immediately indicated, in order that just sufficient energy be generated and sent out to keep up an equal flow through the circuit of each translating device—that is, that the pressure be kept up uniform, whether more or less translating devices be in circuit. This is attained by providing at the central station means for constantly indicating the pressure and for regulating the production if appreciable variation be indicated. At each central station test-lights are arranged, so that an approximate visual test of the effect of pressure upon the circuit of any translating devices in use may be shown. From what has been said, it is evident that as more or less translating devices are brought into circuit the total resistance of the circuit, or all the circuits thereof, to the flow of all the current generated varies. To indicate this electro-dynamometers, galvanometers, or electrometers are placed across the main conductor at the central station, or by return-wire at any point in the circuit, with a zero-mark placed to correspond with the deflection consequent upon the maintenance of the proper amount of pressure. It may be advisable (and I have so done) to place at the central station a series of standard Daniell batteries, connected by a switch-circuit to the galvanometers or electro-dynamometers, in order that they may be frequently tested for any inaccuracy occurring from any cause whatever. By these means any error whatever therein is readily detected.

To correct variations in the pressure various means may be employed. Each supply-generator may be connected into the circuit through a switch, and each series may be likewise so connected, so that the current of one or more of a series, or one or more entire series, may be cut out or thrown into the circuit, or each machine may be arranged so as to be disconnected from the prime motor; or, when needed, the prime motor of an entire series may be disconnected. The plan I prefer, however, is to arrange in connection with the circuit of the battery feeding the field-of-force magnets of the prime field-of-force generator before referred to a series of resistances, so that the energy of the battery-current may be varied, this variation causing in turn a variation in the current induced in the prime field-of-force generator and in all the generators directly or indirectly controlled thereby. Where a dynamo-machine is used these resistances are to be used in the same manner in connection with the circuit, including the coils around the field-magnets. For distributing the current thus generated and regulated at the central stations I prefer to use conductors within insulated pipes or tubing, made water-tight and buried beneath the earth, provision being made at suitable intervals for house or side connections, as shown in a prior application of mine. While this plan is preferable for many reasons, it is evident that conductors may be carried in the air or over house-tops.

While only one pair of conductors may be laid on each street, I prefer, especially where streets are wide, to lay a pair of conductors along each side of the street, near the curb. At proper intervals street-lamps may be connected thereto by derived circuits. From main conductors on principal streets subsidiary main conductors are laid through side streets. From the street conductors, wherever desired, derived circuits are led into houses, one of the conductors passing through a suitable meter, preferably one which measures the amount of electricity passing through, as shown in a prior application of mine for a patent.

In the house each translating device is placed in a derived circuit, the entire system of means for generation, conduction, and translation being one great multiple-arc system with complete or round metallic circuits. The translating devices in each house may be either for light or power, or both. For light, the electric lamp consisting of an incandescing material hermetically sealed in glass (shown in other applications filed by me) is preferred. This lamp is made of a high resistance in comparison with that of any electric lamps which, to my knowledge, have been proposed.

In lights heretofore proposed the endeavor seems to have been to lessen the resistance of the carbon, none having been suggested of higher resistance than, say, ten ohms; but I have discovered that a very much higher resistance—say one hundred ohms—must be used, in order that a number may be economically and successfully used in a system.

The motors used should be so constructed that each, with a constant flow or pressure of current, will give the exact power required. This requires that each motor should be wound with finer or coarser wire and into more or less convolutions, which determine the maximum effect of the motor. In addition, as the motors may be run with variable loads or amounts of work to perform, and as irregularity of speed would be a consequent thereof, it would be preferable to provide each motor with a governor which an excessive speed would operate to break the circuit of the motor or to otherwise control it. A preferable form of governor therefore will form the subject-matter of an application for a patent to be filed by me.

A system arranged as thus described provides for all the conditions precedent to an economical and reliable utilization of electricity as a lighting or motive-power agent.

As within certain ascertainable limits, the greater the horse-power of an engine the less the proportionate cost per horse-power. By consolidating at one station the prime motive force necessary to the generation of a supply for many consumers a great economy as to production occurs.

As ordinarily proposed, each electric light requires its own regulator, which usually is either thermostatic or magnetic, breaking the circuit or bringing in resistance—in any case making a cumbrous lamp, requiring delicate management and constant attention. By regulating at the central station entirely, I am enabled to use a small separate lamp, which may be used with the exercise of no more than ordinary care or attention. The distribution is so provided for that tampering therewith is guarded against and that connections from the mains to localities of translation are readily made.

The means for measuring insure accurateness in furnishing a basis for equitable charges for the amount used by any particular consumer.

In the drawings accompanying and forming part of this specification an arrangement of means is shown for carrying my invention into effect, although it is to be particularly noted that the invention is not dependent upon the specific means and their arrangement noted and shown, but that they may be varied without departing from the spirit of my invention. The drawings illustrate, however, what I now consider the more preferable means and arrangements.

In these drawings, Figure 1 is a plan view of a central station. Fig. 2 is a modification of Fig. 1. Fig. 3 is a plan view illustrating the street-mains and house-connections with translating devices properly introduced. Fig. 4 is a plan showing a locality divided into four districts.

In Fig. 1 three batteries of generation, C C' C^2, are shown, which number may be increased or diminished, as circumstances may demand. One generator, *c*, of each battery is used to generate the current feeding the field-of-force magnets of the other machines in its battery, the circuit from such field-generator through the field-of-force coils in each battery being shown by the broken lines 2 2 2. For actuating the rotating parts an engine, D, is used with each battery, connected by belt *d* to line of shafting E, from which belts c pass to the generator. The coils of each battery in which currents are generated are connected, as in C′ and C^2, in multiple arc to conductors 3 3 3 3, which in turn are connected in multiple arc to the main conductors 6 6, from which lead in multiple arc the street conductors or mains 7 7, or, as shown in part of battery C, each machine may be directly connected in multiple arc to the station-conductors 6 6. F is the prime field-of-force generator, supplying the battery field-of-force generators $c\ c\ c$, its circuit being shown in broken lines 1 1. The field-of-force magnets of F are magnetized by a current from the galvanic battery G, in whose circuit is arranged the series of conductors H, provided with the cut-out K, by which more or less of the resistances are put in or out of the circuit feeding the field of F. This arrangement forms a very effective and simple method of regulating the production of current or the pressure at the central station, for the current generated by F being dependent upon the intensity of the magnetization of its field-of-force magnets, which in turn depends upon the current transmitted around the magnets by the battery G, as the resistance varies such current, it follows that by varying the resistance in the circuit of G the current generated by F varies, which in turn varies the current generated in $c\ c\ c$, which in turn varies the current generated in the supply-machines of the batteries, proportionate increase of current and rise of pressure in the latter following increase of current around the magnets of F, and vice versa. One or more test-lamps, T L, are placed at the central station in derived circuits to serve as a photometric test of the pressure in the lines. For more accurately indicating variations in the pressure, one or more electrometers, galvanometers, or electro-dynamometers, E D, are placed in derived circuits, with a scale-mark indicating the pressure determined on as the standard pressure to be maintained. By the proper use of these indicating devices and the regulating devices described, a uniform pressure may be readily and easily maintained through all the mains. It is preferable to connect all circuits from the generating-machines to the main conductors 6 6 through switches I I I, so that an entire battery or any portion thereof may be thrown in or out of circuit, as the draft upon the station may indicate. It is to be noted, also, that the belt and pulleys of each machine are to be arranged by any of the well-known plans, that it may be disconnected from the motor when desired. These means may be used, when desired, as means of regulation, the number of machines in operation being controlled thereby, while the effective force of each machine while in operation is controlled by the resistances. The engines may be of any desired pattern or power, the number of machines in any one battery being limited by the power of the engine.

In Fig. 2, $c\ c\ c\ c$ are the field-of-force generators of batteries not shown, while c' is the field-of-force generator of a battery, of which three supply-generators are shown, connected to station-conductors 6 6, as before explained. The prime field-of-force generator F′ is in this case a dynamo-electric machine instead of a magneto-electric machine, as shown in Fig. 1, all its coils being included in one circuit, 8 8, which passes around the field-of-force magnets of the battery-generators $c\ c\ c\ c\ c'$. The same principle of regulation is used, however, the resistances H and cut-out K therefor being arranged in connection with the circuit through F′, so as to cause variation in the tension of the current therein, as and with the result before explained. In this figure there is shown what may be used also in connection with the plan shown in Fig. 1—means of testing the electro-dynamometers E D or other indicating instrument used. From a standard Daniell battery, D B, a circuit, $l\ c$, may be formed around E D by means of the switch L, so that, when desired, the correctness of E D may be ascertained and any inaccuracies which might arise be guarded against.

In Fig. 3 the mains 7 7 are shown, leading from corresponding wires at central station (see Fig. 1) down each side of the street. At side streets conductors 12 12 branch off. The small circles o in this figure indicate electric lamps. For street-lighting they are placed, as shown, in derived circuits from the street-mains. From the mains derived circuits 9 9 lead into houses, in which are placed at some suitable spot the meters M, through which one of the house-conductors passes, and by which the amount of electricity supplied to the house is accurately determined. Upon these house-circuits are arranged lamps on the multiple-arc system in such number, position, and grouping as may be desired. In these circuits I also propose to introduce electromotors E M, for furnishing light motive power. From the motor a belt, i, leads to a line of shafting, h, and pulleys $a\ a$, for any needed distribution of the power; or the belt i may pass directly to a sewing or other machine, a separate motor being used for each power-driven machine. Where motors are desired, each, preferably, should be made of a power proportional to the maximum work to be done. While the electrical tension in each machine is regulated at the central station, yet if the maximum load or work be diminished at any particular motor its speed would necessarily be increased. It also might be desired at times to diminish the normal speed of the motor. In order, therefore, that some determinate speed may be maintained, irrespective of load or work, each motor should be furnished with a governor. For this purpose I prefer a governor invented by me, and to be the subject of a separate application, which acts to break the circuit when a certain determinate speed is exceeded.

In Fig. 4 is shown a locality divided into four supply-districts. Each is provided with its own central station, marked C. S. 1, C. S. 2,

C. S. 3, and C. S. 4. From each proper mains, 7 7, lead out, as before described. At convenient points, however—say P P—connections between the mains of the systems may be made, the effect then being to merge the entire locality into one large district with four supply-stations, the pressure through all being uniform and each station doing its own quota toward maintaining the pressure uniform. The use of four stations and districts in this diagram is arbitrary and for illustration only, as the number actually to be made in any one locality depends upon the needs of the locality.

It is to be noted that all the circuits from the generators to the lamps or other translating devices are complete or round metallic circuits, as before stated.

What I claim is—

1. In a system of electrical distribution, the combination, with a complete or round metallic circuit, of a number of generators connected in multiple arc with such circuit, and consisting each of an armature revolving in a magnetic field, and a number of translating devices, also connected in multiple arc with said circuit, substantially as set forth.

2. In a system of electrical distribution, the combination, with a complete or round metallic circuit, of a number of generators connected in multiple arc with such circuit, and consisting each of an armature of low resistance revolving in a magnetic field of great strength, and a number of translating devices, also connected in multiple arc with said circuit, substantially as set forth.

3. In a system of electrical distribution, the combination, with a complete or round metallic circuit, of a number of generators connected in multiple arc with such circuit, and consisting each of an armature revolving in a magnetic field and having the coils of its field-of-force magnet and its generating-coils separate, (*i. e.*, not connected in series,) and a number of translating devices, also connected in multiple arc with said circuit, substantially as set forth.

4. In a system of electrical distribution, the combination, with a complete or round metallic circuit, of a number of generators connected in multiple arc with such circuit, and consisting each of an armature revolving in a magnetic field, a number of translating devices, also connected in multiple arc with said circuit, and a regulator for regulating the supply of current to such circuit, substantially as set forth.

5. In a system of electrical distribution, the combination, with a complete or round metallic circuit, of means for generating electricity connected with such circuit, and consisting of one or more dynamo or magneto electric machines, translating devices connected in multiple arc with said circuit, an indicator of the electric pressure upon such circuit, and a regulator under control of the operator for regulating the supply of current to such circuit, substantially as set forth.

6. In a system of electrical distribution, the combination, with a complete or round metallic circuit, of a number of generators connected in multiple arc with such circuit, and consisting each of an armature revolving in a magnetic field, translating devices connected in multiple arc with said circuit, an indicator of the electric pressure upon such circuit, and a regulator under control of the operator for regulating the supply of current to such circuit, substantially as set forth.

7. In a system for the generation and distribution of electricity for light or power through cities or towns or districts thereof, a central station whereat are combined a number of generators of electricity connected in multiple arc, and consisting each of an armature revolving in a magnetic field, an indicator of the electric pressure, and a regulator of the current generated, conductors forming complete or round metallic circuits leading from such station to distribute the current throughout the system, and translating devices connected in multiple arc with such conductors, substantially as set forth.

8. In a system for the generation and distribution of electricity for light or power through cities or towns or districts thereof, a central station whereat are combined a number of generators of electricity connected in multiple arc, and consisting each of an armature revolving in a magnetic field, an indicator of the electric pressure, and a regulator of the current generated, conductors forming complete or round metallic circuits leading from such station to distribute the current throughout the system, translating devices connected in multiple arc with such conductors, and meters at the houses for measuring the current supplied to such translating devices, substantially as set forth.

In testimony whereof I have hereunto affixed my signature this 28th day of January, A. D. 1880.

THOMAS A. EDISON.

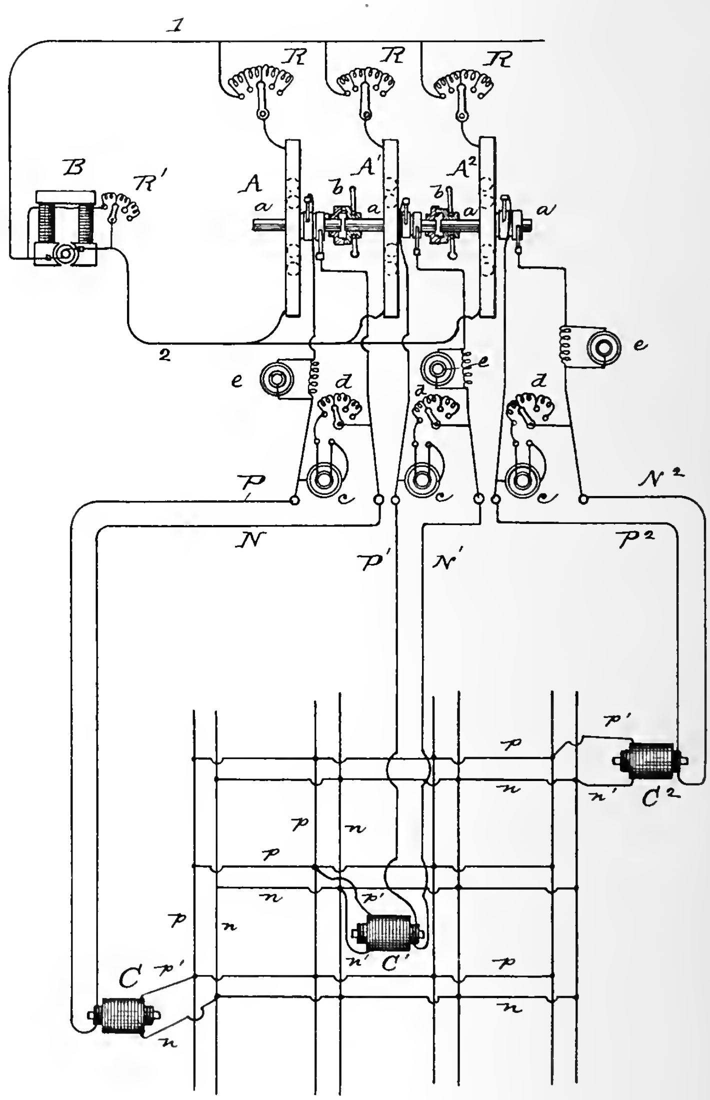
Witnesses:
C. P. MOTT,
S. D. MOTT.

(No Model.)

T. A. EDISON.

SYSTEM OF ELECTRICAL DISTRIBUTION.

No. 369,439. Patented Sept. 6, 1887.



ATTEST:

E. C. Rowland

Wm. Pelzer.

INVENTOR:

Thomas A. Edison

By Dyer & Seely

attys

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY.

SYSTEM OF ELECTRICAL DISTRIBUTION.

SPECIFICATION forming part of Letters Patent No. 369,439, dated September 6, 1887.

Application filed December 6, 1886. Serial No. 220,795. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Systems of Electrical Distribution, (Case No. 694,) of which the following is a specification.

My invention relates to that class of systems for the distribution of electricity in which a source of current of high tension is employed, situated at a distance from the place or district to be supplied, and converters or tension-reducing devices are used to reduce the tension of the current to that at which it is to be used for lighting or other domestic or business purposes, whereby economy is obtained in the amount of metal required for conductors, since the conductors leading from the source have to convey only the current of very high tension.

Said invention relates, mainly, to a novel arrangement of the generators at the source of supply, whereby current of equal and constant potential is given to all parts of the district supplied, and the indication and regulation of such current for the purpose of maintaining such constant and equal potentials is readily and conveniently performed.

In carrying my invention into effect I employ as a source of supply two or more alternating-current dynamo-electric machines having their armatures all mounted upon the same shaft or all mechanically connected together, and preferably having all their field-magnets energized from the same source and arranged to be regulated either independently or simultaneously. From each of these generators a circuit extends to the district supplied, where preferably is a system of intersecting and connected positive and negative main or lighting conductors, with which the electric lamps, electric motors, or other translating devices are connected, the connection between the circuits from the source and said main or lighting circuits being through converters or tension-reducing devices, which, since alternating generators are employed, may be simple induction-coils, and which convert the generated current of high tension to currents of low tension adapted for use in the translating devices. Each generator-circuit is provided with suitable indicating devices, according to whose indications the generators are regulated. I prefer to have the generator-armatures connected by suitable clutches, whereby one or more of them may be thrown out of use when desired.

My invention is illustrated in the accompanying drawing, which is a diagram of a system of electrical distribution embodying said invention.

A, A′, and A^2 represent alternating-current dynamo-electric machines producing high-tension currents, and of which any suitable number may be provided.

B is a continuous-current dynamo-electric machine, from which a circuit, 1 2, extends, and the field-magnets of each alternating machine are connected in derived circuit across the circuit 1 2, each derived circuit including an adjustable resistance, R, whereby the strength of each field-magnet is regulated independently.

The energizing-generator B has a resistance, R′, in its field-circuit, whereby the field-magnets of all the alternating machines are regulated simultaneously.

The rotating armatures of the machines A, A′, and A^2 are placed upon shafts *a a*, which are provided with suitable locking-clutches, *b b*, for coupling them together, whereby all the machines are run from the same source of power at the same speed. From the commutator-brushes of each machine extend, respectively, the circuits P N, P′ N′, and P^2 N^2, which are composed of small conductors adapted to convey the high-tension currents. Each of these circuits includes the primary circuit of a tension-reducing induction-coil, C, C′, or C^2, or other tension-reducing converter.

The system of intersecting and connected main or lighting conductors is shown by *p n*. These conductors, as will be understood, usually extend in pairs along the streets of the district, and are connected like to like wherever they meet at the street intersections.

From the secondary circuit of each induction-coil conductors *p′ n′* extend, which are connected with the system of lighting-conductors, usually at centers of consumption at or near which the converters are placed.

Each of the high-tension circuits is provided with an indicator, *c*, connected across its conductors, and with a resistance, *d*, in circuit with it, whereby the difference in potential of the conductors or the volts of electro-motive force in the circuit is indicated. These indicators are of a character to be used with the alternating current, consisting of two coils in the same circuit, one of which is movable, as is fully shown and described in my application No. 691, Serial No. 220,792. Each circuit also has a similar indicator, *e*, shunted around a resistance, *f*, in one side of the circuit, whereby the ampères of current on said conductor are shown. In accordance with the indications of these devices the regulation of the generators is performed. Each generator is regulated by itself by adjusting the resistance R in its field-circuit, whereby the current on each high-tension circuit is regulated, and the same constant potential is maintained on all the circuits as changes occur in the number of translating devices in circuit in the different parts of the district, while to vary the entire current supplied the resistance R′ in the field circuit of continuous-current generator B is adjusted, whereby the field-magnet strength of all the alternating machines is varied simultaneously.

For greater changes in the whole current supplied, one or more machines may be connected or disconnected from the driving-power by means of the clutches *b*.

What I claim is—

1. In a system of electrical distribution, the combination of two or more dynamo-electric machines generating high-tension currents, and having their armatures mechanically joined together, a circuit from each of said machines, a connected system of main or lighting conductors, and tension-reducing converters connected between the high-tension circuits and the lighting-conductors, reducing the tension of the current, substantially as set forth.

2. In a system of electrical distribution, the combination of two or more dynamo-electric machines generating currents of high tension, having their armature-shafts detachably locked together, a circuit from each of said machines, a connected system of main or lighting conductors, and tension-reducing converters connected between the high-tension circuits and said main or lighting circuits for reducing the tension of the current, subtantially as set forth.

3. In a system of electrical distribution, the combination of two or more alternating-current dynamo-electric machines generating currents of high tension, and having their armatures mechanically joined together, a continuous-current dynamo-electric machine energizing the field-magnets of all said alternating machines, a circuit extending from each of said alternating machines, a system of connected main or lighting conductors, and tension-reducing converters connected between the high-tension circuits and the lighting-circuits for reducing the tension of the current, substantially as set forth.

4. In a system of electrical distribution, the combination of two or more alternating-current dynamo-electric machines generating currents of high tension and having their armatures mechanically connected together, a circuit extending from each of said machines, a system of connected lighting-conductors, tension-reducing converters connected between the high-tension circuits and the lighting-conductors, and means for regulating the electro-motive force of each of said generators, substantially as set forth.

5. In a system of electrical distribution, the combination of two or more alternating-current dynamo-electric machines generating currents of high tension, and having their armatures mechanically connected together, a circuit extending from each of said machines, a system of connected lighting-conductors, tension-reducing converters connected between said high-tension circuits and said lighting-circuits, means for regulating the electro-motive force of each of said generators separately, and means for regulating them all simultaneously, substantially as set forth.

6. In a system of electrical distribution, the combination of two or more dynamo-electric machines generating high-tension currents, and having their armatures mechanically joined together, a circuit from each of said machines, translating devices supplied from all said circuits in common, and tension-reducing converters connected between the high-tension circuits and the translating devices, substantially as set forth.

This specification signed and witnessed this 22d day of November, 1886.

THOS. A. EDISON.

Witnesses:

WM. PEZER,

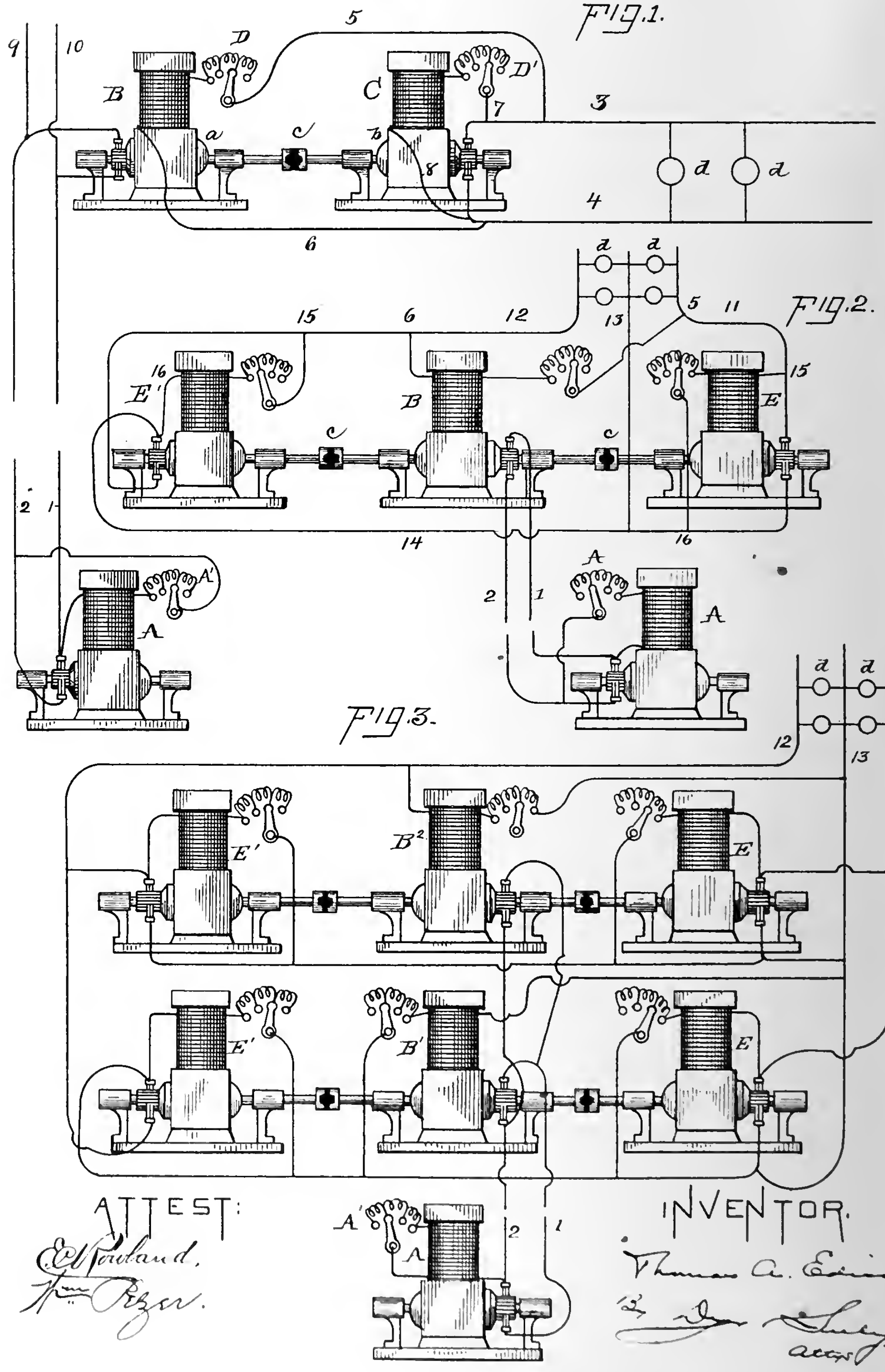
E. C. ROWLAND.

(No Model.) 2 Sheets—Sheet 1.

T. A. EDISON.

SYSTEM OF ELECTRICAL DISTRIBUTION.

No. 369,441. Patented Sept. 6, 1887.



ATTEST:

E. C. Rowland.
Wm. Pelzer.

INVENTOR.

Thomas A. Edison
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Attys

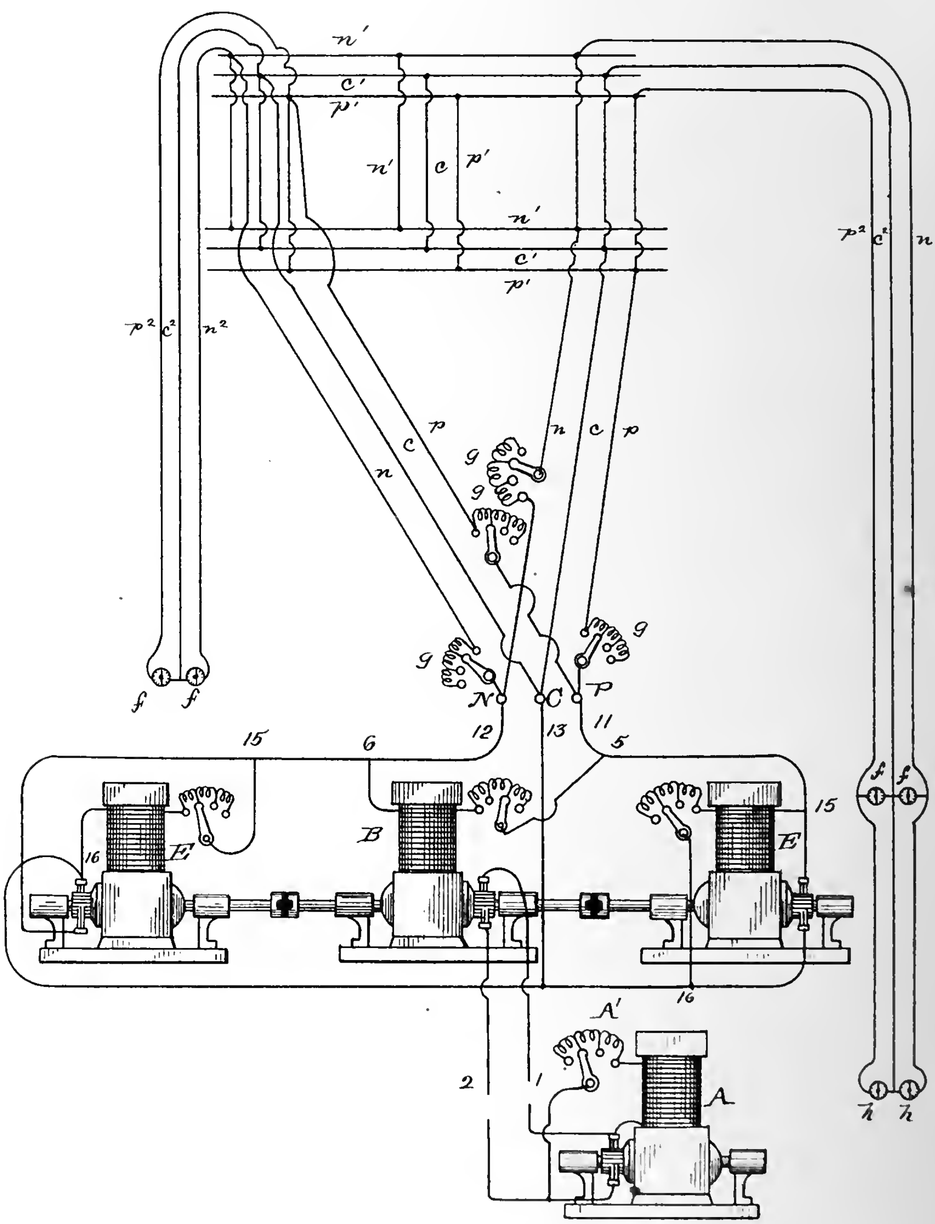
(No Model.) 2 Sheets—Sheet 2.

T. A. EDISON.

SYSTEM OF ELECTRICAL DISTRIBUTION.

No. 369,441. Patented Sept. 6, 1887.

Fig. 4.



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N. PETERS, Photo-Lithographer, Washington, D. C.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY.

SYSTEM OF ELECTRICAL DISTRIBUTION.

SPECIFICATION forming part of Letters Patent No. 369,441, dated September 6, 1887.

Application filed December 16, 1886. Serial No. 221,795. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Systems of Electrical Distribution, (Case No. 708,) of which the following is a specification.

My invention relates to systems of electrical distribution of that character in which high-tension currents are employed, generated at a station situated at a distance from the district to be supplied, and transmitted to a sub-station by small conductors, and from which sub-station currents of lower tension, adapted for use in electric lighting or for other domestic or business purposes, are supplied to such district.

The object of my invention is to provide a simple and efficient system of this general character, which may be readily and conveniently regulated, and which shall employ continuous currents, thereby doing away with the danger to life which arises when high-tension alternating currents are used.

My invention may be employed either with a two-wire or multiple-arc system or with the three-wire or compensating multiple-series system.

My invention is illustrated in the annexed drawings, in which Figure 1 is a diagram of a system embodying said invention arranged as a simple two-wire multiple-arc system; Fig. 2, a diagram showing a simple arrangement for supplying a multiple-series system; Fig. 3, a diagram showing the supplying of a three-wire system in a somewhat different manner, and Fig. 4 a diagram of the complete connections of the three-wire distributing system.

Referring, first, more especially to Fig. 1, A represents a dynamo-electric machine adapted to generate a current of high tension, and which is situated at a place where power is economically available, and which may be termed the "main station." It is evident that any desired number of generators A may be placed at the main station and connected in series, multiple arc, or multiple series, as may be desired. The generator A has an adjustable resistance, A′, in its field-circuit for regulating it.

From the terminals of generator A a circuit, 1 2, extends, which may be composed of small conductors, since it is required to convey only the high-tension current. This circuit extends to a sub-station situated within or near the district to be supplied with current, and at this sub-station is placed an electro-dynamic motor, B, having its armature-coils in the high-tension circuit 1 2. The armature-shaft *a* of this motor is directly connected mechanically with the armature-shaft *b* of a dynamo-electric machine, C, which is wound so as to generate a continuous current of much lower tension than that supplied to motor B—that is, a current adapted for incandescent electric lighting and similar purposes. The same piece of shafting may extend through both armatures; but I prefer to introduce between them an insulating-joint, *c*. From the commutator of generator C a circuit, 3 4, extends, with which are connected in any suitable manner incandescent electric lamps, electric motors, or other translating devices, *d d*, the same being thus supplied with current.

I prefer to energize the field-magnets of the motor B and generator C both from the low-tension circuit 3 4. To this end a multiple-arc circuit, 5 6, is brought from circuit 3 4, which includes the coils of the field-magnet of the motor, and also a circuit, 7 8, which includes the field-coils of the generator. Each of these field-circuits is provided with an adjustable resistance, D or D′, whereby the speed of the motor and the generation of current by the generator are regulated.

Any suitable number of sub-stations may be supplied from the main circuit 1 2, each being provided with the devices just described. This is indicated by the circuit 9 10, extending in multiple arc from 1 2, and which may extend to one of such other sub-stations.

By means of the insulating-joint *c* the high-tension circuits are completely cut off from those of low tension, so that if an accidental ground-connection should occur through the base of one machine no current therefrom can in any way reach the circuits of the other machine.

In the arrangement shown in Fig. 2 the generator A is arranged at the main station, as before, and supplies current to motor B at the sub-station. This motor drives by direct connection two low-tension generators, E and E', and these generators are connected in series in a circuit, 11 12, while a conductor, 13, extends from the joining conductor 14, whereby the two generators are made to form the divided source of supply of a compensating or three-wire system. The field of the motor is energized, as before, by a circuit, 5 6, off the low-tension circuit, while the fields of the generators are energized each by a circuit, 15 16, off one side of the said low-tension circuit. Adjustable resistances are placed in the field-circuits, as before explained. The electric lamps or other translating devices, *d d*, are in multiple series across the circuit 11 13 12, as will be well understood. By adjusting the resistance in the field of the motor the speed of both generators is changed and the whole current supplied to the circuit 11 13 12 is regulated, while each side of the circuit is separately regulated by the separate adjustment of the generator field-circuit resistances. Insulating-joints *c c* are interpolated in the armature-shafts, as before.

Fig. 3 shows the arrangement of several sets of motors and generators at a sub-station, all supplying the same three-wire circuit, 11 13 12. Two motors, B' and B^2, are connected in multiple arc with the high-tension circuit 1 2 from generator A. There may be any desired number of such motors so connected. Each of these motors runs a pair of generators, and each pair of generators is connected in series across the low-tension circuit, the group of generators being thus in multiple series, there being two in series in each multiple-arc circuit. The compensating-conductor 13 is connected between each pair of generators, and the translating devices *d d* are connected across the three-wire circuit, as already explained. The regulation is performed as in Fig. 2.

In all the preceding figures I have shown, for illustration, translating devices placed directly upon the low-tension circuit. The preferred arrangement for a distributing system is, however, shown in Fig. 4, the arrangement at main and sub stations being the same as is shown in Fig. 2.

The three-wire circuit 11 13 12 extends to suitable terminal points or omnibus conductors, P C N, within the station, from which extend two or more feeding-circuits, *p c n*. These extend to different points of a system of intersecting and connected positive, negative, and compensating main or lighting conductors, p' c' n', from which the house-circuits, (not shown,) including translating devices in multiple series, extend. From the terminals of each feeder an indicating-circuit, p^2 c^2 n^2, extends to the sub-station, where each is connected to suitable electrical indicators, *f f*, by which the pressure on each side of the system at all the different parts of the district is shown.

Each feeding-circuit is provided with an adjustable resistance, *g*, in each side thereof, whereby the current supplied by each feeder to its particular part of the district is varied and regulated as changes occur in the distribution of the translating devices in circuit. Preferably one of the indicating-circuits—or a separate circuit—is continued back to the main station, and is there connected with indicators *h h*, so that the tension in the system of conductors is shown at the main station. In accordance with these indications the main-station generator may be regulated to keep the proper constant pressure at the terminals of this particular feeder, which thus serves as a standard feeder, the one or more other feeders being regulated separately at the sub-station to keep them at the same pressure as the standard. The two sides of the system may also be separately regulated to maintain their balance by the adjustment of the field-circuit resistances of the generators.

It is evident that the arrangement shown in Fig. 1 may be and is in practice employed to supply a two-wire multiple-arc system of feeders and connected mains, as will be well understood, and also that the two or more multiple series of generators shown in Fig. 3 and driven by multiple-arc motors may be employed with the system of feeders and mains, as well as the arrangement shown in connection with such system.

What I claim is—

1. In a system of electrical distribution, the combination of a source of electricity of high tension, a circuit extending therefrom, an electro-dynamic motor connected with said circuit, a dynamo-electric machine generating a current of lower tension, a direct mechanical connection between the armature of said motor and that of said generator, and translating devices supplied by said generator, substantially as set forth.

2. In a system of electrical distribution, the combination of a source of electricity of high tension, a circuit extending therefrom, an electro-dynamic motor connected with said circuit, a dynamo electric machine generating a current of lower tension, translating devices supplied by said generator, a direct mechanical connection between the armature of said motor and that of said generator, and means for regulating the speed of said motor, substantially as set forth.

3. In a system of electrical distribution, the combination of a source of electricity of high tension, a circuit extending therefrom, an electro-dynamic motor connected with said circuit, a dynamo electric machine generating a current of lower tension, translating devices supplied by said generator, a direct mechanical connection between the armature of said generator and that of said motor, and means

for regulating the generation of current by said generator, substantially as set forth.

4. In a system of electrical distribution, the combination of a source of electricity of high tension, a circuit extending therefrom, an electro-dynamic motor connected with said circuit, a dynamo-electric machine generating a current of lower tension, a direct electrically-insulating mechanical connection between the armature of said motor and that of said generator, and translating devices supplied by said generator, substantially as set forth.

5. In a system of electrical distribution, the combination of a source of electricity of high tension, a circuit extending therefrom, an electro-dynamic motor connected with said circuit, a dynamo-electric machine generating a current of lower tension, an insulating-coupling between the armature-shaft of said motor and that of said generator, and translating devices supplied by said generator, substantially as set forth.

6. In a system of electrical distribution, the combination of a source of electricity of high tension, a circuit extending therefrom, an electro-dynamic motor having its armature connected with said circuit, a dynamo-electric machine driven by said motor and generating a current of lower tension, a circuit extending from said generator and supplying translating devices, and a circuit extending from said low-tension circuit for energizing the field-magnet of said motor, substantially as set forth.

7. In a system of electrical distribution, the combination of a source of electricity of high tension, a circuit extending therefrom, an electro-dynamic motor connected with said circuit, a dynamo-electric machine, driven by said motor, generating a current of lower tension, a circuit extending from said generator supplying translating devices, and a circuit from said low-tension circuit for energizing the field-magnet of said generator, substantially as set forth.

8. In a system of electrical distribution, the combination of a source of electricity of high tension, a circuit extending therefrom, an electro-dynamic motor having its armature connected with said circuit, a dynamo-electric machine, driven by said motor, generating a current of lower tension, a circuit extending therefrom and supplying translating devices, and multiple-arc circuits from said low-tension circuit, one for energizing the field-magnet of said motor, the other for energizing that of said generator, substantially as set forth.

9. In a system of electrical distribution, the combination of a source of electricity of high tension, a circuit extending therefrom, an electro-dynamic motor connected with said circuit, a dynamo-electric machine, generating a current of lower tension, driven by said motor and supplying translating devices, means for regulating the current on such high-tension circuit, and means for regulating said low-tension generator, substantially as set forth.

10. In a system of electrical distribution, the combination of a source of electricity of high tension, a circuit extending therefrom, two or more electro-dynamic motors connected with said circuit in multiple arc, and dynamo-electric machines, driven by said motors, generating currents of lower tension and supplying translating devices, substantially as set forth.

11. In a system of electrical distribution, the combination of a source of electricity of high tension, two or more electro-dynamic motors connected in multiple arc with said circuit, and dynamo-electric machines generating currents of lower tension and supplying translating devices, and each having its armature directly connected mechanically with the armature of one of said motors, substantially as set forth.

12. In a system of electrical distribution, the combination of a source of electricity of high tension, a circuit extending therefrom, an electro-dynamic motor connected with said circuit, and two dynamo-electric machines, each having its armature directly connected mechanically with the armature of said motor and supplying currents of lower tension to translating devices, substantially as set forth.

13. In a system of electrical distribution, the combination of a source of electricity of high tension, a circuit extending therefrom, an electro-dynamic motor connected with said circuit, and two dynamo-electric machines, generating currents of lower tension, driven by said motor, said generators being connected in series and arranged to form the divided source of a three-wire or compensating system of electrical distribution, substantially as set forth.

14. In a system of electrical distribution, the combination of a source of electricity of high tension, a circuit extending therefrom, an electro-dynamic motor connected with said circuit, a dynamo-electric machine driven by said motor and generating a current of lower tension, two or more feeding-circuits extending from said generator, and a connected system of main or lighting conductors, with which said feeding-circuits are connected, substantially as set forth.

15. In a system of electrical distribution, the combination of a source of electricity of high tension, a circuit extending therefrom to a sub-station, an electro-dynamic motor at said sub-station, connected with said circuit, a dynamo-electric machine, driven by said motor, generating current of lower tension, feeding-circuits extending from said generator, a connected system of main or lighting conductors, with which said feeding-circuits are connected, indicating-circuits extending from the terminals of said feeding-circuits to indicators at the sub-station, and means for regulating the current of each feeding-circuit, substantially as set forth.

16. In a system of electrical distribution, the combination of a source of electricity of

high tension, a circuit extending therefrom, an electro-dynamic motor connected with said circuit, two dynamo electric machines, driven by said motor, generating currents of lower tension and connected in series, two or more three-wire feeding-circuits extending from said generators, and a three-wire system of main or lighting conductors, with which said feeding-circuits are connected, substantially as set forth.

This specification signed and witnessed this 10th day of December, 1886.

THOS. A. EDISON.

Witnesses:

WM. PEZER,

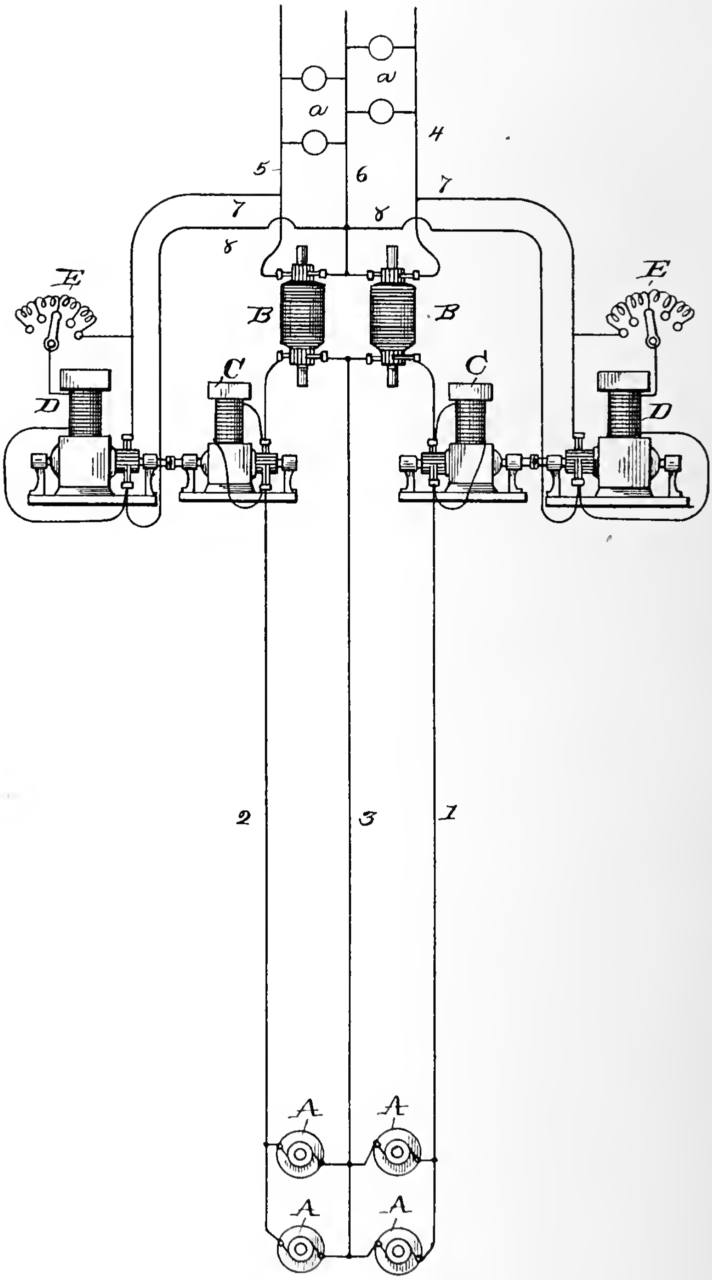
E. C. ROWLAND.

(No Model.)

T. A. EDISON.

SYSTEM OF ELECTRICAL DISTRIBUTION.

No. 369,442. Patented Sept. 6, 1887.



ATTEST:

E. C. Rowland.
Wm. Pelzer.

INVENTOR:

Thomas A. Edison
By Dyer & Seely
Attys.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY.

SYSTEM OF ELECTRICAL DISTRIBUTION.

SPECIFICATION forming part of Letters Patent No. 369,442, dated September 6, 1887.

Application filed December 22, 1886. Serial No. 222,271. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Systems of Electrical Distribution, (Case No. 709,) of which the following is a specification.

My invention relates to that class of systems of electrical distribution in which a source of electricity of high tension is employed, from which the high-tension current is conveyed by small conductors to a sub-station, where by means of suitable induction apparatus or devices the high-tension current is converted into a low-tension current suitable for use in electric lighting or for other domestic or business purposes, such current being distributed from the sub-station to the electric lamps, electric motors, or other translating devices in the district supplied.

The object of my invention is to regulate at the sub-station the electro-motive force on the high-tension line, a constant electro-motive force being maintained at the main station. I accomplish this by placing in the high-tension circuit at the sub-station a suitable current-varying device, the regulation or adjustment of which varies the condition of the high-tension circuit.

The accompanying drawing is a diagram of a three-wire system embodying the preferred form of my invention.

A A represent dynamo-electric machines generating currents of high tension, situated at the main station at a place where power is economically available. They are shown as arranged to form the divided source of electricity of a three-wire or compensating system. From the terminals of the generators a three-wire circuit, 1 3 2, extends, conveying the high-tension current to the sub-station, which is situated within or near the district to be supplied with current.

At the sub-station are placed double-wound rotating converters B B, which receive the high-tension current at one commutator and discharge at another current of the desired comparatively low tension. The two converters, as shown, are placed in series as a divided source, and the three-wire low-tension circuit 4 6 5 extends from such source, supplying translating devices *a a* in multiple series.

In each side of the high-tension line at the sub-station is connected an electro-dynamic motor, C. These motors are so wound that at a normal speed—say at one-half their full speed—they throw a low or minimum counter electro-motive force into the high-tension circuit. The fields of these motors may be energized in any suitable manner. As shown, they are energized from the high-tension circuit.

D D are motors run from the low-tension circuit 4 6 5 by circuits 7 8, and having adjustable resistances E E in their field-circuits, whereby their speed is regulated. Each of these motors has its armature-shaft connected, either directly, as shown, or through suitable belts or gearing, with the armature-shaft of one of the motors C C.

The operation is as follows: Suppose the main source to have a constant pressure of two thousand five hundred volts and the motors C to give each a back-pressure of five hundred volts. The effective pressure will then be two thousand volts; but if an increased load on the converters causes a decrease in this pressure, and it is desired to bring the pressure up again, the fields of the motors D are strengthened by throwing out more resistance, and the speed of such motors, and consequently of motors C, is decreased, whereby the counter electro-motive force of motors C is reduced and the pressure on the high-tension circuit is brought up to the desired two thousand volts again. If the load on the converters decreases so that the pressure must be reduced to bring it to the constant, the fields of motors D are weakened and the counter electro-motive force of motors C is reduced again.

Either side of the three-wire circuit may be regulated separately, as will be readily seen, as the relative number of translating devices on the two sides varies. My invention, however, is not confined to the three-wire system; but may be as readily used with a two-wire system of distribution.

What I claim is—

1. In a system of electrical distribution, the combination of a source of electricity of high tension, a circuit extending therefrom to a substation, a tension-reducing converter at said sub-station, a circuit extending therefrom to translating devices, an electro-dynamic motor in the high-tension circuit at the sub-station,

and means for varying the counter electro-motive force of said motor, substantially as set forth.

2. In a system of electrical distribution, the combination of a source of electricity of high tension, a circuit extending therefrom to a sub-station, a tension-reducing converter at said sub-station, a circuit extending therefrom to translating devices, an electro-dynamic motor in the high-tension circuit, a motor connected mechanically therewith, and means for varying the speed of the second motor, substantially as set forth.

3. In a system of electrical distribution, the combination of a source of electricity of high tension, a circuit extending therefrom to a sub-station, a tension-reducing converter at said sub-station, a circuit extending therefrom to translating devices, an electro-dynamic motor in the high-tension circuit and another in the low-tension circuit at the sub-station, having a mechanical connection between their armatures, and means for regulating the strength of the field-magnet of the low-tension current-motor, substantially as set forth.

4. In a system of electrical distribution, the combination of a divided source of electricity of high tension, a three-wire circuit extending therefrom to a sub-station, tension-reducing converters in series at the sub-station, a three-wire circuit extending therefrom, and a current-varying device in each side of the high-tension circuit at the sub-station, substantially as set forth.

5. In a system of electrical distribution, the combination of a divided source of electricity of high tension, a three-wire circuit extending therefrom to a sub-station, tension-reducing converters at the sub-station in series, a three-wire circuit extending therefrom to translating devices, an electro-dynamic motor in each side of the three-wire circuit at the sub-station, and means for regulating the speed of said motors, substantially as set forth.

This specification signed and witnessed this 16th day of December, 1886.

THOS. A. EDISON.

Witnesses:

WM. PEZER,

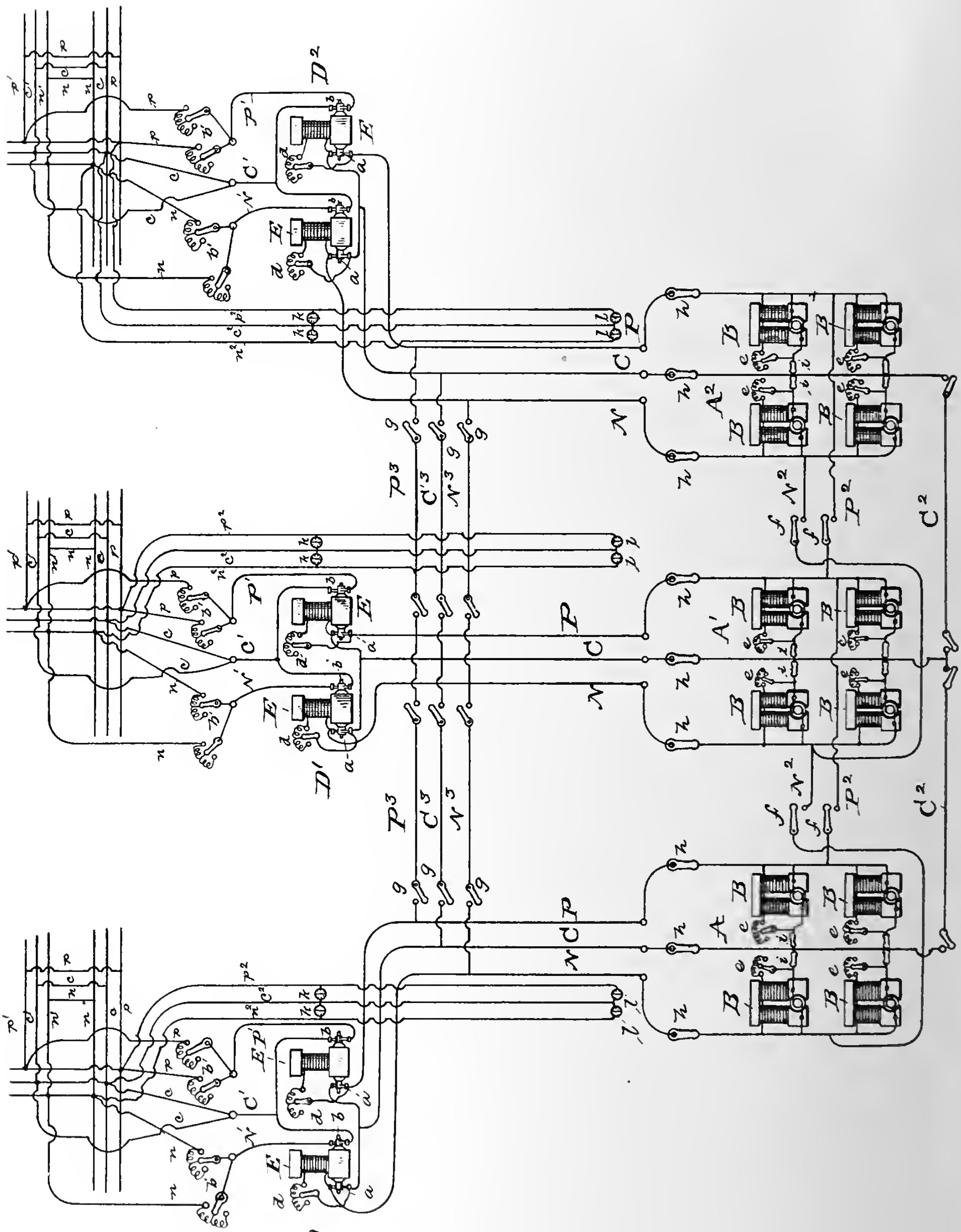
E. C. ROWLAND.

(No Model.)

T. A. EDISON.

SYSTEM OF ELECTRICAL DISTRIBUTION.

No. 369,443. Patented Sept. 6, 1887.



ATTEST:

INVENTOR:

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY.

SYSTEM OF ELECTRICAL DISTRIBUTION.

SPECIFICATION forming part of Letters Patent No. 369,443, dated September 6, 1887.

Application filed December 27, 1886. Serial No. 222,731. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Systems of Electrical Distribution, (Case No. 710,) of which the following is a specification.

My invention relates to a modification of or improvement upon the system of electrical distribution set forth in my application, No. 703, Serial No. 220,799. In that application is shown and described a source of electricity of high tension, from which a circuit extends to a sub-station, where are placed devices receiving such high-tension current and discharging a current of low tension, which is thence conveyed by feeding-circuits to a connected system of translation-circuits, with which electric lamps or other translating devices are connected.

My present invention consists in providing two or more systems of this general character and conductors, including switches, by means of which such systems may be joined together, so that one source may be made to supply two or more distributing systems, or two or more sources may be thrown onto one distributing system, as such changes are made desirable by reason of variations in the current required by the districts.

My invention is illustrated in the annexed drawing, which is a diagram of a system embodying said invention.

A, A′, and A² represent three groups of generators, B B, which may be all situated at the same place or station, or may be divided between three places or stations. There may be any desired number of such groups of generators, according to the area to be supplied. The generators of each group are shown as arranged to form the divided source in a three-wire or compensating system, although, as will be evident, the invention is as readily applicable to a two-wire system. From each group of generators a three-wire circuit, P C N, extends to a sub-station, D, D′, or D², such sub-stations being each situated within or near the district to be supplied by it.

The generators shown are continuous-current generators, and I therefore provide double-wound rotating tension-reducing converters E E at each sub-station, receiving the high-tension current by connections *a a* in one set of armature-coils and discharging a current of low tension by commutators *b b* from another set of armature-coils. The converters E E at each station are shown as joined in series, and a three-wire circuit, P′ C′ N′, extends from the terminal points or omnibus wires within the station, from which two or more feeding-circuits, *p c n*, extend to different points of the district supplied, where they are joined to the system of connected mains or lighting-circuits *p′ c′ n′*, from which the house-circuits extend, (not shown,) including translating devices, which may be electric lamps, electric motors, or other electrical apparatus adapted to be operated by the current of low tension, such translating devices being connected in multiple series, as is now well understood.

The feeding-circuits are provided with adjustable resistances *b b* for regulating the current conveyed by them, whereby either side of each feeding-circuit may be regulated as the relative number of lamps on the two sides varies, or each feeding-circuit may be regulated relative to the others for unequal distribution or changes in the number of lamps in different parts of the district.

The field-magnets of the converters are shown as energized from the high-tension circuit, (though the field-circuits may extend from the low-tension circuit,) and each is provided with an adjustable resistance, *d*, for regulating the speed of the converter.

The generators B at the main station are provided with regulating resistance *e* in their field-circuits. The high-tension circuits are preferably provided with line-switches *h* in each conductor, and each dynamo also may have a switch, *i*, in its armature-circuit.

Between the three main stations or three groups of generators, A A′ A², may extend positive, negative, and compensating conductors P² N² C², joining the conductors of the high-tension circuits together—positive to positive, negative to negative, and neutral to neutral. Each of these conductors is provided with a circuit making and breaking switch, *f*. Instead of this, there may extend between the sub-stations positive, negative, and compensating conductors P³ N³ C³, joining like conductors of the high-tension circuits together, and at the sub-stations circuit making and breaking switches g are placed in these joining-conductors, or both these sets of connecting-conductors may be provided, as illustrated.

Normally each of the three systems is run by itself, and is regulated by the adjustment of the field-magnets of generators B for the general regulation of the district and by the feeder-resistances for the changes in distribution and balance; but when so many translating devices are disconnected in the several or in any one or more of the districts that it becomes unnecessary to run so many dynamos to supply those remaining all three of the districts may be thrown upon the generators of one group. In some cases it may be desired to do this at the sub station. In this case it is done by closing the proper set of switches, g, in the conductors P^3 N^3 C^3, so that all three of the districts are thrown upon either one of the generator groups or upon any two of them; or two districts may be thrown upon a single group and the third district still run separately from its own group; or such combinations may be made as the exigencies of the case may require. These operations may be performed at the main station, if desired, the circuits P^2 C^2 N^2 being provided for this purpose.

Indicating-circuits p^2 n^2 c^2, extending from the translation-circuits, preferably from terminals of feeders, are connected to electrical indicators k k at the sub-stations, or similar indicators, l l, at the main station or stations, or, preferably, as shown, to both. In accordance with the showing of these indicators the regulation of the system is accomplished either by the adjustable resistances, which have been described, or by the closing or opening of connecting-circuits.

What I claim is—

1. In a system of electrical distribution, the combination of two or more sub-systems, each composed of a source of supply and a system of translation-circuits supplied therefrom, with circuits provided with switches for connecting said sub-systems together, substantially as set forth.

2. In a system of electrical distribution, the combination of two or more sub-systems, each consisting of a source of supply, a circuit extending therefrom to a sub-station, and feeding-circuits extending from such sub-station to translation-circuits, with conductors provided with switches for connecting said sub-systems together, substantially as set forth.

3. In a system of electrical distribution, the combination of two or more sub-systems, each composed of a source of supply and a system of translation-circuits supplied therefrom, means for regulating the supply of current in each sub-system, and conductors provided with switches for connecting such sub-systems together, substantially as set forth.

4. In a system of electrical distribution, the combination of two or more sub-systems, each composed of a source of electricity of high tension, a circuit extending therefrom to a tension-reducing converter, and translation-circuits supplied from said converter, with conductors provided with switches for connecting said sub-systems together, substantially as set forth.

5. In a system of electrical distribution, the combination of two or more sub systems, each composed of a source of electricity of high tension, a circuit extending therefrom to a sub-station, a tension-reducing converter at said sub-station, translation-circuits supplied from said converter, and means at the sub-station for regulating the current supplied, with conductors provided with switches for connecting said sub-systems together, substantially as set forth.

6. In a system of electrical distribution, the combination, with two or more sub-systems, each composed of a source of electricity of high tension, a circuit extending therefrom to a tension-reducing converter, and translation-circuits supplied from said converters, of conductors joining like conductors of the high-tension circuits and provided with switches whereby the sub-systems may be joined together, substantially as set forth.

7. In a system of electrical distribution, the combination, with two or more sub-systems, each composed of a source of electricity of high tension, a circuit extending therefrom to a sub-station, a tension-reducing converter at said sub-station, two or more feeding-circuits extending from said converter to a system of translation-circuits, indicating devices connected with said translation-circuits, and means for regulating the current in said feeding-circuits, of conductors connecting like conductors of the high-tension circuit and provided with switches whereby the sub-systems may be joined together, substantially as set forth.

This specification signed and witnessed this 16th day of December, 1886.

THOS. A. EDISON.

Witnesses:

WM. PEZZER,

E. C. ROWLAND.

(No Model.) 2 Sheets—Sheet 1.

T. A. EDISON.

ELECTRIC METER.

No. 370,123. Patented Sept. 20, 1887.

Fig. 1

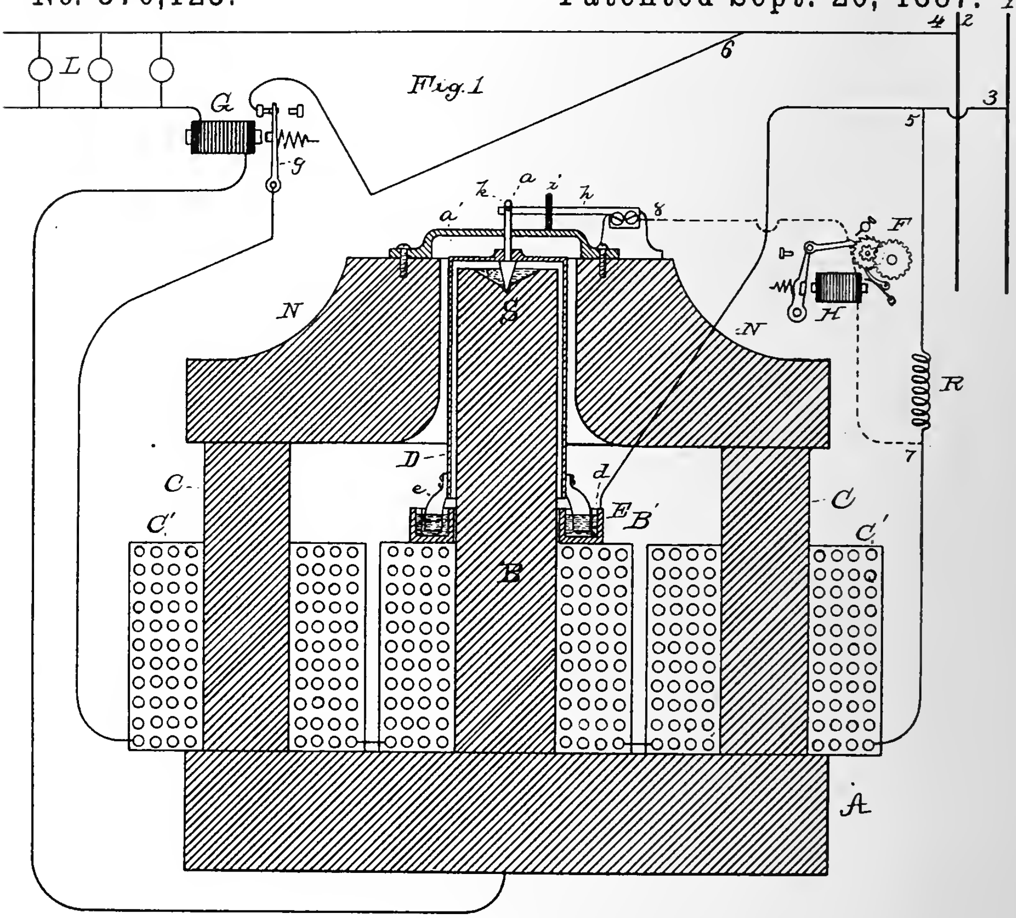


Fig 2.

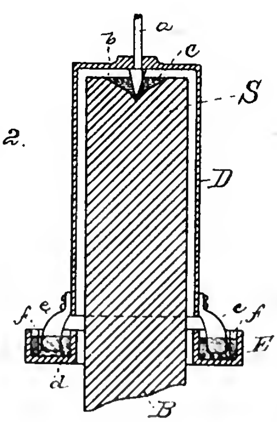


Fig. 4.

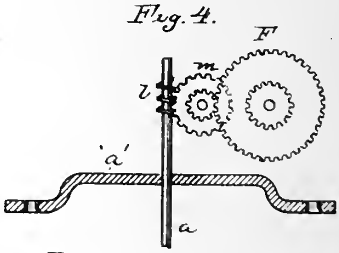
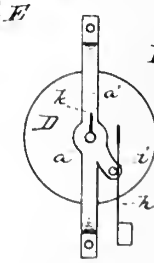


Fig. 3.



ATTEST:

E. C. Rowland

H. W. Seely

INVENTOR:

Thomas A. Edison,

By Rich'd N. Dyer,

Atty.

(No Model.)

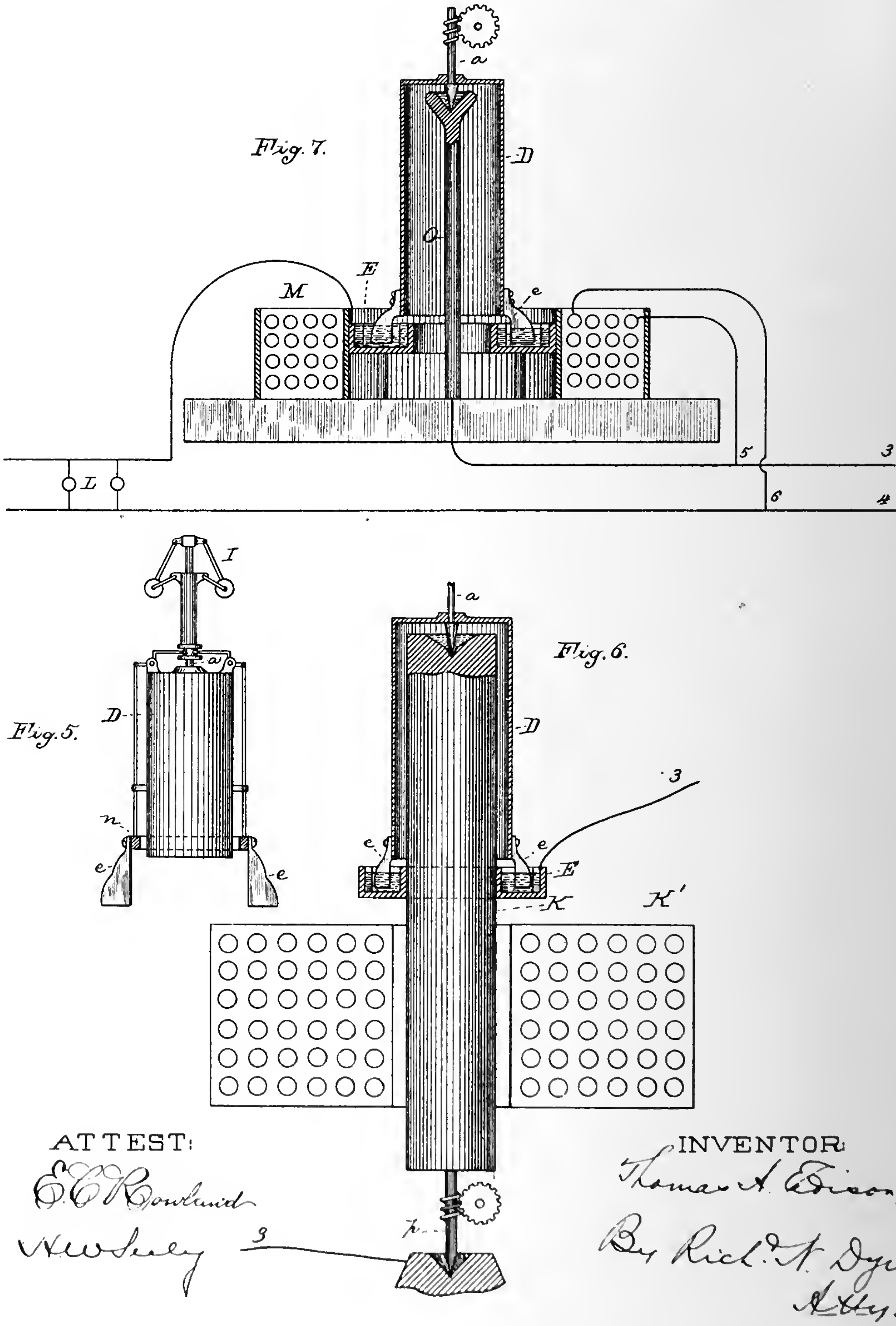
2 Sheets—Sheet 2.

T. A. EDISON.

ELECTRIC METER.

No. 370,123.

Patented Sept. 20, 1887.



ATTEST:

E. C. Rowland

H. W. Seely

INVENTOR:

Thomas A. Edison,

By Richd. N. Dyer.

Atty.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

ELECTRIC METER.

SPECIFICATION forming part of Letters Patent No. 370,123, dated September 20, 1887.

Application filed April 17, 1883. Serial No. 91,956. (No model.) Patented in England May 30, 1883, No. 2,675.

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Electrical Meters, (Case No. 559,) of which the following is a specification.

The object I have in view is to produce a cheap and reliable meter for measuring automatically the electric current or energy consumed in a system for the general distribution of electricity for light, heat, and power, and this I accomplish by the use, in connection with the translation-circuit of which the current is to be measured, of a peculiarly-constructed electro-dynamic motor, and providing a proper indicating, registering, or counting mechanism controlled or operated by such motor, and also providing such peculiar motor with devices for causing the motor to perform a definite amount of work in order to reduce to the minimum the importance of the indefinite or variable friction as a factor in the work of the motor.

In my Patent No. 242,901 there is described a meter composed of an electro-dynamic motor arranged in the translation-circuit and having a definite loading and operating, indicating, or registering apparatus; but such motor is shown as a machine provided with a commutator, which machines, when used as the operative or controlling elements of electrical meters, are subject to the objection that the multiple contacts of the commutator cannot be made without considerable indefinite or variable friction, which increases the liability to error in registering, the wear upon the parts is great, and there is difficulty experienced in attaining sufficiently-low resistance. These objections and difficulties I overcome by the use of the peculiar electro-dynamic motor, which is a non-commutator or uni-polar machine of such character that I apply to it the term "mono-electro-dynamic motor," its inductive or rotating part being a straight or one-part conductor, the current passing through it in one direction only.

The peculiar construction of this motor and the connections and accompanying parts used with it to form a meter will be fully hereinafter explained.

By the use of the mono-electro-dynamic motor I am enabled to convey powerful currents through the apparatus without loss by the resistance at solid metallic or multiple contacts, and also to obtain slow movement or rotations with powerful currents, and at the same time to attain these results with exceedingly small, indefinite, or variable friction.

In the accompanying drawings, forming a part hereof, Figure 1 is a sectional elevation of the mono-electro-dynamic motor used as a meter with an elevation of an indicating or registering mechanism and a diagram of connections; Fig. 2, a separate sectional view of the revolving cylinder forming the single or straight non-magnetic inductive portion of the machine, and of the magnetic core upon which said cylinder revolves; Fig. 3, a top view of the revolving cylinder, showing means for completing the circuit of the registering mechanism; Fig. 4, an elevation of a modification showing the registering mechanism operated directly by the revolving cylinder; Fig. 5, an elevation of the cylinder, showing means for varying the loading of the motor to compensate for variations in proportionate friction; Fig. 6, a vertical section of a modification wherein the magnetic core revolves and the non-magnetic cylinder remains stationary, and Fig. 7 a vertical section of a modified form of the motor wherein no magnetic parts are used.

The mono-electro-dynamic motor is composed of an iron base, A, which forms the back of the field electro-magnet of the machine, one pole of which is the upper end, S, of the central core, B, while the other pole is formed by the ring or a number of separate pole-pieces, N, supported on cores C, rising from A and surrounding the pole S. The cores B C are provided with wire bobbins B′ C′. In the magnetic field, between S and N, is located the revolving one-part or straight inductive portion of the machine. This is preferably a cylinder, D, which may be of copper, and which is supported upon S by a central pivoting spindle, *a*, resting in a depression, *b*, in the top of S. This spindle passes through a guiding-yoke, *a′*, and through the center of the closed upper end of the cylinder, and is secured rigidly thereto. It is pointed, and is constructed of platinum or platinum-iridium alloy, so as not to amalgamate with the mercury, c, with which the depression b is partly filled. The revolving pivot or spindle is located in the circuit, as will be presently explained, and the mercury is used to make good and sufficient contact in order to carry a powerful current without heating.

The lower end of the cylinder D is provided with means for maintaining contact with the mercury, d, in a circular trough, E. This means is preferably in the form of fans or paddles e, which dip into the mercury, and, while maintaining the circuit complete, act to retard the movement of the motor, giving it a definite loading or a definite amount of work to perform. The mercury-trough E may be provided with stationary blades f, to prevent the rotation of the mercury in a body. Current being passed through the bobbins B′ C′ and through the cylinder D, such cylinder will revolve, the speed being directly proportionate to the current, and this motion may be used to advantage to operate or control suitable indicating or registering mechanism, F, for measuring the electrical current or energy consumed in a circuit.

In Fig. 1 the connections are shown for the use of the peculiar motor as a meter in my multiple-arc system of electrical distribution.

1 2 are the street-mains, and 3 4 a house-circuit therefrom, having connected therewith in multiple arc, lamps or other translating devices L. In the house-circuit, between the street-mains and the translating devices, the line 3 is broken and is carried to the mercury-trough E, from whence the current passes through the mercury, d, to paddles e and up the one-part or straight inductive portions of the machine formed by cylinder D to spindle a, and then through this spindle and the mercury, c, to core B. The current passes down core B to base A, with which the other side of line 3 is connected. The motor is thus brought directly into the translation-circuit and all the current supplied to the translating devices passes through it; but it is evident that the same result would be produced if the motor were located in a shunt around a definite resistance in line 3. The translating devices being in multiple arc, variations in the number of such devices produce direct variations in the current or energy consumed in the circuit and in the speed of the motor.

The field-coils of the motor are in a multiple-arc circuit, 5 6, from 3 4, all the bobbins B′ C′ being located in such circuit, and an additional resistance, R, being also preferably employed. The location of the field-magnet in a separate multiple-arc circuit makes the field a constant one, while all the variations are produced in the revolving one-part or straight inductive portion of the machine.

A permanent steel magnet can be used to produce the constant field; but I prefer to use the electro-magnet, as already described.

To prevent loss of energy by a flow of current through the field-circuit 5 6 when there is no translating device in circuit, I provide means for opening the circuit 5 6 when there is no translating device in circuit and for closing such circuit when a single translating device is placed in circuit. For this purpose an electro-magnet, G, is located in line 3, or in a shunt therefrom, between the translating devices and the street-mains, and controls a lever, g, in circuit 5 6, and closing circuit 5 6 at its front contact when a single translating device is in circuit, and opening such circuit at its back contact when the last translating device is removed from circuit.

The indicating or registering mechanism F may be operated by an electro-magnet, H, which is placed in circuit 7 8 between the wire 5 on one side of resistance R to a spring, h, mounted on an insulating-block on X and springing toward the spindle a of the revolving cylinder. This spring is prevented from striking the spindle by an insulated pin, i, on yoke a'; but once in every revolution of the cylinder it is struck by a metal pin, k, on the spindle a, closing circuit through the magnet H and giving one impulse to the indicating or registering apparatus. In this way the indicating or registering apparatus will indicate or register the revolutions of the cylinder. The indicating or registering apparatus may, however, be operated directly by the cylinder through suitable gearing, as shown in Fig. 4, the spindle a being provided with a worm, l, meshing with a worm-wheel, m, forming part of the indicator or register.

In order that the rotating shell may so perform its work that the speed of rotation will be directly proportionate to the current, the paddles upon the cylinder must be correctly proportioned and arranged in a proper manner.

Since the meter may be made of quite large size, and when so made will have a large initial friction, it is preferred for large-sized meters to make the cylinder-paddles loose and provide means for varying their dip in the mercury in proportion to the speed, in order to make the speed of rotation of the cylinder directly proportionate to the current. Such a construction is shown in Fig. 5, wherein the paddles e are mounted on a ring, n, connected with a centrifugal governor, I, mounted on the spindle a.

It is not essential that the shell D should revolve, since it may be held stationary and the magnetic core be arranged for revolution, as shown in Fig. 6. In that figure the shell D is held stationary in a suitable frame, (not shown,) while the core K revolves. This core may be a permanent magnet or be made of iron magnetized by bobbin K′, which may be stationary or be carried by the core. The mercury-trough E is carried by and revolves with the core, although it can be stationary and the core be provided with paddles dipping into the mercury. The core K is mounted on a spindle, p, turning in mercury, and may operate the indicator or register directly, as shown, or by closing at intervals a local circuit. The cylinder D and core K will be located in the line 3 of the translation-circuit, while the bobbin K' will be in a multiple-arc circuit from the translation-circuit. It is also not essential to have a field-magnet, since the cylinder will rotate if a helix, M, alone be used, as shown in Fig. 7; but by the use of iron less current is required to perform the work.

In Fig. 7 the cylinder D revolves upon a non-magnetic support, O, such support and the cylinder being located directly in the translation-circuit, while the helix M is in a multiple-arc circuit therefrom.

What I claim is—

1. In an electrical meter, the combination, with indicating or registering apparatus, of an electro-dynamic motor operating such indicating or registering apparatus and having its inductive portion in the translation-circuit, the electrical energy consumed in which is to be measured, and a multiple-arc circuit including the field-coils of such motor, substantially as set forth.

2. A mono-electro-dynamic motor, in combination with means for giving such motor a definite loading, and means for varying such load, to compensate for variations in proportionate friction, substantially as set forth.

3. In an electrical meter, the combination, with indicating or registering apparatus, of an electro-dynamic motor located in the translation-circuit, a multiple-arc circuit including the field-of-force coils of such motor, and means located in the translation-circuit for opening and closing such field-circuit when the last translating device is removed from circuit and the first one placed in circuit, substantially as set forth.

4. In an electrical meter, a non-commutator electro-dynamic motor provided with a single or straight inductive portion, and having the opposite poles of its field-magnet brought together on opposite sides of such inductive portion, in combination with a register operated or controlled by the motor, substantially as set forth.

5. In a mono-electro-dynamic motor forming the operative part of an electrical meter, the revolving cylinder forming the inductive portion of the motor, in combination with a register operated or controlled by the motor, substantially as set forth.

6. In a mono-electro-dynamic motor forming the operative part of an electrical meter, the combination, with a centrally-located pole and a surrounding pole, of a revolving cylinder mounted upon the centrally-located pole, and a register operated or controlled by the motor, substantially as set forth.

This specification signed and witnessed this 6th day of April, 1883.

THOS. A. EDISON.

Witnesses:

H. W. SEELY,

EDWARD H. PYATT.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

MANUFACTURE OF FILAMENTS FOR INCANDESCING ELECTRIC LIGHTS.

SPECIFICATION forming part of Letters Patent No. 370,124, dated September 20, 1887.

Application filed April 20, 1883. Serial No. 92,398. (No specimens.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in the Manufacture of Incandescing Conductors for Electric Lamps, (Case No. 561,) of which the following is a specification.

The object of this invention is to produce efficient and durable incandescing conductors for electric lamps, said invention consisting in a process of manufacturing carbon filaments to be used for this purpose.

This process may be generally described as follows: The filament of suitable material is first carbonized, then placed in a temporary vacuum-chamber and heated to high incandescence. It is then dipped in a solution of carbonizable material, dried and recarbonized, and is then ready for use. I prefer to employ filaments of natural vegetable fibrous material—such as bamboo—though I may employ paper or thread, and any of these materials may be parchmentized before carbonization, if desired. The filament is carbonized by heat in a closed flask or chamber, and under strain or pressure, or both. It is then placed in a receiver and connected in an electric circuit. The receiver is exhausted of air, the current is applied, and the filament is heated to a degree of incandescence higher than that at which it is intended to be permanently used. This sets the filament in its bent shape and renders it flexible and elastic. It is removed from this temporary receiver and dipped in a solution of sugar or other carbonizable material, with which it becomes impregnated, and any defective spots are filled with this carbonizable material. The filament is then recarbonized, preferably in a furnace, as before, the whole becoming a homogeneous structure. This is attached to wires and placed in the lamp globe, which is exhausted and sealed off in the usual manner. Instead of recarbonizing in a furnace, however, the filament may be placed in the lamp, said lamp exhausted, and the recarbonization accomplished by an electric current *in vacuo*.

What I claim is—

1. The process of making an incandescent conductor for electric lamps, consisting in first carbonizing a filament of suitable material, then heating said filament to incandescence in a vacuum, then dipping said filament into a solution of carbonizable material, and then carbonizing the whole, substantially as set forth.

2. The process of making an incandescent conductor for electric lamps, consisting in first carbonizing a filament of suitable material, then heating said filament to incandescence in a vacuum, then dipping said filament into a solution of carbonizable material, and then recarbonizing by electrical heating in a vacuum, substantially as set forth.

This specification signed and witnessed this 12th day of April, 1883.

THOS. A. EDISON.

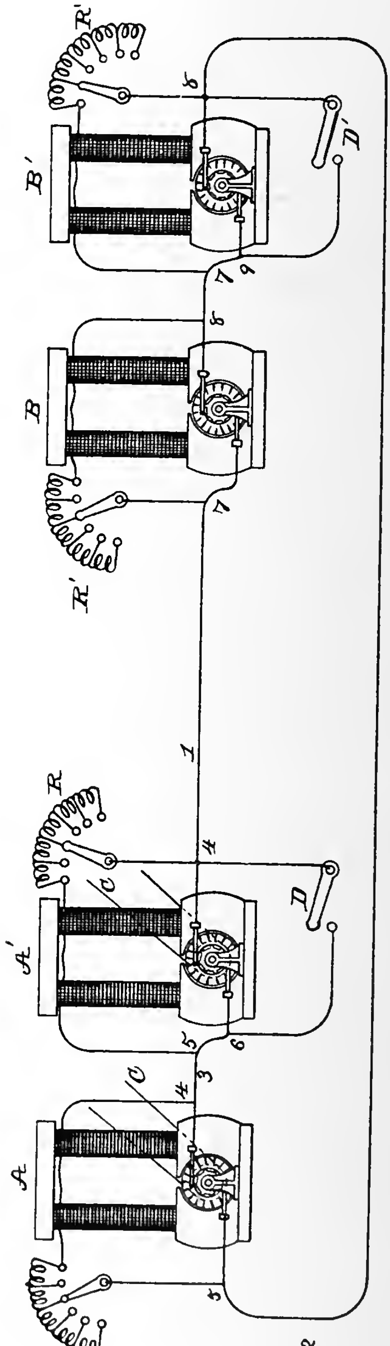
Witnesses:
H. W. SEELY,
EDWARD H. PYATT.

(No Model.)

T. A. EDISON.

ELECTRICAL TRANSMISSION OF POWER.

No. 370,125. Patented Sept. 20, 1887.



ATTEST:
E. C. Rowland
H. W. Seely

INVENTOR:
Thomas A. Edison
By Rich^d. N. Dyer,
Atty.

N. PETERS, Photo-Lithographer, Washington, D. C.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

ELECTRICAL TRANSMISSION OF POWER.

SPECIFICATION forming part of Letters Patent No. 370,125, dated September 20, 1887.

Application filed June 7, 1883. Serial No. 97,325. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Electrical Transmission of Power, (Case No. 567,) of which the following is a specification.

My invention relates to systems in which dynamo-electric generators and electro-dynamic motors are run in series, my object being to so arrange such machines that the generators and motors can be regulated independently each machine of each other machine, and so that any one machine may be cut out of circuit without affecting the others. In accomplishing this I place the two or more generators in series as to their armatures, but with their field-magnets each in a separate shunt-circuit provided with an adjustable resistance; and I also provide shunts around individual generators, provided with switches or circuit-controllers for cutting them out of circuit. The two or more motors I arrange and connect in the same way. The generators arranged in this way are independently controllable, as likewise are the motors.

If one or more of the motors be cut out of circuit, so that the remainder can be supplied by a less number of generators than those previously in use, one or more generators can be cut out, so that only enough current will be generated for the motors in use; or if the decrease in the number of motors is not sufficient to make it desirable to decrease the number of generators, the resistances in the field-circuits of the generators already in circuit would be increased to diminish the current generated. This arrangement is shown diagrammatically in the accompanying drawing.

A A′ represent dynamo-electric machines, and B B′ electro-dynamic motors. The generators A A′ are placed in series connected by a wire, 3, and 1 2 are the conductors of the main circuit extending from them. Their armatures are revolved by belts C, connecting them with a suitable source of power. The field-magnet of each machine is in a shunt-circuit, 4 5, and each field-circuit contains an adjustable resistance, R. Around the generator A′ a shunt, 4 6, is formed, provided with a circuit-controller, D, by closing which the generator is removed from circuit. The electro-dynamic motors B B′ are arranged in a similar manner, their fields being in shunts 7 8, and such shunts being each provided with an adjustable resistance, R′. The shunt 8 9 around the motor B′ contains a circuit-controller, D′, for cutting the motor out of circuit.

It is evident that as many generators as desired can be employed in connection with any desired number of motors. Any or all of them can be provided with shunts for throwing them out of circuit. It is also evident that this arrangement of generators can be employed in connection with a single motor or with any number of motors arranged in any convenient manner other than that described; or, vice versa, a single generator or a number arranged in any convenient way can be used in connection with a series of motors arranged and connected as described.

What I claim is—

1. The combination, with two or more dynamo or magneto electric machines connected in series and independently controllable, of two or more electro-dynamic motors also connected in series and independently controllable, substantially as set forth.

2. The combination of dynamo or magneto electric machines and electro-dynamic motors arranged in series, and means for regulating the current in the field-circuit of each generator and each motor independent of all the other generators and motors, substantially as set forth.

3. The combination, with dynamo or magneto electric machines and electro-dynamic motors arranged in series in a main circuit, of shunt-circuits, one including the field-coils of each generator or motor, and means for regulating the current in each shunt-circuit, substantially as set forth.

4. The combination, with dynamo or magneto electric machines and electro-dynamic motors arranged in series in a main circuit, of shunts around individual generators or motors, and a circuit-controller in each shunt, substantially as set forth.

5. The combination, with two or more dynamo or magneto electric machines arranged in series and connected with two or more independent electro-dynamic motors also arranged in series, of means for independently regulating each of said generators, and means for removing individual generators from circuit without affecting the other generators, substantially as set forth.

This specification signed and witnessed this 1st day of June, 1883.

THOS. A. EDISON.

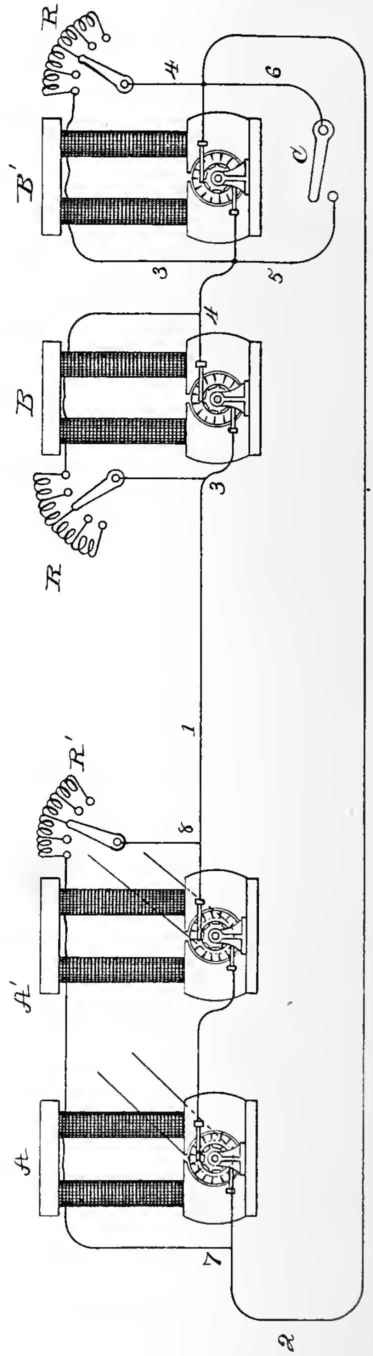
Witnesses:
H. W. SEELY,
EDWARD H. PYATT.

(No Model.)

T. A. EDISON.

ELECTRICAL TRANSMISSION OF POWER.

No. 370,126. Patented Sept. 20, 1887.



ATTEST:

E. C. Rowland,

H. W. Seely

INVENTOR:

Thomas A. Edison,

By Richd N. Dyer,

Atty.

United States Patent Office.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

ELECTRICAL TRANSMISSION OF POWER.

SPECIFICATION forming part of Letters Patent No. 370,126, dated September 20, 1887.

Application filed June 7, 1883. Serial No. 97,326. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Electrical Transmission of Power, (Case No. 568,) of which the following is a specification.

This invention relates to the running of independent electro-dynamic motors—that is, separate motors not connected with the same driving-shaft—by current produced by two or more electrical generators, and has for its object to regulate simultaneously the generation of current by such generators according to the number of motors in circuit from them or the speed at which such motor or motors are run. While such simultaneous regulation of the generators is applicable to the running of a single motor, or of a number of motors arranged in any suitable manner, yet I prefer to use it in connection with a number of independently-controllable electro-dynamic motors provided with means for removing individual motors from operation without affecting the remainder of the motors. The motors, therefore, are preferably arranged in series, with their field-coils in independent shunts, each shunt being provided with a regulating-resistance, and shunts are formed around the motors for cutting them out of circuit. There are, however, very many other ways in which the motors could be arranged. For instance, in multiple arc across main conductors, with their fields either in series or in separate multiple-arc circuits; or the fields may be energized from a separate local source and regulated simultaneously, the armatures being either in series or multiple arc.

In carrying out my invention the manner of arranging the generators so that they may be simultaneously regulated is as follows: The armatures of the two or more dynamo-electric machines which are employed as generators are placed in series, and the field-coils of all the machines are included in a single shunt-circuit. This circuit is provided with an adjustable resistance, by adjusting which the current in the shunt is regulated, and therefore the generation of current by all the machines is regulated simultaneously. This arrangement is illustrated diagrammatically in the accompanying drawing.

A A′ are dynamo-electric machines, and B B′ electro-dynamic motors. The motors B B′ are connected in series in the main circuit 1 2. The field-coils of each motor are in a shunt-circuit, 3 4, and each shunt-circuit is provided with an adjustable resistance, R. Around the motor B′ is formed a shunt, 5 6, provided with a circuit-controller, C, for cutting the motor out of circuit. The generators A A′ are also connected in series, and the main conductors 1 2 extend from them.

A shunt-circuit, 7 8, from the main conductors includes the coils of the field-magnets of both generators, and an adjustable resistance, R′, is placed in this shunt for regulating the generators simultaneously.

It is evident that any desired number of generators could be employed in connection with any number of independent electro-dynamic motors.

As motors are placed in or cut out of circuit, the resistance R′ is adjusted to regulate the generation of current according to these changes, so that current enough is always supplied for the motors in use.

What I claim is—

1. The combination, with mechanically-independent electro-dynamic motors, of two or more dynamo or magneto electric machines arranged in series connected with said motors, said machines having all their field-coils connected in one circuit, and said circuit being provided with an adjustable resistance, substantially as set forth.

2. The combination of two or more mechanically-independent electro-dynamic motors, with their armatures connected in series, a shunt around the armature of each motor, including its field-magnet coils, and an adjustable resistance in each shunt, with two or more dynamo-electric machines arranged in series connected with said motors, said machines having all their field coils connected in one circuit, and said circuit being provided with an adjustable resistance, substantially as set forth.

This specification signed and witnessed this 1st day of June, 1883.

THOS. A. EDISON.

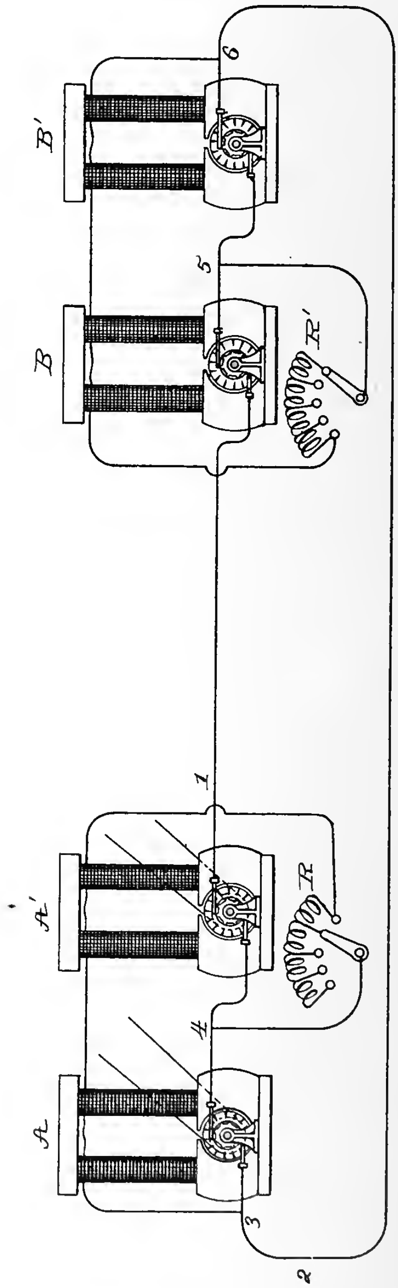
Witnesses:
H. W. SEELY,
EDWARD H. PYATT.

(No Model.)

T. A. EDISON.

ELECTRICAL TRANSMISSION OF POWER.

No. 370,127. Patented Sept. 20, 1887.



ATTEST:
E. C. Rowland
H. W. Seely

INVENTOR:
Thomas A. Edison,
By Richd. N. Dyer
Atty.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

ELECTRICAL TRANSMISSION OF POWER.

SPECIFICATION forming part of Letters Patent No. 370,127, dated September 20, 1887.

Application filed June 7, 1883. Serial No. 97,327. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Electrical Transmission of Power, (Case No. 569,) of which the following is a specification.

My invention relates to the running of two or more electro-dynamic motors mechanically independent of one another and connected electrically in series from a source of supply consisting of dynamo-electric machines also connected in series, and has for its object to enable all such motors to be regulated simultaneously and from a common point, to regulate all the generators simultaneously, so as to keep the generation of current proportioned to the amount utilized by the motors, and to enable the field-magnets of the motors and of the generators to be charged by currents of low electro-motive force, whereby coarse wire may be employed for the field-windings, and the danger of injury to such coils, which occurs with high-tension currents, is avoided. I accomplish this by placing the motors in series in the main circuit from the generators, and their fields in series in a shunt around one of the motors. Such shunt is provided with means for regulating the current flowing in it, and so regulating simultaneously the current supplied to the fields of all the motors. The generators are arranged in a similar manner with an adjustable resistance or other means for regulating their fields simultaneously. Thus, when the motors are regulated by reducing the current in their fields, so that less current is required to operate them, the generators, also, are correspondingly regulated, so that they supply only the proper amount of current, and when one or more motors are removed from operation the generators are regulated so as to supply only enough current to those remaining in use. By shunting all the fields of the generators and all the fields of the motors around a single generator or motor, respectively, such fields are supplied with currents of low electro-motive force or tension. Of course with a very large number of generators or motors the fields may be shunted around two or any other small part of the whole series of the machines, which arrangement is evidently equivalent for the purpose mentioned. This arrangement is illustrated diagrammatically in the accompanying drawing.

A A′ are dynamo-electric machines connected in series, and 1 2 are the main-circuit conductors extending from the series of generators. The feeders of both generators are in a shunt-circuit, 3 4, around the generator A, such shunt containing an adjustable resistance, R.

B B′ are electro-dynamic motors connected in series. Their fields are in a shunt-circuit, 5 6, around the motor B′. The motors, while independent in operation, may thus be regulated simultaneously by means of the adjustable resistance R′ in the shunt-circuit 5 6, which resistance controls the fields of all the motors.

What I claim is—

1. The combination, with two or more dynamo-electric machines arranged in series, of a shunt around one of said machines, including the field-magnet coils of all said machines, and means for regulating the current in said shunt, substantially as set forth.

2. The combination, with two or more dynamo electric generators arranged in series and having their field-magnet coils in series in a shunt around one of them, and means for regulating the current in said shunt, of two or more electro-dynamic motors arranged in series connected with said generators, having their field-magnet coils in series in a shunt around one of them, and means for regulating the current in said shunt, substantially as set forth.

This specification signed and witnessed this 1st day of June, 1883.

THOS. A. EDISON.

Witnesses:

H. W. SEELY,

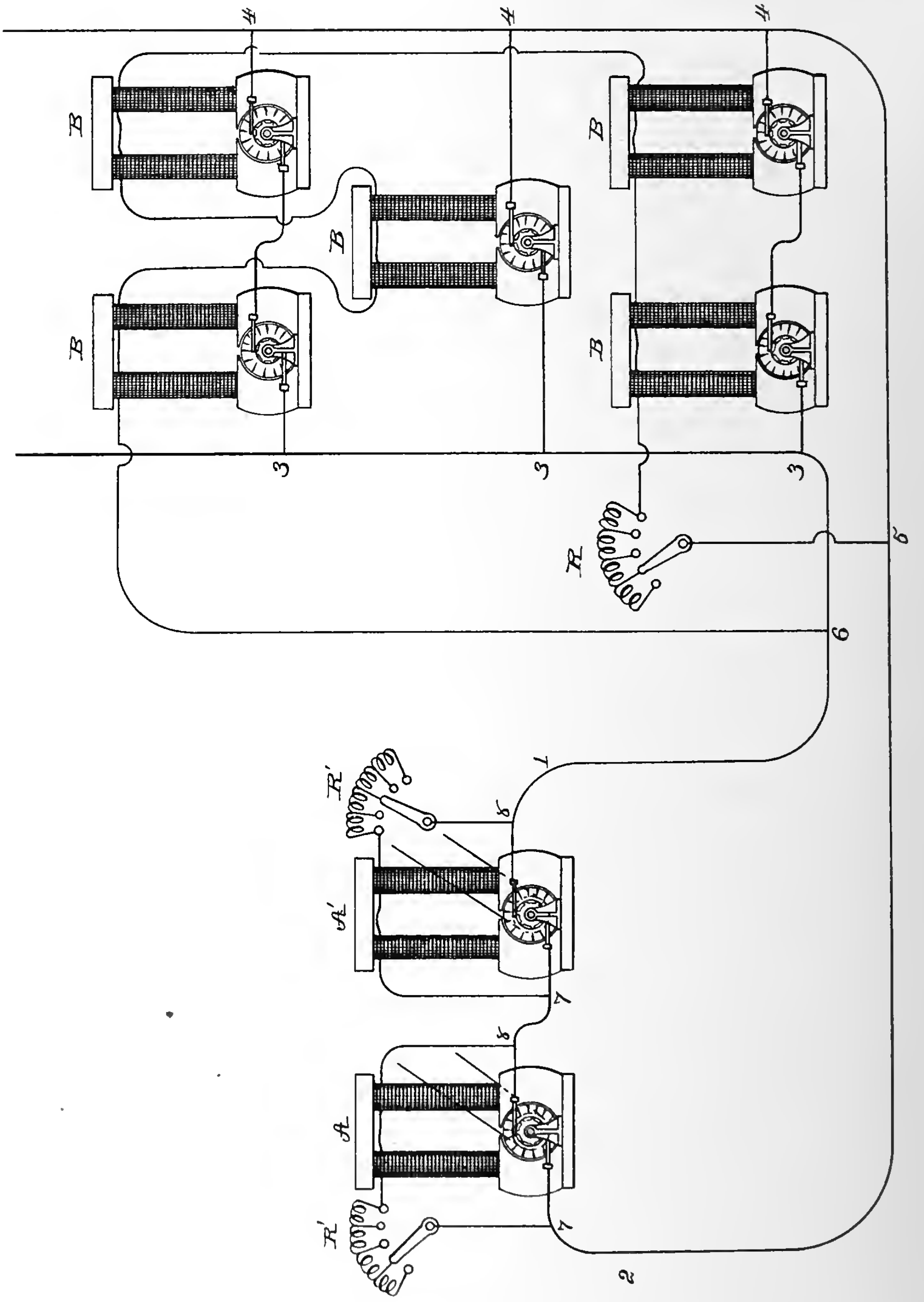
EDWARD H. PYATT.

(No Model.)

T. A. EDISON.

ELECTRICAL TRANSMISSION OF POWER.

No. 370,128. Patented Sept. 20, 1887.



ATTEST:

E. C. Rowland

H. W. Seely

INVENTOR:

Thomas A. Edison,

By Richd. N. Dyer,

Atty.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

ELECTRICAL TRANSMISSION OF POWER.

SPECIFICATION forming part of Letters Patent No. 370,128, dated September 20, 1887.

Application filed June 7, 1883. Serial No. 97,328. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Electrical Transmission of Power, (Case No. 570,) of which the following is a specification.

The object of this invention is to so arrange a number of independent electro-dynamic motors supplied from the same source of energy (that is, separate motors not attached to the same driving-shaft, as in my Patent No. 248,435,) that they may be controlled or regulated simultaneously, while they can be put in or removed from operation without affecting one another.

A further object is to cause the field-magnets of the motors when their armatures are on a high-tension line to be energized by a current of low tension.

In carrying out the invention, the source of energy may consist of any desired number of generators—preferably dynamo-electric machines. Such machines may be arranged in any suitable manner. Preferably they are placed in series, with their field-coils in shunts from the main line; or the field-coils could all be included in a single shunt around one or more or all of the machines. An adjustable resistance is placed in the field-circuit of each machine, or in the shunt including all the fields, whereby the generation of current is regulated according to the requirements of the motors supplied by the generators. The main conductors extend from the series of generators to the locality in which the electro dynamic motors are situated. Such motors are placed in multiple arc or multiple series across the main conductors—that is, cross-circuits are provided, each of which may contain one, two, or any desired number of motors. The fields of all the motors are placed in series in a multiple-arc circuit across the main conductors or in a shunt-circuit from one of them. An adjustable resistance or other means for regulating the current in the circuit which includes the fields is provided. By thus connecting all the fields in series, instead of connecting them separately across the line, the fields receive a lower tension-current, and they may therefore be wound with coarse wire, and the danger to the coils which arises with high-tension currents is avoided.

Each multiple-arc circuit, containing one or more motors, may, it is evident, be connected with or disconnected from the main conductors, so as to throw in or out of operation the motor or motors contained in such circuit, without affecting the motors in the other multiple-arc circuits of the system.

The generators which supply current to the system of motors are regulated as motors are thrown into or removed from operation, so that the proper current may always be supplied. The adjustable resistance in the field-circuit of all the motors is regulated to vary the speed of such motors.

My invention is illustrated diagrammatically in the annexed drawing.

A A′ are dynamo-electric machines arranged in series, so as to produce a current of high tension or electro-motive force. The main conductors 1 2 extend from the series of generators, of which there may be any desired number, two only being shown for illustration. Multiple-arc or derived circuits 3 4 extend across the main conductors. Each of such circuits includes the armatures of one or more of the electro-dynamic motors B. The field-coils of all these motors are in the multiple-arc circuit 5 6, which contains also the adjustable resistance R, by adjusting which the current in the fields, and consequently the speed of all the motors, is regulated. The field-coils of each generator are in a shunt-circuit, 7 8, and each shunt-circuit contains an adjustable resistance, R′.

The uses of the resistances R and R′ have been previously explained.

What I claim is—

1. The combination, with one or more dynamo or magneto electric machines, of main conductors extending therefrom, multiple-arc circuits extending across said main conductors, each containing one or more electro-dynamic motors, all such motors being mechanically independent of each other, a circuit including the field-magnets of all said motors, and means for regulating the current in said field-magnet circuit, substantially as set forth.

2. The combination, with two or more dynamo or magneto electric machines, means for regulating the generation of current thereby, and main conductors extending therefrom, of two or more mechanically-independent electro-dynamic motors connected in multiple arc or multiple series across said main conductors, a circuit including the field-magnets of all said motors, and means for regulating the current in said circuit, substantially as set forth.

This specification signed and witnessed this 1st day of June, 1883.

THOS. A. EDISON.

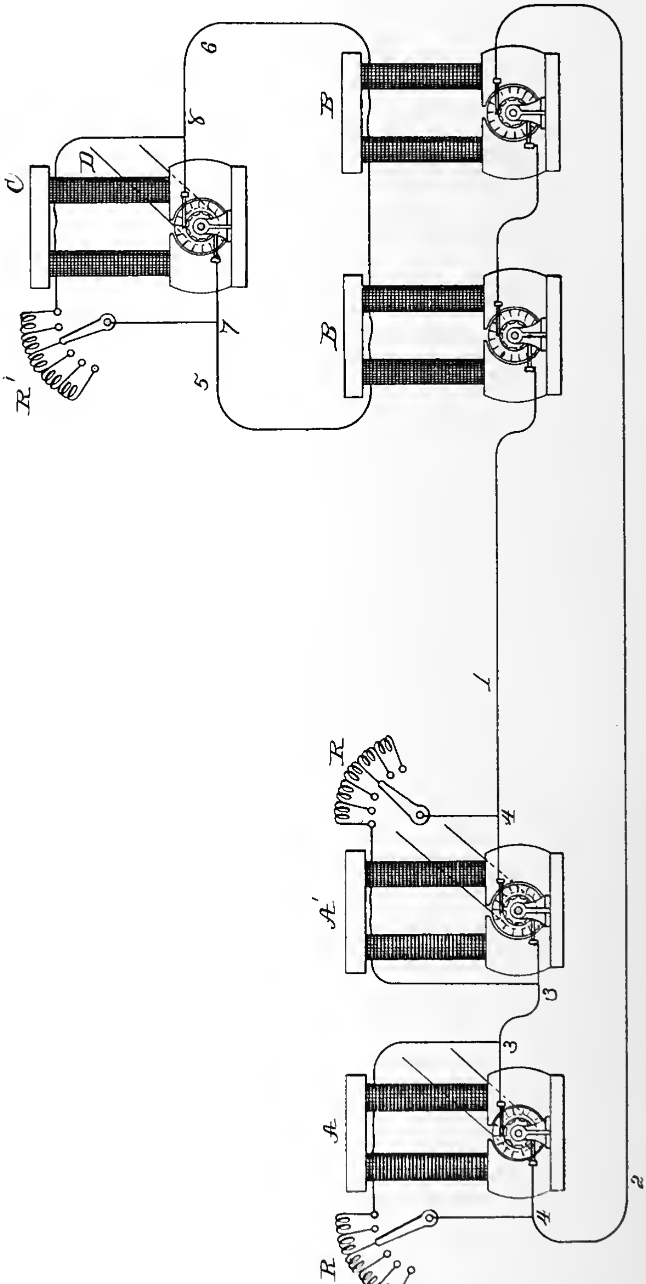
Witnesses:
H. W. SEELY,
EDWARD H. PYATT.

(No Model.)

T. A. EDISON.

ELECTRICAL TRANSMISSION OF POWER.

No. 370,129. Patented Sept. 20, 1887.



ATTEST:

E. C. Rowland

H. W. Seely

INVENTOR:

Thomas A. Edison.

By Rich^d. N. Dyer.

Atty.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

ELECTRICAL TRANSMISSION OF POWER.

SPECIFICATION forming part of Letters Patent No. 370,129, dated September 20, 1887.

Application filed June 7, 1883. Serial No. 97,329. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Electrical Transmission of Power, (Case No. 571,) of which the following is a specification.

This invention relates to operating independent electro-motors (that is, motors separate from each other and not placed on the same shaft, as is the case with those shown in my Patent No. 248,435 (by means of dynamo or magneto electric machines placed at a distant point, and my object is to make the regulation of the speed and power of such motors independent of the current on the supplying-circuit; and the invention consists in the use, in connection with two or more independent electro-dynamic motors operated by dynamo or magneto electric machines placed at a distance, of one or more dynamo or magneto electric machines operated by a local source of power for energizing the fields of said motors. Such local source of power may be either mechanical or electrical. The latter arrangement, however, will be the subject of a separate application for Letters Patent. By thus separately energizing the field-magnets, instead of placing them in connection with the line, the regulation is performed without affecting the line-current, and the fields are not affected by variations on the line.

In carrying out my invention I prefer to employ, as a source of electrical energy, two or more dynamo-electric machines connected in series for generating high-tension currents; but one generator alone might be used, if desired. Each machine preferably has its field-coils in a shunt from the main circuit, such shunts being each provided with an adjustable resistance for regulating the generation of current by the machine. The armatures of the two or more independent electro-dynamic motors are also preferably connected in series, and means may, if desired, be provided for cutting individual motors out of circuit without affecting the others of the series. The fields of these motors are connected, in series or otherwise, in a circuit leading from one or more dynamo or magneto electric machines operated by a suitable local source of mechanical energy. Such exciting machine or machines may be regulated in any suitable manner, so that the speed of the motors is correspondingly regulated. Such regulation is preferably accomplished by an adjustable resistance in the field-circuit of the exciter or exciters. This arrangement of generators, motors, and exciter is illustrated diagrammatically in the accompanying drawings.

A A′ are dynamo-electric machines, of which any desired number may of course be used. They are connected in series, and main conductors 1 2 extend from them. The field-coils of each generator are included in a shunt-circuit, 3 4, around its armature, and each of such shunts is provided with an adjustable resistance, R, for regulating the generation of current according to the requirements of the motors supplied.

B B represent any desired number of electro-dynamic motors placed in series in the main circuit 1 2.

C is a dynamo-electric machine, connected by a belt, D, with a local source of mechanical power. A circuit, 5 6, leads from the commutator-brushes of the generator C, and includes the field-magnet coils of both or all the electro-dynamic motors B B. A shunt-circuit, 7 8, includes the field-magnet coils of the generator C, and in said shunt is placed an adjustable resistance, R′, for regulating the generation of current by the exciter, and in consequence the speed of the motors B; but the exciter may be regulated in any other suitable manner. By thus energizing the fields of the motors from a local source less current is required to traverse the circuit 1 2, and the motors may be regulated or controlled at or near the locality where they are placed.

The main current being supplied from a water-power at a distance, a small steam-engine can be employed to energize the fields.

What I claim is—

1. The combination, with dynamo or magneto electric machines and electro-dynamic motors connected therewith, of a local source of electricity for energizing the fields of said motors, substantially as set forth.

2. The combination, with dynamo or mag-

neto electric machines and electro-dynamic motors connected therewith, of a mechanically-operated local source of electricity for energizing the fields of said motors, substantially as set forth.

3. The combination, with dynamo or magneto electric machines and electro-dynamic motors connected therewith, of a local source of electricity for energizing the fields of said motors and means for regulating the production of current by said source, substantially as set forth.

4. The combination, with one or more dynamo or magneto electric machines and two or more independent electro-dynamic motors arranged in series and connected therewith, of a local source of electricity for energizing the fields of said motors, substantially as set forth.

5. The combination of one or more dynamo or magneto electric machines, two or more independent electro-dynamic motors having their armatures connected therewith, and one or more dynamo or magneto electric machines for energizing the fields of said motors, substantially as set forth.

6. The combination, with two or more independent electro-dynamic motors, of one or more dynamo or magneto electric machines and a circuit therefrom, including the armatures of said motors arranged in series, and one or more other dynamo or magneto electric machines and a circuit therefrom, including, in series, the fields of said motors, substantially as set forth.

This specification signed and witnessed this 1st day of June, 1883.

THOS. A. EDISON.

Witnesses:

H. W. SEELY,

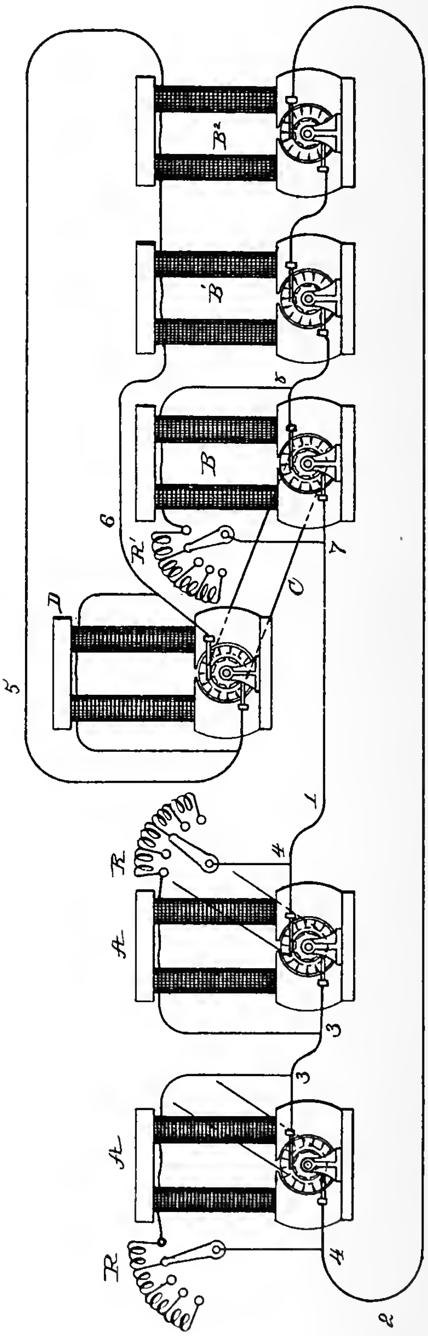
EDWARD H. PYATT.

(No Model.)

T. A. EDISON.

ELECTRICAL TRANSMISSION OF POWER.

No. 370,130. Patented Sept. 20, 1887.



ATTEST:

Edward C. Rowland

H. W. Seely

INVENTOR:

Thomas A. Edison,

By Richd N. Dyer,

Atty.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

ELECTRICAL TRANSMISSION OF POWER.

SPECIFICATION forming part of Letters Patent No. 370,130, dated September 20, 1887.

Application filed June 7, 1883. Serial No. 97,330. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Electrical Transmission of Power, (Case No. 572,) of which the following is a specification.

This invention relates to the operation of independent electro-dynamic motors, (that is, a number of separate motors not mounted upon the same driving-shaft, as in my Patent No. 248,435.)

My object is to enable all the motors of a series to be regulated simultaneously from a common point and in a simple and effective manner. In my application Serial No. 97,329 a series of motors is shown with the field-magnets thereof energized from a local mechanical source of power. In the present invention I desire to do away with this additional power, while at the same time I provide a separate regulable supply of current to the fields.

The invention consists in the employment of a local electrically-operated source of electricity for energizing the fields of the independent electro-dynamic motors, whose armatures are placed, preferably in series, in a circuit leading from one or more dynamo or magneto electric machines placed at a distance.

In carrying out the invention I connect one of the motors of the series by a belt or otherwise with a dynamo or magneto electric machine, and in the circuit of this machine I include the field-coils of all the other motors of the series. The motor used to operate the exciting-machine preferably has its field-coils in a shunt-circuit from the main line, and an adjustable resistance is placed in said shunt to regulate the speed of the motor, and consequently that of the exciting-machine and the current supplied to the fields of the other motors. The generators employed to operate the series of motors, if more than one are used, are preferably placed in series to generate a current of high tension. Their fields are energized, preferably, by shunt-circuits from the main line, and an adjustable resistance is placed in each shunt; or other means are provided for regulating the generation of current by the machines, either separately or simultaneously.

The invention is illustrated diagrammatically in the annexed drawing.

A A represent any desired number of dynamo-electric machines connected in series, from which main conductors 1 2 extend. The field-coils of each machine are in a shunt-circuit, 3 4, and each shunt contains an adjustable resistance, R, for regulating the generation of current by the machine.

Independent electro-dynamic motors B B′ B² are connected in series in the main circuit 1 2. From the armature-shaft of motor B a belt, C, extends to dynamo-electric machine D. From the generator D a circuit, 5 6, extends, including the field-coils of the motors B′ B².

It is evident that any desired number of motors may be placed in series; that, if desired, more than one of them may be employed for driving exciters, and that more than one exciter may be employed for the fields of the working motors.

The field of the motor B is in a shunt-circuit, 7 8, which contains an adjustable resistance, R′, by means of which the speed of the motor and of the exciter driven thereby is regulated, and the speed and power of all the motors of the series are thus regulated simultaneously by a single operator.

The field-circuit of the exciter D is a shunt from its own main circuit 5 6. This does not require a regulating-resistance, as the resistance R′ answers the purpose.

What I claim is—

1. The combination, with one or more dynamo or magneto electric machines and two or more mechanically-independent electro-dynamic motors connected therewith, of a local electrically-operated source of electricity for energizing the fields of said motors, substantially as set forth.

2. The combination, with one or more dynamo or magneto electric machines and two or more mechanically-independent electro-dynamic motors arranged in series connected therewith, of a local electrically-operated source of electricity for energizing the fields of said motors, substantially as set forth.

3. The combination, with one or more dynamo or magneto electric machines, of two or more mechanically-independent electro-dynamic motors connected therewith, and one or more other dynamo or magneto electric machines operated by one or more of said motors for energizing the field of the other motor or motors, substantially as set forth.

4. The combination, with one or more dynamo or magneto electric machines, of two or more mechanically-independent electro-dynamic motors connected therewith, one or more of said motors having their fields in a shunt or shunts from the main line and operating one or more dynamo or magneto electric machines for energizing the fields of the other motors, substantially as set forth.

This specification signed and witnessed this 1st day of June, 1883.

THOS. A. EDISON.

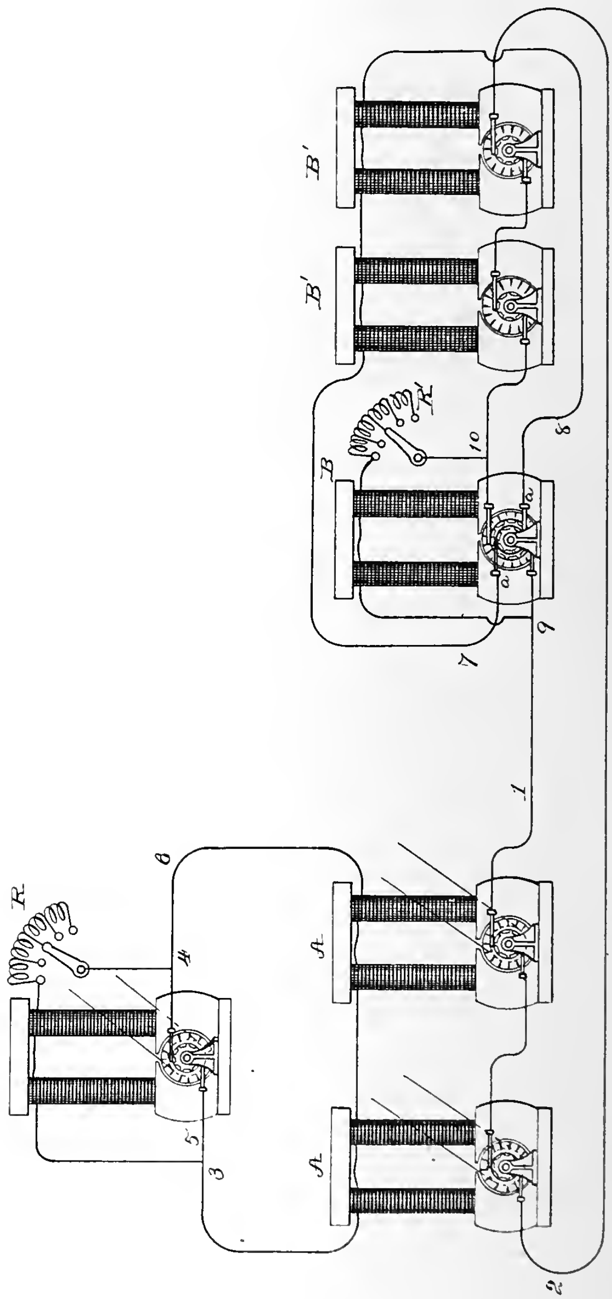
Witnesses:
H. W. SEELY,
EDWARD H. PYATT.

(No Model.)

T. A. EDISON.

ELECTRICAL TRANSMISSION OF POWER.

No. 370,131. Patented Sept. 20, 1887.



ATTEST:
E. C. Rowland,
H. W. Seely

INVENTOR:
Thomas A. Edison
By Rich.d N. Dyer
Atty.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

ELECTRICAL TRANSMISSION OF POWER.

SPECIFICATION forming part of Letters Patent No. 370,131, dated September 30, 1887.

Application filed June 7, 1883. Serial No. 97,331. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Electrical Transmission of Power, (Case No. 573,) of which the following is a specification.

The object of my invention is to effectively operate a number of independent electro-dynamic motors from dynamo or magneto electric machines placed at a distant source of power and to regulate all said motors simultaneously from a common point. By "independent" motors I mean mechanically separate from each other and not placed on the same driving-shaft, as is the case with those described in my Patent No. 248,435. In my application No. 97,330 is shown for this purpose a local electrically-operated source of electricity for energizing the fields of the motors, consisting of a generator run by a belt from one of the motors, whose circuit includes the fields of the motors, and the current generated by which is regulated to regulate the motors. By my present invention I do away with this separate generator; and to energize the fields of the motors I provide one or more combined motors and generators, each consisting of a field-magnet and a double-wound armature core. One set of coils on said core is connected in the circuit of the generators and acts as a motor to revolve the other set of coils between the poles of the field-magnet, so that the latter set generate current, being connected with a circuit including the field-coils of the series of independent electro-dynamic motors. As a source of supply for the motors, I prefer to employ a series of dynamo-electric generators, and I prefer to energize their fields by a single separate exciter, which is the best arrangement with generators in series. It is evident, however, that any other arrangement of generators may be employed in connection with the independent motors having the combined generator and motor for energizing their fields.

My invention is illustrated diagrammatically in the accompanying drawing.

A A represent any desired number of magneto-electric machines connected in series, from which main conductors 1 2 extend.

A′ is a dynamo-electric machine, having its field-coils in a shunt-circuit, 3 4, from the circuit 5 6, which includes the field-coils of the magneto-electric machines A A. An adjustable resistance, R, is placed in the shunt-circuit 3 4 for regulating the generation of current by the generator A′, and consequently that by the series of generators A A. The circuit 1 2 includes the motor-coils of a combined generator and motor, B, and the armatures of the electro-dynamic motors B′ B′.

The commutator of the combined generator and motor B, on which the brushes *a a* bear, is connected with its generator-coils, and from these brushes a circuit, 7 8, extends, which includes the field coils of the motors B′ B′.

The field-magnet of the combined generator and motor B is energized by a shunt, 9 10, from the main circuit 1 2, and this shunt contains an adjustable resistance, R′, by varying which the production of current is regulated and the speed of the motors B′ B′ is controlled.

The resistance R is adjusted to regulate the supply of current by the generators A A in accordance with the requirements of the series of motors.

I do not claim herein the series of generators with an exciter for all their fields, since this will form the subject of another application.

What I claim is—

1. The combination, with one or more dynamo or magneto electric machines, of two or more independent electro-dynamic motors connected therewith and a combined generator and motor having its motor-coils in the circuit of said generators and its generator-coils connected with the fields of said motors, substantially as set forth.

2. The combination of one or more magneto-electric machines, an exciting-machine for its or their field-magnets, two or more independent electro-dynamic motors connected with said magneto machines, and a combined generator and motor having its motor-coils in the circuit of said magneto-electric machines, and its generator-coils connected with the field-magnet coils of said electro-dynamic motors, substantially as set forth.

This specification signed and witnessed this 1st day of June, 1883.

THOS. A. EDISON.

Witnesses:

H. W. SEELY,

EDWARD H. PYATT.

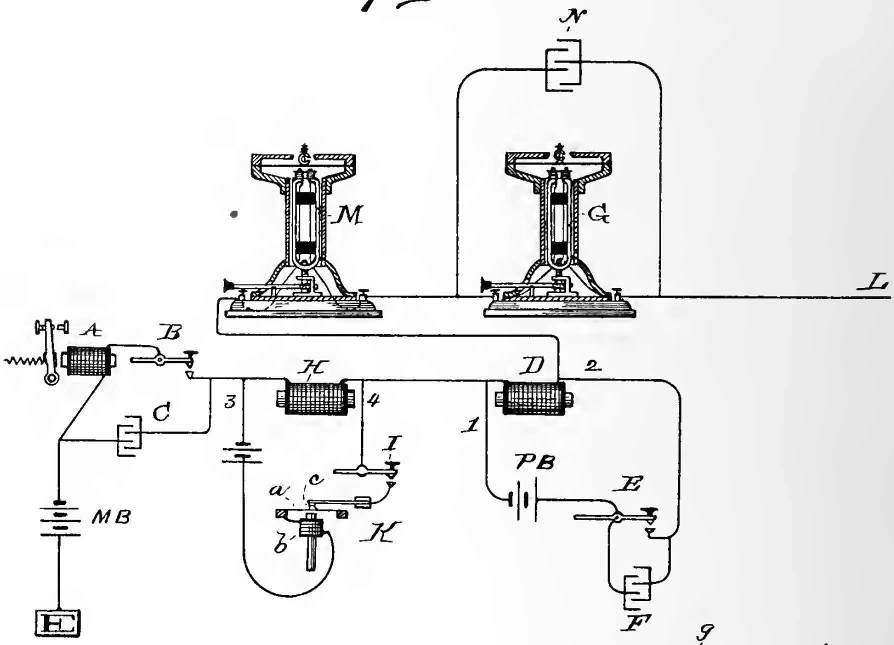
(No Model.)

T. A. EDISON.

TELEGRAPHY.

No. 370,132. Patented Sept. 20, 1887.

Fig. 1.



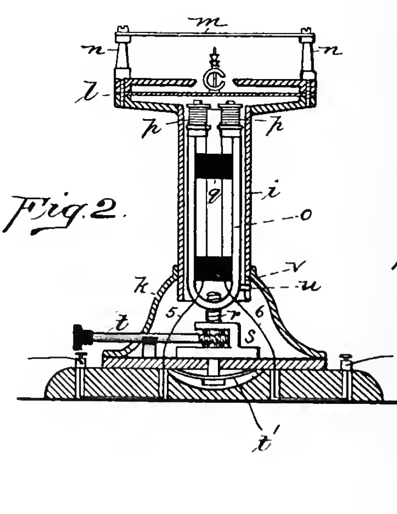


Fig. 2.

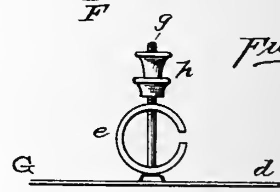


Fig. 3.

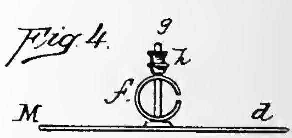


Fig. 4.

ATTEST:
E. C. Rowland
Wm. Pelzer

INVENTOR:
Thomas A. Edison
By Dyer & Seely
Attys

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

TELEGRAPHY.

SPECIFICATION forming part of Letters Patent No. 370,132, dated September 20, 1887.

Application filed May 15, 1886. Serial No. 202,226. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Telegraphy, (Case No. 664,) of which the following is a specification.

The object I have in view is to increase the capacity of telegraph-wires for way as well as terminal stations.

In my Patent No. 333,289 I double the capacity of such wires by the use, in addition to the ordinary Morse instruments, of induction apparatus which operates to transmit and receive Morse signals formed by induction impulses independently of and without interference from or with the ordinary Morse signaling-keys and relays. By my present invention I treble the capacity of the ordinary Morse way-line by the use of apparatus in many respects similar to the induction apparatus described in my said patent.

In carrying out my invention I use upon the same wire the ordinary Morse instruments, consisting of a line-battery, signaling-keys and relays, and also simple induction apparatus similar to that described in the patent referred to, the Morse keys being shunted by condensers to keep the line constantly closed for the induction impulses. In addition to the ordinary Morse and the simple induction apparatus I provide the line with a third class of signal transmitting and receiving apparatus. This, like the simple induction apparatus, also utilizes induction impulses; but instead of transmitting and receiving Morse signals by simple induction impulses of considerable strength, as does the simple induction apparatus, this third apparatus employs rapidly-occurring induction waves or vibrations which form a musical note, such note being divided at the transmitter into dots and dashes for producing Morse harmonic signals. The arrangement is such, as will be presently described, that the three classes of signals are independent.

The invention relates, further, to certain details of construction in the transmitting and receiving instruments.

In the accompanying drawings, forming a part hereof, Figure 1 is a view, principally in diagram, illustrating the invention; Fig. 2, an enlarged sectional view of one of the diaphragm-sounders, and Figs. 3 and 4 views showing the diaphragm-weights and their adjustment for the simple induction and harmonic sounders.

In Fig. 1 is illustrated the arrangement of apparatus at one station—a terminal station. This would be the same for all stations, except, of course, that at way stations there would be no line-battery. The line L L is the usual Morse line, with main battery M B, Morse relays A, and ordinary signaling-keys, B, the latter being shunted, preferably, by condensers C to keep the line closed for the induction impulses. With these ordinary Morse instruments telegraphing between all stations provided with them—both terminal and way—will be carried on in the usual manner by opening and closing the line-circuit of the battery M B. At each office there is also a set of simple induction instruments, comprising an induction-transmitter and a diaphragm sounder or receiver. The simple induction-transmitter is preferably composed of magnet-coils D, located directly in the line and shunted by circuit 1 2, including a battery, P B, and signaling-key E, the latter being shunted by a condenser, F, to sharpen the waves and absorb the spark. The simple induction-receiver is a diaphragm-sounder, G, which is preferably an instrument similar to an ordinary magneto-electric telephone-receiver, but differing therefrom in respects which will be pointed out.

By opening and closing the simple induction-transmitter shunt at key E the magnet-coils D will be charged and discharged, and simple induction impulses will be thrown upon the line, which will be responded to by the receiver G. The harmonic transmitter has magnet-coils H in the line, and shunt 3 4 around these coils includes a battery, H B, a signaling-key, I, and a vibrating circuit-controller, K. This last instrument has a diaphragm-armature, a, and a magnet, b, similar to a magneto-electric telephone-receiver. The diaphragm controls contact-points c, at which the shunt 3 4 is opened and closed, such points and the coils of b being directly in circuit 3 4. This form of circuit-controlling vibrator is highly efficient for giving rapid vibrations. The harmonic receiver is a diaphragm-sounder, M, located directly in the line. Upon the diaphragms d of G and M are mounted hopping weights e f. These are held loosely by pins g, rising from the center of the diaphragms and passing through such weights. Limiting-nuts h are screwed on the upper ends of the pins g. As will be seen by Figs. 3 and 4, the weight f of the harmonic sounder is much lighter than weight e of the simple induction-sounder, and while weight e is permitted a considerable movement on its pin, the limiting-nuts for weight f are adjusted so that this weight has an exceedingly small movement, which may not be more than one-thousandth of an inch. The diaphragm of M, carrying this light weight f, responds to the rapid or harmonic vibrations, which are not strong enough to sensibly disturb the heavier weight, e, which, however, responds to the strong simple induction-waves, and, in addition, the sounder G is shunted by a small condenser, N, which quite completely absorbs the rapidly-occurring but weak harmonic vibrations, so far as their effect upon this sounder is concerned. Thus the simple induction and harmonic instruments will be independent in their action of each other and of the ordinary Morse instruments, which are too sluggish to respond to the induced impulses.

The harmonic and simple induction receivers are both diaphragm-sounders of similar construction. These, as shown, have each an upright tubular body, i, resting on a hollow base, k. At the upper end of the tubular body i is a larger circular case, l, holding the horizontal metallic diaphragm. Through an opening in the center of the top of case l the diaphragm-weight projects, as shown. Above this is a horizontal plate, m, supported by posts n from diaphragm-case, the function of which is to protect the weight from accidental injury.

The magnet o is preferably an elongated horseshoe permanent magnet with its poles presented to the under side of the metal diaphragm and carrying coils p, the wires 5 6 from which run down through the tubular body and hollow base to binding-posts for circuit-connections. The sides of the elongated horseshoe-magnet o are connected by blocks q to give stiffness, and this magnet is supported in the tubular body by a vertical screw, r, which turns in its yoke and is adjusted by means of a worm, s, and a horizonal worm-spindle, t, a spring, t', being used to hold the parts in adjustment. A pin, u, on o works in slot v in tubular body to guide the magnet in its vertical movement.

Another peculiar feature is the construction of the diaphragm-weights. These are designed to increase the sound emitted by striking on the diaphragm. I prefer for this purpose a metal weight constructed to be resonant and made as a ring standing on edge, and preferably open at one side, as shown in the drawings, to increase the sound.

What I claim is—

1. In telegraphs, the combination, with a line-wire, of (a) sets of Morse telegraph-instruments consisting each of an ordinary relay and a signaling-key and shunt-circuits to keep the line constantly closed for induction impulses at the signaling-keys, (b) sets of Morse telegraph-instruments consisting each of an induction-transmitter producing Morse signals composed of simple induction impulses and a diaphragm-sounder responding to such simple induction impulses, and (c) sets of Morse telegraph-instruments consisting each of an induction-transmitter producing Morse signals composed of harmonic or rapidly-occurring induction vibrations and a diaphragm-sounder responding to such harmonic induction vibrations, substantially as set forth.

2. In telegraphs, the combination, with a line-wire, of (a) sets of Morse telegraph-instruments consisting each of an induction-transmitter producing Morse signals composed of simple induction impulses and a diaphragm-sounder responding to such simple induction impulses, and (b) other sets of Morse telegraph-instruments consisting each of an induction-transmitter producing Morse signals composed of harmonic or rapidly-occurring induction vibrations and a diaphragm-sounder responding to such harmonic induction vibrations, substantially as set forth.

3. In telegraphs, the combination, with a line-wire, of (a) sets of Morse telegraph-instruments consisting each of an induction-transmitter producing Morse signals composed of simple induction impulses, a separate source of electrical energy, and a diaphragm-sounder responding to such simple induction impulses, and (b) other sets of Morse telegraph-instruments consisting each of an induction-transmitter producing Morse signals composed of harmonic or rapidly-occurring induction vibrations, a separate source of electrical energy, and a diaphragm-sounder responding to such harmonic induction vibrations, substantially as set forth.

4. In telegraphs, the combination, with a line-wire, of sets of Morse telegraph-instruments, each consisting of an induction-transmitter producing Morse signals composed of simple induction impulses and a diaphragm-sounder, and other sets of Morse telegraph-instruments consisting each of an induction-transmitter producing Morse signals composed of harmonic or rapidly-occurring induction vibrations, and a diaphragm-sounder, the sounders of the two classes having diaphragm-weights of different weight and adjustment, substantially as set forth.

5. In telegraphs, the combination, with a line-wire, of sets of Morse telegraph-instruments, each consisting of an induction-transmitter producing Morse signals composed of simple induction impulses and a diaphragm-sounder, and other sets of Morse telegraph-instruments consisting each of an induction-

transmitter producing Morse signals composed of harmonic or rapidly-occurring induction vibrations and a diaphragm-sounder, the diaphragm-sounders of the first class of instruments being shunted by condensers, substantially as set forth.

6. In telegraphs, the combination, with a line-wire, of sets of Morse telegraph-instruments, each consisting of an induction-transmitter producing Morse signals composed of simple induction impulses and a diaphragm-sounder, and other sets of Morse telegraph-instruments consisting each of an induction-transmitter producing Morse signals composed of harmonic or rapidly-occurring induction vibrations, and a diaphragm-sounder, the sounders of the two classes having diaphragm-weights of different weight and adjustment, and the diaphragm-sounders of the first class of instruments being shunted by condensers, substantially as set forth.

7. In telegraphs, the combination, with a signaling-key, an induction device, and a source of electrical energy, of a transmitting self making and breaking vibrator, consisting of a magnet, a diaphragm-armature, and contact-points directly in circuit with said magnet and controlled by the movement of such diaphragm-armature, substantially as set forth.

8. In telegraphs, a harmonic Morse signal-transmitter having in combination magnet-coils in the line and a shunt connected with the line around such magnet-coils, said shunt including a battery, a circuit making and breaking vibrator, and a signaling-key, substantially as set forth.

9. In telegraphs, a diaphragm-sounder having in combination a vertical magnet, a horizontal diaphragm, a hopping weight on such diaphragm, and a horizontally-located adjusting-spindle for changing the vertical position of the magnet, substantially as set forth.

10. In telegraphs, the combination, in a diaphragm-sounder, of a horizontal diaphragm, a supporting-case for the same, a hopping weight and holding-pin mounted on said diaphragm and projecting upwardly from the same above the case, and a horizontal protecting-plate supported from said case and extending across the same above the hopping weight, substantially as set forth.

11. In telegraphs, the combination, with a diaphragm-sounder, of a diaphragm hopping weight consisting of a split ring standing on its edge on the diaphragm, substantially as set forth.

This specification signed and witnessed this 11th day of May, 1886.

THOS. A. EDISON.

Witnesses:

A. W. KIDDLE,

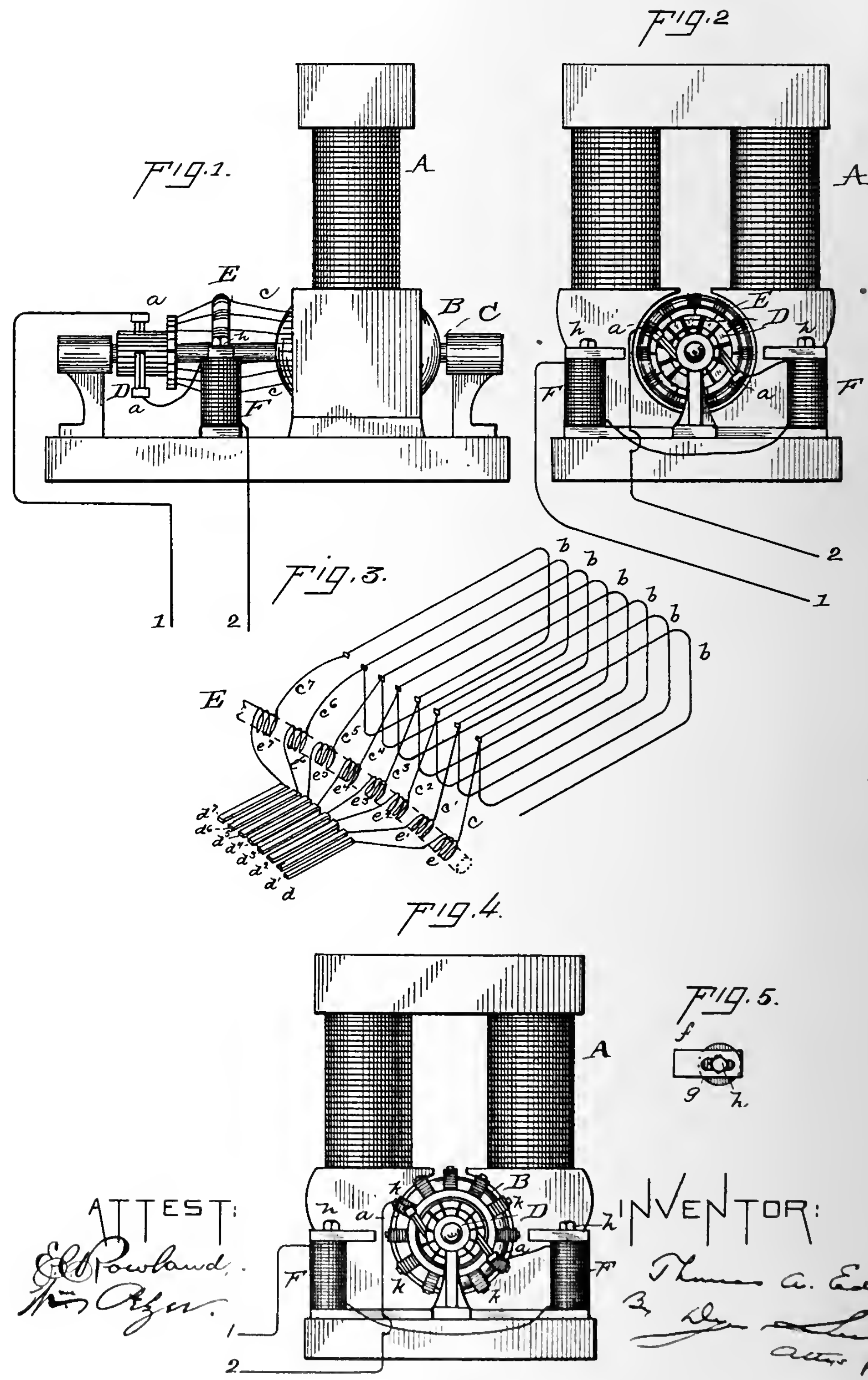
M. F. KELLY.

(No Model.)

T. A. EDISON.

DYNAMO ELECTRIC MACHINE.

No. 373,584. Patented Nov. 22, 1887.



ATTEST:

E. C. Rowland.

INVENTOR:

Thomas A. Edison

By Dyer & Seely Attys

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY.

DYNAMO-ELECTRIC MACHINE.

SPECIFICATION forming part of Letters Patent No. 373,584, dated November 22, 1887.

Application filed December 28, 1886. Serial No. 222,755. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Dynamo-Electric Machines, (Case No. 714,) of which the following is a specification.

The object of my invention is to avoid the spark which occurs at the commutator of a dynamo electric machine, due to the breaking of the short circuit through an armature-coil, arising when two blocks of a commutator are bridged by a brush. I accomplish this by making each connection from the armature-coils to the commutator through an extra coil revolving in an extra field of force, such extra coils being so arranged that at the moment of bridging two commutator-blocks one of said extra coils is in a condition to generate an electro-motive force contrary to that in the short-circuited armature-coil, whereby when the short circuit is broken the discharge and spark due to such breaking are prevented. I prefer to place upon the armature-shaft, between the armature and commutator, a ring-armature wound with or otherwise carrying several separated coils of wire, each of which coils is included directly in one of the connections which extend at intervals from the continuously-wound armature-coil to the different metal blocks of the commutator. A small magnet is placed with its poles on opposite sides of this ring, such poles being very narrow and adjusted close to the ring, and the coils on the ring being so far separated that only two coils directly opposite each other on the ring are ever in such position relative to the poles at any one time as to generate any appreciable electro-motive force. The direction of winding of the coils on the ring is such that the electro-motive force generated in them is opposed to that generated by the short-circuiting of an armature-coil. The small extra field-magnet preferably has its coils directly in the armature-circuit of the machine, so that the electro-motive force in the extra coils varies with that in the armature-coils.

Instead of winding a number of separate coils on a ring, I may have an equal number of small electro-magnets projecting radially from a ring on the shaft, the coils of each magnet being connected like the ring-coils already described, and the effect being the same.

My invention is illustrated in the annexed drawings, in which—

Figure 1 is a side view of a dynamo electric machine embodying my invention, with the ring form of extra armature; Fig. 2, a front view of the same; Fig. 3, a diagram illustrating the armature-connections; Fig. 4, a front view of a dynamo with the modified form mentioned for the extra coils, and Fig. 5 a top view of one of the poles of the extra field-magnet.

A is the field-magnet, B the armature, C the armature-shaft, and D the commutator-cylinder, of a dynamo-electric machine.

a a are the commutator-brushes.

I have shown in Fig. 3 the ordinary Edison winding, though my invention is applicable to any continuously-wound armature. The armature-coils *b b* are wound as shown, each coil being brought around the armature and connected at its ends by connections *c c'*, &c., to two consecutive commutator-blocks, d d' or d^2 d^3, &c.

It will be seen that when any two commutator-blocks are bridged by a brush the coil connected therewith will be short-circuited, and when the brush moves on and breaks the bridge the short circuit will be broken and a discharge-spark will occur on the commutator-cylinder. To obviate this I make use of the following devices:

Referring to Figs. 1, 2, 3, and 5, an iron ring, E, is mounted on the shaft between armature B and commutator D. The wires *c c'*, &c., extending from armature-coils to commutator-blocks, are each wound in a small coil, *e e'*, &c., around the ring E, the coils being separated upon the ring, as shown. The direction of winding of these coils is such, as already explained, as to generate counter electro-motive force opposed to that in the short-circuited armature-coils.

F is the extra field-magnet, placed on the base-plate of the machine, and having narrow pole-pieces *f f* extending close to the ring G. These pole-pieces are preferably made adjustable by means of slots *g* and bolts and nuts *h*. The coils of the magnet F are directly in the main circuit 1 2, extending from the brushes *e e*.

In the construction shown in Fig. 4 the magnet F is constructed and arranged as above described. Upon a ring, G, on the shaft are a number of radially-projecting electro-magnets, k k, whose coils are wound and connected in the same way relative to the armature-coils and commutator-bars as the coils e on ring E in the other form. It is evident therefore that the coils of these magnets will have the same effect as the said coils e.

The operation is as follows: Suppose the brush on one side to bridge the commutator-bars d and d', and so short-circuit the armature coil connected between said blocks. Then with the parts arranged as shown and described the extra coil e' will be opposite the poles of magnet F, and will therefore generate a certain counter electro-motive force opposed to that in the short-circuited coil b, whereby the spark due to the breaking of the short circuit is obviated. At the same time bars on the opposite side of the commutator-cylinder are short circuited—for instance, d^6 and d^7—and then coil e^7 will be in the position to generate the opposing electro-motive force. As the commutator revolves and other coils are short-circuited, the extra coil for each armature-coil is brought in front of the extra magnet-poles and generates the necessary opposing electro-motive force. Since the coils of the extra field-magnet are in the armature-circuit, the strength of the extra field varies with the armature-current, and therefore the opposing electro-motive force always varies with the electro-motive force in the armature-coils. The adjustability of the pole-pieces permits them to be adjusted to such position as to generate the proper electro-motive force at the starting of the machine, after which the magnet takes care of itself.

By the use of my invention the necessity for changing the position of the commutator-brushes with variations in the load upon the machine is obviated, and the brushes may always be kept at the points of greatest generation, as they are shown in the drawings.

It is evident that my invention is equally applicable to dynamo electric machines used either as generators or as motors.

What I claim is—

1. In a dynamo-electric machine, the combination, with the field magnet, the armature, and the commutator, of an extra field of force and extra inducing-coils therein, such coils producing a counter electro-motive force in the armature-coils short circuited by the commutator-brushes, substantially as set forth.

2. In a dynamo-electric machine, the combination, with the field-magnet, the armature, and the commutator, of an extra magnet in the armature-circuit and extra inducing-coils producing a counter electro-motive force in the armature-coils short-circuited by the commutator brushes, substantially as set forth.

3. In a dynamo-electric machine, the combination, with the field-magnet, the armature, and the commutator, of extra inducing-coils so arranged and situated that as each armature-coil is short-circuited one of said extra coils will produce a counter electro-motive force therein, substantially as set forth.

4. In a dynamo electric machine, the combination, with the field-magnet, the armature, and the commutator, of extra inducing-coils, each interposed in a connection between the armature-coils and the commutator-bars, and an extra field of force for said coils, substantially as set forth.

5. In a dynamo electric machine, the combination, with the field-magnet, the armature, and the commutator, of an extra field-magnet, extra coils carried by the armature-shaft and revolving between the poles of said magnet, and wound so as to produce a counter electro-motive force in the armature-coils short-circuited by the commutator-brushes, substantially as set forth.

6. In a dynamo-electric machine, the combination, with the field-magnet, the armature, and the commutator, of an extra magnet, a ring on the armature-shaft revolving between the poles of said extra magnet, and a number of separated coils on said ring, each included in a connection between the armature-coils and the commutator-bars, and said coils being so wound as to produce an electro-motive force opposed to that of the armature-coils short-circuited by the commutator-brushes, substantially as set forth.

7. In a dynamo electric machine, the combination, with the field-magnet, the armature, and the commutator, of the extra inducing-coils and the extra field-magnet having adjustable pole-pieces, substantially as set forth.

This specification signed and witnessed this 21st day of December, 1886.

THOS. A. EDISON.

Witnesses:

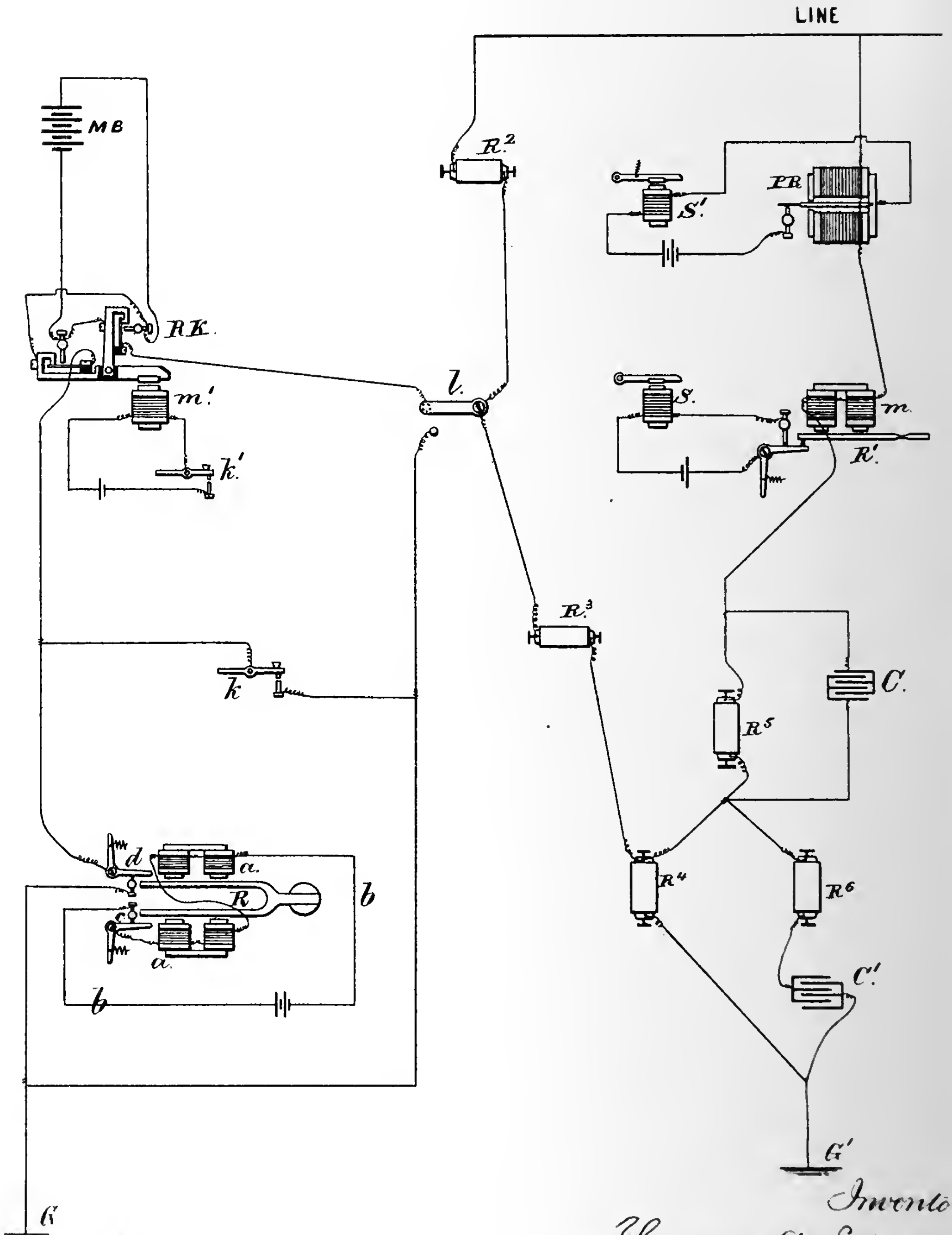
WM. PELZER.

E. C. ROWLAND.

T. A. EDISON.

TELEGRAPHY.

No. 377,374. Patented Feb. 7, 1888.



Witnesses.

Chas. H. Smith.
Harold Terrell.

Inventor

Thomas A. Edison.

for Lemuel W. Serrell.

Atty.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, ASSIGNOR TO THE WESTERN UNION TELEGRAPH COMPANY, OF NEW YORK.

TELEGRAPHY.

SPECIFICATION forming part of Letters Patent No. 377,374, dated February 7, 1888.

Application filed May 14, 1877.

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented an Improvement in Acoustic Telegraphs, of which the following is a specification.

This invention relates to the combination, in a telegraph system, with the line-wire and a battery, of a circuit preserving and reversing key, a vibrating circuit-breaker and a short-circuiting key at the transmitting-station, and a polarized relay and a reed or vibrating receiver and sounder at the other station, whereby one set of signals can be operated upon the line by the vibrations of the current and the key to short-circuit the same, and the other set of signals can be operated by the reversal of the current.

In the diagram annexed, R is a reed, fork, or equivalent vibrator kept in motion by the magnets *a*, local circuit *b*, and circuit-closer *c*. In the circuit between the earth G and battery M B is the circuit-closer *d*, that is opened and closed by the action of the reed R; and *k* is a key in the shunt-wire that passes around the circuit-closer *d*, so that when this key *k* is open the main battery will be pulsated over the line by the reed R and contact-point *d;* but when the key *k* is closed the pulsations will stop in consequence of the metallic connection being uninterrupted. At the receiving-station the reed R′ will be vibrated by the line-pulsations by the magnet *m* in the bridge-wire, but it will cease when *k* is closed. The signal will be given either by opening or closing the key *k*, according to the arrangement of the local circuit and sounder S, operated by the reed R′.

The reversing key R K is of ordinary construction, operated either by hand or, preferably, by the key *k′* and local circuit and magnet *m′;* and at the receiving-station the polarized relay P R responds to the reversals of current and gives the signals in the local circuit and sounder or other receiver, *s′*. The switch *l* serves to connect the line and artificial line directly to the earth to facilitate the adjustment of the distant receiving-instruments. The rheostats R^2 R^3 R^4 serve to proportion the resistance of the line and artificial line to G′, and the condenser C neutralizes the static charge and discharge in the bridge, and the condenser *c′* acts similarly in relation to the ground and artificial-line currents, the rheostats R^5 R^6 serving to proportion the resistance that diverts the currents to the condensers.

It will be evident that two reeds of different tone may be used for transmitting and corresponding reeds for receiving, so as to operate as a multiplex telegraph.

In Letters Patent No. 217,781, granted to me July 22, 1879, an instrument is shown that acts by electro-harmonic pulsations in the same circuit with instruments that respond to rise and fall of tension and change of electric polarity. In this application I have confined myself to the relay-instrument and the reed or reeds, so as to show the simpler forms of connections and to illustrate the manner in which the Morse system can be used with a harmonic or acoustic instrument without one interfering with the other.

I claim as my invention—

1. In a telegraphic system, the combination, with a line-wire and battery, of a circuit preserving and reversing key, a vibrating circuit-breaker and a short-circuiting key at the transmitting-station, a polarized relay, and a reed or vibrating receiver and sounder at the other station, substantially as set forth.

2. In a telegraphic system, the combination, with the main line, of a battery, a circuit preserving and reversing key, a vibrator, a magnet and local circuit for operating the same, yielding contacts *c d*, and a short-circuiting key and connections at the transmitting-station, and a polarized relay and sounder and a vibrating receiver and sounder at the receiving-station, substantially as set forth.

3. The combination, in a telegraphic system, of a reed or vibrating receiver, one transmitter composed of a vibrating circuit-breaker and short-circuiting-key, the other transmitter consisting of a circuit preserving and reversing key, and a polarized receiving-magnet to respond to the same, substantially as set forth.

Signed by me this 8th day of May, A. D. 1877.

THOS. A. EDISON.

Witnesses:

GEO. T. PINCKNEY,
HAROLD SERRELL.

(No Model.)

T. A. EDISON.

MAGNETIC SEPARATOR.

No. 377,518. Patented Feb. 7, 1888.

Fig. 1.

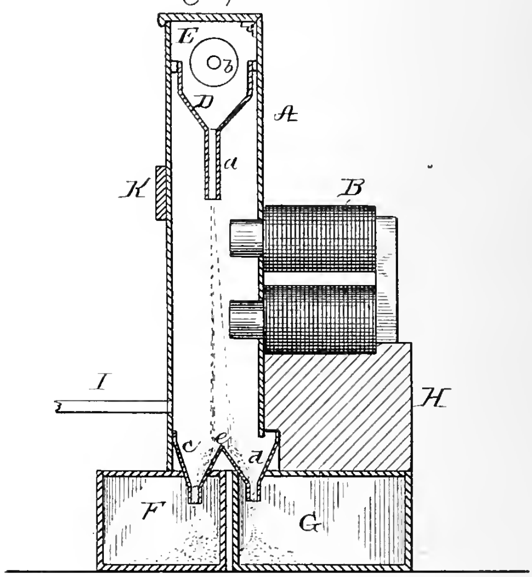
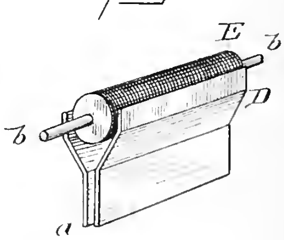


Fig. 2.



ATTEST:

E. C. Rowland

INVENTOR:

Thomas A. Edison

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY.

MAGNETIC SEPARATOR.

SPECIFICATION forming part of Letters Patent No. 377,518, dated February 7, 1888.

Application filed July 6, 1887. Serial No. 243,490. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Magnetic Separators, (Case No. 725,) of which the following is a specification.

My invention relates to magnetic separators in which the separation of magnetic from non-magnetic particles is accomplished by permitting them to fall together past the poles of a magnet, which alters the trajectory of the magnetic particles, so that they fall separately from the non-magnetic ones.

The object of my invention is to cause the material to fall in a straight and even stream past the magnet-poles and to prevent the particles from being affected by drafts of air.

To this end my invention consists partly in the use of a closed air-chamber, through which the material is caused to fall, whereby it is protected from air-currents, and also in the use of such closed air-chamber when it has its atmosphere rarefied or a portion of its air removed, which is advantageous in the case of very light or finely-divided material, as the rarefied atmosphere will not affect the direction of falling of the particles.

In addition to these features of invention, my invention consists in the various novel devices employed by me in accomplishing the above-named object, as hereinafter set forth and claimed.

My invention is illustrated in the accompanying drawings, in which—

Figure 1 is a view in elevation of apparatus embodying my invention, with the chamber in section; and Fig. 2, a perspective view of the feeding device.

A is a box, chamber, or shaft, preferably made of wood. B is a powerful electro-magnet placed outside of said chamber, but preferably with its poles extending through into the chamber. The top of the chamber is closed by a hinged cover, C. Within the chamber, near its top, is supported a hopper, D, which is a box with inclined sides and with a straight-sided narrow feeding-passage, *a*, at its bottom. Within the hopper, or immediately above it, is placed a cylindrical sieve, E, on a shaft, *b*, which turns in bearings in the walls of the chamber and may be revolved in any suitable way. At the lower end of the chamber are two inclined troughs, *c* and *d*, with open bottoms, opening, respectively, into closed bins or receptacles F and G. The dividing-point *e* between the troughs is to one side of the feed-passage *a*, so that material falling straight from said passage enters the bin F. The magnet B has a support, H, or is otherwise supported with its poles a little below the feeding-passage *a*.

The mixture of finely-divided magnetic and non-magnetic material, which may be of gold mixed with iron particles, or of iron and sand, is placed in the sieve E, and on the same being revolved the fine particles are fed from the sieve, those which are too coarse to be effectively operated upon being retained thereby. The narrow straight-sided feeding-passage causes the material to assume a straight course in falling from the hopper. It thus falls in the closed air-chamber straight past the poles of the magnet and the attraction of the magnet alters the trajectory of the magnetic portion of the stream, so that this falls separately from the rest and enters the trough *d* and bin G. Being in a closed space, there can be no drafts of air which would alter the direction of either of the falling streams and prevent the particles from reaching their respective receptacles. If the particles are very fine or light, as where the material must be ground very fine to liberate the gold, I prefer to exhaust or rarefy the air in the chamber, so that the resistance of the air will not affect its fall. When it is desired to do this, suitable rubber packing is provided for the cover C and around the poles of the magnet, and stuffing-boxes for the shaft of the feeding-sieve, so that the chamber is made sufficiently air-tight. A pipe, I, extends from the chamber, which is connected to an ordinary steam vacuum apparatus by which the air is exhausted, say to a twenty-nine-inch column of mercury, which is sufficient for the purpose.

Since it is necessary or desirable that the poles of the magnet should be near the end of the feeding-passage *a*, the attraction might draw the magnetic particles to one side of the passage and cause the clogging of the opening. To obviate this I place upon the wall of the chamber, opposite the end of the feeding-passage, a heavy piece of iron, K, whose counter attraction holds the particles straight in the passage, so that they have the proper vertical direction when they leave the same.

What I claim is—

1. In a magnetic separator, the combination of a closed air-chamber, feeding devices at the top of the chamber and receptacles at the bottom, and a magnet for altering the trajectory of falling magnetic particles in said chamber, substantially as set forth.

2. The method of separating magnetic from non-magnetic materials, consisting in causing the mingled materials to fall past the poles of a magnet in a closed chamber from which a portion of the air has been removed, whereby the trajectory of the magnetic material is altered, substantially as set forth.

3. In a magnetic separator, the combination of a closed chamber from which a portion of the air is exhausted, feeding devices at the top of the chamber and receptacles at the bottom, and a magnet for altering the trajectory of falling magnetic particles in said chamber, substantially as set forth.

4. In a magnetic separator, the combination, with the horizontally-placed magnet, of the narrow straight-sided feeding-passage above said magnet, whereby the material is delivered past the poles of said magnet in a thin stream, substantially as set forth.

5. In a magnetic separator, the combination, with the feeding-passage, of the magnet below the same on one side, and an opposing magnetic device on the other side of said passage, substantially as set forth.

This specification signed and witnessed this 30th day of June, 1887.

THOS. A. EDISON.

Witnesses:
WILLIAM PELZER,
E. C. ROWLAND.

(No Model.)

2 Sheets—Sheet 1.

T. A. EDISON.

TELEPHONE TRANSMITTER.

No. 378,044.

Patented Feb. 14, 1888.

Fig. 1.

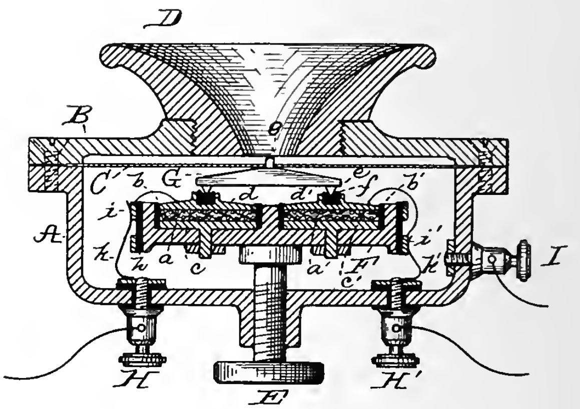
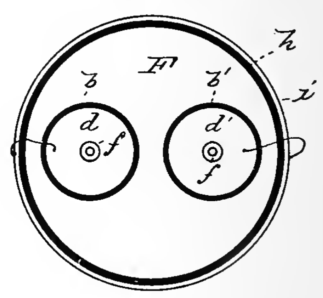


Fig. 2.



ATTEST:

E. C. Rowland

J. G. Greene Jr

INVENTOR:

Thomas A. Edison.

By Dyer & Seely.

Attys

(No Model.) 2 Sheets—Sheet 2.

T. A. EDISON.

TELEPHONE TRANSMITTER.

No. 378,044. Patented Feb. 14, 1888.

Fig. 3

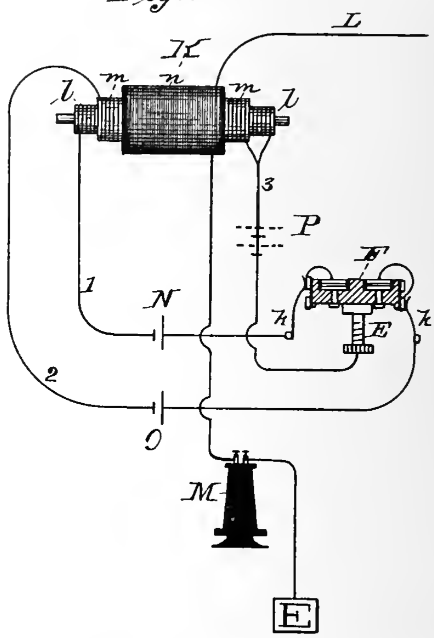
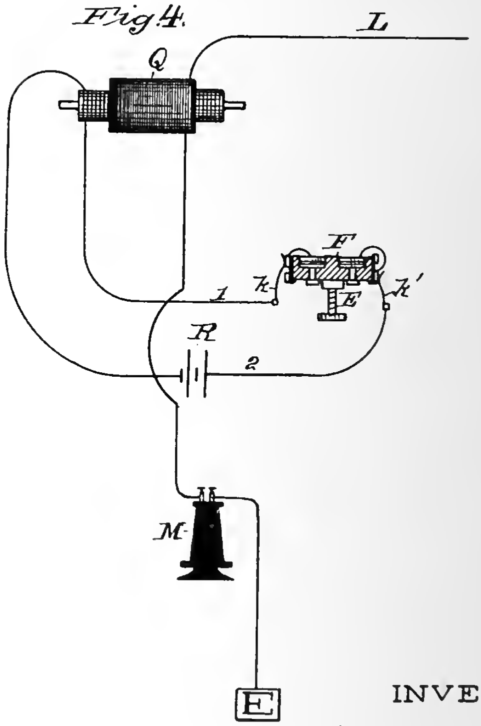


Fig. 4.



ATTEST:

E. C. Rowland

H. W. Seddle

INVENTOR:

Thomas A. Edison.

By Dyer & Seely.

Attys.

N. PETERS, Photo-Lithographer, Washington, D. C.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

TELEPHONE-TRANSMITTER.

SPECIFICATION forming part of Letters Patent No. 378,044, dated February 14, 1888.

Application filed October 14, 1885. Serial No. 179,868. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Telephone-Transmitters, (Case No. 646,) of which the following is a specification.

My invention relates to electric telephone-transmitters, preferably of the class employing carbon buttons; and my object is to produce a simple and efficient multiple instrument of this character and an arrangement for working multiple instruments in circuit which will be more effective than those heretofore proposed.

In the accompanying drawings, forming a part hereof, Figure 1 is a vertical section of the transmitter; Fig. 2, a top view of the electrode-carrier; Fig. 3, a view, principally in diagram, showing the preferred arrangement of the instrument in circuit; and Fig. 4, a similar view of an arrangement that may be employed.

The case of the instrument is preferably of metal, made in two parts, A B, between which is clamped the diaphragm C, of metal or mica. The part B of the case comes to mouth-piece D. Centrally in part A of the case is a metal adjusting-screw, E, which carries a metal plate, F. This plate is the carbon-button carrier. It is shown as carrying two carbon buttons; but a greater number may be used. This plate F has on its face two circular receptacles with metal plates *a a'* in their bottom. These receptacles have rings *b b'* of insulating material—such as hard rubber—which rings insulate the carbon buttons and superimposed plates from the carrier. Upon plates *a a'* are carbon buttons *c c'*, and above these are metal plates *d d'*, upon which bear the arms of a yoke, G. Points *e* on the yoke-arms enter sockets *f*, of insulating material, carried by plates *d d'*. The yoke G has on its back a central stud, *g*, which enters a central opening in the diaphragm and is adapted to turn freely therein.

The periphery of plate F is faced with insulation, *h*—such as hard rubber—and upon this insulating-face are secured metal rings *i i*, one for each carbon button. These rings are connected with the plates *d d'*, as shown, ring *i* being connected electrically by a fine wire with plate *d* and ring *i'* with plate *d'*. Insulated binding-posts H H' have springs *k k'*, which bear on rings *i i'*.

If three or more carbon buttons are employed, the plate F will have a corresponding number of receptacles, and the arms of the yoke, the rings on the periphery of the button-carrier, and the insulated binding-posts and springs will be increased correspondingly in number. The instrument has a binding-post, L, which is not insulated from the metal case.

To adjust the instrument, the screw E is turned, the springs *k k'* having a broad enough bearing on rings *i i'* to permit this to be done and the yoke G turning on the diaphragm.

In use I prefer to arrange the carbon buttons in circuit with different primary induction-circuits, the induction-coil having two primary circuits and one secondary circuit, as shown in Fig. 3.

K is the induction-coil, having two primaries, *l m*, and a secondary, *n*. The primaries are preferably the same in resistance, size of wire, and number of turns, the wires for the two primaries being wound together, although for clearness in illustration they are shown as separated in Fig. 3. The wires 1 2 to the insulated binding-posts are connected with one end of the two primary coils *l m*, while at the other end the primary coils are connected to a common wire, 3, connected with the base-post. The line L passes through secondary to the receiver M and the ground.

I prefer to employ two separate batteries, N O, one in the circuit of each wire 1 and 2; but these batteries may be combined in one, P, and located in circuit of wire 3, as shown in dotted lines. The transmitter-circuit, assuming the two separate batteries N O are used, will be from N O by wires 1 2 through primaries *l m*, by wire 3 to base, and by screw E to plate F, through plates *a a'*, carbon buttons *c c'*, plates *d d'* to rings *i i'*, springs *k k'*, insulated posts, and wires 1 2 back to batteries.

By the arrangement shown in Fig. 4 a simple induction-coil, Q, is employed. The line passes through the secondary and receiver to ground. The simple primary circuit is connected with the two insulated binding-posts by wires 1 2, and a single transmitting-battery, R, is employed. This throws the carbon buttons into series, the circuit being down through one carbon button, across plate F, and up through the other carbon button. For these connections the base-post L is not connected with the circuit.

What I claim is—

1. In a multiple electric telephone-transmitter, the combination of two or more sets of electrodes supported by a common carrier mounted on a central adjusting-screw and turning therewith, substantially as set forth.

2. In a multiple electric telephone-transmitter, the combination of two or more sets of electrodes supported by a common carrier mounted on and turning with a central adjusting-screw, with a turning-yoke bearing on such electrodes and connected centrally with the diaphragm, substantially as set forth.

3. In a multiple electric telephone-transmitter, the combination of two or more sets of electrodes mounted upon a common metallic support and having separate insulated bearing or contact plates connected with insulated circuit-connections, substantially as set forth.

4. In a multiple telephone-transmitter, the combination of the central adjusting-screw supporting a metallic electrode-carrying plate turning therewith, two or more sets of electrodes carried by said plate and connected together on one side electrically by such plate, separate insulated bearing or contact plates for such electrodes connected mechanically with the diaphragm, insulated rings on the carrier-plate with which said separate contacts are electrically connected, springs bearing on such insulated rings, and insulated binding-posts for such springs, substantially as set forth.

This specification signed and witnessed this 9th day of January, 1885.

THOMAS A. EDISON.

Witnesses:
H. W. SEELY,
T. G. GREENE, Jr.

(No Model.)

T. A. EDISON.

INCANDESCENT ELECTRIC LAMP.

No. 379,770. Patented Mar. 20, 1888.

Fig. 1.

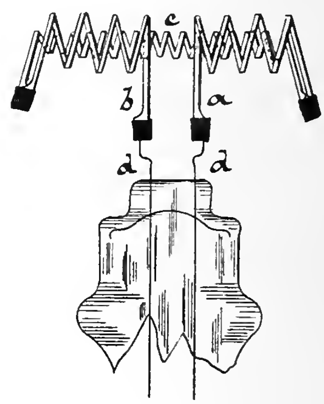
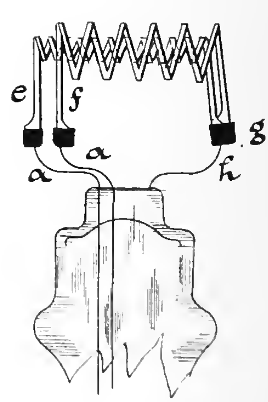


Fig. 2.



WITNESSES:

O. D. Mott

Thomas E. Birch

INVENTOR:

T. A. Edison

BY Dyer & Wilber

ATTORNEYS.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, ASSIGNOR TO THE EDISON ELECTRIC LIGHT COMPANY, OF NEW YORK, N. Y.

INCANDESCENT ELECTRIC LAMP.

SPECIFICATION forming part of Letters Patent No. 379,770, dated March 20, 1888.

Application filed December 9, 1881. Serial No. 47,469. (No model.) Patented in England October 23, 1878, No. 4,226; in Italy November 21, 1878, No. 4,351/10,456; in Belgium November 30, 1878, No. 46,567; in Spain February 1, 1879, No. 128; in France February 4, 1879, No. 127,341; in Sweden February 8, 1879; in Victoria March 27, 1879, No. 2,632; in Denmark May 8, 1879; in Norway May 20, 1879; in Canada May 28, 1879, No. 10,031; in Austria-Hungary June 30, 1879, No. 30/864; in Germany March 10, 1880, No. 9,165, and in Russia September 24, 1881.

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Incandescing Electric Lamps, (Case No. 379;) and I do hereby declare that the following is a full and exact description of the same, reference being had to the accompanying drawings, and to the letters of reference marked thereon.

The object I have in view is to produce a lamp which shall have a high resistance with a small radiating-surface. This I do by employing a great length of carbon coiled and arranged in such a way that a small radiating-surface only will be exposed.

The accompanying drawings show two forms of my invention.

In the drawings the coils are drawn apart and enlarged in order that their arrangement will be apparent; but in practice they are compactly-coiled carbon filaments.

In Figure 1 three separate spiral carbons, *a b c*, are used. The carbons *a b* are connected to the "leading-in wires" *d d*, and at their other ends to the ends of the carbon *c*, so that the current passes through all three carbons. The large coils of *a b* are so wound and coiled around the smaller ones of *c* as to hide the latter and obscure its light.

All the connections are preferably made by electroplating. The best mode of so doing is to first wrap a thin piece of metal about the two ends to be joined, and then electroplate the whole.

In the form shown in Fig. 2 only two carbons, *e f*, are used, connected together at *g*, and each having its other end attached to one of the leading-in wires *a a*, *h* being simply a support. The coils of *f* are placed above those of *c*, so as to obscure them.

It is evident that many other forms of coiled and spiral carbons could be used without departing from the principle of my invention.

The excessive length of carbon gives the proper amount of resistance, while the manner in which the carbons are coiled decreases the radiating-surface.

What I claim is—

1. In an incandescing electric lamp, the combination of two carbons, placed one within the other, for reducing their effective radiating-surface and increasing the electrical resistance, substantially as set forth.

2. In an incandescing electric lamp, the combination of two or more spiral carbon conductors, connected in series, the coils of one covering and partially hiding those of the others, substantially as and for the purpose set forth.

This specification signed and witnessed this 5th day of December, 1881.

THOMAS A. EDISON.

Witnesses:

H. W. SEELY,

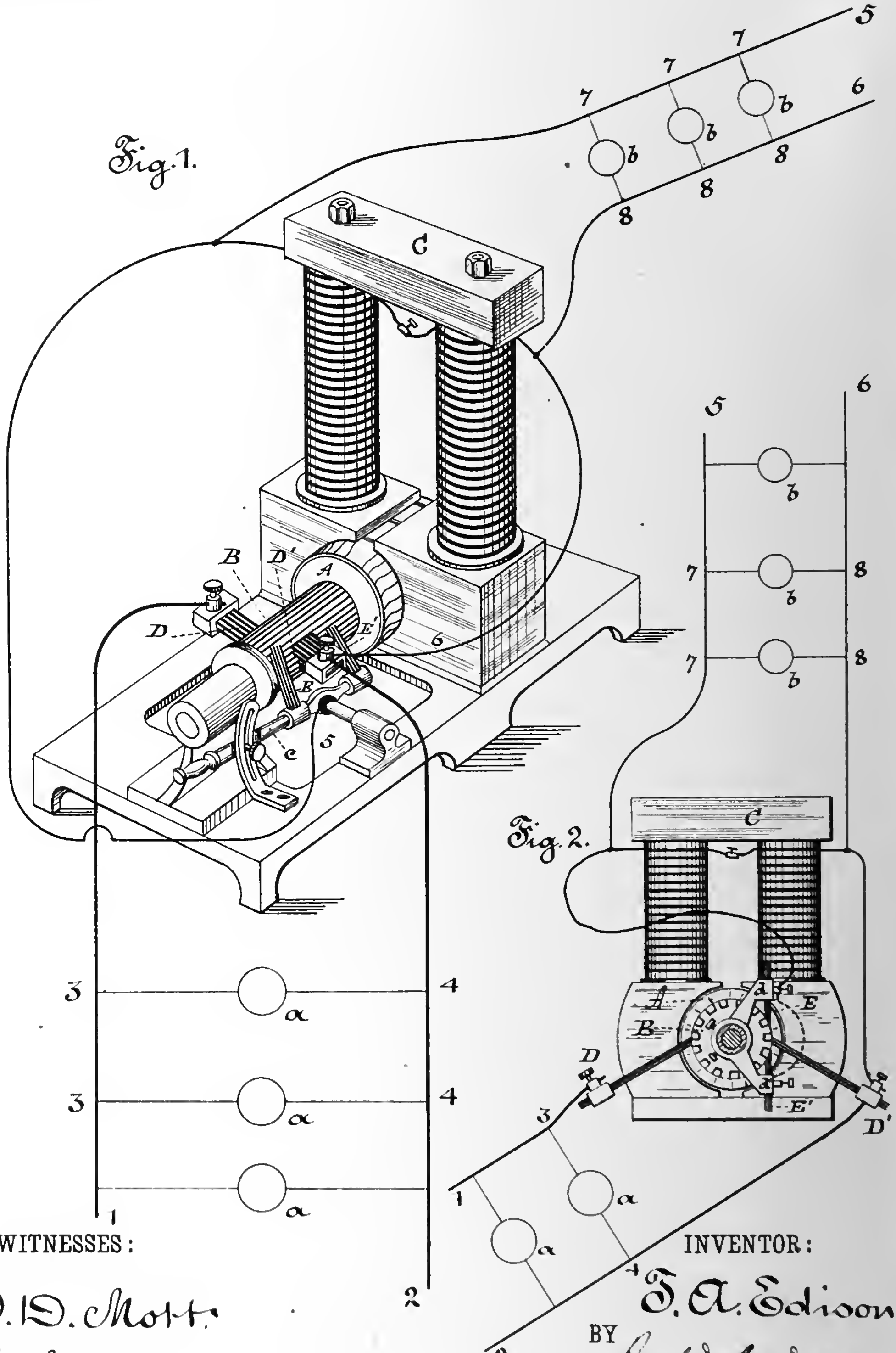
WM. H. MEADOWCROFT.

(No Model.) 2 Sheets—Sheet 1.

T. A. EDISON.

REGULATOR FOR DYNAMO ELECTRIC MACHINES.

No. 379,771. Patented Mar. 20, 1888.



WITNESSES:

O. D. Mott.

H. W. Seely

INVENTOR:

T. A. Edison

BY Rich^d A. Dyer.

ATTORNEY.

(No Model.) 2 Sheets—Sheet 2.

T. A. EDISON.

REGULATOR FOR DYNAMO ELECTRIC MACHINES.

No. 379,771. Patented Mar. 20, 1888.

Fig. 3.

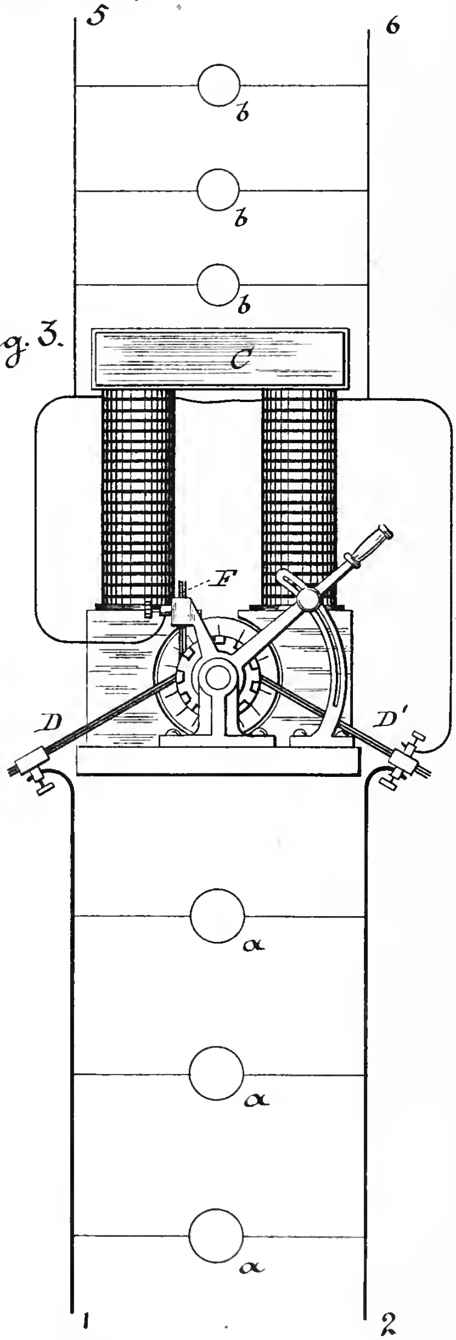
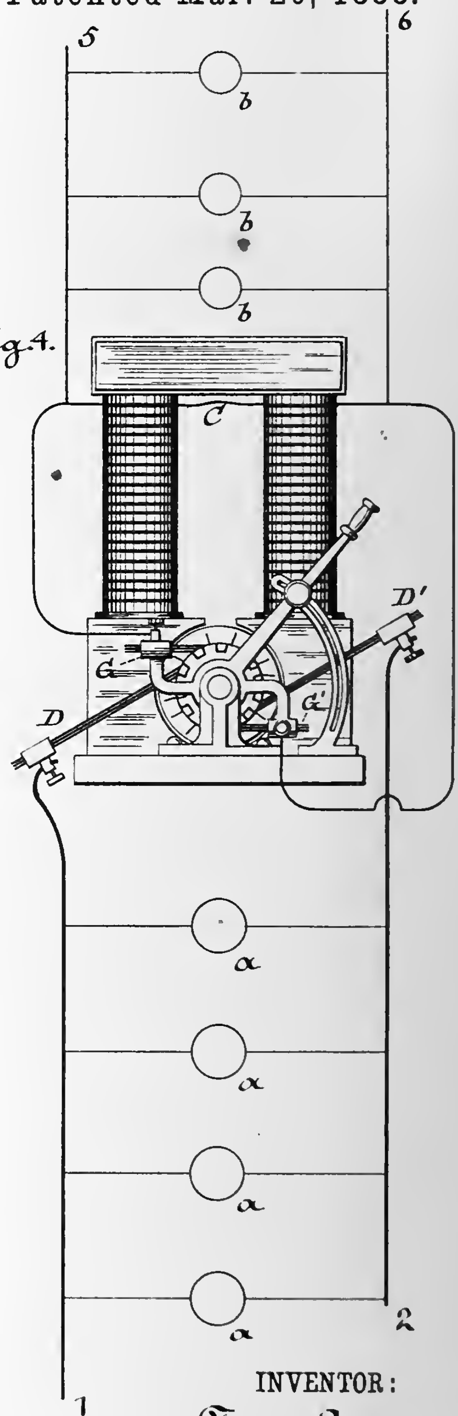


Fig. 4.



WITNESSES:

O. D. Mott

N. W. Seely

INVENTOR:

T. A. Edison

BY Richd. N. Dyer

ATTORNEY.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, ASSIGNOR TO THE EDISON ELECTRIC LIGHT COMPANY, OF NEW YORK, N. Y.

REGULATOR FOR DYNAMO-ELECTRIC MACHINES.

SPECIFICATION forming part of Letters Patent No. 379,771, dated March 20, 1888.

Application filed August 7, 1882. Serial No. 68,626. (No model.) Patented in England August 5, 1882, No. 3,576; in Italy November 29, 1882, No. 14,825; in Belgium November 30, 1882, No. 59,593; in France January 18, 1883, No. 151,725; in Spain April 4, 1883, No. 3,736, and in Germany December 21, 1883, No. 25,000.

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Dynamo-Electric Machines, (for which I have obtained Letters Patent in Great Britain, No. 3,576, August 5, 1882; Italy, No. 14,825, November 29, 1882; Belgium, No. 59,593, November 30, 1882; France, No. 151,725, January 18, 1883; Spain, No. 3,736, April 4, 1883, and in Germany, No. 25,000, December 21, 1883;) and I do hereby declare that the following is a full and exact description of the same, reference being had to the accompanying drawings, and to the letters of reference marked thereon.

The object I have in view is to produce a method and means for deriving from a dynamo-electric machine two or more independent circuits in which there will be a different electro-motive force or pressure, such circuits being adapted for independent regulation. The extra circuit (or circuits) will have a lower electro-motive force than the main circuit, and is designed more especially for use in energizing the field-of-force magnet of the machine or for operating translating devices, of which incandescing electric lamps form the best example, placed in multiple-arc circuits and requiring a current of lower tension than the lamps or other translating devices in the main circuit; or this extra circuit may have both the magnet-coils and the lamps connected therewith in multiple arc.

This object I accomplish by arranging to bear upon the commutator-cylinder on each side of one of the main commutator-brushes a secondary brush, which is mounted so as to be capable of adjustment toward or away from the main brush independent of or together with its fellow on the other side of the main brush. These two secondary brushes are connected together electrically, and from them is led one part of the secondary circuit, the other part being connected with the main brush on that side of the commutator-cylinder. The farther apart the secondary brushes are placed on opposite sides of the main brush the greater will be the tension of the current in the extra circuit, and hence the tension can be readily regulated by varying the position of such brushes with reference to the main brush. The tension of the current in the main circuit can be independently regulated by shifting the main brushes, or in any other suitable manner. The connection of the secondary brushes together electrically does not short-circuit any of the coils of the armature, since currents are generated in the same circumferential direction on both sides of the armature. It is evident that in this manner two extra circuits could be derived from the same machine instead of one, a set of secondary brushes being arranged to form a circuit with each main commutator-brush. In that case it will be seen that the extra circuits themselves may be regulated independently of each other or together, and may have currents of the same or different tension. It will also be understood that one secondary brush instead of two could be used in connection with a main brush to form each extra circuit, which secondary brush would be mounted for adjustment to and from the main brush forming the other pole of the extra circuit, and in this manner almost any desired number of extra circuits could be derived from one machine, the tension of the current in each depending upon the distance of the secondary brush from the main brush with which it is connected. It is also evident that an extra circuit could be formed by placing two secondary brushes on opposite sides of the commutator-cylinder at points between the main brushes, the secondary brushes forming the poles for the extra circuit, and the tension of the current in the extra circuit being dependent upon the position of these brushes with relation to the line of neutralized generation.

It will be understood that the armature of the machine is of the Pacinotti or Siemens type, being provided with a continuously-wound bobbin connected at intervals with the parallel bars of a commutator, and also that the currents of different tension are derived from this continuous bobbin, all the brushes resting upon the single commutator-cylinder.

The foregoing will be better understood by reference to the drawings, in which Figure 1 is a view, partly diagrammatic, illustrating my present invention and showing the form first described, with the secondary brushes mounted for simultaneous adjustment; Fig. 2, a view of the same arrangement when the secondary brushes are independently adjustable, and Figs. 3 and 4 views of other arrangements for accomplishing the same object.

A is the armature, B the commutator-cylinder, and C the field-of-force magnet, of the machine.

D D′ are the main commutator-brushes, which are mounted so as to be adjustable upon the commutator-cylinder. From these brushes run the main conductors 1 2 in multiple arc or derived circuits 3 4, from which are the lamps or other translating devices, *a*. The secondary commutator-brushes E E′, Figs. 1 and 2, bear on the commutator-cylinder on opposite sides of the main brush D′. From the secondary brushes E E′ and the main brush D′ runs the extra circuit 5 6. The coils of magnet C and lamps or other translating devices, *b*, are in multiple arc or derived circuits 7 8 from the conductors 5 6. These translating devices do not require a current of as high a tension as that required by the translating devices *a*.

In Fig. 1 the secondary brushes E E′ are shown as carried by a pivoted arm, *c*, so that they can be adjusted simultaneously in opposite directions toward and away from the main brush D′. In Fig. 2 they are carried by separate and independently-adjustable arms *d d′*.

In Fig. 3 a single secondary brush, F, is shown as used to form one pole for the extra circuit 5 6, the other pole being formed by one of the main brushes.

In Fig. 4 the secondary brushes G G′ are mounted to bear on opposite sides of the commutator-cylinder at points between the main brushes, and the conductors of the extra circuit are connected only with the secondary brushes.

I do not claim herein the arrangement of incandescing electric lamps or other translating devices in multiple arc on separate circuits derived from main and auxiliary commutator-brushes bearing on the same commutator, for this will form the subject of a separate application for Letters Patent.

What I claim is—

1. The combination, with a dynamo-electric machine having a continuously-wound bobbin and a single commutator, of two or more circuits having currents of different tension derived from said commutator, and means for independently regulating the tension of the currents in said circuits, substantially as set forth.

2. The combination, with a dynamo-electric machine having a continuously-wound bobbin and a single commutator, of main commutator-brushes and one or more auxiliary brushes bearing on said commutator, two or more circuits connected with said brushes, and the field-of-force magnet of the machine, having its coils in one of said circuits, substantially as set forth.

3. The combination, with a dynamo-electric machine having a continuously-wound bobbin and a single commutator, of main commutator-brushes and one or more auxiliary brushes bearing on said commutator, two circuits connected with said brushes, the field-of-force magnet of the machine, having its coils in the circuit of the auxiliary brush or brushes, and means for adjusting said auxiliary brush or brushes independent of the main brushes for regulating the machine, substantially as set forth.

This specification signed and witnessed this 28th day of February, 1882.

THOMAS A. EDISON.

Witnesses:

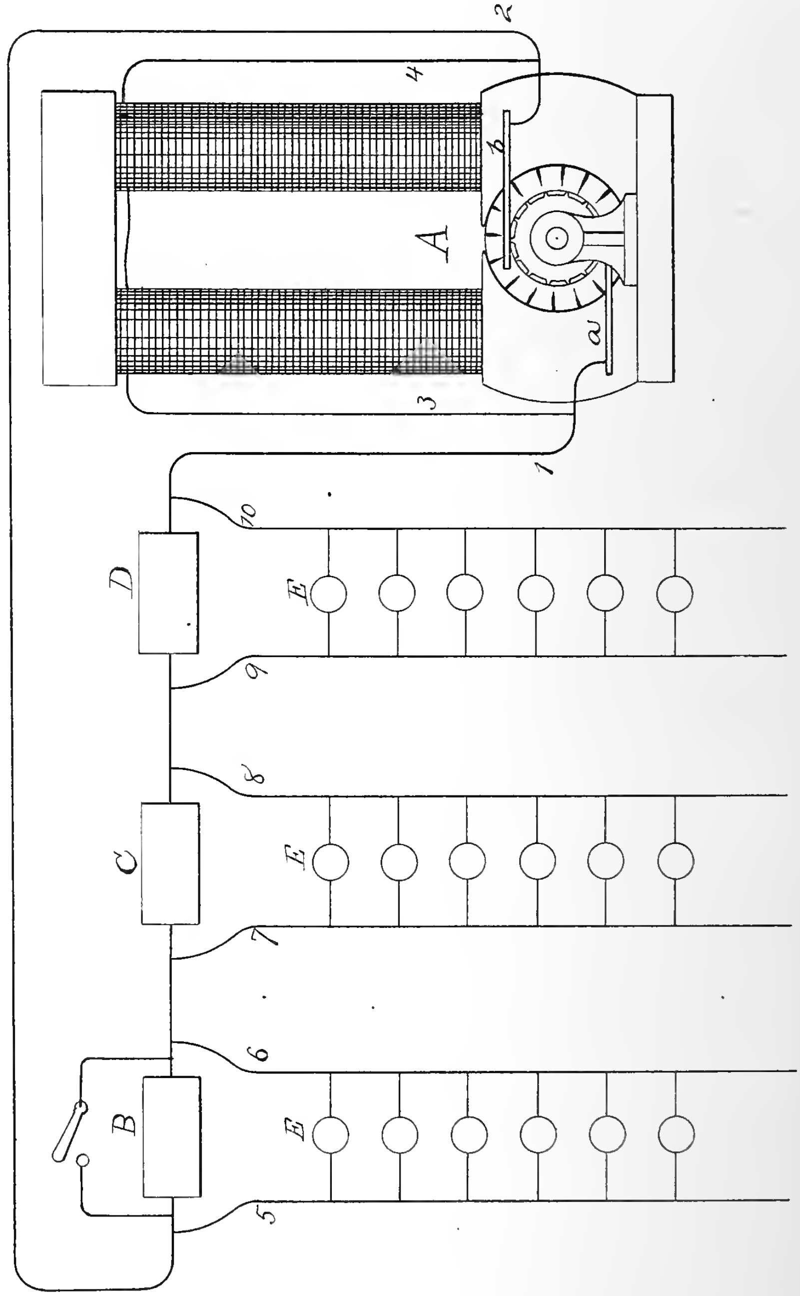
H. W. SEELY,
THOMAS JOHNSTON.

(No Model.)

T. A. EDISON.

SYSTEM OF ELECTRICAL DISTRIBUTION.

No. 379,772. Patented Mar. 20, 1888.



WITNESSES:

E. C. Rowland

H. W. Seeley

INVENTOR:

Thomas A. Edison

BY Rich^d. N. Dyer,

ATTORNEY.

United States Patent Office.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, ASSIGNOR TO THE EDISON ELECTRIC LIGHT COMPANY, OF NEW YORK, N. Y.

SYSTEM OF ELECTRICAL DISTRIBUTION.

SPECIFICATION forming part of Letters Patent No. 379,772, dated March 20, 1888.

Application filed August 7, 1882. Serial No. 68,639. (No model.) Patented in England August 5, 1882, No. 3,752; in Italy November 14, 1882, No. 14,758; in Belgium November 15, 1882, No. 59,457; in France December 13, 1882, No. 151,279; in Spain April 4, 1883, No. 3,737, and in Germany July 26, 1883, No. 23,270.

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Systems of Electrical Distribution, (for which I have obtained Letters Patent in Great Britain, No. 3,752, August 5, 1882; Italy, No. 14,758, November 14, 1882; Belgium, No. 59,457, November 15, 1882; France, No. 151,279, December 13, 1882; Spain, No. 3,737, April 4, 1883, and Germany, No. 23,270, July 26, 1883;) and I do hereby declare that the following is a full and exact description of the same, reference being had to the accompanying drawing, and to the letters of reference marked thereon.

The object I have in view is to produce efficient and economical means for dividing an electric current of high electro-motive force or tension into a number of currents of lower electro-motive force or tension, and for making all the translating devices operated by the currents of lower tension independent of each other. Such an arrangement makes a great saving in conductors, since a high-tension current can be used from the point of generation to near the point of consumption, and the translating devices can be made independent by a multiple-arc arrangement. It is the especial design of the peculiar means employed by me to accomplish this subdivision of an electric current, to reduce to the minimum the loss of power occasioned thereby.

The main object is accomplished by throwing into the main circuit, at a number of points, a counter electro-motive force, which causes between certain points a definite drop in the tension of the main circuit. From these points are run pairs of conductors, and the translating devices—such as lamps or motors—are located in multiple-arc circuits from these auxiliary conductors. Each pair of auxiliary conductors, with its translating devices, forms a shunt-circuit from the main circuit. Electric motors may be used for producing the counter electro-motive force; but economy is best secured by means of secondary batteries, which can be used to supply the translating devices for a time after being fully charged.

In the accompanying drawing, forming a part hereof, an arrangement embodying the invention is shown diagrammatically.

A is a dynamo or magneto electric machine, from the commutator-brushes *a b* of which run the conductors of the main circuit 1 2. The field-circuit 3 4 of the machine A is a multiple-arc circuit from 1 2, and the machine is regulated in any of the known ways, preferably by shifting the commutator-brushes or by varying primarily the current flowing through the field-circuit. This machine has a high electro-motive force. For purposes of illustration, this may be considered as three hundred volts. A number of these machines may be arranged in multiple arc, or machines having a lower electro-motive force may be arranged in series or multiple series to produce a current of high tension.

B C D represent the means for throwing counter electro-motive force into the circuit 1 2, which means may be secondary batteries, electric motors, or other devices. To the main circuit, on opposite sides of B C D, are connected the conductors 5 and 6, 7 and 8, and 9 and 10 of shunt-circuits, in multiple-arc circuits from which conductors are located the lamps, motors, or other translating devices E. The counter electro-motive force of each device B C D is approximately one hundred volts, and there is approximately a drop of one hundred volts between the points where 5 and 6 are connected with 1 2, as well as between the connections of 7 and 8 and 9 and 10 with 1 and 2. This causes a current to flow through each shunt-circuit having a tension approximately of one hundred volts. The making or breaking of the circuit of any translating device does not affect other translating devices in the same shunt-circuit or those in the other shunt-circuits. To secure the greatest economy, secondary batteries are used to give the necessary counter electro-motive force. B C D represent such secondary batteries. After the secondary batteries are fully charged, the main circuit between the same and the machine A may be broken, when the secondary batteries will discharge through the shunt-circuits supplying the translating devices.

By arranging the devices B C D, whether secondary batteries or not, to give counter electro-motive force of different degrees of intensity, or of different volts, currents varying in tension can be produced in the shunt-circuits, and circuits can be provided for half as well as whole lights, or this can be done by dividing the current in one or more of the shunts on the same principle that is employed to divide the current in the main circuit. A simple shunt-circuit of low resistance (shown at the device B) may be arranged around each of the devices B C D, by closing which and breaking the circuit of the secondary battery the translating devices in the shunt around the secondary battery will be cut off from the source of supply. In that case it is necessary to reduce the electro-motive force at the source of supply, which can be readily done by adjusting the machine or machines.

What I claim is—

1. The method of dividing an electric current, consisting in throwing counter electro-motive force into a main circuit at two or more points, and providing shunt-circuits around the sources of such counter electro-motive force, through which shunt-circuits currents of lower tension flow, substantially as set forth.

2. The combination of one or more dynamo or magneto electric machines supplying a current of high tension in a main circuit, with means for throwing counter electro-motive force into such main circuit at two or more points, shunt-circuits around the sources of such counter electro-motive force, and translating devices connected in multiple arc in such shunt-circuits, substantially as set forth.

3. The combination, with a main circuit having a current of high tension, of two or more secondary batteries arranged in series in such main circuit and shunts around such secondary batteries containing translating devices, such as electric lamps or motors, whereby a division of the current in the main circuit is secured, substantially as set forth.

4. The combination, with one or more dynamo or magneto electric machines supplying a current of high tension in a main circuit, of two or more secondary batteries arranged in series in such main circuit, shunt-circuits around such secondary batteries, and translating devices connected in multiple arc in such shunt-circuits, substantially as set forth.

This specification signed and witnessed this 22d day of May, 1882.

THOMAS A. EDISON.

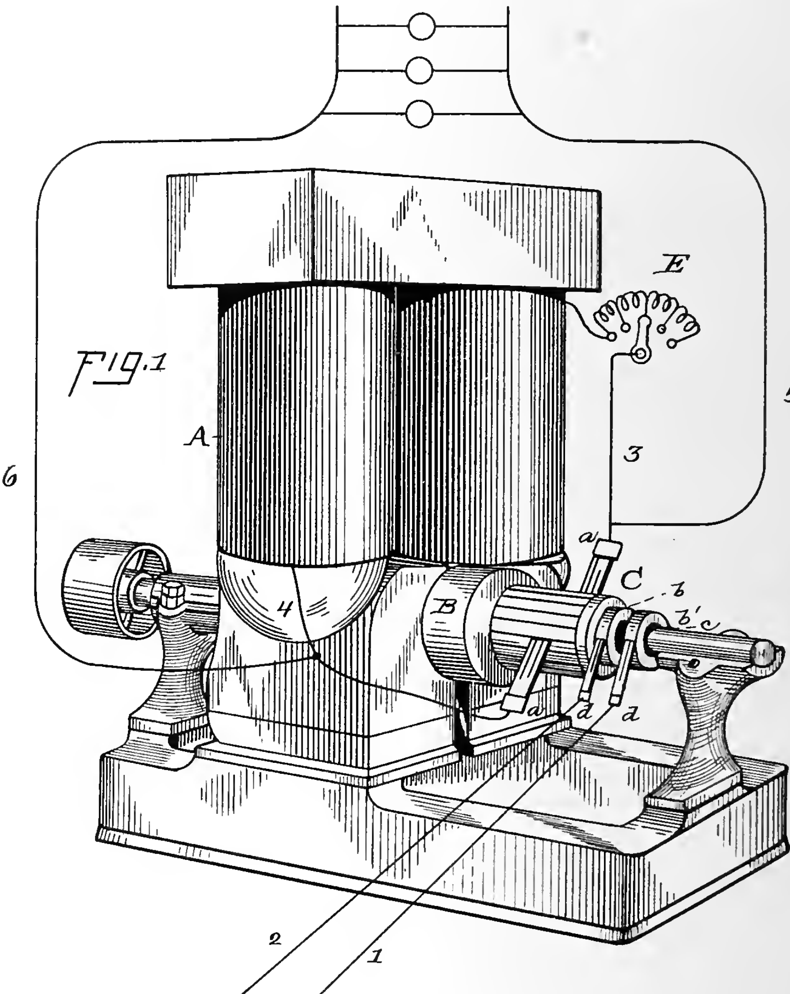
Witnesses:
EDW. C. ROWLAND,
C. P. MOTT.

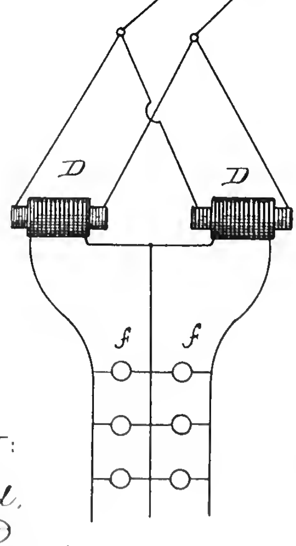
(No Model.)

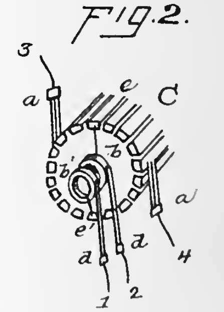
T. A. EDISON.

COMMUTATOR FOR DYNAMO ELECTRIC MACHINES.

No. 379,944. Patented Mar. 27, 1888.







ATTEST:

E. C. Rowland.

Wm. Pelzer

INVENTOR:

Thomas A. Edison

By Dyer & Seely

Att'ys.

N. PETERS, Photo-Lithographer, Washington, D.C.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY.

COMMUTATOR FOR DYNAMO-ELECTRIC MACHINES.

SPECIFICATION forming part of Letters Patent No. 379,944, dated March 27, 1888.

Application filed December 6, 1886. Serial No. 220,798. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Dynamo-Electric Machines, (Case No. 702,) of which the following is a specification.

My invention relates, mainly, to a dynamo-electric machine designed to produce both alternating and continuous currents, such machine being especially adapted for use as a source of high-tension current to be conveyed to a distance and converted by tension-reducers into a current of low tension adapted for lighting and similar purposes. The alternating current from the machine may be used for this purpose, while the continuous current is employed to energize the field-magnet of the machine, it being desirable to use a continuous current for this purpose. Translating devices may, however, be connected with the continuous-current circuit.

My invention is illustrated in the accompanying drawings, in which Figure 1 is a perspective view of a dynamo-electric machine embodying my invention with the circuits therefrom in diagram, and Fig. 2 a diagram of the commutator-connections.

A is the field-magnet, and B the armature, of a dynamo-electric machine, the latter being wound with a continuous coil connected at intervals with the conducting-bars of a commutator, C, whereby continuous currents are taken off by the commutator-brushes *a a*, bearing on opposite bars of the commutator. Placed upon the armature-shaft, between the commutator C and the shaft-bearing, is another commutator consisting of two continuous metal rings, *b b'*, placed upon a collar, *c*, of insulating material, whereby they are insulated from the shaft and from each other. Upon each of these rings a brush, *d*, bears. Ring *b* is connected, in any suitable manner, as shown in Fig. 2, with a commutator-bar, *e*, and ring *b'* is similarly connected with a diametrically-opposite bar, *e'*. A circuit, 1 2, extends from the brushes *d d*, and a circuit, 3 4, from the brushes *a a*. It will be seen that while a continuous current is given to circuit 3 4 there will be at each revolution a reversal of the current in circuit 1 2, whereby a rapidly-alternating current will be produced in said circuit. The circuit 1 2 is connected with the field-magnet coils of the machine, and therefore serves to energize the magnet by a continuous current.

I have shown the circuit 1 2 as extending to the multiple-arced primaries of induction-coils D D, from whose secondary circuits a three-wire multiple-series circuit, including electric lamps or other translating devices, *f f*, extends. The converters may, however, be otherwise constructed or arranged, or the circuit 1 2 may evidently be connected with electric lights or other translating devices.

I have shown a circuit, 5 6, shunted from the field-circuit 3 4, across which translating devices are placed in multiple arc, as shown, though they may be in series or multiple series. Such a circuit may be employed, if desired. The field-magnets should be wound with fine wire, so as to interpose a high resistance in the high-tension circuit. An adjustable resistance, E, may be provided to regulate the strength of the field-magnet.

What I claim is—

1. The combination, in a dynamo-electric machine, of an armature having a continuously-wound coil with two commutators on the shaft of said armature, each of which is directly connected with said coil, from one of which is derived a continuous current and from the other an alternating current, current collectors bearing on each of said commutators, and independent circuits extending therefrom, substantially as set forth.

2. The combination, in a dynamo-electric machine, of an armature having a continuously-wound coil connected at intervals to blocks of a commutator, two insulated rings on the armature-shaft, and connections from the armature-coil to said rings, substantially as set forth.

3. The combination, in a dynamo-electric machine, of an armature having a continuously-wound coil, a commutator composed of blocks, to all of which blocks said coil is connected at intervals, two insulated rings on the armature-shaft, and connections from the armature-coil to said rings, substantially as set forth.

4. The combination, in a dynamo-electric

machine, of an armature having a continuously-wound coil, a commutator composed of blocks connected at intervals with said coil, two insulated rings on the armature-shaft, and connections from opposite blocks of the commutator to said rings, respectively, substantially as set forth.

This specification signed and witnessed this 26th day of November, 1886.

THOS. A. EDISON.

Witnesses:
WM. PELZER,
E. C. ROWLAND.

(No Model.)

T. A. EDISON.

PYROMAGNETIC MOTOR.

No. 380,100. Patented Mar. 27, 1888.

Fig. 1.

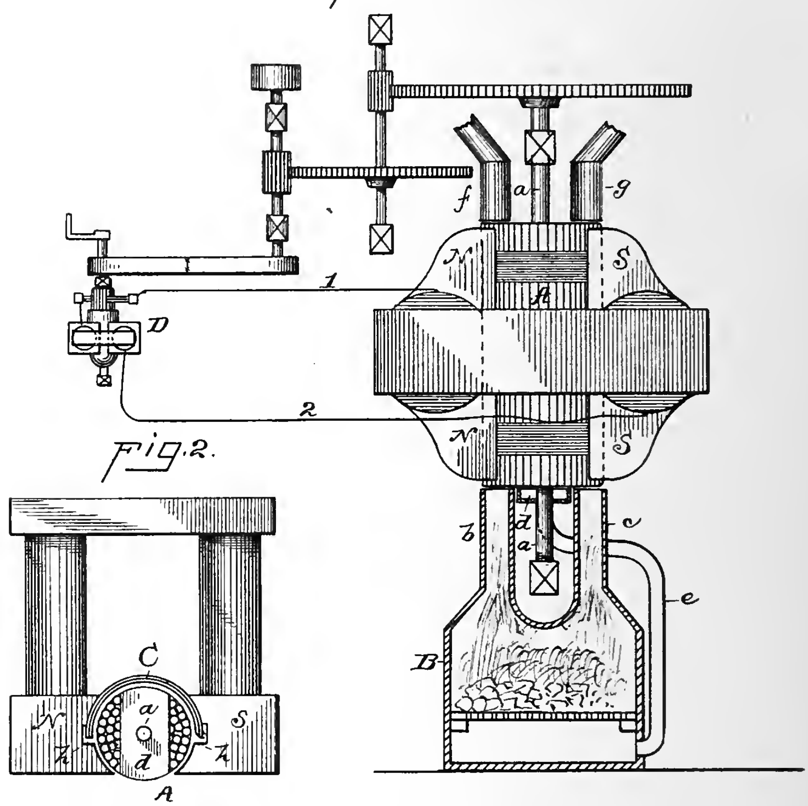


Fig. 2.

Fig 3

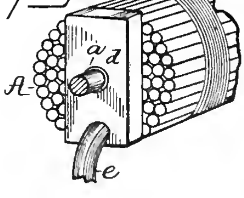


Fig 4

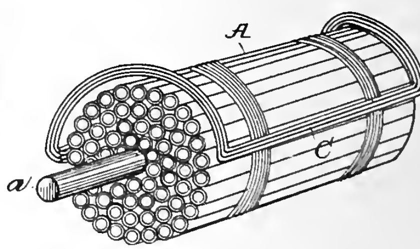
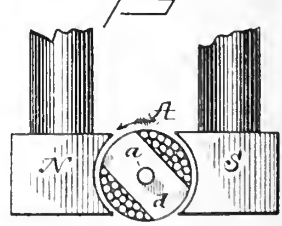


Fig 5.



ATTEST:

E. H. Rowland

William Pelzer.

INVENTOR:

Thomas A. Edison,

By Dyer & Seely

Attys.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY.

PYROMAGNETIC MOTOR.

SPECIFICATION forming part of Letters Patent No. 380,100, dated March 27, 1888.

Application filed June 13, 1887. Serial No. 241,098. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Engine or Prime Motor, (Case No. 720,) of which the following is a specification.

My invention relates to engines or prime motors, and is based upon the principle that the capacity of iron for magnetism diminishes as its temperature is raised, and that at a bright-red heat it becomes practically diamagnetic. Advantage is taken of this fact to construct an apparatus in which motion is produced by the combined action of heat and magnetism, and to this machine I have applied the term "thermo-magnetic engine." The heat is utilized to destroy the magnetic balance of iron parts moving in the field of one or more magnets, or to successively make magnetic parts diamagnetic as they reach centers of attraction. I am aware that it has been suggested that this principle might be utilized to produce motion; but no practical means capable of developing a useful amount of power has been proposed for that purpose, so far as I know.

In carrying out my invention I employ an interstitial armature constructed of thin sheet-iron, so that it will be capable of rapid changes in temperature. This armature is one having interstices extending through it, and it may be made up of or provided with iron tubes extending longitudinally of the armature, the armature being mounted on a vertical shaft, so that the tubes will act as flues; or a corrugated iron sheet could be rolled up to form an equivalent construction, or the interstitial armature could be made in many other ways that would suggest themselves to skilled persons. Beneath the interstitial armature may be located a suitable furnace, with flues for the exit of the products of combustion extending to and covering at their ends opposite portions of the armature. The ends of the armature-tubes will move in close relation with the open ends of the furnace exit-flues, so that the products of combustion will be directed into the tubes as they successively come over the flues. The intermediate tubes are protected from the furnace, and since the power of the machine depends largely upon the rapidity with which the iron tubes can be heated and cooled these intermediate tubes may be covered by a stationary box connected by a flue with the furnace beneath its grate, so that the fresh air for supporting combustion will be drawn down through the tubes that are being cooled.

To increase the power of the machine, a fixed coil of wire for magnetizing or polarizing the armature may be wound in recesses formed in the pole-pieces of the field-magnet.

The field-magnet may be a permanent magnet; but for large machines I prefer to employ an electro-magnet, which may be charged by a battery or by a small dynamo run by the machine, and which can be turned by hand for starting the machine, unless, indeed, the residual magnetism is sufficient for that purpose.

In the accompanying drawings, forming a part hereof, Figure 1 is an elevation and partial section of an apparatus embodying my invention; Fig. 2, a plan view taken from the lower end of the armature, looking upwardly; Fig. 3, a perspective view of one end of the armature, showing also the cold-air box over the central tubes; Fig. 4, a perspective view of the armature with the relative position of the fixed magnetizing-coil shown, and Fig. 5 a view similar to Fig. 2 of a machine without the coil for magnetizing or polarizing the armature.

A is a cylindrical armature mounted upon a shaft, *a*, and composed of thin iron tubes suitably held to the shaft, or otherwise constructed as an interstitial body. These tubes may be nickel plates or thinly covered with enamel or otherwise protected to prevent oxidation. This armature is mounted between the poles N S of a magnet, which may be a permanent magnet, but is preferably an electro-magnet. The parts are suitably supported so that the armature has a vertical position, the tubes extending longitudinally thereof. Beneath the armature is a furnace, B, having two exit-flues, *b c*, extending upwardly and covering the open lower ends of a number of the armature-tubes on opposite sides of the armature. The open upper ends of these furnace exit-flues fit as closely as possible against the ends of the armature-tubes while permitting the armature to turn. Between the flues *b c* the lower end of the armature is preferably covered with a cold-air box, *d*, which is stationary, and is connected by a pipe, *e*, with the furnace beneath the grate-bars. Above the armature are flues *f g*, forming continuations of the furnace exit-flues *b c* through the armature-tubes. The tubes between the flues *f g* at the upper end of the armature may be left uncovered.

When the cold-air box *d* is arranged to cover an oblique section of the tubes, as shown in Fig. 5, and the flues *b c* cover the spaces left uncovered by that box, the tubes will be heated on the diametrically-opposite sides of the armature that come opposite the lower corner of the pole N and the upper corner of the pole S. These heated portions of the armature being diamagnetic or less magnetic than the remaining portion of the armature, it will be seen that the armature will occupy an unbalanced position in the field, and consequently it will be turned in the direction of the arrow in Fig. 5. The unbalanced position of the armature is maintained by the fact that the heat is always applied to those portions of the armature at obliquely-opposite points in the magnetic field. Hence the rotation of the armature will be continuous, its rapidity of movement being largely dependent upon the rapidity with which the armature-tubes can be heated and cooled.

To increase the power of the engine, I employ a fixed coil of wire, C, which is located in recesses *h* in the pole-pieces N S. The coil C may be connected in series with the coils of the field-magnet. Its function is to magnetize or polarize the armature. Its tendency is to produce poles in the armature at right angles to the poles of the field-magnet and to cause a repulsion as well as an attraction between the field-magnet and the armature, or, at least, to reduce the retarding attraction between each pole of the field-magnet and that portion of the armature which is moving away from it. When the coil C is employed, the sides of the armature directly opposite the centers of the poles N S will be heated instead of the obliquely-opposite portions, as in Fig. 5.

The wire-winding of the field-magnet, as well as the wire of the coil C, will be covered by an insulation capable of withstanding heat. I preferably use a very few turns of large-size copper wire both in the field-winding and in the fixed coil, and energize the same by a current of a sufficiently large quantity to give the desired magnetizing effects. With the large wire insulating-washers of some infusible material—such as porcelain—may be used to separate the wires.

A small dynamo, D, may be employed to supply the current for energizing the field and fixed coil through the circuit 1 2. This dynamo will be operated by the engine through a speed-increasing gearing, as shown, and it may have a hand-crank for giving the field-magnet energy in starting the engine.

A machine driven by the engine will be connected with the armature by speed-increasing gearing unless the machine is one having a low rate of speed.

The form of apparatus shown in the drawings is given as a simple illustration of an embodiment of the invention.

It will be understood that many modifications and changes can be made in the form, construction, and arrangement of the parts of the engine without departing from the spirit of my invention.

What I claim is—

1. A prime motor having, in combination, an interstitial magnetic body, a magnetic field in which said body is located, and means for heating said body to produce an unbalanced magnetic condition of the same, substantially as set forth.

2. A prime motor having, in combination, an interstitial magnetic body, a magnetic field in which said body is located, means for heating said body to produce an unbalanced magnetic condition of the same, and means for cooling the other parts of said body, substantially as set forth.

3. A prime motor having, in combination, a revolving interstitial magnetic body, a magnetic field in which said body is located, and means for heating said body to produce an unbalanced magnetic condition of the same, substantially as set forth.

4. A prime motor having, in combination, a revolving interstitial magnetic body, a magnetic field in which said body is located, and means for heating opposite parts of said revolving magnetic body to produce an unbalanced condition of the same, substantially as set forth.

5. A prime motor having, in combination, a revolving interstitial magnetic body, a magnetic field in which said body is located, means for heating opposite parts of said revolving magnetic body to produce an unbalanced condition of the same, and means for cooling the intermediate parts of said body, substantially as set forth.

6. A prime motor having, in combination, a magnetic interstitial body, a magnetic field in which said body is located, and means for passing a heating medium through the interstices of such body to produce an unbalanced condition of the body, substantially as set forth.

7. A prime motor having, in combination, a magnetic interstitial body, a magnetic field in which said body is located, and a furnace with exit-flues communicating with a part of the interstices of said body, substantially as set forth.

8. A prime motor having, in combination, a magnetic interstitial body, a magnetic field in which said body is located, a furnace with exit-flues communicating with a part of the inter-

stices of said body, and a fresh-air supply for said furnace, drawing fresh air through other interstices, substantially as set forth.

9. A prime motor having, in combination, a magnetic body, a magnetic field in which said body is located, means for heating said body to produce an unbalanced condition thereof, and a coil for magnetizing or polarizing said body, substantially as set forth.

10. A prime motor having, in combination, a revolving magnetic body, a magnetic field in which said body is located, means for heating said body to produce an unbalanced condition thereof, and a fixed coil for magnetizing or polarizing said body, substantially as set forth.

11. A prime motor having, in combination, a magnetic body, a magnetic field produced by an electro-magnet, means for heating said body to produce an unbalanced condition thereof, and a dynamo-electric machine driven by the movement of said magnetic body and supplying current for energizing said field-magnet, substantially as set forth.

This specification signed and witnessed this 24th day of May, 1887.

THOS. A. EDISON.

Witnesses:
WILLIAM PELZER,
E. C. ROWLAND.

(No Model.)

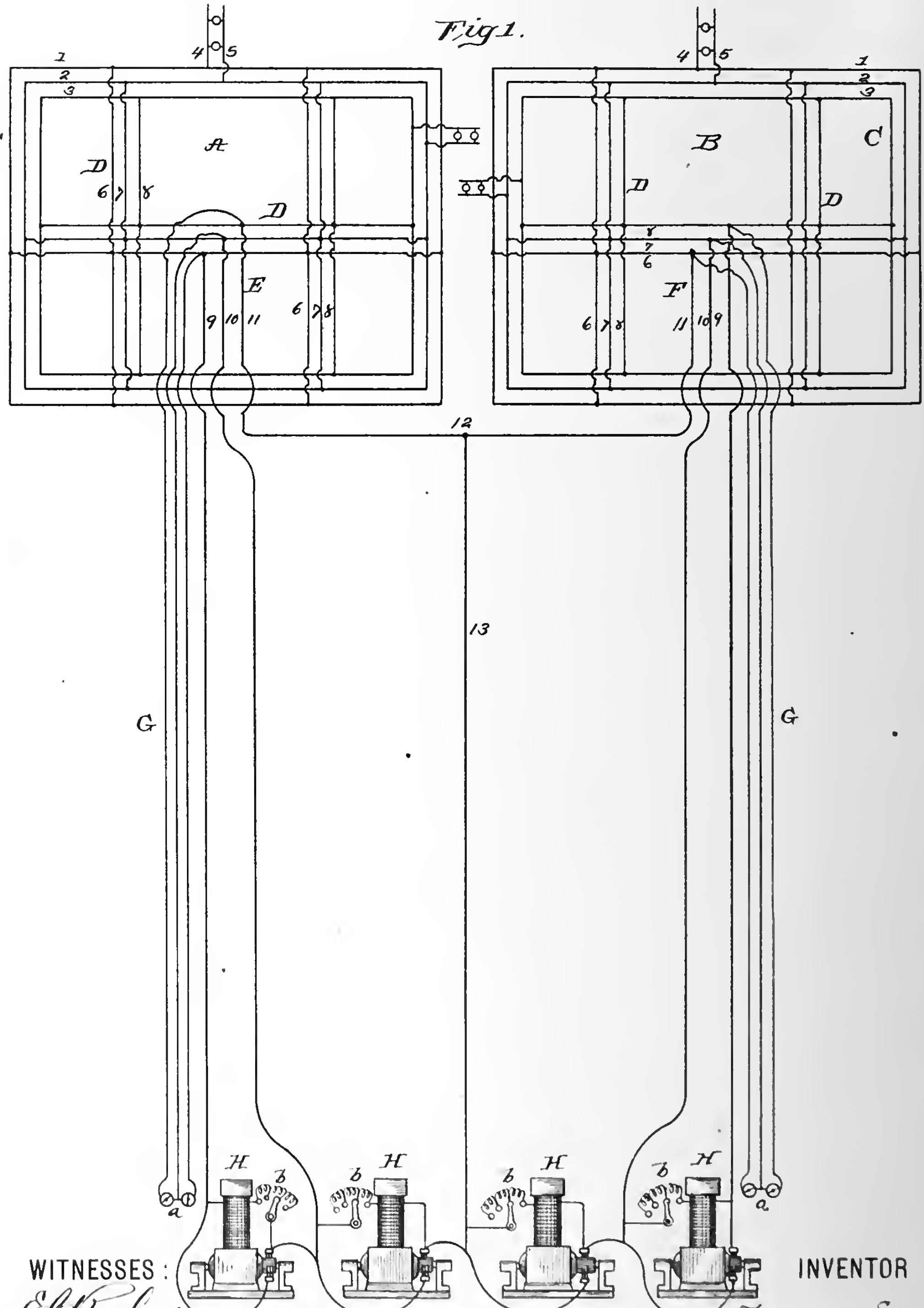
2 Sheets—Sheet 1.

T. A. EDISON.

SYSTEM OF ELECTRICAL DISTRIBUTION.

No. 380,101.

Patented Mar. 27, 1888.



WITNESSES:

E. C. Rowland

William Pelzer

INVENTOR

Thomas A. Edison

BY

Dyer & Seely

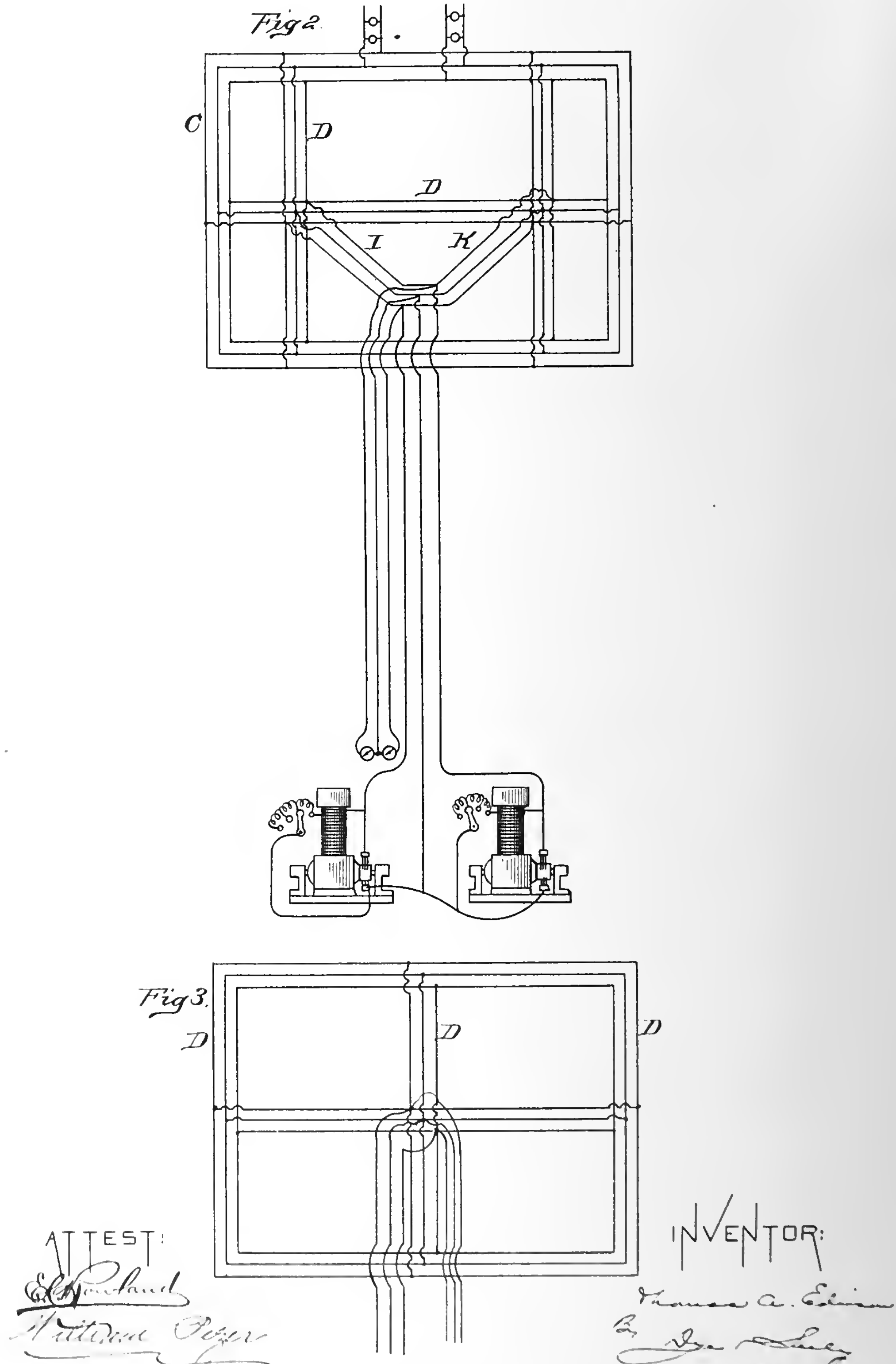
ATTORNEYS

(No Model.) 2 Sheets—Sheet 2.

T. A. EDISON.

SYSTEM OF ELECTRICAL DISTRIBUTION.

No. 380,101. Patented Mar. 27, 1888.



United States Patent Office.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY.

SYSTEM OF ELECTRICAL DISTRIBUTION.

SPECIFICATION forming part of Letters Patent No. 380,101, dated March 27, 1888.

Application filed September 23, 1887. Serial No. 250,476. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Systems of Electrical Distribution, (Case No. 730,) of which the following is a specification.

My invention relates to systems of high-tension electrical distribution, and may be considered an improvement upon my patent, No. 365,978, dated July 5, 1887.

The object I have in view is to produce an arrangement of conductors which will make unnecessary the sub-stations and the regulating and indicating devices thereat described in said patent. This I accomplish by the employment of sub-feeders so arranged and constructed that the drop in potential upon them at full load will be very small—say, for example, only two per cent.—and hence no regulators for these sub-feeders will be required. For this purpose the sub-feeders are preferably constructed as a net-work of conductors. They have no lamps connected with them, but run to the net-work of mains at various points. A main feeder extends from the center of the net-work comprising the sub-feeders back to the station. This is calculated for a larger drop in potential—say ten or fifteen per cent.—and has pressure-wires carried back with it for indicators. The main feeders, sub-feeders, and mains are arranged on the three-wire system. I preferably divide the area to be lighted into two or more sections, each arranged, as described, on the three-wire plan, with mains, sub-feeders, and a main feeder, and I connect the two or more sections together in series, forming, in the case of two sections, a five-wire system. All except the two outside conductors of the main feeders are balancing-wires, preferably of smaller size than such outside conductors. The dynamos used have separate regulators and have a surplus capacity for increased electrical pressure, so that if any side of either section is thrown greatly out of balance the pressure can be kept constant at all points notwithstanding a great drop on the smaller balancing-conductors. The sections into which the entire area to be lighted is divided being small, the sub-feeders will be short, so that to secure the small drop in potential great mass of copper is not required, especially when they are arranged to intersect. The drop upon the sub-feeder net-work being inconsiderable, no feeder-equalizers will be required for them, the differences in distribution in each section being taken up by flow of current upon the sub-feeder net-work instead of upon the mains.

In the accompanying drawings, forming a part hereof, Figure 1 is a diagram of a two-section system, illustrating the invention; Fig. 2, a diagram of one section, showing a slightly-different arrangement of the sub-feeders; Fig. 3, a diagram of a modified arrangement of the sub-feeders for a section, showing the connection of the main feeder and pressure-wires therewith. Fig. 1 illustrates the preferred arrangement, the area to be lighted being divided into two sections, A B, and the whole forming a five-wire system.

1 2 3 are the three conductors of the mains C of each section, from which are taken house-circuits 4 5. For simplicity of illustration the mains of each section are shown as describing a rectangle; but in practice the mains will of course follow the streets and will preferably intersect and form a net-work, as will be well understood. The sub-feeders D of each section are composed of the three conductors 6 7 8, branching in several directions and intersecting and forming a net-work, as shown, which is connected at a number of points (shown in the drawings as at six points) to the mains. To the center of this net-work of sub-feeders of the two sections A B are connected the conductors 9, 10, and 11 of the main feeders E F, the sub-feeders from these points of connection to their outer ends being calculated for a small drop in potential—say two per cent.—while the main feeders are calculated for a larger drop—say ten or fifteen per cent. A bridge-conductor, 12, connects the inner conductors, 11, of the main feeders of the two sections together and to a common balancing-conductor, 13, extending back to the station. The other conductors, 9 and 10, of the two main feeders run directly back to the station. Three pressure-wires, G, are carried back with each feeder and have the usual pressure-indicators, *a*, one for each of the four divisions of the five-wire system, which show

the pressure for each division of the system. Four dynamo-electric machines, H, are employed—one for each division of the system—and each of these machines is separately regulable by means of an adjustable resistance, *b*, in its field-circuit.

The lamps in section A are in series with the lamps of section B, the same as the lamps of one division of each section A or B are in series with those of the other section, compensating conductors extending back between the divisions of each section, as well as between the sections. The pressure on the mains of each section will be equalized through the low-resistance sub-feeder net-work, while inequalities in balance between the divisions of the system will be equalized at the dynamos.

The system possesses advantages for lighting one section from a distance. This is shown in Fig. 2, which also illustrates a modified arrangement of sub-feeders and main feeders which is applicable to a system of two or more sections. The sub-feeders in Fig. 2 are the same as in Fig. 1, with the exception that the main feeder is divided at its end and by branches I K connects with the sub feeder network at two points.

In Fig. 3 no mains are shown, the sub-feeder net-work being shown in a somewhat modified arrangement, branching immediately in four directions from the point of connection of the main feeder, and having all these branches bridged together.

What I claim is—

1. In a system of electrical distribution, the combination of main conductors and consumption-circuits therefrom with sub-feeding conductors having no translating devices connected therewith and constructed to have a low resistance or small drop in potential, so as to equalize the pressure between various points on the mains without adjustable resistances or equivalent devices, and a main feeder connected with the sub-feeders and extending to the point of electrical supply, the drop in potential upon such main feeder being greater than upon the sub-feeders, substantially as set forth.

2. In a system of electrical distribution, the combination of main conductors and consumption-circuits therefrom with a connected network of conductors connected with said mains and forming sub-feeders having a low resistance or small drop in potential, and a main feeder extending from the sub-feeder net-work back to the point of electrical supply, substantially as set forth.

3. In a system of electrical distribution, the combination of two or more sections of main conductors, sub-feeders of low resistance for each section, a main feeder from each set of sub-feeders back to the station, and a conductor connecting such sections in series, substantially as set forth.

4. In a system of electrical distribution, the combination of two or more sections of main conductors, sub-feeders of low resistance for each section, a main feeder from each set of sub-feeders back to the station, a conductor connecting such sections in series, and a compensating conductor extending from a point electrically between the sections back to the station, substantially as set forth.

5. In a system of electrical distribution, the combination of two or more sections of mains, each formed of three conductors, a set of three-wire sub-feeders for each section of low resistance, a three-wire main feeder from the sub-feeders of each section, and a connection between the adjoining conductors of the feeders, substantially as set forth.

6. In a system of electrical distribution, the combination, with mains and consumption-circuits, of a set of low-resistance sub-feeders, a main feeder from the sub-feeders to the station, and pressure-indicators at the station showing the pressure at the outer end of the main feeder, substantially as set forth.

7. In a system of electrical distribution, the combination of two or more sections of main conductors, each of one or more divisions, sub-feeders of low resistance for each section, a main feeder for each section extending from the sub-feeders back to the station, a conductor connecting the sections in series, compensating conductors for the divisions of the system, pressure-indicators showing the pressure at the outer end of each main feeder, and a dynamo-electric machine for each division of the system provided with means for its independent regulation, substantially as set forth.

This specification signed and witnessed this 13th day of September, 1887.

THOS A. EDISON.

Witnesses:

WILLIAM PELZER,
E. C. ROWLAND.

(No Model.)

T. A. EDISON.

SYSTEM OF ELECTRICAL DISTRIBUTION.

No. 380,102. Patented Mar. 27, 1888.

Fig. 1.

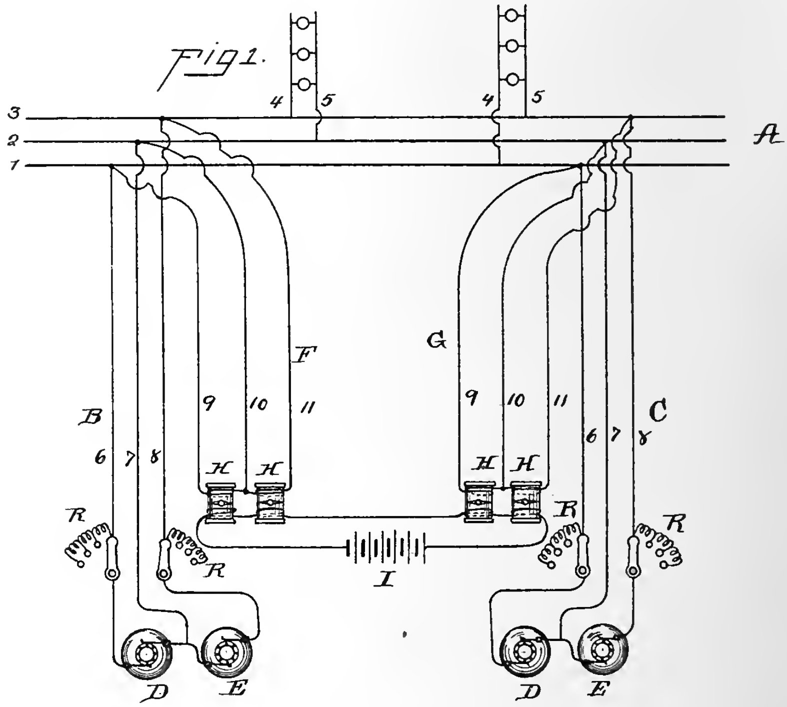
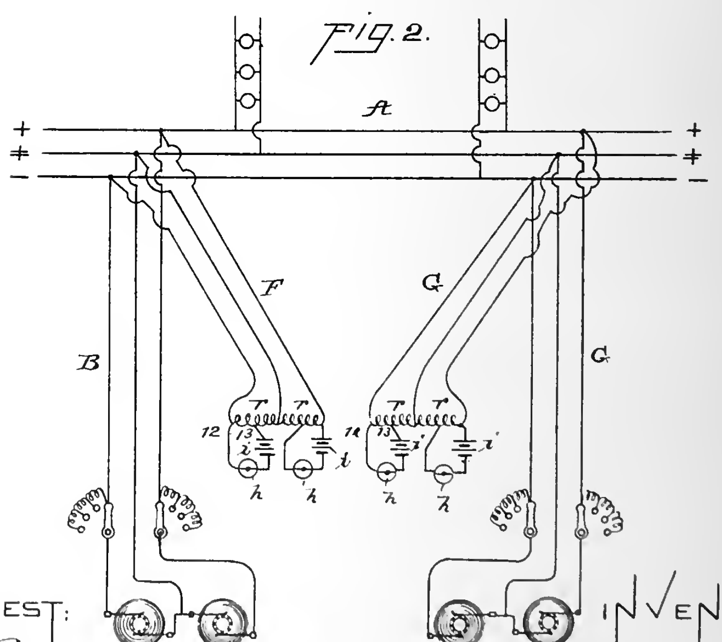


Fig. 2.



ATTEST:

E. C. Rowland

William Pelzer.

INVENTOR:

Thomas A. Edison.

By Dyer & Seely,

Attys.

N. PETERS, Photo-Lithographer, Washington, D. C.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY.

SYSTEM OF ELECTRICAL DISTRIBUTION.

SPECIFICATION forming part of Letters Patent No. 380,102, dated March 27, 1888.

Application filed September 23, 1887. Serial No. 250,477. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Systems of Electrical Distribution, (Case No. 731,) of which the following is a specification.

The object I have in view is to accomplish the indication of pressures for a system of electrical distribution by means which will be accurate and not liable to get out of order. This I accomplish by opposing at an electrical indicating-instrument for each set of pressure-wires the energy upon such wires and the energy of a standard battery, so that the indicator will stand at zero when the pressure is normal, and will move in one direction or the other, according to whether the pressure varies above or below the normal. In carrying out my invention I may put one coil of a differentially-wound galvanometer in the circuit of each set of pressure-wires, while the reverse coils of the several galvanometers will be in the circuit of a standard battery; or I may use a small standard battery for each set of pressure-wires, it being located in a shunt around a fraction of a resistance in the circuit of such pressure-wires, the shunt including, also, a simple galvanometer, and the parts being so proportioned that the standard battery in the shunt will produce a balance in such shunt when the pressure at the ends of the particular feeder is normal.

In the accompanying drawings, forming a part hereof, Figure 1 is a diagram illustrating the preferred arrangement, and Fig. 2 a diagram of a modified arrangement.

A represents the mains of a system of electrical distribution composed of three conductors, 1 2 3. A three-wire or compensating system is shown; but it is evident that the invention is applicable to any multiple-arc system. The consumption-circuits are represented at 4 5. Two three-wire feeders, B C, are shown extending back to the station, each composed of three conductors, 6, 7, and 8, having connected therewith two dynamo-electric machines, D E. The outside conductors of each feeder are provided with adjustable resistances R. Two sets of pressure-wires, F G, extend back from the outer ends of the feeders to the station, each set of such wires being composed of three wires, 9, 10, and 11.

By the preferred arrangement, Fig. 1, differentially-wound galvanometers H are employed, two for each set of pressure-wires, and having each two separate windings or coils. One coil of a galvanometer is in circuit with two pressure-wires, as shown, while the other coils of the two or more galvanometers are in circuit with a standard battery, I, the current of which serves to oppose at the galvanometers the current flowing on the pressure-wires, bringing the needles to zero when the pressures at the ends of the feeders are normal.

By the modified arrangement, Fig. 2, a fixed resistance, *r*, is located in circuit with each pair of pressure-wires, and a shunt, 12 13, is taken around a portion of the resistance, the shunt including a standard battery, *i*, and a simple galvanometer, *h*. The parts are proportioned so that the standard battery in each shunt will balance the electro-motive force at the shunt-terminals under normal conditions. In the case of either arrangement, when one of the galvanometer-needles moves, it is an indication that the pressure at the end of the particular feeder and on the particular side of the system is above or below the normal. By adjusting the proper resistance R the normal conditions will be restored. By this means of indication the accuracy of the result is not dependent upon the delicacy of the indicating apparatus, which may have a deflection of several inches for one volt; hence friction and other defects which render ordinary indicating apparatus liable to give incorrect readings, owing, principally, to the necessity for great delicacy, are obviated. As all indicating apparatus is originally standardized by a battery, it follows that a properly-constructed battery is the best possible means for securing constant pressures in a station for a long period of time.

The battery I prefer to use is the ordinary gravity battery with moderately-pure zinc and sulphate of copper; but of course I do not desire to limit my invention to the use of any particular battery.

What I claim is—

1. In a system of electrical distribution, the combination, with a set of pressure-wires, of

an electrically-moved indicator connected with such pressure-wires, and a standard battery, also connected with such indicator and opposing the effect of the system pressure at such indicator, substantially as set forth.

2. In a system of electrical distribution, the combination, with two or more sets of pressure-wires, of a double-wound electrically-moved indicator for each set of pressure-wires and connected by one winding with such pressure-wires, and a standard battery connected with the other windings of the two or more indicators and opposing at such indicators the energy of the system, substantially as set forth.

3. In a system of electrical distribution, the combination, with a feeder having means for varying the pressure at its outer end, and a set of pressure-wires extending from the outer end of the feeder back to the station, of an electrically-moved indicator connected with such pressure-wires, and a standard battery, also connected with such indicator and opposing the effect of the system pressure at such indicator, substantially as set forth.

4. In a system of electrical distribution, the combination, with two or more feeders having means for varying the pressure at their outer ends, and a set of pressure-wires extending from the outer end of each feeder back to the station, of a double-wound electrically-moved indicator for each set of pressure-wires and connected by one winding with such pressure-wires, and a standard battery connected with the other windings of the two or more indicators and opposing at such indicators the energy of the system, substantially as set forth.

This specification signed and witnessed this 14th day of September, 1887.

THOS. A. EDISON.

Witnesses:

WILLIAM PELZER,

E. C. ROWLAND.

(No Model.)

T. A. EDISON.

BURNISHING ATTACHMENT FOR PHONOGRAPHS.

No. 382,414. Patented May 8, 1888.

Fig. 1.

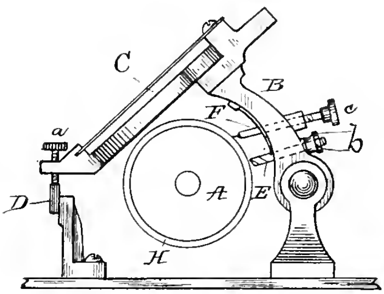


Fig. 2.

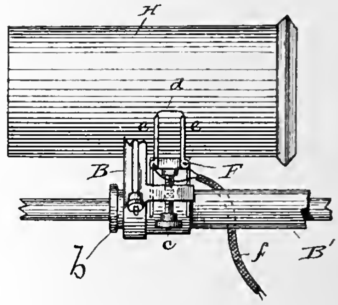


Fig. 3

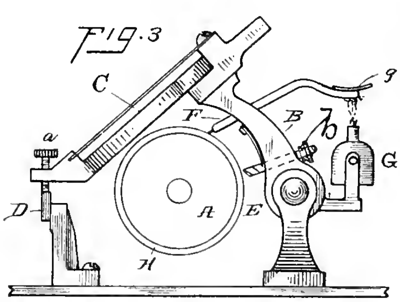
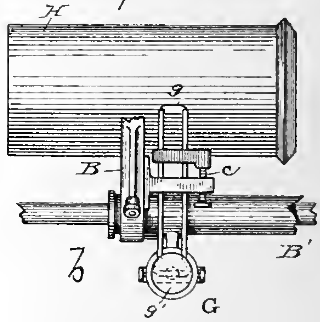


Fig. 4.



Witnesses.
E. C. Rowland
William Pelzer

Inventor.
Thomas A. Edison
By his Attorneys
Dyer & Seely

United States Patent Office.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY.

BURNISHING ATTACHMENT FOR PHONOGRAPHS.

SPECIFICATION forming part of Letters Patent No. 382,414, dated May 8, 1888.

Application filed November 26, 1887. Serial No. 256,190. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Phonographs, (Case No. 742,) of which the following is a specification.

The object I have in view is to improve the articulation of the phonograph. This I find can be accomplished by burnishing with a heated burnishing-tool the wax or wax-like surface of the phonogram-blank. The effect is to smooth out the tool-marks produced in turning the surface to a true cylinder, and to reduce greatly the scratching noise heard in the recorder, and consequently made a part of the record which is reproduced by the reproducer.

I provide the phonograph itself with the heated burnishing-tool as well as with the cutting-tool, the former acting after the latter upon the surface. Both tools are adjustably carried by the holding-arm or guide-sleeve of the phonograph, so that they can be brought into proper relation with the surface and made to work at the same time upon it. The burnishing-tool may be a piece of platinum wire heated by the electric current, or it may be a piece of wire which is heated by a small alcohol-lamp and conducts the heat to the burnishing-point of the tool.

In the accompanying drawings, forming a part hereof, Figure 1 is an end elevation of the phonogram-cylinder and phonogram-blank with the holding-arm and the cutting and burnishing tools carried thereby; Fig. 2, a top view with the holding-arm broken away; Fig. 3, a view similar to Fig. 1, showing a modified form of the heated burnishing-tool; and Fig. 4, a view similar to Fig. 2, showing the modified form of burnishing-tool.

A is the revolving phonogram-cylinder.

B is the traveling holding-arm mounted on the guide-sleeve B′ and carrying the recorder and reproducer, the arm and sleeve being fed laterally by a lead-screw on the shaft of the phonogram-cylinder, as will be well understood. The frame C, carried by the arm B, rests upon the guide-rest D, it being adjustably supported thereon by a set-screw, *a*.

Through the arm B passes the shank of the cutting-tool E, adjustable by means of the nut *b*. There is also carried by an extension on the arm B the heated burnishing-tool F. This is adjustable by means of the screw *c*, and acts upon the phonogram-blank surface after the cutting-tool.

In Figs. 1 and 2 the burnishing-tool is composed of a platinum strip or wire, *d*, to which heavier wires or rods *e* lead. The rods *e* are connected by a flexible cord, *f*, with a battery for supplying current for heating the strip or wire *d*. The strip or wire *d* is heated to a dull red, and is made to bear lightly on the wax or wax-like surface of the phonogram-blank.

In Figs. 3 and 4 the heat is produced by a small alcohol-lamp, G, which is carried by the guide-sleeve B′ and travels with the holding-arm. The burnishing-tool in this latter arrangement may be a silver or aluminium wire, *g*—say one-eighth of an inch in diameter and reduced to one thirty-second of an inch at its burnishing end, such end being heated by conduction from the lamp. The end of the wire *g* above the flame of the lamp may carry a plate, *g′*, so that the tool can be adjusted without disturbing the influence of the lamp. The wire, except at the flame and the burnishing end, may be covered by a poor conductor of heat, such as asbestus.

The phonogram-blank H is a cylinder slipping over the phonogram-cylinder A. It has a surface of wax or a wax-like material on a base of harder material—such as plaster-of-paris. The phonogram-blank may be turned and burnished before being placed on the phonogram-cylinder of the phonograph; but it is preferred to have the cutting and burnishing tools upon the phonograph itself, since the phonogram-blank can then be turned true to the cylinder of the machine, and can have the record removed from its surface, so that the phonogram blank can be used over again repeatedly.

I do not claim in this application the process of preparing the wax surface of a phonogram-blank by burnishing the same, or first cutting and then burnishing the same, since I propose to file a separate application for patent upon such process. Nor do I claim herein a phonogram-blank having a recording-surface of wax or a wax-like material, or having such a surface and a backing of tougher material, since this is covered by my application for Patent No. 734, Serial No. 252,964; neither do I claim herein such a phonogram-blank when the base is of a molded material—such as plaster-of-paris—since this is covered by my application No. 740; Serial No. 256,188; neither do I claim herein a phonogram-blank having a burnished wax or wax-like surface, since this will be made the subject of a separate application for patent.

What I claim is—

1. In a phonograph, the combination, with the phonogram-blank carrier adapted to carry a wax-surfaced blank, of a burnishing-tool mounted upon the machine in position to act on the wax surface of the blank, substantially as set forth.

2. In a phonograph, the combination, with the phonogram-blank carrier adapted to carry a wax-surfaced blank, of a heated burnishing-tool mounted upon the machine in position to act on the wax surface of the blank, substantially as set forth.

3. In a phonograph, the combination, with the phonogram-blank carrier adapted to carry a wax-surfaced blank, of a cutting-tool and a burnishing-tool mounted upon the machine in position to act in succession on the wax surface of the blank, substantially as set forth.

4. In a phonograph, the combination, with the revolving phonogram-cylinder and the traveling holding-arm, of the cutting-tool and the heated burnishing-tool moving with such traveling holding-arm, substantially as set forth.

5. In a phonograph, the combination, with the phonogram-blank carrier adapted to carry a wax-surfaced blank, of a burnishing-tool mounted upon the machine in position to act on the wax surface, and electric-circuit connections for heating the tool by an electric current, substantially as set forth.

This specification signed and witnessed this 22d day of November 1887.

THOS. A. EDISON.

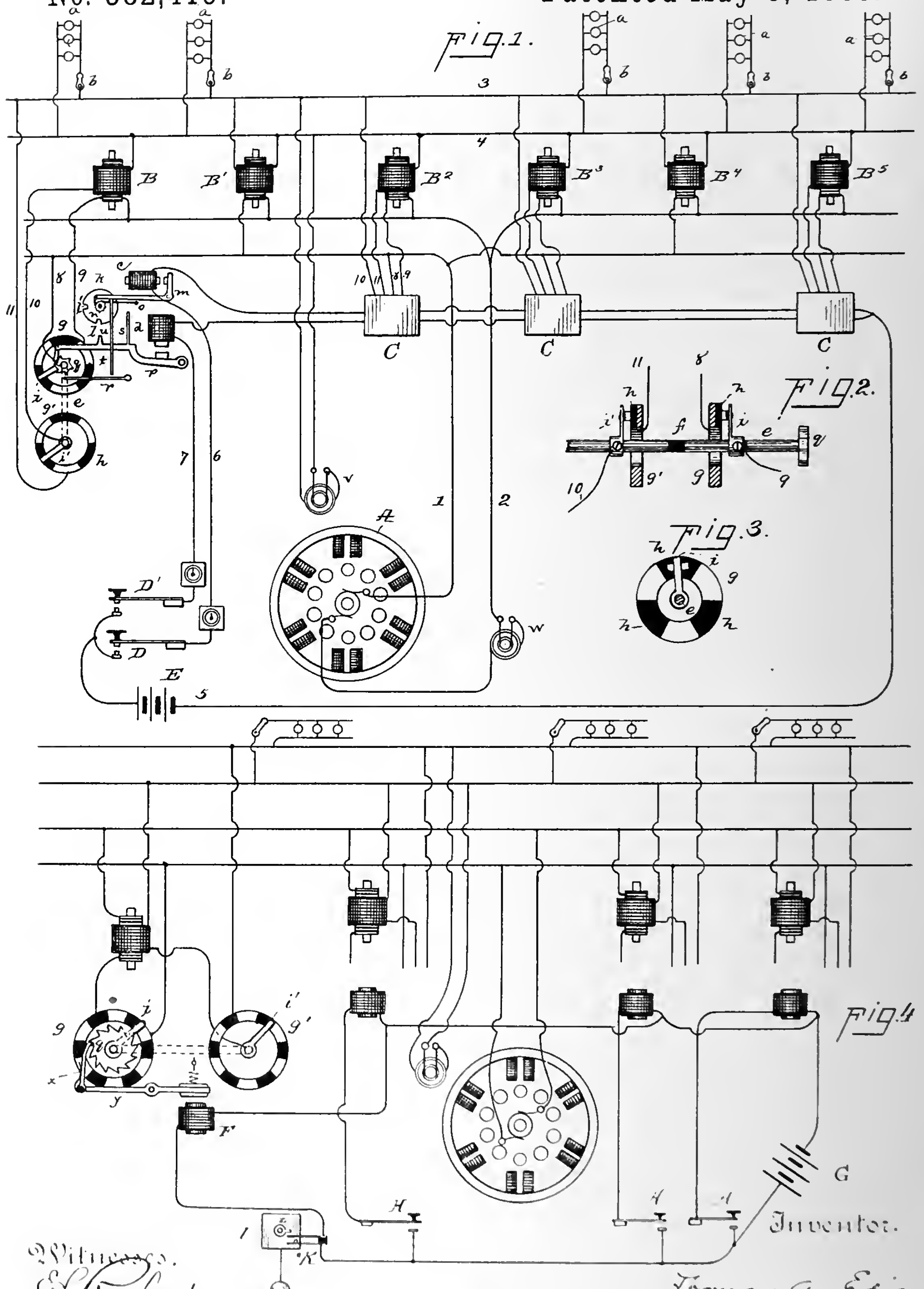
Witnesses:
WILLIAM PELZER,
E. C. ROWLAND.

(No Model.) 2 Sheets—Sheet 1.

T. A. EDISON.

SYSTEM OF ELECTRICAL DISTRIBUTION.

No. 382,415. Patented May 8, 1888.



Witnesses.

E. C. Rowland

Inventor.

Thomas A. Edison

By his Attorneys.

N. PETERS, Photo-Lithographer, Washington, D.C.

(No Model.) 2 Sheets—Sheet 2.

T. A. EDISON.

SYSTEM OF ELECTRICAL DISTRIBUTION.

No. 382,415. Patented May 8, 1888.

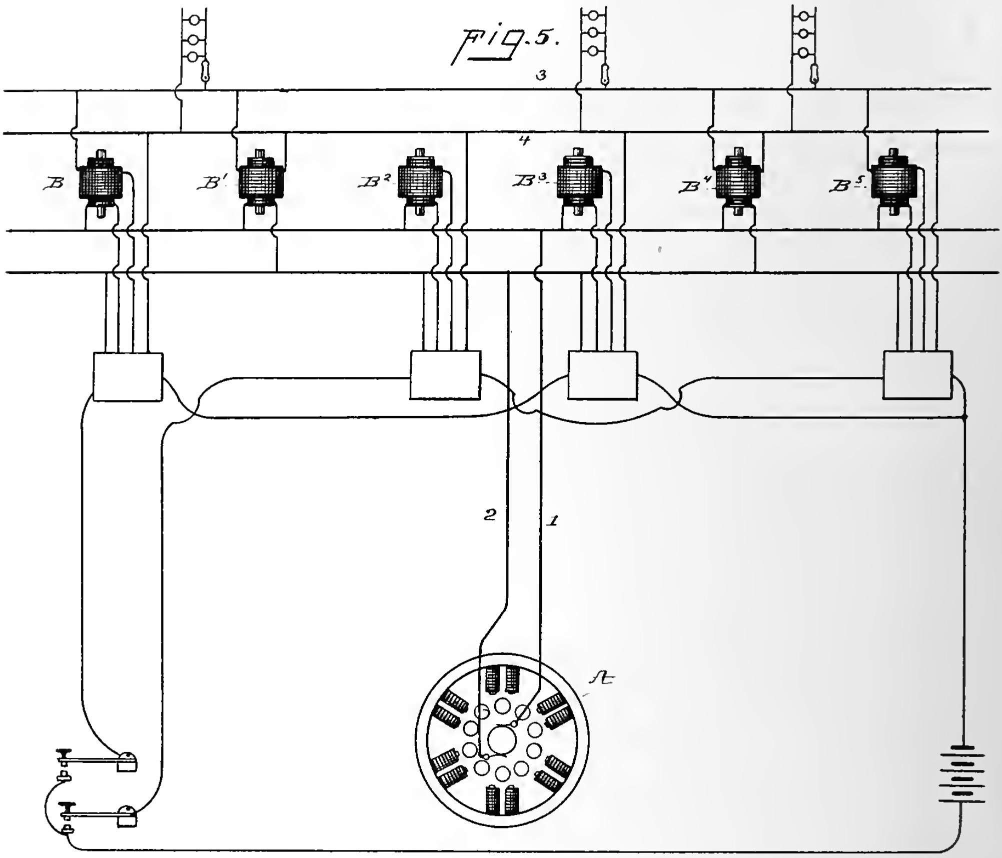


Fig. 5.

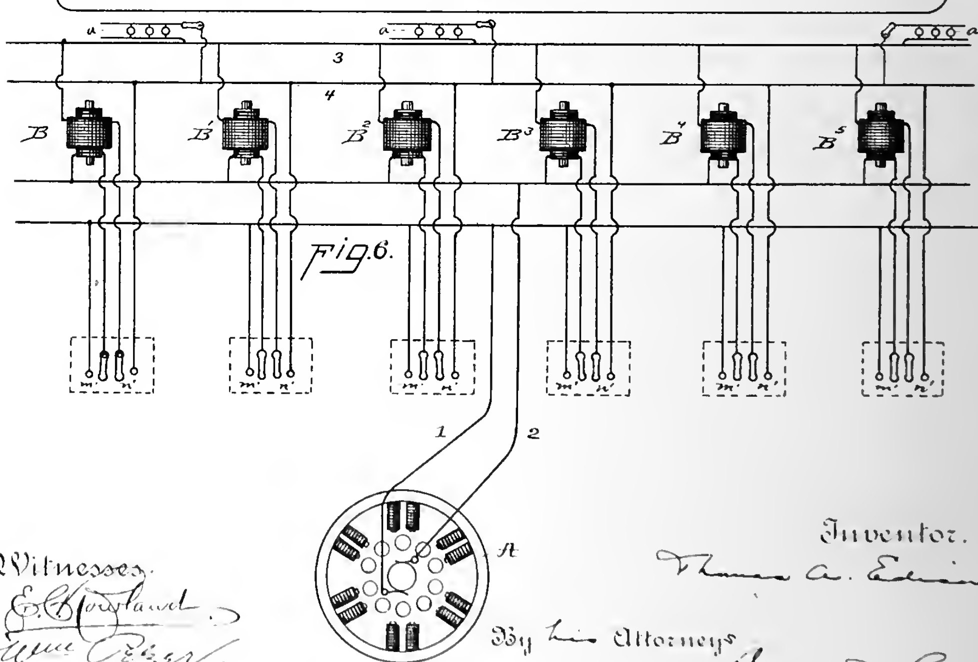


Fig. 6.

Witnesses.
E. C. Rowland
Wm. Pelzer.

Inventor.
Thomas A. Edison.
By his Attorneys
Dyer & Seely.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY.

SYSTEM OF ELECTRICAL DISTRIBUTION.

SPECIFICATION forming part of Letters Patent No. 382,415, dated May 8, 1888.

Application filed December 27, 1887. Serial No. 259,141. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Systems of Electrical Distribution, (Case No. 746,) of which the following is a specification.

My invention relates to systems for the distribution of electricity of that character in which a source of current of high tension is employed, and such current is conveyed by conductors of small size to or near to the place where the current is to be used, where the current is transformed by means of tension-reducing converters into a current of low tension suitable for lighting by electrical incandescence, or for other domestic or business purposes. In such systems the source of current is usually a dynamo electric machine generating an alternating current, and the converters are induction-coils receiving the high-tension current in their primary circuits of fine wire, and discharging the low-tension current from their secondary circuits of coarser wire.

In systems wherein a number of converters are used, all receiving current from a common source and all discharging into a common lighting circuit or system of circuits, the difficulty arises that, although the whole or the greater number of the lamps supplied are in circuit and using current only during about four hours out of the twenty-four, the converters themselves are using current during the whole day. There is a loss of from seven to twelve per cent., according to the construction in each converter, and this loss goes on all the time, whether all the lamps are in circuit or only a very few of them, so that the removal of lamps does not cause a corresponding reduction in the amount of current required in the system. It will be seen that this detracts enormously from the economy of the system, since though only a few lamps may be in use it is necessary to always keep the generation of current at a sufficient amount to supply the loss in all the converters. In some cases the current used in the converters—which of course is a dead loss to those operating the plant—will be equal in amount to that sold to the consumers. Evidently this results in a great diminution of the profits of the business.

The object of my invention is to remedy this by so arranging the system that only so many converters will be in circuit at any time as are required to supply the lamps or translating devices actually in use. I do this by providing the converters, or certain of them, with switches whereby their primary and secondary circuits may be opened or closed, as desired, and thus any desired number of the converters may be removed from or maintained in connection with the system, according to the amount of current required to be used at any time. I may provide simple hand-switches for this purpose; but I prefer to employ switches controlled from the central station. For the latter purpose I may employ electro-magnetic switches—such as are set forth in my application, Serial No. 257,369, filed December 9, 1887—whereby any particular switch may be operated without affecting the others, though they are all controlled by the same circuit; or I may have a separate controlling-circuit extending from the station to a controlling-magnet for each switch; or I may place the switching-magnets for two or more converters in one controlling-circuit, so as to throw them on or off at once; or I may control the circuits by time mechanism, which at a certain hour—according to the requirements of the particular system—will cause the converter to be disconnected; or various other modifications may evidently be made.

My invention is illustrated in the accompanying drawings.

Figure 1 is a diagram of a system in which switches are employed, controlled from the station by the same circuit; Fig. 2, a side view and partial section of one of these switches; Fig. 3, a front view of the switch; Fig. 4, a diagram of a system in which the converters are controlled by separate circuits. Fig. 5 illustrates one in which two or more converters are controlled by each circuit, and Fig. 6 illustrates the use of hand switches for the converters.

In each of the figures, A represents a dynamo-electric machine, generating an alternating current of high tension, and 1 2 is the circuit extending therefrom to the locality to be supplied.

B B′, &c., are tension reducing induction coils or converters, having their primary coils all connected in multiple arc across the high-tension circuit, 1 2, and their secondary coils all feeding in multiple arc into the low-tension or secondary circuit, 3 4, with which electric lamps or other translating devices *a a* are joined in multiple arc, each lamp or group of lamps having a switch, *b*, for connecting and disconnecting it. Certain of these converters are provided with switches for connecting and disconnecting them from the circuit. It is not usually necessary to provide all the converters with such switches, since there will probably always be use for some of them; but they may all be so provided, if desired. Converters B′ and B¹ are shown as unprovided with switches.

The switching mechanism for each converter is preferably placed in a suitable box, C, which may be attached to a pole or placed in any other convenient situation. One of the switches is shown at the left of the drawings, and the switches are all alike. Two circuits, 5 6 and 5 7, extend from the central station through all the boxes, the circuit 5 6 including all the magnets *c* of the switches, and circuit 5 7 all the magnets *d* in series. Both these circuits are supplied by a battery, E, and each has a key, D or D′, at the station.

The switching mechanism, it will be seen, is substantially such as is shown and described in my application above referred to. The switch itself is different, however. It consists of a shaft, *e*, Figs. 2 and 3, which has at its middle part an insulating-section, *f*. Loose on the shaft are two metal disks, *g* and *g′*, the faces of which have insulating-segments *h*, and upon the face of each disk bears an arm, *i* or *i′*, carried by the shaft. The primary circuit 8 9 of the converter is connected to the arm *i* and metal disk *g*, and the secondary circuit 10 11 is connected to arm *i′* and disk *g′*. Therefore, when the shaft is turned so that the arms rest on the insulating-segments, both circuits of the converters are broken; but when the arms are on the metal spaces both circuits are closed.

The switching mechanism consists of a stop-disk, *k*, having two notches, *l* and *l′*, the notches *l* being all in different positions on the disks in the different switches, and the notches *l′* all situated alike; a magnet, *c*, in the circuit 5 6, for revolving the disk by means of its vibrating armature *m*, engaging with the ratchet *n*; a unison stop-arm, *o*, for stopping the disks when they are all at unison; a magnet, *d*, in circuit 5 7, turning the switch-shaft *e* and arms *i i′* by its armature-lever *p* engaging the ratchet *q* on said shaft; a unison stop-arm, *r*, for stopping all the switches at unison; an arm, *s*, extending from lever *p*, for releasing the stop-disk *k* when the disks are at unison, and an arm, *t*, extending from armature-lever *m*, for releasing the switches when they are at unison.

The stop-disks are first all brought to unison by working the key D in circuit 5 6 until all the disks are held from revolution by the unison-arms *o*. Then all the notches *l′* come opposite the fingers *u* on levers *m*, and all the notches *l* are at different places on the disks. Then a movement of key D′ in circuit 5 7 throws the unison-arm up and releases the disks. Next the switches are all brought to unison by key D′, and they are finally all stopped by unison-arms *r*. Then a movement of key D throws this arm out of engagement and releases the switches. The parts are now ready for operation.

The operator at the station by observing the volt-indicator *v* in the indicating-circuit extending back from the secondary system, or the ampère-indicator *w* in the high-tension circuit, can see when the number of lamps in circuit is so reduced as to make it desirable to remove a converter from circuit. It will be understood, of course, that with the converters all in circuit the arms *i* and *i′* of all the switches are bearing on the metal parts thereof. To remove a converter the key D is worked until the stop-disk of the switch to be operated is turned so as to bring its notch *l* opposite the finger *u* of that switch. Then by means of key D′ the arms *i i′* of that switch are turned so as to bear upon insulating sections and both the circuits of the converter will be broken. No other converter will be affected, because the other switches will be held from motion by the fingers *u* encountering the peripheries of the disks. The operator is provided with electrically-operated dials *b′* in the circuits 5 6 and 5 7, by observing which he knows how far he has moved the stop disks and switches.

It is evident that any desired number of converters may thus be removed from action, and they may also be readily replaced, the stop disk of the proper switch being turned to release the arms of that switch, and such arms being then turned so as to bear on the metal portions of the switch disks. It will be seen that by this means any converter may be readily removed from or placed in circuit, and thus the number of converters in use is always kept proportional to the amount of the load as the load varies, so that there is no greater loss in the converters than is absolutely necessary at any time.

Fig. 4 shows another way of accomplishing the same result. Here each converter is provided with a switch consisting of two stationary disks, *g* and *g′*, having alternate metal and insulating spaces, and arms *i i′*, carried by the shaft and working on said disks, respectively, the shaft being turned by a pawl, *x*, engaging with ratchet *q* and carried by armature-lever *y* of magnet F. Such a switch is provided with each converter which it is desired to ever remove from circuit, though I have shown only the operating-magnets except in one instance. These magnets are all placed in separate circuits, having a common return through battery G, and each of these circuits is provided with a circuit breaker, which may be a simple key, H, by the movement of any one of which keys the magnet in that circuit is made to turn the arms i i' of that switch, so as to disconnect or connect the circuits of the converter desired to be affected. Instead of this I may use a clock-work or time mechanism, as shown at I, which at a certain point in its operation closes the switch K by means of a cam, z, or otherwise, and so causes the converter to be connected or disconnected. It can be readily determined in practice at what time of the day it will be desirable to throw off or throw on a converter, and the time-movement will then be set to act at that time. Any number of the converters may thus be provided with separate time-operated switches, each of which will be set to operate at the desired moment.

Fig. 5 shows an arrangement in which switches like those of Fig. 4 are used; but two or more such switches are placed in the same circuit, so that both or all of them may be connected or disconnected at once. Thus the converters B and B^3 in different parts of the district are both affected by the same circuit. Converters B^2 and B^5 are both affected by another circuit, while converters B' and B^4 are arranged to always remain in circuit.

Fig. 6 shows an arrangement of hand-switches for the converters. Such switches—m' for the primary circuits, and n' for the secondaries—are placed, preferably, in suitable boxes near the converters. In this case it will be necessary for the operator to go from one converter to another to connect or disconnect them at certain hours, or as the load varies.

What I claim is—

1. The combination of a source of current of high tension, a circuit extending therefrom, two or more tension-reducing converters having their primary circuits connected with said high-tension circuit, a translation-circuit supplying a variable number of translating devices, to which the secondary circuits of all said converters are connected, and switches for making and breaking the primary and secondary connections of individual converters, substantially as set forth.

2. The combination of a source of current of high tension, a circuit extending therefrom, two or more tension-reducing converters having their primary circuits connected in multiple arc with said high-tension circuit, a translation-circuit supplying a variable number of translating devices, with which the secondary circuits of all said converters are connected in multiple arc, and switches for making and breaking the primary and secondary circuits of individual converters, substantially as set forth.

3. The combination of a source of current of high tension, a circuit extending therefrom, two or more tension-reducing converters having their primary circuits connected with said high-tension circuit, a translation-circuit supplying a variable number of translating devices, to which the secondary circuits of all said converters are connected, and switches controlled from the central station or source of supply for making and breaking the primary and secondary connections of individual converters, substantially as set forth.

4. The combination of a source of current of high tension, a circuit extending therefrom, two or more tension-reducing converters having their primary circuits connected with said high-tension circuit, a translation-circuit supplying a variable number of translating devices, to which the secondary circuits of all said converters are connected, one or more separate circuits extending from the central station, electro-magnets energized thereby, and switches controlled by said electro-magnets for making and breaking the primary and secondary circuits of individual converters, substantially as set forth.

This specification signed and witnessed this 4th day of December, 1887.

THOS. A. EDISON.

Witnesses:
WM. PELZER,
E. C. ROWLAND.

(No Model.)

T. A. EDISON.

FEED AND RETURN MECHANISM FOR PHONOGRAPHS.

No. 382,416. Patented May 8, 1888.

Fig. 1.

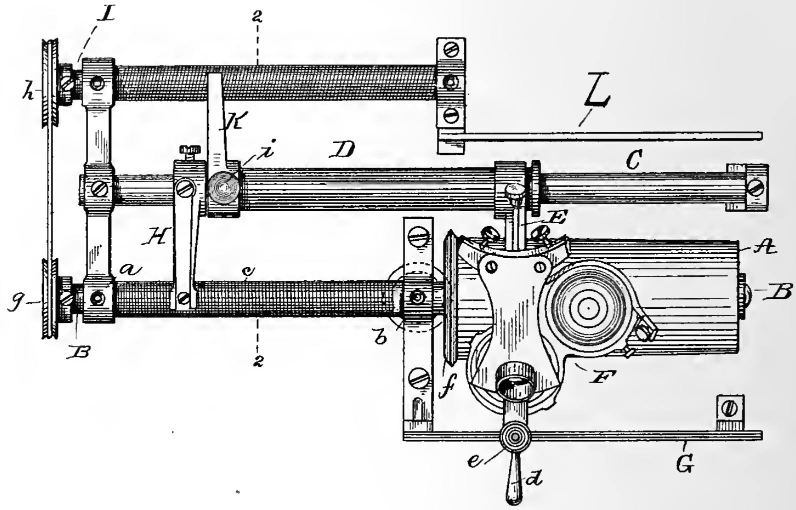


Fig. 2.

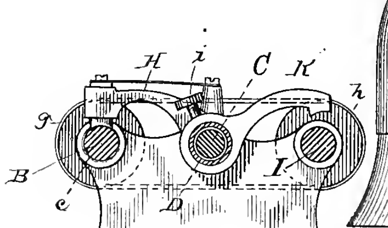


Fig. 3.

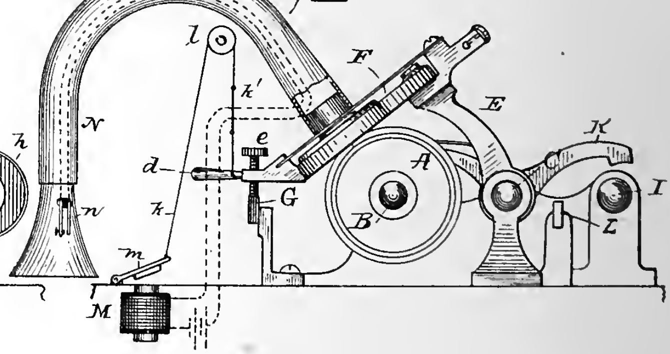
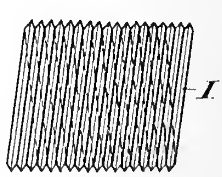


Fig 4.



Witnesses,
E. C. Rowland,
T. W. Witherspoon.

Inventor.
Thomas A. Edison,
By his Attorneys
Dyer & Seely

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY.

FEED AND RETURN MECHANISM FOR PHONOGRAPHS.

SPECIFICATION forming part of Letters Patent No. 382,416, dated May 8, 1888.

Application filed January 5, 1888. Serial No. 259,897. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Phonographs, (Case No. 745,) of which the following is a specification.

The object I have in view is to produce a simple and efficient mechanism for setting back automatically on the depression of a key or treadle the reproducer of a phonograph for reproducing the whole or a portion of the record. This I desire to do without reversing the motion of the lead-screw and by a movement which lifts the reproducer from the surface of the phonogram. I accomplish this end by means of a screw-shaft revolving with the lead-screw and engaging when the reproducer is lifted from the phonogram-surface an arm on the guide-sleeve and moving such guide-sleeve back with a rapid motion.

To give rapidity to the movement, the retracting-screw is composed of a number of parallel threads which are as fine as the threads of the lead-screw, so that the arm will engage at any point, but, by reason of having a number of parallel threads, can be given a much greater pitch than the threads of the lead-screw. The rocking holding-arm carrying the reproducer is connected through a cord preferably having an elastic section with a lever, which may be a key or treadle, so that by striking the key or treadle the parts will be set back, or an electro-magnet can be used to lift the rocking holding-arm. The arm that engages with the retracting-screw is held by a set-screw and can be set up out of action, or can be adjusted and held so as to engage the retracting-screw the moment the guide arm is released from the lead-screw.

In the accompanying drawings, forming a part hereof, Figure 1 is a top view of parts of a phonograph, illustrating my invention; Fig. 2, a cross-section through the leading and retracting screws on the line 2 2, looking at the engaging-arms; Fig. 3, an elevation from the outer end of the phonogram-cylinder, and Fig. 4 a separate enlarged view of a portion of the retracting-screw.

A is the phonogram-cylinder, mounted on a shaft, B, held by bearings *a b*. Between these bearings the shaft is cut with a fine screw-thread, forming the lead-screw *c*. In rear of the cylinder A and shaft B is the guide-rod C, upon which is mounted the guide sleeve D. This guide sleeve D slides on the guide-rod C, as will be understood. At one end of the sleeve D the rocking holding-arm E rises therefrom, carrying the swinging spectacles F, in the eyes of which are the recorder and reproducer. The spectacles have fingers *d* and set-screws *e*, which bear upon the guide-rest G. The guide-sleeve D has at its other end a guide-arm, H, with a screw-threaded end, which engages the lead-screw *c*. The cylinder A and shaft B being revolved from a motor by means of a soft bevel-wheel bearing on the bevel-flange *f* of the cylinder, the guide-sleeve D and the rocking holding-arm E, with the recorder and reproducer, are advanced from the left to the right, as seen in Fig. 1.

In rear of the guide-rod C, and parallel therewith and with the cylinder-shaft B, is a shaft, I, mounted in suitable bearings on the frame and revolved by a small round belt passing over wheels *g h* on the ends of this shaft and the cylinder-shaft. The shaft I is a screw cut with three parallel threads, which are as fine as the single thread of the screw *c*, but have a greater pitch. An arm, K, projects rearwardly from the guide sleeve D and has a corresponding screw cut on its end to engage with the screw-shaft I. The arm K is secured to the sleeve D by a set-screw, *i*, so that it can be turned upon such sleeve and held at any point of adjustment. This permits the arm K to be thrown up out of the way and held by the set-screw, so that the rocking holding-arm E can be thrown over onto the back rest, L, without engaging the arm K with the screw-shaft I, or the arm K can be fixed at such a point that it will engage the screw-shaft I as soon as the guide-arm H is released from the lead-screw *c*. The arm K will engage the multiple thread of the shaft I at any point that the guide-arm H is released from the single thread of the screw *c*, because the threads are of equal fineness; but the screw-shaft I will retract the parts with much greater speed than the screw *c* feeds them forward by reason of its greater pitch, permitted by the use of a number of threads.

For lifting the reproducer from the phonogram and causing the arm K to engage the screw-shaft I, I connect the finger d of the eye of the spectacles carrying the reproducer with a cord, k, passing up over a wheel, l, and down to a lever, m, which may be a hand-key or foot-treadle. This cord preferably has an elastic section, k', which will yield to permit the retracting movement of the reproducer. An electro-magnet, M, acting on an armature on the lever m and controlled by a circuit-controller, n, on the listening-tube N, may be used for lifting the rocking holding-arm to set it back.

What I claim is—

1. In a phonograph, the combination, with the rocking holding-arm carrying the reproducer, of a revolving screw-shaft and an arm connected with the rocking holding-arm and engaging this screw-shaft when the rocking holding-arm is rocked to lift the reproducer from the phonogram, whereby the reproducer is retracted or set back, substantially as set forth.

2. In a phonograph, the combination, with the phonogram-cylinder, the lead-screw, and holding and guide arms, of a revolving screw-shaft having a screw of greater pitch than the lead-screw, and an arm engaging this screw-shaft when the guide-arm is raised from the lead-screw, substantially as set forth.

3. In a phonograph, the combination, with the phonogram-cylinder, the lead-screw, and holding and guide arms, of a revolving screw-shaft having a screw composed of a number of threads of greater pitch than the lead-screw, and an arm engaging this screw-shaft when the guide-arm is raised from the lead-screw, substantially as set forth.

4. In a phonograph, the combination, with the phonogram-cylinder, the lead-screw, the guide-sleeve, and the holding and guide arms, of the retracting-screw shaft and the arm engaging therewith fixed adjustably upon the guide-sleeve, substantially as set forth.

5. In a phonograph, the combination, with the phonogram-cylinder, the lead-screw, the guide-sleeve, and the holding and guide arms, of the retracting-screw shaft driven by a belt from the cylinder-shaft, and the arm engaging therewith fixed adjustably upon the guide-sleeve, substantially as set forth.

6. In a phonograph, the combination, with the rocking holding-arm, the lead and retracting screws, and the arms engaging such screws alternately, of a lever connected by an elastic lifting-cord with such rocking holding-arm to rock and set back the holding-arm, substantially as set forth.

7. In a phonograph, the combination, with the rocking holding-arm carrying the reproducer or recorder, of an electro-magnet and armature acting to lift such arm and disengage the reproducer or recorder from the phonogram-surface, substantially as set forth.

8. In a phonograph, the combination, with the rocking holding-arm carrying the reproducer or recorder and the lead-screw, of an electro-magnet and armature acting to lift such arm, disengaging it from the phonogram and from the lead-screw, substantially as set forth.

9. In a phonograph, the combination, with the rocking holding-arm carrying the reproducer or recorder and the lead and retracting screws, of an electro-magnet and armature acting to lift such arm, disengaging it from the lead-screw and connecting it with the retracting-screw, substantially as set forth.

This specification signed and witnessed this 29th day of November, 1887.

THOS. A. EDISON.

Witnesses:

WILLIAM PELZER,
E. C. ROWLAND.

(No Model.)

T. A. EDISON.

PROCESS OF MAKING PHONOGRAM BLANKS.

No. 382,417. Patented May 8, 1888.

Fig. 1.

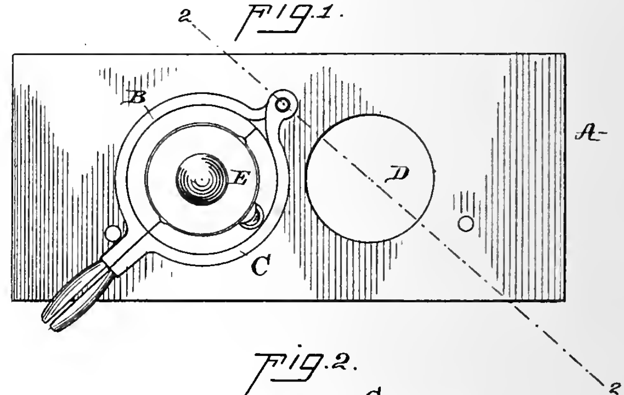


Fig. 2.

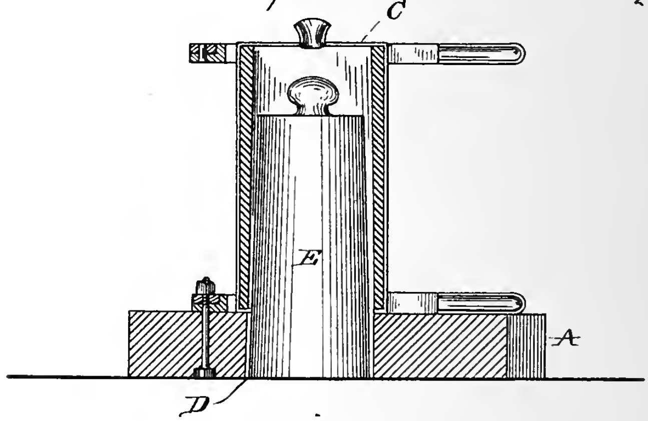
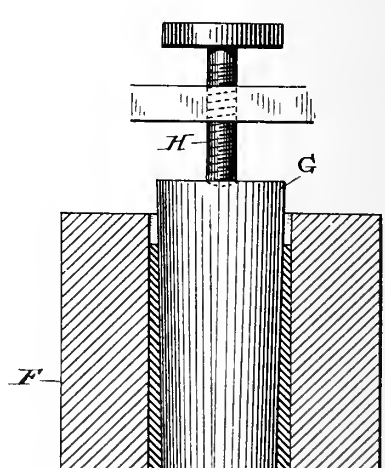


Fig. 3.



Witnesses.
E. C. Rowland.
William Pelzer

Inventor.
Thomas A. Edison.

By his Attorneys [illegible]

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY.

PROCESS OF MAKING PHONOGRAM-BLANKS.

SPECIFICATION forming part of Letters Patent No. 382,417, dated May 8, 1888.

Application filed February 4, 1888. Serial No. 263,047. (No specimens.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, a citizen of the United States, residing at Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Processes of Making Phonogram-Blanks, (Case No. 758,) of which the following is a specification.

The object I have in view is to produce a method or process of making wax phonogram-blanks which will result in a more accurate blank and one having a better surface for receiving the phonograph-record.

The blank which I prefer to use is a hollow tapering cylinder; but the process is applicable to blanks of other forms. It is hereinafter described as applied to the tapering cylindrical blanks.

I first mold the wax blank by pouring melted wax into a mold having the necessary shape for producing a hollow tapering cylinder. The molded cylinder is then pressed in a die of highly-polished metal, (preferably speculum metal,) and it is thereby given the exact shape and size desired, both externally and internally, and its surfaces are given a high polish, so that upon the removal of a blank from this die it will be ready for use without any cutting. The blank is removed from the mold and placed in the die while it is still partially plastic—say after its temperature has fallen to about 100° Fahrenheit.

In the accompanying drawings, forming a part hereof, Figure 1 is a top view of the mold. Fig. 2 is a cross-section of the mold on the line 2 2, when the mold is swung to the right; and Fig. 3 is a view, partially in section and partially in elevation, showing the pressing of the blank in the finishing-die.

The mold for molding the cylinder is shown, for convenience, as of the particular construction described in a prior application for patent, (Serial No. 260,923,) although it may be of any other suitable construction. It is composed of a base, A, upon which the mold is pivoted, such mold being composed of two parts, B C, adapted to be separated for opening the mold, and also adapted to be swung bodily upon the base, so as to bring the mold over the opening D in the base or over the solid portion of the base.

E is the tapering core of the mold. The mold is swung to the left over the solid part of the base, and the core being placed in it and the mold closed, hot wax is poured into the mold, forming a cylinder around the core E. When the wax is partially cool, sufficiently so to retain its shape, the mold is swung to the right over the opening D and the core E is pushed down into the opening D, as shown in Fig. 2, thus permitting the wax to contract without breaking. After the cylindrical blank has cooled down to a temperature where it is still slightly plastic—say 100° Fahrenheit—it is removed from the mold and is placed in the die F. This die may be a divided die or one that is solid. It has a cylindrical opening with a shoulder, *a*, at its lower end. A tapering plunger, G, pressed forward by a screw, H, is forced into the bore of the phonogram-blank, pressing the blank against the walls of the surrounding die, and giving it the exact shape and size both externally and internally that it is desired the blank should have. The die and its plunger are made of highly-polished metal. Speculum metal is preferably used for this purpose. The plunger is then removed from the blank and the blank removed from the die, when it will be ready for use on a phonograph. The blank formed in this way is accurate in its size and has a highly-polished recording-surface, which improves the articulation of the phonograph, and also has its bore accurately tapered, so as to fit the cylindrical phonogram-carrier of the phonograph.

What I claim is—

1. The process of making wax phonogram-blanks, consisting in first molding the blank from melted wax and then pressing the blank in a polished die, substantially as set forth.

2. The process of making cylindrical wax phonogram-blanks, consisting in first molding the cylindrical blank from melted wax and then pressing the blank both externally and internally in a polished die, substantially as set forth.

This specification signed and witnessed this 30th day of January, 1888.

THOS. A. EDISON.

Witnesses:

WILLIAM PELZER,
E. C. ROWLAND.

(No Model.)

T. A. EDISON.

PHONOGRAM BLANK.

No. 382,418. Patented May 8, 1888.

Fig. 1.

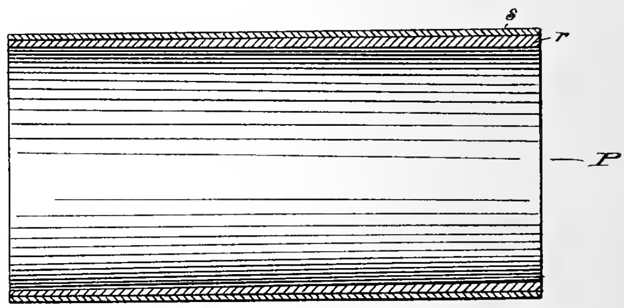
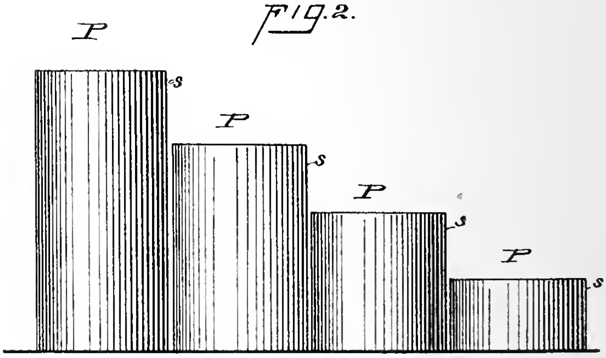


Fig. 2.



Witnesses:
E. C. Rowland.
William Pelzer

Inventor.
Thomas A. Edison.
By his Attorneys
Dyer & Seely

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY.

PHONOGRAM-BLANK.

SPECIFICATION forming part of Letters Patent No. 382,418, dated May 8, 1888.

Original application filed November 26, 1887, Serial No. 256,189. Divided and this application filed March 2, 1888. Serial No. 265,889. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, a citizen of the United States, residing at Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Phonogram-Blanks and Phonograms, (Case No. 762, division of Case No. 741,) of which the following is a specification.

The object I have in view is to produce a cylindrical phonogram-blank or phonogram which can be readily placed upon the phonogram-cylinder of a phonograph, and will center itself, and will also be adapted to retain its place upon the phonogram-cylinder by friction alone. This I accomplish by providing the cylindrical phonogram blank or phonogram with a tapering bore adapted to fit over a similarly-tapered phonogram-cylinder. The phonogram-blank or phonogram is provided with a cylindrical recording-surface. Blanks or phonograms of the full length of the tapering phonogram-cylinder of the phonograph can be used as well as those of shorter length, the tapering bore centering the blank or phonogram, and adapting it to be pushed onto the phonogram cylinder until it binds thereon with sufficient friction to hold it in place.

In the accompanying drawings, forming a part hereof, Figure 1 is a sectional view of a phonogram-blank or phonogram, showing by dotted lines its division into sections; and Fig. 2 an elevation, showing four different sizes of the phonogram-blank or phonogram.

P represents phonogram-blanks or phonograms. They have a cylindrical recording-surface, *s*, made of wax, or a wax-like substance, which may be mounted upon a backing, *r*, which is also a cylinder, but has a tapering bore adapted to fit upon a similarly-tapered phonogram-cylinder of a phonograph.

I propose to make these phonogram-blanks the entire length of the phonogram-cylinder, and also to divide such full-length phonogram-blanks into parts, so that sectional phonogram-blanks will be produced, which will be, for illustration, one-fourth, one half, and three-fourths the length of the full-size phonogram-blanks. All of these sectional phonogram-blanks, as well as the full-sized phonogram-blank, will have the tapering bore, so that they can be pushed upon the tapering phonogram-cylinder until they bind, and the instrument can then be adjusted to them for recording and reproducing.

I do not claim herein a phonogram-blank having a recording surface of wax, or a wax-like material, nor such a surface mounted upon backing of tougher material, such matters being covered by my application for patent, (Case No. 734, Serial No. 252,964,) filed October 21, 1887.

What I claim is—

1. A phonogram-blank or phonogram having a bore tapered throughout its length, substantially as set forth.

2. A phonogram blank or phonogram having a cylindrical recording-surface and a tapering bore, substantially as set forth.

3. A phonogram-blank or phonogram having a cylindrical recording-surface of wax or wax-like material and provided with a tapering bore, substantially as set forth.

This specification signed and witnessed this 20th day of February, 1888.

THOS. A. EDISON.

Witnesses:

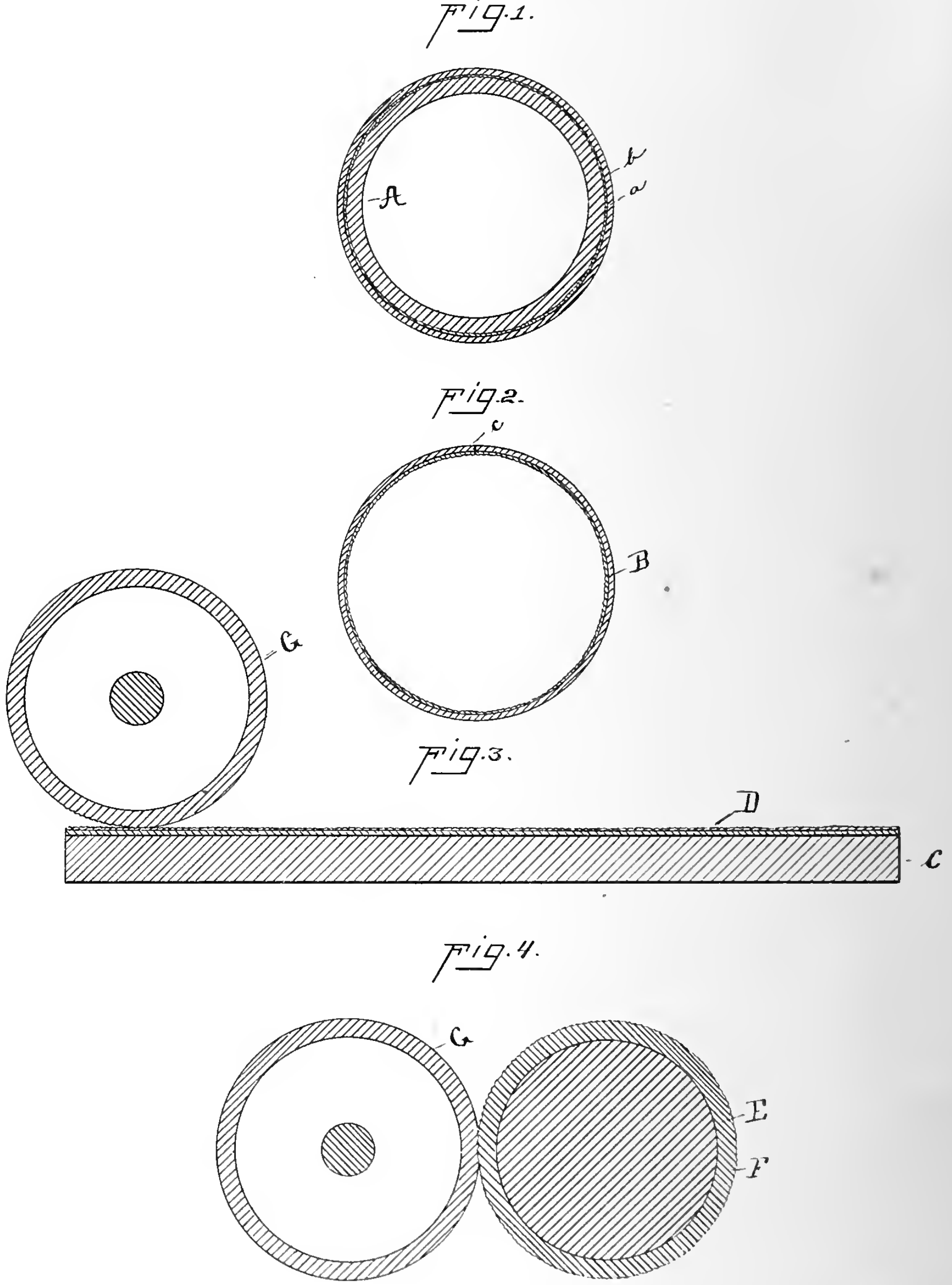
WILLIAM PELZER,
E. C. ROWLAND,

(No Model.)

T. A. EDISON.

PROCESS OF DUPLICATING PHONOGRAMS.

No. 382,419. Patented May 8, 1888.



Witnesses
E. C. Rowland.
William Pelzer

Inventor.
Thomas A. Edison.
By his Attorneys Dyer & Seely

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY.

PROCESS OF DUPLICATING PHONOGRAMS.

SPECIFICATION forming part of Letters Patent No 382,419, dated May 8, 1888.

Application filed March 8, 1888. Serial No. 266,596. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, a citizen of the United States, residing at Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Processes for Duplicating Phonograms, (Case No. 765,) of which the following is a specification.

The object of my invention is to produce a simple and efficient process for duplicating phonographic records. In applications already filed by me I describe a process for duplicating phonograms, wherein a metallic matrix is formed by depositing metals over the surface of cylindrical wax phonograms and then dissolving out the wax, leaving a hollow matrix or mold with the record in relief upon its inner surface. By my present invention I propose to apply the process of knurling to the duplication of phonograms as distinguished from molding. In my English Patent No. 1,644 of 1878 I proposed to construct a knurl by depositing metal over the record; but it is obvious that if this deposit were made of any thickness at all the record would be largely obliterated.

By my present invention I deposit metals over the record of the recording surface of a cylindrical wax phonogram, and after melting out the original wax I divide the remaining cylinder by splitting it longitudinally with a thin saw on one side. I then open the cylinder out flat or further bend it into the form of a cylinder, with the record upon its exterior. To give the necessary strength I provide a suitable backing. The result is a flat or cylindrical knurling surface having the record in relief, so that by rolling a wax phonogram-blank upon it the original record will be reproduced.

For making the first deposit upon the original wax phonogram I prefer to employ silver, which is deposited upon the wax phonogram by the vacuum process or by electroplating. A thin coating is produced in this way, which is backed up by a coating of lead or tin, which is also quite thin. For example, it may be one-sixteenth of an inch in thickness. The silver gives an inoxidizable surface, which is cheaper than gold or platinum. After the wax is dissolved out and this cylinder split on one side it will be found to have sufficient flexibility by reason of the materials employed and the thinness of the cylinder to permit of its being bent without injury to the record into the form of a flat sheet or a reversed cylinder. If bent around a cylinder it will be secured to the same by cement, and if bent into a flat sheet it will likewise be secured to a suitable bed plate, the cylinder or bed-plate giving the necessary strength to the record. The duplicate phonogram-blanks upon which I impress the original record by means of the knurl are preferably of a wax composition, which is too hard to be practically indented directly in the phonograph, although softer compositions may be employed, or materials other than wax.

In the accompanying drawings, forming a part hereof, Figure 1 is a sectional view showing the original phonogram with the deposit thereon; Fig. 2, a similar view with the original phonogram melted out or removed from the encircling metal deposit. Fig. 3 is a sectional view illustrating the flat knurling surface, and Fig. 4 a similar view illustrating the cylindrical knurling-surface.

A is the original wax phonogram, upon the surface of which is the phonographic record, upon which is formed a thin deposit of silver, *a*, and over this a thicker deposit of lead or tin, *b*, the entire metallic deposit being, for illustration, one-sixteenth of an inch thick. After this deposit is made the wax cylinder A is melted out of the metal coating, leaving the metallic cylinder B (shown in Fig. 2) with the record in relief upon its inner surface. This cylinder B is split longitudinally on one side at the point *c*, and it is then bent out flat and mounted upon a suitable base plate, C, to which it is secured by cement, forming a flat knurling-surface, D; or the cylinder B may be bent reversely over a solid cylinder, E, and secured thereto by cement, forming a cylindrical knurl, F. (Shown in Fig. 4.) The wax duplicate phonogram-blank G is impressed with the original record by rolling it against the flat or the cylindrical knurling surface, as will be readily understood.

I do not claim herein the method of duplicating phonograms by depositing metals upon a cylindrical wax phonogram and then melting or dissolving out the original wax phonogram, leaving a matrix with the record in relief upon its inner surface; neither do I claim herein the use of a vacuum deposit for producing a coating upon the wax phonogram; neither do I claim herein a duplicate phonogram constructed of a hard material not capable of being satisfactorily indented by a phonograph, since these features are covered in my applications Nos. 743, 744, and 751, already filed by me. Such applications have respectively the Serial Nos. 259,895, 259,896, and 262,428.

What I claim as my invention is—

1. The process of duplicating phonograms, consisting in forming a knurl having the original record in relief by depositing metal upon the original record, removing the original phonogram and opening the metallic coating, and then impressing duplicate phonogram-blanks with the original record by means of such knurl, substantially as set forth.

2. The process of duplicating phonograms, consisting in depositing a flexible metallic coating upon an original cylindrical phonogram, removing the original phonogram from the inclosing-coating, splitting the inclosing-coating longitudinally, bending the same to form a knurl, and then impressing the duplicate phonogram-blanks with the original record by means of this knurl, substantially as set forth.

This specification signed and witnessed this 3d day of March, 1888.

THOS. A. EDISON.

Witnesses:
WM. PELZER,
E. C. ROWLAND.

(No Model.)

T. A. EDISON.

PHONOGRAM BLANK.

No. 382,462. Patented May 8, 1888.

Fig. 1.

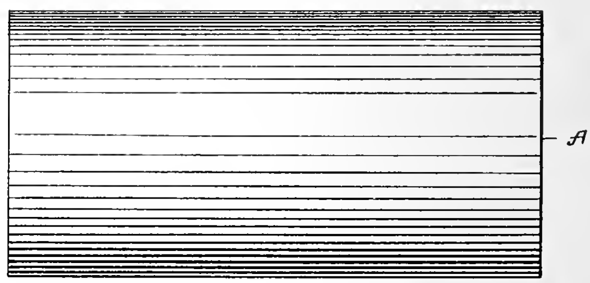


Fig. 2.

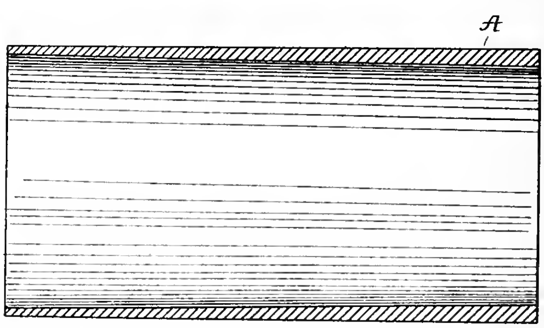
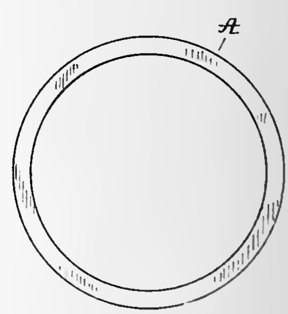


Fig. 3.



Witnesses:
E. C. Rowland,
William Pelzer.

Inventor.
Thomas A. Edison

By his Attorneys
Dyer & Seely

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY.

PHONOGRAM-BLANK.

SPECIFICATION forming part of Letters Patent No. 382,462, dated May 8, 1888.

Application filed January 5, 1888. Serial No. 259,898. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Phonogram-Blanks and Phonograms, (Case No. 747,) of which the following is a specification.

I have found in practice that the most available surface for phonogram-blanks and phonograms is one composed of wax, gum, or other plastic hydrocarbon. Such compounds, however, I find contract and expand under variations of temperature to a much greater extent than paper, wood, metals, and other similar harder substances. While under ordinary conditions the wax or wax-like surface may not be injured by this difference in the coefficient of expansion, yet when subjected to extreme cold the contraction of the wax is so much greater than the harder backing that the wax will crack and destroy the continuity of the surface. For instance, a phonogram-blank or phonogram may be subjected to a temperature of nearly 100° Fahrenheit at one time and at another time the temperature may fall below zero. If the waxy substance is sufficiently hard at the high temperature to hold its shape under the pressure of one on the other in a packing-box, it will at the low temperature harden and contract so greatly in excess of the backing of harder material that the wax will crack and render the surface useless.

The object I have in view is to produce a phonogram-blank or phonogram which will have the wax or wax-like surface and will not be subject to the objection that has been stated. This I accomplish by constructing the phonogram-blank or phonogram wholly of the wax or wax-like material. I prefer to mold the entire phonogram-blank of the one wax-like compound; but I may construct the base or backing of the surface of a somewhat different mixture of wax or wax-like materials than that of which the surface is made, so long as the whole has substantially the same coefficient of expansion.

My phonogram-blank I prefer to mold as a hollow cylinder with a tapering bore for slipping over the tapering phonogram-cylinder of my phonograph.

In the accompanying drawings, forming a part hereof, Figure 1 is an elevation of the phonogram-blank; Fig. 2, a longitudinal section thereof, and Fig. 3 an end view.

A is the cylindrical phonogram-blank, molded of the plastic wax or wax-like material, as described, and having a tapering bore.

The invention is also applicable to duplicate phonograms having the phonographic record thereon.

What I claim is—

1. A phonogram-blank or phonogram constructed wholly of wax or wax-like materials and having the same coefficient of expansion throughout its mass, substantially as set forth.

2. A phonogram-blank or phonogram constructed as a hollow cylinder wholly of wax or wax-like materials and having the same coefficient of expansion throughout its mass, substantially as set forth.

3. A phonogram-blank or phonogram constructed as a hollow cylinder, with a tapering bore wholly of wax or wax-like materials, and having the same coefficient of expansion throughout its mass, substantially as set forth.

This specification signed and witnessed this 5th day of December, 1887.

THOS. A. EDISON.

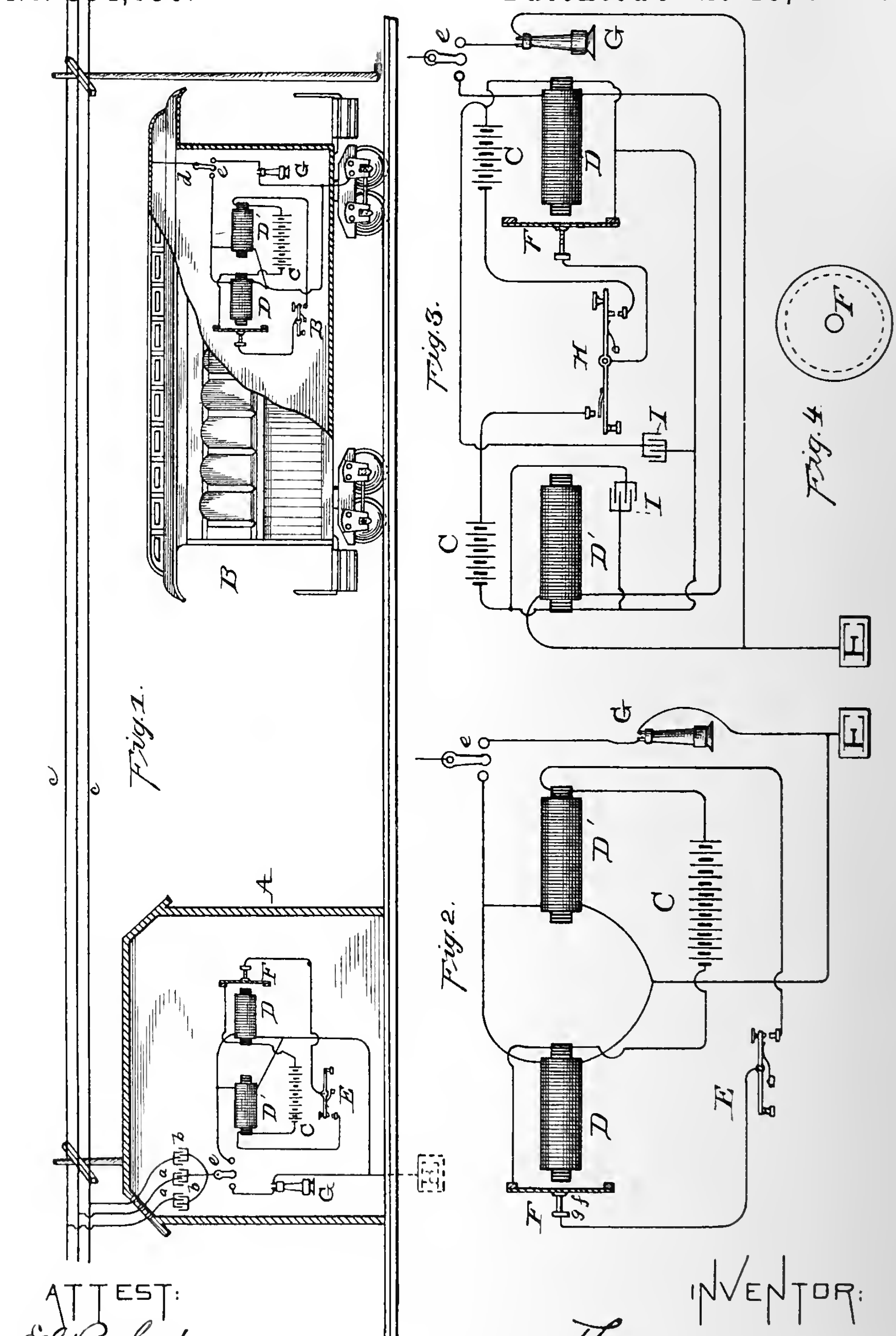
Witnesses:
WILLIAM PELZER,
E. C. ROWLAND.

(No Model.)

T. A. EDISON & E. T. GILLILAND.

RAILWAY SIGNALING.

No. 384,830. Patented June 19, 1888.



ATTEST:

Edw. Rowland.

Wm. Pelzer.

INVENTOR:

Thomas A. Edison

Ezra T. Gilliland.

By Dyer & Seely

attys.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY, AND EZRA T. GILLILAND, OF NEW YORK, N. Y.

RAILWAY SIGNALING.

SPECIFICATION forming part of Letters Patent No. 384,830, dated June 19, 1888.

Application filed November 29, 1886. Serial No. 220,115. (No model.)

To all whom it may concern:

Be it known that we, THOMAS A. EDISON, of Llewellyn Park, in the county of Essex and State of New Jersey, and EZRA T. GILLILAND, of the city, county, and State of New York, have invented a certain new and useful Improvement in Systems of Railway Signaling, (Case No. 684,) of which the following is a specification.

Our invention relates to signaling systems for communicating between stations and moving trains by induction from the telegraph-wires to the roofs of the cars. In such a system we prefer to employ as transmitters vibrators operated by keys, by which signals are sent upon the line, and as receivers telephone-receivers connected to ground. In the operation of such a system it is desirable to make the transmitted vibrations as short and distinct as possible in order that they may be clearly reproduced at the receiver.

The object of our invention is to increase the quickness, rapidity, and clearness of the vibrations, and we accomplish this by means of novel devices and combinations of devices which constitute our invention and are hereinafter described and claimed.

In the accompanying drawings, Figures 1 illustrates a railway signaling system embodying our invention, the circuits and instruments in the car and station being shown diagrammatically. Fig. 2 is a larger diagram of the preferred arrangement of circuits for either a car or station; Fig. 3, a similar diagram of a modified arrangement of circuits, and Fig. 4 a view of the vibrator which we prefer to use.

One feature of our invention is the dividing of the transmitting induction-coil—that is, using two or more small coils instead of one large one. Heretofore we have placed in each station or car a single induction-coil having in its primary circuit a key and a vibrator, while its secondary circuit was connected in one direction with the earth, and in the other, at the station, through condensers to the telegraph-wires, and on the car with the metal roof thereof. By our present invention we employ two or more induction-coils, preferably having their primary coils in series and their secondary coils in multiple arc, though they may be otherwise connected, as will be presently explained.

Referring to the drawings, A represents a station, and B a car, each provided with signal transmitting and receiving apparatus embodying our invention. In the station such apparatus is connected by wires *a a*, through condensers *b b*, with the ordinary telegraph-wires, *c c*, which extend along the track. In the car the apparatus is connected by wire *d* with the metal roof of the car or with metal strips placed thereon. Each signaling apparatus is provided with a switch, *e*, by which either the receiving or transmitting apparatus is connected in circuit.

As is now well understood, the vibrations communicated to the telegraph-wires by the transmitter at the station are transmitted by induction to the roof of the car and to the receiving apparatus therein, while the vibrations transmitted from the car induce vibrations upon the telegraph-wires which are received at the station.

The apparatus in Fig. 2 is that either of a car or a station. C is the transmitting-battery. D D′ are induction-coils, having their primary coils connected in series with each other and in circuit with the battery C. The same circuit includes a circuit making and breaking key, E, and also a vibrator.

The use of the form of vibrator shown constitutes another feature of our invention in pursuance of the general object of increasing the rapidity and distinctness of the vibrations. It consists of a diaphragm, F, like a telephone-diaphragm, and preferably of metal, secured rigidly at its edges, and having at its center, which is immediately in front of the core of the induction coil D, a contact-piece, *f*, which makes and breaks circuit as the diaphragm is moved by the attraction of said core with a stationary contact-point, *g*. The secondaries of the induction-coils are connected in multiple arc, as shown, between switch *e* and the earth, the ground-connection being made in the car by a connection with the wheels thereof.

The receiving apparatus is a telephone-receiver, G, in circuit between switch *e* and ground.

When the key E is depressed, the diaphragm-vibrator F is at once set in operation, and by rapidly opening and closing the primary circuits of the two induction-coils induces corresponding vibrations in the two secondaries, which are transmitted to the receivers in circuit, as already explained.

The movements of the key break the vibrations into Morse signals, as now well understood.

Diaphragms used as vibrators give more rapid, clear, and distinct vibrations than have heretofore been produced by the use of reeds or pivoted or other vibrators. The division of the induction-coils has a similar effect, since the smaller induction-coils act with much greater rapidity than large ones.

In Fig. 3 a different arrangement of circuits is shown. Here the battery is divided into two parts in multiple arc to each other, and each in series with the primary of one of the inductions, which also are in multiple arc to each other. The vibrator is common to both primary circuits, and a double key, H, is employed, which affects the two primary circuits alike and simultaneously.

Each induction-coil primary is shunted by a condenser, I, which we find also serves to increase the clearness of the vibrations.

What we claim is—

1. In transmitting apparatus for induction railway signaling, the combination, with two or more induction-coils having their secondary circuits connected to line, of a battery, a key, and a vibrator, all located in the primary circuits of the two or more induction-coils, substantially as set forth.

2. In transmitting apparatus for induction railway signaling, the combination, with an induction-coil having its secondary circuit connected to line, of a battery, a key in the primary circuit of such induction-coil, and a diaphragm-vibrator also located in such primary circuit, the diaphragm being located near the end of the core of the induction-coil and being attracted thereby, substantially as set forth.

3. In transmitting apparatus for induction railway signaling, the combination, with two or more induction-coils having their secondary circuits connected to line, of a battery, and a key in the primary circuits of such induction-coils, and a diaphragm-vibrator also located in the primary circuits of both coils, the diaphragm being located opposite the core of one coil and being attracted thereby, substantially as set forth.

4. In transmitting apparatus for induction railway signaling, the combination, with the transmitting battery and key, of a diaphragm-vibrator in circuit therewith, substantially as set forth.

This specification signed and witnessed this 24th day of November, 1886.

THOS. A. EDISON.
EZRA T. GILLILAND.

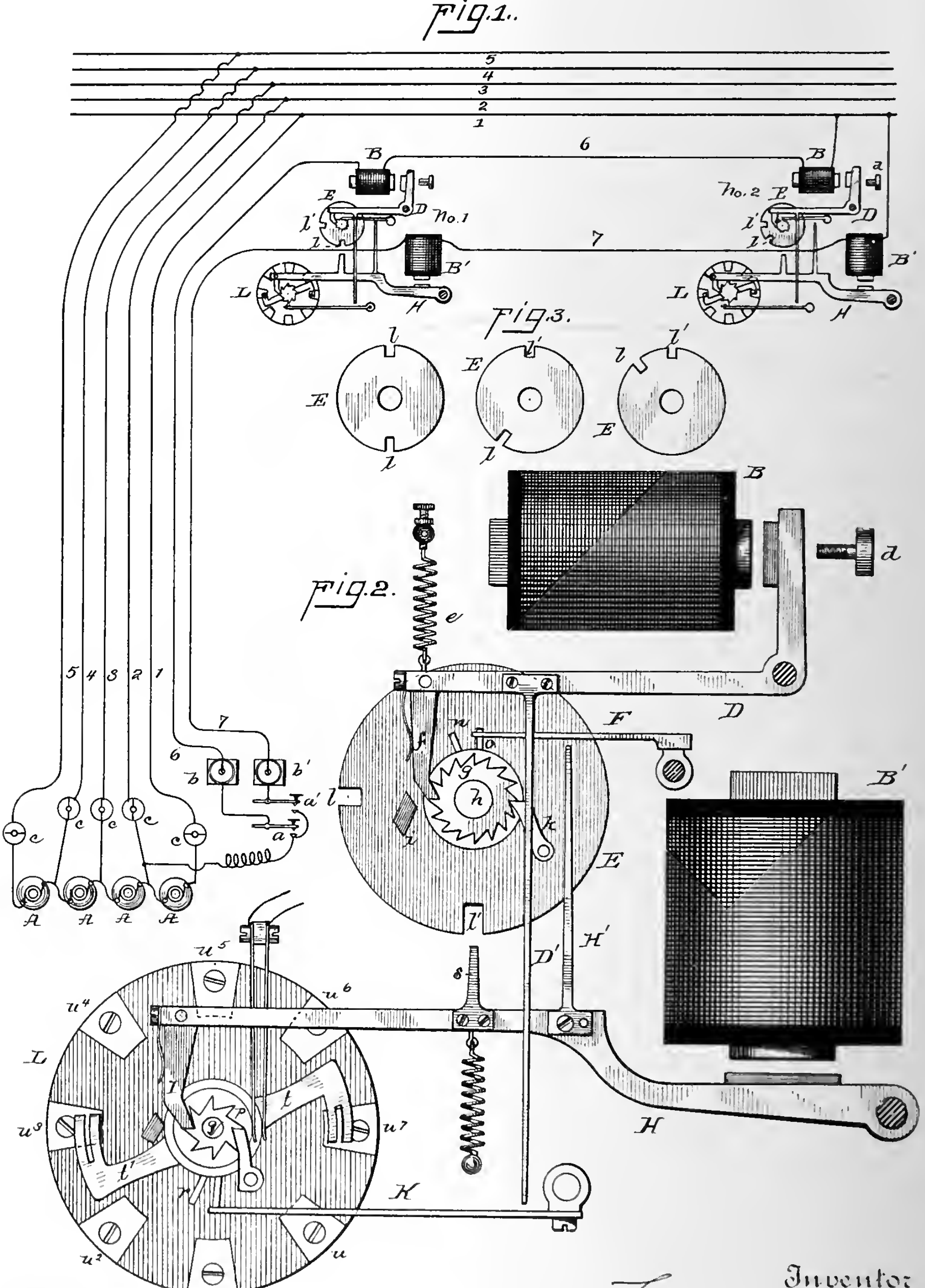
Witnesses:
WM. PELZER,
E. C. ROWLAND.

(No Model.) 2 Sheets—Sheet 1.

T. A. EDISON.

SYSTEM OF ELECTRICAL DISTRIBUTION.

No. 385,173. Patented June 26, 1888.



Witnesses

E. C. Rowland

William Pelzer

Inventor

Thomas A. Edison

By his Attorneys

Dyer & Seely

Atty's.

N. PETERS, Photo-Lithographer, Washington, D. C.

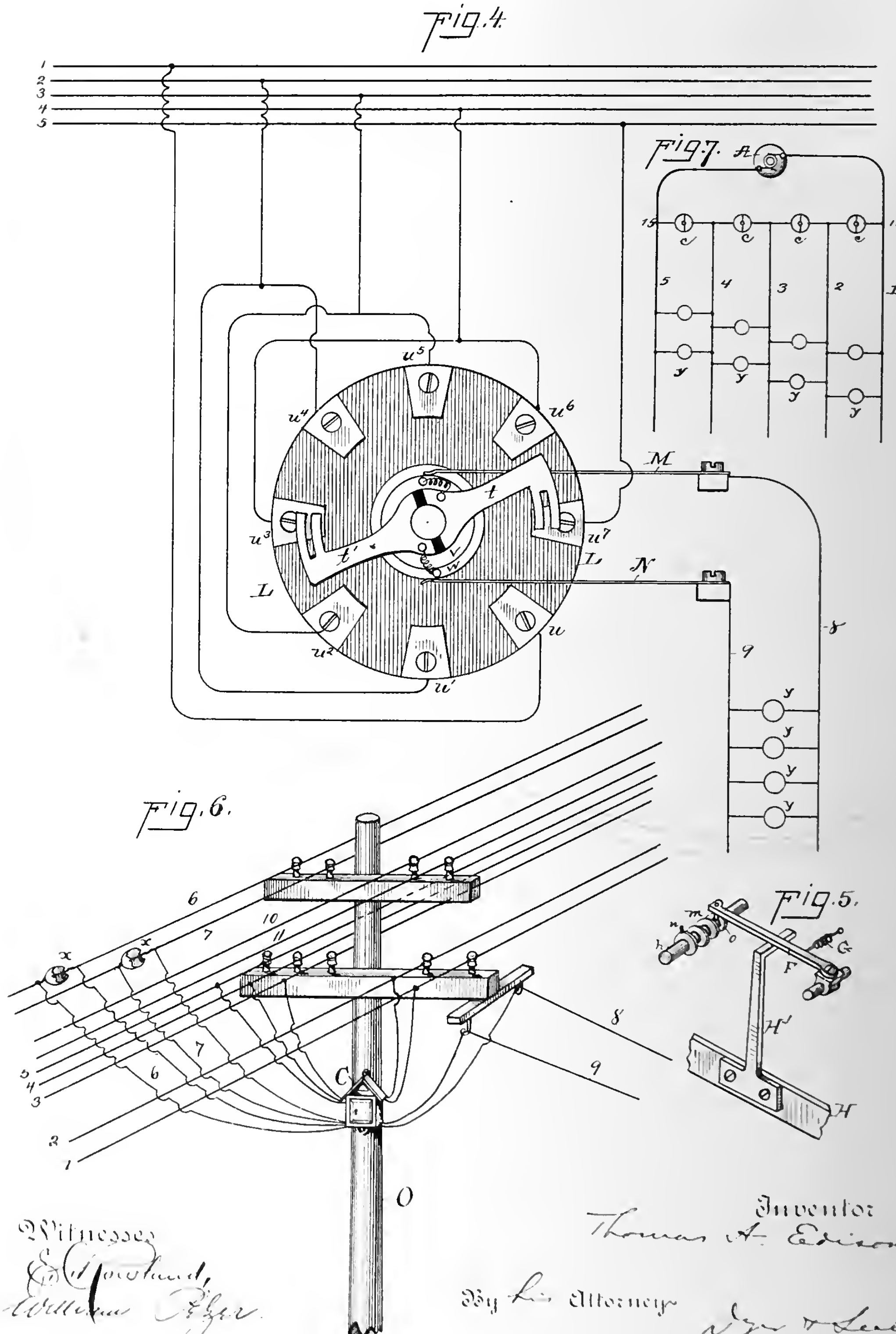
(No Model.)

2 Sheets—Sheet 2.

T. A. EDISON.

SYSTEM OF ELECTRICAL DISTRIBUTION.

No. 385,173. Patented June 26, 1888.



Witnesses
E. C. Rowland,
William Pelzer.

Inventor
Thomas A. Edison
By his Attorneys
Dyer & Seely.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY.

SYSTEM OF ELECTRICAL DISTRIBUTION.

SPECIFICATION forming part of Letters Patent No. 385,173, dated June 26, 1888.

Application filed December 9, 1887. Serial No. 257,369. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Systems of Electrical Distribution, (Case No. 737,) of which the following is a specification.

My invention relates in part to compensating systems of electric lighting in which more than three wires are used, and more especially to the providing of apparatus in such systems controlled from the central station for shifting translating devices from one division of the system to another, so as to maintain the balance of the system. In my patent, No. 283,983, dated August 28, 1883, is set forth apparatus for this purpose for a simple three-wire system; but this apparatus cannot be employed in a more extended system except by multiplying the controlling circuits and apparatus.

One object, therefore, of my present invention is to provide simple and efficient devices for accomplishing the result above set forth in a system employing more than three main wires, whereby very small wires may be used for the compensating conductors, since they will never have to carry much current. I accomplish this, generally speaking, by connecting a suitable number of the house-circuits throughout the system to the main conductors through suitable circuit-controlling or switching devices, worked by electro-magnets placed in circuits from the station and of such character as when operated from the station to shift the connections—each of its particular house-circuit—progressively across from one division of the system to another division. I have devised a switching apparatus for this purpose, the use of which, however, is not confined to this purpose alone, but it may be used in any case where it is desired to control separately two or more of the circuits of a system from the central station. This switching apparatus forms a portion of my invention.

Generally speaking, the apparatus consists of an electrically-operated switch for each circuit to be controlled, and simultaneously electrically-controlled stops for these switches, such stops being situated or arranged differently with respect to the several switches, so that when such stops are moved simultaneously any particular switch can be released for action, while the other switches are kept from action by their stops.

My invention is illustrated in the accompanying drawings.

Figure 1 is a diagram of the system with the switching devices shown on a small scale; Fig. 2, a view of the switching apparatus at one point. Fig. 3 represents some of the simultaneously-operated stop-disks. Fig. 4 is a view of the switch with a diagram of the circuits; Fig. 5, a perspective view of the unison-stop device. Fig. 6 represents the preferred way of locating the circuits and switching apparatus, and Fig. 7 is a diagram of an arrangement which may be employed at the central station.

I have shown my invention in a five-wire system having four generators, A A, from which extend positive and negative conductors 1 5, and compensating conductors 2 3 4. Such a system will employ four lamps in series across these conductors.

6 and 7 are extra circuits of small wire, both extending from an outside conductor, 1, at some point in the district to the adjacent conductor, 2, at the station, whereby sufficient current is obtained for working the switching devices. At the station in each of these circuits is placed a key, a or a', and an indicating-dial, b or b', worked by a magnet. Ampère-indicators c are provided, as usual, in the conductors 1 to 5 at the station. Each switching apparatus includes two magnets, B and B'. All the magnets B are in series in circuit 6 and all the magnets B' in series in circuit 7.

All the switching mechanisms are alike, and I will describe one of them. Each is placed in a box, C, supported on a pole, or in any other convenient situation.

D is an armature-lever worked by magnet B, having a limiting-stop, d, retracted by a spring, e, and terminating in a pawl, f, for working a ratchet-wheel, g, on a shaft, h. The ratchet g has a greater number of teeth than there are switching-boxes in the whole system. I provide a stop, i, for the pawl f, and a stop-pawl, k, for preventing backward movement of the ratchet. On the shaft h is a disk, E, having two notches, $l\ l'$, in its periphery. The notches l' are all at the same points on the periphery of all the disks in the system when the disks are at unison; but the notches l are then all at different points. The shaft h has a spiral groove or coarse screw-thread, m, at one end of which is the unison-pin n. The pivoted unison-arm F terminates in a pin, o, which rests in groove m, and a spring, G, tends to draw arm F away from pin n.

The magnet B' has a pivoted spring-retracted armature-lever, H, terminating in a pawl, I, which works ratchet p on shaft q, and a similar unison mechanism to that above described is employed, K being the pivoted unison-arm, and r the unison stop-pin. The armature-lever H has an upwardly-projecting finger, s, close to the disk E, so that the arm is stopped from movement unless a notch, l or l', is presented to the finger s. A releasing-arm, D', extends down from lever D close to unison-arm K, and a releasing-arm, H', extends from lever H close to unison-arm F. Also upon the shaft q are two spring-arms, t t', which move across the eight stationary contact-plates u u' u^2, &c., secured in a circle upon the insulating-base L.

The connections from the five-wire circuit to the switch shown in Fig. 4 are as follows: The outside wires, 1 and 5, are respectively connected to the terminal plates u and u^7 of the series. The wires 2, 3, and 4 are each connected to two plates—wire 2 to u' and u^4, 3 to u^2 and u^5, and 4 to u^3 and u^6. There are also on the shaft two metal rings, v and w, on which bear, respectively, two springs, M N. From these springs extends the house-circuit 8 9, including lamps or other translating devices y y, which the particular switching-box controls. The rings v and w are connected, respectively, with the arms t and t'.

It will be seen that in the situation shown in Fig. 4 the house-circuit 8 9 is connected across the division 4 5 of the five-wire system, but that its connection can be progressively shifted across from one division to another by the movement of the arms t t'.

In Fig. 6 is shown a box, C, containing the switching mechanism above described, placed on a pole, O, of the pole-line of conductors. The box is looped in around insulators x in wires 6 and 7 in the usual manner, so that all the boxes are in series.

10 11 are the ordinary indicating or pressure wires of the system.

As above stated, I place these boxes at suitable intervals throughout the system. In ordinary practice one box for about every fifteen house-circuits will be sufficient. Ten lights controllable will maintain the balance for one hundred and fifty not controllable.

The operation of these devices is as follows: It is first usually required to bring all the switching-boxes into unison. To do this the operator works the key a, controlling the magnet B, so that the pawl f works the ratchet g around until the pin o, working in the spiral groove m, reaches the pin n, which prevents any further movement. He should continue working the key long enough to be sure that in all the boxes at least one complete revolution is given to the ratchets, so that he may know that the unison-arm has reached the unison-pin in every box. Then all the notches l' of all the disks E will be opposite the fingers s of levers H, but all the notches l will be in different positions relative to such fingers. He then taps the key a' and moves levers H and arms H', which throws up arms F, and springs G pull arms F back to the other ends of grooves m, so that all the disks E are left at unison and free to be moved. To bring the switches into unison the key a' is now worked, so that magnets B', armature-levers H, and pawls I work ratchets p around until all the arms K reach pins r. The fingers s enter the notches l' at each movement, such notches being provided for that purpose. Now by a single tap on key a arm D' moves K, and K is thrown away from p, leaving the switches free to move, and also notches l' are all moved away from fingers s. The parts are now in position for switching. The operator at the station observes by the ampère-meters c c what is the condition of the different divisions of the system. If he observes a considerable change in any meter, he knows that certain customers have taken from or added to the number of lights in circuit to such an extent as to destroy the balance of the system. He therefore must change the connections of one or more circuits so as to restore the equality. Suppose the circuit of box No. 1 is connected to conductors 4 5 (as in Fig. 4) and it is desired to shift it over to 1 2. Key a is first worked—the operator noting the movements of dial b—until the notch l of step-disk E of box No. 1 is brought opposite the finger s of that box; but in all the other boxes no notches will be presented to the fingers s. Now by working key a' only box No. 1 will be affected, since in the other boxes the motion of arms H will be stopped by disks E. In box No. 1 the first movement of the key will cause ratchet p to turn and move arms t and t' to plates u^2 and u^6, which will put the house-circuit across conductors 3 and 4. The next impulse moves the arms to u' and u^5, which puts the circuit across 2 and 3, and the next impulse moves the arms to u and u^4 and connects the house-circuit between 1 and 2. The apparatus thus progressively shifts the connections of the house-circuit across the system to any one of the divisions to which it is desired to connect it. Another tap of the key will bring the arms to u^3 and u^7 again and connect the house-circuit once more to 4 5, but with the circuit reversed. There is no objection to this in systems where no house-meters, or meters other than electrolytic meters, are employed; but where electrolytic meters are in circuit it will not do to reverse the connections permanently, and the operator therefore, in order to shift back to 4 5, must work his key rapidly, and work the arms entirely around the disk back to the original point without allowing the arms to rest on the plate. There will thus be only a momentary reversal of the current, which will make no practical difference.

In Fig. 1 box No. 1 is shown in position to have its circuit shifted, and box No. 2 is not. If No. 2 is to be changed, the operator—still watching his indicating-dial *b*—works the key *a* until he brings the notch *l* of disk E of that box around opposite the finger *s*, when the switch may be worked by the key *a'* to change the connection made from this box to any desired division of the system.

It is evident that each set of magnets may be placed in multiple arc across a circuit, instead of in series; or I may place both sets of magnets in multiple arc or in series in the same circuit and provide differently-polarized armatures for said magnets, so as to work one set by a current of one polarity and the other by current of opposite polarity, a reverser being provided at the station.

Instead of the keys at the station, I may use a revolving circuit making and breaking transmitter, in which case the indicating-dials might be dispensed with.

Since by my invention I am enabled to so maintain the balance of the system that little or no current will flow on the intermediate or compensating wires at any time, it is not always essential to have as many generators as there are divisions of the system; but a single generator or other undivided source of supply may be employed, as in Fig. 7, with a connection, 15, across the circuit near its terminals, to which connection all the compensating wires are brought, such connections being through electrical indicators—one for each division. The system is thus divided, and the indicators show when it is slightly out of balance, and such irregularities are corrected by the switching mechanisms in the manner already explained. In this figure, A may represent a single generator, or two or more generators, arranged in series and giving the required electro-motive force.

What I claim is—

1. In a system of electrical distribution, the combination of two or more electrically-operated switches, two or more simultaneously electrically-controlled stops—one for each switch—such stops being situated or arranged differently relative to their respective switches, whereby any particular switch can be released for action while the others are held from action by the stops, and a circuit controlled by each switch, substantially as set forth.

2. In a system of electrical distribution, the combination of a main circuit extending from a central station, two or more branch circuits supplied therefrom, a switch for each of said branch circuits, a magnet for operating each switch, a circuit from the station including all said magnets, a circuit-breaker in said circuit at the station, a movable stop for each switch, such stops being situated or arranged differently relative to their respective switches, a magnet controlling the position of each stop, a circuit from the station including all said stop magnets, and a circuit-breaker in said circuit at the station, substantially as set forth.

3. In a system of electrical distribution, the combination of a main circuit composed of four or more conductors, house-circuits, each connected in multiple arc with a pair of said conductors, and switches for certain of said house-circuits, controlled from the central station, for shifting the connections thereof progressively from one pair of conductors to the other pairs, substantially as set forth.

4. In a system of electrical distribution, the combination of a main circuit composed of four or more conductors, a switch having a suitable number of contact-plates, connections from pairs of said plates to the main conductors, two arms bearing on said plates and movable relative thereto, and a house circuit connected with said arms, whereby the movement of said arms shifts the connections of said house circuit from one pair of main conductors to another, substantially as set forth.

5. In a system of electrical distribution, the combination of a main circuit composed of four or more conductors, house-circuits, each connected in multiple arc with a pair of said conductors, switches for certain of said house-circuits, for shifting the connections thereof progressively from one pair of conductors to the other pairs, and magnets controlled from the central station for operating said switches, substantially as set forth.

6. In a system of electrical distribution, the combination of a main circuit composed of four or more conductors, a switch having a suitable number of contact-plates, connections from pairs of said plates to the main conductors, two arms bearing on said plates and movable relative thereto, a house-circuit connected with said arms, whereby the movement of said arms shifts the connections of said house-circuit from one pair of main conductors to another, and a magnet controlled from the central station for operating said switch, substantially as set forth.

7. In a system of electrical distribution, the combination of a main circuit extending from a central station, two or more branch circuits supplied therefrom, a switch for each of said branch circuits, a magnet and an armature-lever for operating each switch, a circuit from the station including all said magnets, a circuit-breaker in said circuit at the station, a rotating stop disk for limiting the movement of each of said armature-levers, said disks each having a notch and such notches being all located at different points on the disks' peripheries, a magnet and suitable gearing controlled thereby for revolving each disk, a circuit from the station including all said magnets, and a circuit-breaker in said circuit at the station, substantially as set forth.

8. In a compensating system of electrical distribution, the combination, with the main and compensating conductors forming the

main circuit, of branch circuits connected therewith and unisoned switching mechanism controlled from the central station, for independently controlling said branch circuits, substantially as set forth.

9. In a system of electrical distribution, the combination of the switches revolved by electro-magnets controlled from the station, the stop-disks for said switches revolved by other magnets controlled from the station, unison-stops for the switches, unison-stops for the disks, releasing devices for the stop-disk unisons operated by the switch-magnets, and releasing devices for the switch-unisons operated by the stop-disk magnets, substantially as set forth.

10. In a system of electrical distribution, the combination of a main circuit composed of four or more conductors, switches, each having a suitable number of contact-plates, connections from pairs of contact-plates in each switch to the main conductors, two arms bearing on the plates of each switch and movable relative thereto, a house-circuit connected with the arms of each switch, a magnet for operating each switch, a circuit from the station including all said magnets, a circuit-breaker in said circuit at the station, a movable stop for each switch, such stops being situated or arranged differently relative to their respective switches, a magnet controlling the position of each stop, a circuit from the station including all said stop-magnets, and a circuit-breaker in said circuit at the station, substantially as set forth.

This specification signed and witnessed this 5th day of November, 1887.

THOS. A. EDISON.

Witnesses:
WILLIAM PELZER,
E. C. ROWLAND.

(No Model.) 3 Sheets—Sheet 1.

T. A. EDISON.

PHONOGRAPH.

No. 386,974. Patented July 31, 1888.

Fig. 1.

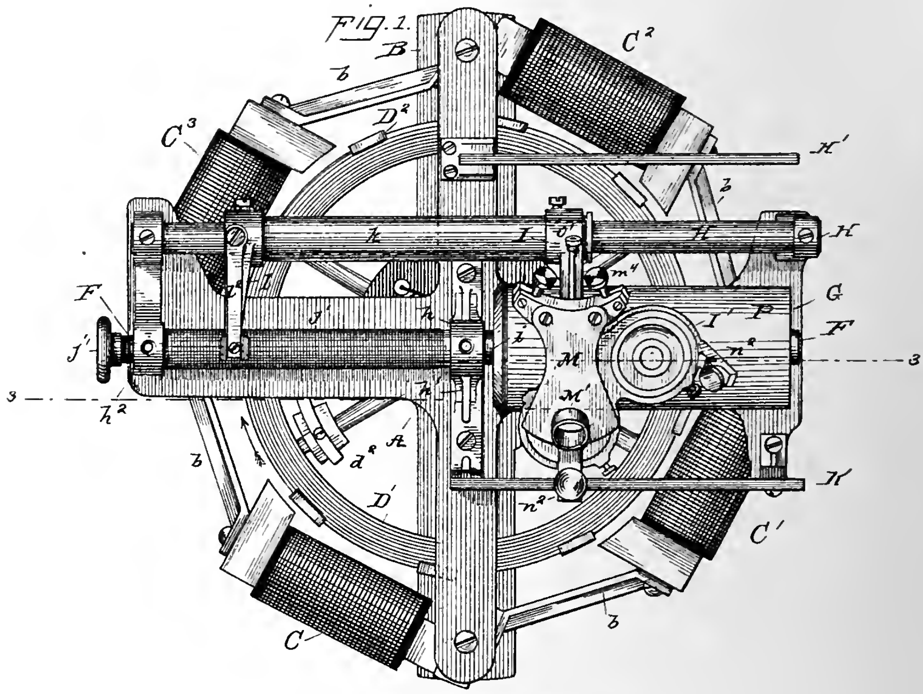
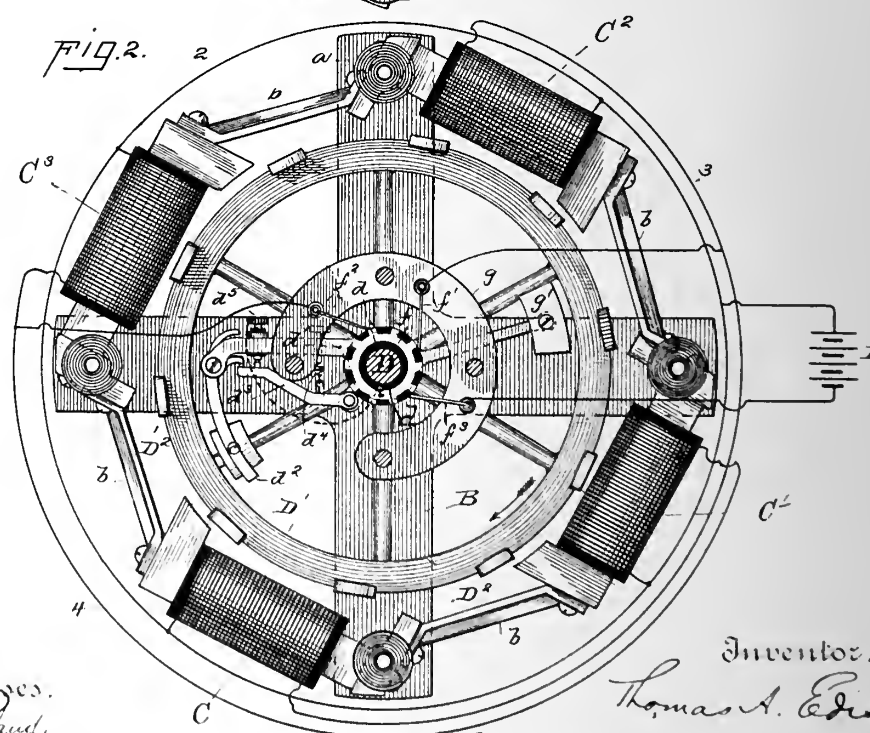


Fig. 2.



Witnesses.

E. L. Rowland

William Pelzer.

Inventor,

Thomas A. Edison.

By his Attorneys

Dyer & Seely.

(No Model.) 3 Sheets—Sheet 2.

T. A. EDISON.

PHONOGRAPH.

No. 386,974. Patented July 31, 1888.

Fig. 3.

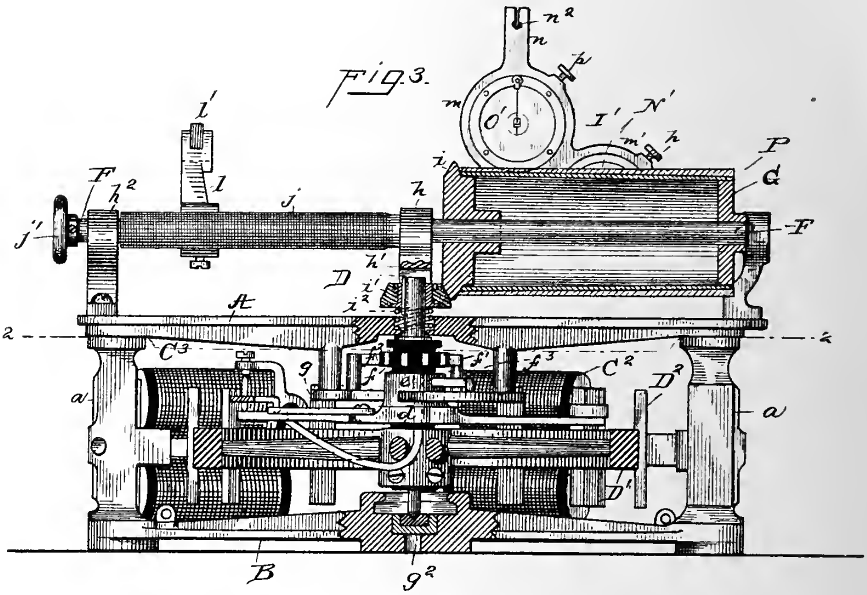
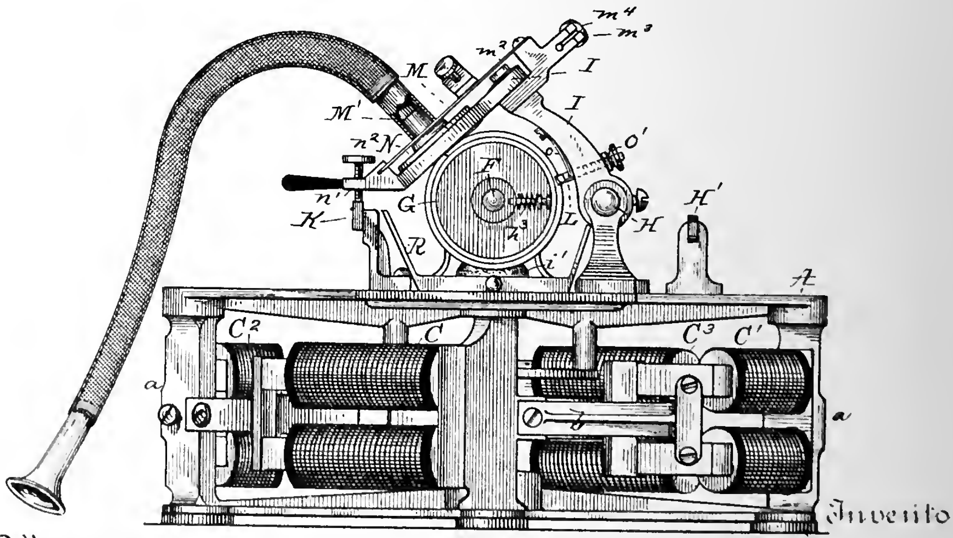


Fig. 4.



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(No Model.) 3 Sheets—Sheet 3.

T. A. EDISON.

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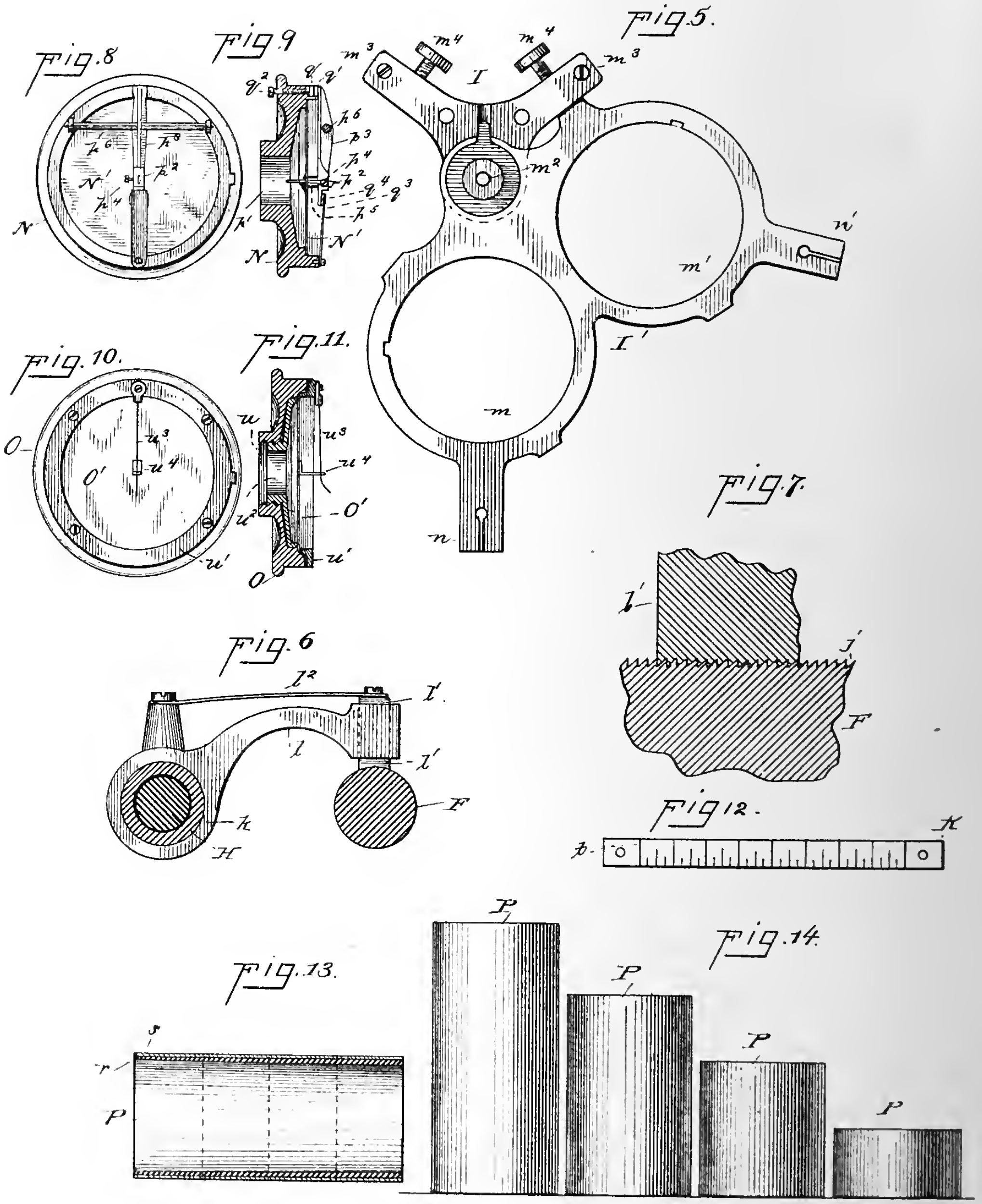

Witnesses:
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William Pelzer

Inventor
Thomas A. Edison,
By his Attorneys
Dyer & Seely.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY.

PHONOGRAPH.

SPECIFICATION forming part of Letters Patent No. 386,974, dated July 31, 1888.

Application filed November 26, 1887. Serial No. 256,189. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Phonographs, (Case No. 741,) of which the following is a specification.

The object I have in view is, generally, to so improve the phonograph that it will be well adapted for use by the public and will be a convenient and efficient machine for various uses.

In the accompanying drawings, forming a part hereof, Figure 1 is a top view of the machine; Fig. 2, a horizontal section on the line 2 2 in Fig. 3, with a diagram of the motor connections; Fig. 3, a vertical section on the line 3 3 in Fig. 1, with the swinging holder and guide-arm thrown back; Fig. 4, an elevation of the machine looking at the end of the phonogram-cylinder; Fig. 5, top view of the swinging holder carrying the recorder and reproducer; Fig. 6, a side elevation of the guide-arm; Fig. 7, a sectional view, on an enlarged scale, showing the engagement of the spring guide-block with the lead-screw; Figs. 8 and 9, a bottom view and central section, respectively, of the recorder; Figs. 10 and 11, a bottom view and central section, respectively, of the reproducer; Fig. 12, an elevation of the guide-rest; Fig. 13, a sectional view of a phonogram blank showing by dotted lines its division into sections, and Fig. 14 an elevation showing the four different sizes of the phonogram-blank.

Like letters denote corresponding parts in all the figures.

The frame of the machine is constructed, for convenience, of a top and a bottom plate, A B, each constructed as a spider composed of four arms, the ends of the arms of the two frames being joined by vertical posts *a*. To these posts are connected the yokes of four magnets, C C′ C^2 C^3, each projecting from the post to which it is attached toward the adjoining post, to which its pole-pieces are connected by braces *b* of brass or other non-magnetic metal. The poles of the four magnets project inwardly, as shown, and are cut with concave faces, the poles of all four magnets being in the line of a circle. Within this circle and mounted upon a vertical shaft, D, is a fly-wheel, D′, constructed of brass and having a heavy rim so as to increase its weight. Upon the periphery of the rim of the fly-wheel are secured a number of armatures, D^2, of iron, which are placed vertically, equal distances apart, and travel in their movement close to the pole-pieces of the magnets C, C′, C^2, and C^3. Upon the shaft D, above the wheel D′, is mounted a sleeve, *d*, of insulating material, upon which is secured a metal collar, *e*, and above this collar a commutator, *f*, the commutator being composed of a ring of metal having its surface broken by blocks of insulating material, so that it presents alternate spaces of insulation and metal in a manner well understood. From the collar *e* projects an arm, *d′*, in a radial direction, and upon the end of this arm is pivoted a swinging weight-arm, d^2, which, by its outward movement, moves a lever, d^3, which is held against its movement by an adjustable spring, d^4. The lever d^4 bears normally upon the insulated contact-screw d^5, which is connected by a wire with the base of the commutator *f*.

The magnets C C′ C^2 C^3 have one end of their windings connected together by a wire, 2. The other end of the windings of the two opposite magnets C and C^2 are connected together by a wire, 3, while the other ends of the windings of the opposite magnets C′ and C^3 are connected together by a wire, 4. The wires 3 and 4 are connected with two springs, *f′* and f^2, which bear upon the face of the commutator *f*. A spring, f^3, bears directly upon the collar *e*. These three springs are supported by a circular piece of insulation, *g*, which is supported above the wheel D′ and below the top plate by means of posts extending down from the top plate.

One pole of the battery E which drives the motor is connected with the wire 2, which joins one end of the windings of all the magnets, while the other pole of the battery is connected with the spring f^3, bearing upon the collar *e*. The parts are arranged so that the wheel D′ will be turned by the magnets always in the direction shown by the arrow in the drawings.

The magnets C and C^2 first receive the current and attract two armatures upon the wheel, and then the magnets C′ and C^3 receive the current and attract two armatures upon the wheel, the current being transferred from one pair of magnets to another in succession, so that the wheel is given a continuous rotary movement. An excess of battery-power is preferably used, and the speed of the wheel controlled by the governor, formed by the spring-retracted arms d^2 and d^3. This governor opens the circuit when the speed exceeds the normal, so that within limits of variation which are so small as to be practically of no effect in the operation of the machine the speed will be kept uniform. By the adjustment of the spring d^4 the governor can be made to work at any desired point. By the use of an electro-magnetic motor of this description—namely, one composed of a heavy fly-wheel carrying armatures on its periphery, which are attracted by magnets arranged in a circle around the fly-wheel—a slow and uniform motion can be obtained, which is a matter of the highest importance in the operation of the phonograph, and tends to simplify the construction, since the complication introduced by the employment of a number of speed-reducing wheels is avoided. Projecting from the collar e on the opposite side to the governor is an arm, g', carrying a weight at its end for counterbalancing the weight of the governor, so that the wheel may be a balanced one. The shaft D is stepped on a jewel, g^2, at the center of the bottom plate, A, giving freedom of movement to the wheel and reducing the noise of friction to the minimum, so as to not affect materially the operation of the phonograph.

Upon the top plate, A, is journaled the horizontal shaft F, this shaft being carried by a journal-box, h, in the top of an arched standard, h', at the center of the top plate, and at one end by a journal-box, h^2, at the end of one of the arms of the top plate. Between the bearings h and h^2 the shaft F is larger than it is outside of such bearings, so that it bears against the inner faces of the bearings by shoulders which prevent any longitudinal movement of the shaft. The shaft F projects beyond the bearing h to the opposite side of the machine from the bearing h^2, but is not supported at its end, it being free to receive the phonogram-cylinder G, which is slipped upon this shaft, preferably removably, and held by a spring pin, h^3, taking into a hole in the end of the shaft. This phonogram-cylinder is made hollow, of brass or other suitable metal, its heads bearing upon the shaft, so as to center the cylinder properly. The cylinder is made slightly tapering, for a purpose which will be presently explained, its inner end—that next to the bearing h—being somewhat larger than its outer end. The inner end of the phonogram-cylinder is constructed as a beveled friction wheel, i, upon which bears a beveled pinion, i', of some suitable soft material. This pinion i' is mounted upon the upper end of the shaft D, which projects through the top plate into the space between the legs of the arched standard h'. The pinion i' may be provided with an operative face, of leather or other similar material, mounted upon a metal hub. This metal hub is preferably constructed to slide vertically upon the shaft D, it being prevented from turning thereon by a suitable key, and beneath the pinion is a spiral spring, i^2, which forces the pinion upwardly and keeps it solidly against the beveled wheel on the inner end of the phonogram cylinder, so that the wear of the surfaces is taken up and the pinion is kept in firm contact. By the use of this beveled friction-tion-gearing, of which the soft surfaced pinion is a part, I am enabled to change the motion from the vertical shaft of the motor to the horizontal shaft of the phonogram-cylinder without the production of noise, which would be detrimental to the operation of the instrument.

The horizontal arrangement of the motor permits a large fly-wheel to be used, while the compactness of the instrument is maintained. Between the bearings h and h^2 the shaft F is cut with an exceedingly fine screw-thread, j, of the peculiar construction which will be explained farther on, while outside of the bearing h^2 the shaft is provided with a hand-wheel, j', by which it can be held when it is desired to remove the phonogram-cylinder from the shaft or remove the phonogram-blank or phonogram from the phonogram cylinder without taking the latter off of the shaft.

Parallel with the shaft F, and located in the rear of the same, is a guide-rod, H, mounted in suitable supports at its ends and extending entirely across the machine. Upon this guide-rod is an accurately-fitting tube, k, which is of such length that it can be moved upon the rod between the supports at the end of the rod a distance equal to the length of the phonogram-cylinder. Upon the end of this tube next to the phonogram cylinder is secured the holding arm, which carries the recorder and reproducer, while at the opposite end of this tube is the guide-arm, which engages with the lead-screw j. The guide-arm is a rigid arm, l, having a hub which slips on the tube k, and is secured thereto by a set-screw. This guide-arm projects toward the shaft F, terminating at its free end above the screw-thread j. The end of the arm l is slotted, so as to form two guide-cheeks, between which plays a vertically-sliding block, l'. This block l' bears upon the screw thread j, and is cut with a section of the corresponding thread. A spring, l^2, extends along the top of the arm l, and is secured to the block l', forcing such block downwardly upon the screw-thread, so that a rocking movement of the tube k can be made within certain limits without disengaging the block l' from the screw-thread j. The screw-thread j and the thread upon the block l' are cut as fine as it is possible to make a screw-thread having the desired wearing capacity. I make this screw-thread, preferably, with about one hundred threads to the inch, and in order to make such a fine thread do the work required of it without danger of the guide-arm being forced back, I construct these threads as a ratchet, as shown in Fig. 7, the engaging sides of the threads being straight and the other sides beveled, so that the danger of slipping backward is entirely obviated. Upon the other end of the tube k is secured the arm I by means of a set-screw, such arm projecting forward over the center of the phonogram-cylinder. Upon the upper end of this arm I is pivoted the holding-frame I′, placed nearly at right angles to the arm I, and made, similar to the frame of spectacles, with two eyes, m m'. The pivoting-screw m^2 for this frame passes through the frame at one side and centrally between the eyes m m', the nut for securing the frame bearing upon the spring-washer beneath it, so that the frame will hold itself at either limit of its throw and will not be jarred from position.

The arm I has two horns, m^3, through which the set-screws m^4 pass for limiting the movement of the frame I′ and for adjusting the point at which the frame will be stopped when swung in either direction, so as to bring its holding eyes in the correct relation to the phonogram-cylinder. These holding-eyes carry the recorder and reproducer, the construction of which will be presently explained, and the object of the swinging frame is to permit either the recorder or reproducer to be brought into operative relation with the phonogram-cylinder.

The screws m^4, bearing upon the swinging frame I′, form a means for adjusting such frame and the recorder or reproducer carried by it laterally with respect to the spiral line of record upon the surface of the phonogram-blank. This adjustment is a matter of especial importance so far as the reproducer is concerned. The recorder produces the record, and hence makes its own track; but the reproducer must follow that track. It has been proposed to mount the reproducing-point in such a flexible manner that it will follow the track made by the recorder without adjustment; but I have found that the lateral adjustment of the reproducer enables me to bring its point readily into the track of the record, and to give it the proper relation to the record for producing the maximum effects. The adjustment is made while the operator has his ear to the listening-tube, the character of the reproduced sounds determining when the proper adjustment is reached.

The eyes m m' have fingers n n', which project forward and have passing through them adjusting screws n^2, which rest as each eye is brought into position for operation upon a guide-rest, K, which extends parallel to the shaft F in front of the phonogram-cylinder and supports the holding-frame at the required elevation to bring the recorder or reproducer into accurate adjustment. The fingers n n' have small handles attached to them, as shown in Fig. 4, by which the swinging holding frame can be more conveniently manipulated. Back of the guide-rod H there is another rest, H′, to receive the arm I when it is thrown back. This rest is preferably more or less springy in its character, so as not to jar the parts injuriously when the arm is thrown back upon it. Passing through the arm I near the tube k is the shank of a cutting-tool, L, which is thrown forward by a spring, o, on the inner side of the arm and is retracted by a thumb-nut, o', on the screw-threaded end of the shank outside of the arm. This cutter L is designed to turn off the surface of the phonogram or phonogram-blank, so as to make it true for recording, or to turn off one record and leave the surface ready for another record. This enables one phonogram-blank to be used over and over again for recording and reproducing, the recorder and reproducer being brought into operative relation with the clear surface, as the diameter of the phonogram-blank is decreased, by the adjustment of the screws n^2, the yielding guide-block l' permitting this to be done.

Upon the arm I, above the swinging holding-frame for the recorder and reproducer, is secured a carrying-plate, M, to which is connected a tube, M′. This tube serves as the mouth and ear piece of the instrument, or it may have mouth and ear pieces removably attached to it. The plate M is stationary, and the holding-eyes are swung under it alternately, so that one tube answers both for recording and reproducing, thus adding to the simplicity of the instrument.

The recorder N is a circular plate, which fits either eye, m or m', of the carrying-frame, it being provided with a rib engaging with a groove in the eye, so that it will always have the same position in the eye. It is shown as held by the eye m'. A set-screw, p, is used for holding the plate in the eye. This plate N has an opening, p', through it, which is brought into line with the tube M′ when the eye m' is swung into position for the operation of the recorder. The back of the plate N is recessed to form a circular chamber, on a shoulder in which is placed the diaphragm N′, which is preferably made of celluloid or some other light material, and is placed in the recess at the back of the plate N, but is left free at its edges. The recording-point p^2 is secured to the center of the diaphragm by wax or in any other suitable way. This point is constructed of a thin plate of steel, which is cut or ground to a point on one edge and is beveled backwardly away from that edge, so as to give a support for the indenting point and prevent vibration of that point in operation. This point passes through the end of the lever p^3, and is secured therein by a set screw, p^4, the point being surrounded between the lever and the diaphragm by a small tube, p^5, of rubber or other suitable material. The lever p^3 is rigid in its construction, and is mounted upon a cross-pin, p^6, of considerable length, which is journaled at its ends at the sides of the plate N. The lever p^3 extends beyond the pivoting-pin p^6 and rests at its outer end against a block, q, which is faced with a piece of pure india rubber, q'. This block is set in a recess in the edge of the plate N, and is adjusted forward by a screw, q^2. The adjustable block q and its elastic face q' form a yielding limiting-stop for the movement of the indenting-point. The other end of the lever p^3 extends beyond the indenting-point p^2 and receives inward pressure from a spring, q^3, which is secured to the rim of the plate N, opposite to the block q, and presses the lever p^3 and the indenting-point inwardly, so as to give the center of the diaphragm a slight inward bend, producing an initial strain upon the diaphragm. Between the end of the spring q^3 and the lever p^3 a piece of india-rubber, q^4, is placed. The lever p^3, being rigid in its construction and in its support by the long bearing, prevents any vibration of the indenting-point, while the adjustable limit-stop formed by the block q and rubber q' limit the movement of the diaphragm to a small compass. This construction of recorder I have found exceedingly effective in use. The diaphragm is highly sensitive and responds accurately to speech vibrations. The movement of the indenting-point is quite free within exceedingly small limits; but the resistance to its movement increases enormously as the extent of the movement is increased; hence the importance of the fundamental tones in the operation of the instrument is reduced, while the hissing tones which produce movements of a small extent are given an undue importance in the record. This makes the reproduced sound clear and intelligible, since the hissing sounds are brought out clearly and can be distinguished from the scraping noises of the instrument.

It will be observed that the diaphragm is under constant tension and can have no movement at all except that which is permitted by the elasticity of the yielding limit-stop q'. Heretofore the diaphragm of the phonograph-recorder and the indenting point have not been limited in their forward movement, except by the capacity of the diaphragm for vibration. This has permitted strong waves, owing to great momentum and the small amount of energy stored up as a retracting-force, to give abnormal and untruthful vibrations to the diaphragm. With my present recorder the diaphragm does not force the lever forward into space, but compresses matter always in contact—viz., the rubber q'; hence nearly all the work is stored up in the compression of q' to effect the return movement, and momentum becoming a small factor compared to the power stored up, the diaphragm is not given untruthful vibrations. This principle of construction of the recorder I have termed a "closed" or "constrained" system of movement as distinguished from the open or free system of movement heretofore employed.

I do not claim herein the peculiar recorder *per se*, since it is made the subject of a separate application for patent filed March 2, 1888, Serial No. 265,887.

The reproducer which I employ is also an improved instrument of great effectiveness. It has a plate, O, similar to the plate N, which is held removably in the eye m' in the same way that the plate N is held in the eye m'. This plate O has an opening, u, through it, which is brought into line with the tube M, for bringing the reproducer into operative relation with the phonogram cylinder. The plate O is recessed at its back and has stretched across it a diaphragm, O', which is preferably a thin animal membrane. This diaphragm is secured in place by a ring, u', which is secured to the back of the plate O, while the diaphragm is stretched by another ring, u^2, which has a neck screwing into the opening u of the plate, and is capable of being turned by a tool, so as to stretch the diaphragm O' more or less. To one edge of the ring u' is secured a fine spring-wire, u^3, which is long enough to reach from the point where it is secured to the center of the diaphragm, and has its inner end turned downwardly, as shown, to follow the spiral line of indentations upon the phonogram. The inner end of this spring wire u^3 is attached to the center of the diaphragm by a strip, u^4, of rubber. The tendency of the spring-wire is to bend away from the diaphragm, so that it strains the small rubber strip u^4 and places the diaphragm under an initial tension. The movement of the point of the wire u^3 in reproducing is so slight that the strain is never wholly removed from the rubber strip u^4, and hence the diaphragm is always under tension, which tends to draw it outwardly at the center. This makes the instrument exceedingly sensitive and capable of reproducing sounds accurately. The end of the wire u^3 being rounded and burnished, it will not obliterate the phonogram-record, even though that record is made in quite soft material.

I have found that by connecting the reproducing-point with the diaphragm by a strip of elastic material—such as rubber held under tension—the proper wave motion is transmitted to the diaphragm, but the scratching noises, which seem to require molecular transmission, are largely obliterated.

I do not claim herein the peculiar reproducer *per se*, since this is made the subject of a separate application for patent filed March 2, 1888, Serial No. 265,888.

The indenting-point of the recorder has an appreciable width, while the reproducing-point of the reproducer is much finer; hence the track of indentations on the phonogram will be much wider than the reproducing-point and the adjustment of the reproducing-point laterally with respect to the indented track need not be extremely accurate. Should the reproducing-point be found to rest only on the edge of the indented track—which will be indicated by imperfect reproduction—the adjustment of one of the screws m^4 while the listening-tube is held to the ear will cause the spectacles to be adjusted so as to bring the reproducing-point sufficiently into the indented track to give the required clearness of reproduction.

It will be observed that both the recorder and reproducer are complete instruments, each in itself, held by a plate readily removable from the machine. This enables these instruments, which are delicate parts of the apparatus, to be readily removed from the machine for repairs, adjustment, or replacement by other similar parts. As has been previously stated, the phonogram-cylinder is slightly tapering. This is also true of the bore of the phonogram-blanks P, which are constructed of a cylinder, *r*, of some hard material and covered with a recording-surface, *s*, of wax or a wax-like substance. The recording-surface *s* is a true cylinder, while, as before stated, the internal bore of the cylinder *r* is tapering to fit the phonogram-cylinder, so that the phonogram-blank can be pushed upon the cylinder and will be held thereon by friction. I propose to make these phonogram-blanks the entire length of the phonogram-cylinder and also to divide such full-length phonogram-blanks into parts, so that sectional phonogram-blanks will be produced, which will be, for illustration, one-fourth, one-half, and three-fourths the length of the full-sized phonogram-blank. All of these sectional phonogram-blanks as well as the full-sized phonogram-blank will have the tapering bore, so that they can be pushed upon the tapering phonogram-cylinder until they bind and the instrument can then be adjusted to them for recording and reproducing.

I do not claim herein a phonogram-blank or phonogram having a recording-surface of wax or a wax-like material, nor such a device when the wax surface is mounted on a backing of tougher material, such features being claimed in my application No. 734, Serial No. 252,964. Neither do I claim herein a phonogram-blank or phonogram having a tapering bore, or such a bore and a cylindrical recording-surface, since these latter features are set forth and claimed in my Patent No. 382,418, dated May 8, 1888.

By having the phonogram-cylinder mounted upon the shaft F outside of the bearing *h* the phonogram-blanks can be slipped onto and off of the cylinder without disturbing any part of the machine. Upon the guide-rest K, I mark a graduated scale, *t*, by which I can set the reproducing-instrument for reproducing from any part of the phonogram.

A phonogram may have upon its surface the record of two or more letters or other papers or memoranda, and a note may be filed with the phonogram stating between what numbers on the scale *t* each letter or memorandum is recorded on the phonogram. This will enable the instrument to be set for reproducing the exact letter or memorandum by adjustment with reference to the scale *t*. As shown in Fig. 4, a pan, R, may be slipped under the phonogram-cylinder G upon the frame A, for receiving the shavings from the phonogram or phonogram-blank when the cutter L is being used.

For the control of the instrument it is only necessary that a proper circuit-breaker should be placed in the circuit between the battery and the motor, so that the motor can be stopped and started at will. It will be observed that by raising the recorder or reproducer off of the phonogram-cylinder the yielding guide-block *l'*, which takes into the lead-screw *j*, will also be raised out of engagement with the lead-screw, and, although the phonogram-cylinder continues to turn, the recorder or reproducer is not advanced. This enables an operator of the instrument to set the instrument back any distance he may desire to reproduce over again any portion of the matter which he has misunderstood or desires to have repeated.

What I claim as my invention is—

1. In a phonograph, the combination, with the revolving phonogram-carrying shaft and phonogram-cylinder adapted to carry a removable phonogram-blank, of an electric motor having a heavy fly-wheel, armatures carried by such fly-wheel, electro-magnets attracting such armatures, and a commutator, substantially as set forth.

2. In a phonograph, the combination, with the horizontal shaft carrying the phonogram, of a vertical shaft, an electro-magnetic motor mounted upon such vertical shaft, and a beveled friction-gearing transmitting the motion from the vertical shaft to the horizontal shaft, substantially as set forth.

3. In a phonograph, the combination, with the vertical shaft carrying the balance-wheel, electro-magnetic motor, and stepped in a jewel-bearing, of the horizontal phonogram-carrying shaft, and the beveled friction-gearing having one wheel of soft material, substantially as set forth.

4. In a phonograph, the combination of the electro-magnetic motor, consisting of a heavy fly-wheel carrying armatures on its periphery, magnets attracting such armatures, and a commutator with a centrifugal governor controlling the electric circuit of the motor and maintaining a uniform speed of such motor, and a phonogram-carrying shaft connected with the motor by friction-gearing, substantially as set forth.

5. The combination, with the vertical motor-shaft, of the horizontal phonogram-shaft carrying a beveled friction-wheel, and a beveled friction-pinion of soft material mounted on the motor-shaft and pressed against the wheel on the phonogram-shaft by a spring, substantially as set forth.

6. In a phonograph, the combination, with a phonogram-cylinder and advancing screw-thread, of a swinging frame carrying together the separate recorder and reproducer and adapted to bring either into position for operation by the swinging of the frame, substantially as set forth.

7. In a phonograph, the combination, with

the revolving recording-surface, of a swinging spectacle-frame carrying the recorder and reproducer and adapted to be swung so as to bring either into operative relation with the surface, substantially as set forth.

8. In a phonograph, the combination, with a revolving recording-surface, of a swinging frame carrying the recorder and reproducer, and a stationary plate carrying the single speaking or listening tube, the swinging of the frame bringing either the recorder or reproducer into operative relation with the surface and with the speaking or listening tube, substantially as set forth.

9. In a phonograph, the combination, with a revolving phonogram-cylinder, an arm having a movement parallel with the axis of said cylinder, and the reproducer carried by a frame mounted on such arm and adjustable laterally thereon, whereby the reproducer can be readily adjusted to the record, substantially as set forth.

10. In a phonograph, the reproducer carried by a pivoted frame swinging across the lines of record, and an adjusting-screw for determining the lateral position of the reproducer, substantially as set forth.

11. In a phonograph, the combination, with the revolving phonogram-cylinder, of the holding-arm mounted to swing toward and away from the surface of said cylinder, and the reproducer mounted on such arm and laterally adjustable thereon, substantially as set forth.

12. In a phonograph, the combination, with the revolving phonogram-cylinder, of the holding-arm mounted to swing toward and away from the surface of such cylinder, the reproducer mounted on such arm and laterally adjustable thereon, an adjusting-screw for determining the position of the holding-arm relative to the phonogram-cylinder, and an adjusting-screw for determining the lateral position of the reproducer, substantially as set forth.

13. In a phonograph, the combination, with the revolving phonogram-cylinder, of the advancing holding-arm carrying the recorder or reproducer, and a stationary guide-rest for supporting the holding-arm in proper relation with the phonogram-cylinder, substantially as set forth.

14. In a phonograph, the combination, with the revolving phonogram-cylinder, of the advancing holding-arm carrying the recorder or reproducer, a stationary guide-rest for supporting the holding-arm in proper relation with the phonogram-cylinder, and an adjusting-screw for adjusting the height of the holding-arm above the guide-rest, substantially as set forth.

15. In a phonograph, the combination, with the phonogram-cylinder and the lead-screw, an arm carrying the recorder or reproducer, a guide-arm connected with the carrying-arm, a yielding guide-block engaging with the lead-screw, a guide-rest, and an adjusting-screw for adjusting the height of the carrying-arm upon the guide-rest, substantially as set forth.

16. In a phonograph, the combination, with the swinging arm and the recorder or reproducer carried thereby, of the springy back-rest upon which such carrying-arm is thrown, substantially as set forth.

17. In a phonograph, the combination, with the revolving phonogram-cylinder, of the advancing recorder or reproducer, and the scale for determining the position of the recording or reproducing point upon the phonogram or blank, substantially as set forth.

18. In a phonograph, the combination, with the revolving phonogram-cylinder, and recorder and reproducer mounted upon an advancing holding-arm and adjustable toward and away from the phonogram-cylinder, of a cutting-tool movable with such holding-arm and independently adjustable toward and away from the phonogram-cylinder, whereby the recorder and reproducer can be adjusted out of operative engagement with the phonogram-blank, and the cutting-tool can be adjusted forward into engagement with such blank, substantially as set forth.

19. In a phonograph, the combination, with the revolving phonogram-cylinder and the lead-screw, of the arm carrying the recorder or reproducer, a cutting-tool on such arm for reducing the surface of the phonogram or blank, and a guide-arm engaging the lead-screw and advancing the carrying-arm, substantially as set forth.

20. In a phonograph, the combination, with the revolving phonogram-cylinder, of the swinging arm carrying the recorder or reproducer, a cutting-tool also carried by said arm, a guide-rest, a screw for adjusting the position of the recorder or reproducer and said cutting-tool with relation to the phonogram or blank surface, and a yielding guide-block engaging with the lead-screw and advancing said carrying-arm, substantially as set forth.

21. In a phonograph, the combination, with the cylinder-shaft having a fine screw-thread, the phonogram-cylinder mounted on such shaft, a stationary guide-rod, a sleeve mounted on such guide-rod and capable of sliding and turning movements thereon, a guide-arm secured to said sleeve and having a screw-threaded guide-block engaging the screw-thread, and the holding-arm for the recorder or reproducer, also secured to said sleeve, substantially as set forth.

22. In a phonograph, the combination, with the cylinder-shaft having a fine screw-thread, the phonogram-cylinder mounted on such shaft, a stationary guide-rod, a sleeve mounted on such guide-rod and capable of sliding and turning movements thereon, a guide-arm secured to said sleeve and having a screw-threaded guide-block engaging the screw-thread, the holding-arm for the recorder or re-

producer, also secured to said sleeve, and a guide-rest for determining the rotary position of the guide-sleeve, substantially as set forth.

23. In a phonograph, the combination, with the cylinder-shaft having a fine screw-thread, the phonogram-cylinder mounted on such shaft, a guide rod and sleeve, a guide-arm secured to said sleeve and having a screw-threaded yielding guide-block engaging the screw-thread, the holding-arm for the recorder or reproducer, also secured to said sleeve, and a guide-rest for determining the rotary position of the guide-sleeve, substantially as set forth.

24. In a phonograph, the phonogram-cylinder tapering throughout its length, substantially as set forth.

25. In a phonograph, the combination, with the cylinder-shaft mounted in bearings and projecting at one end beyond such bearings, of a smooth surface phonogram-cylinder tapering throughout its length and carried by the shaft outside of its bearings, substantially as set forth.

26. In a phonograph, the combination, with a tapering phonogram-cylinder, of two or more phonogram-blanks of different lengths having tapering bores adapted to fit said phonogram-cylinder and provided with cylindrical recording surfaces, substantially as set forth.

27. In a phonograph, the combination, with a tapering phonogram-cylinder, of a phonogram having a tapering bore and a cylindrical outer surface held upon said cylinder by friction, substantially as set forth.

28. In a phonograph, the combination, with a holding-frame, of the recording and reproducing devices constructed each as a complete self-contained body removably attached to said holding-frame, substantially as set forth.

This specification signed and witnessed this 22d day of November, 1887.

THOS. A. EDISON.

Witnesses:

WILLIAM PELZER,

E. C. ROWLAND.

(No Model.)

T. A. EDISON.

INCANDESCING ELECTRIC LAMP.

No. 389,369. Patented Sept. 11, 1888.

Fig. 1.

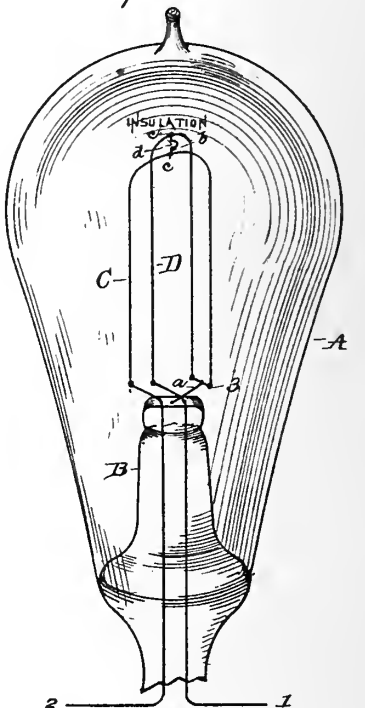
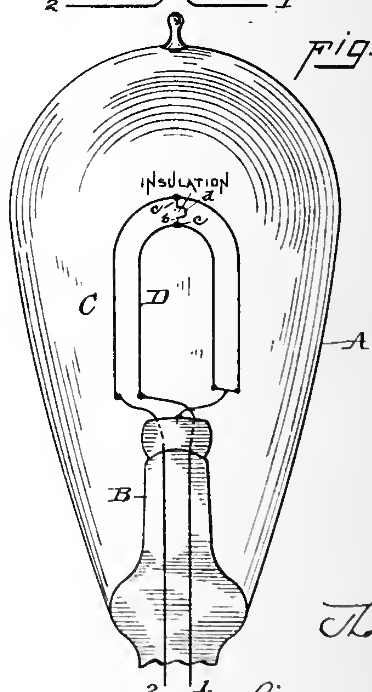


Fig. 2.



Witnesses,
E. C. Rowland
William Pelzer

Inventor,
Thomas A. Edison,
By his Attorneys Dyer & Seely.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY.

INCANDESCING ELECTRIC LAMP.

SPECIFICATION forming part of Letters Patent No. 389,369, dated September 11, 1888.

Application filed February 6, 1888. Serial No. 263,136. (No model.)

To all whom it may concern:

Be it known I, THOMAS A. EDISON, a citizen of the United States, residing at Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Incandescing Electric Lamps, (Case No. 759,) of which the following is a specification.

In an application for a patent filed by me February 5, 1880, (Serial No. 202,180,) is described an incandescing electric lamp having two or more carbon filaments connected in series, whereby a lamp of exceedingly-high resistance is obtained, necessitating the employment of a high electro-motive force, and consequently enabling a great saving to be made in the cost of conductors for carrying the current in a multiple-arc system of electric lighting. As described in the application referred to, I am able by the use of two or more filaments of proportionately smaller cross-section to maintain the same radiating-surface as in lamps having but one filament, and yet to increase largely the resistance, while the normal candle-power of the lamp remains the same. To do this requires that the filament should be exceedingly fine or small in cross-section. Such fine filaments have great flexibility and are more readily deflected or distorted than filaments of greater cross-section.

It is now well-known that there is a very considerable attraction between the electrified surfaces of the glass globe and the filament, such parts being, of course, charged statically in the opposite way. On the other hand, when two filaments are placed in the same globe, the mutual repulsion and attraction of the currents traversing the filaments tends also to displace the filaments. The result of these disturbing influences upon exceedingly-fine filaments may cause them to touch the walls of the globe or each other, and thus to destroy the lamp.

The object I have in view is to produce a multiple-carbon lamp such as is described in my application referred to which will have the advantage of an exceedingly-high resistance at the same time that the filaments will be maintained in their proper relation to each other and to the walls of the inclosing-globe.

In carrying out my invention I connect the fine carbon filaments at one or more points between their ends by a sustaining-bridge of insulating material. This bridge, in order that it may cast the minimum shadow, I prefer to make of a thread or filament of a proper insulating material. For this purpose I may use a filament of pure silica melted by the oxyhydrogen blow-pipe, or I may use the most infusible Bohemian glass. The filament of insulating material is connected at its ends with the carbon filaments by means of a carbon paste, which, by enlarging the radiating-surfaces at the points of connection, reduces the temperature of the carbon filaments at those points and prevents the fusion of the bridge. This glass filamentary bridge I prefer to place midway between the ends of the carbon filaments. In order that the filaments may be free to contact and expand, the bridge of insulating material is also made elastic, which may be accomplished by bending the insulating-filament into a small loop, or by coiling, or by otherwise forming it so that it can yield lengthwise.

The carbon filaments I prefer to make of an arched or looped form and straight, as distinguished from being coiled. I prefer to employ two carbon filaments in each lamp, and in order to neutralize as far as possible the attraction and repulsion between the currents I prefer to arrange such carbon filaments at right angles, although they may be placed side by side, or one over the other and in the same plane. In placing the filaments at right angles one filament is made somewhat longer than the other, so that the loop formed by it will be longer. Where one filament is placed over the other in the same plane, the outside filament will necessarily, also, be longer than the inside one. It is essential of course, whether the carbon filaments are of the same or of different lengths, that they should have the same resistance per unit of radiating-surface, so that with a definite current the same degree of incandescence will be produced at every point throughout the length of both filaments. This is accomplished by making the filaments of the same material, having a uniform density throughout, and by making them of the same shape and of the same cross sectional area, so that the filaments will have the same resistance per unit of length, although the total resistance of the longer filament (if one filament is longer than the other) will be greater than the total resistance of the shorter filament.

The use of straight or simple filaments as distinguished from coiled filaments has an advantage, since when the filament is coiled it is unequally heated by radiation from one spiral to another, and, in addition, the straight filaments can be more readily and more perfectly carbonized than the coiled filaments.

In the accompanying drawings, forming a part hereof, Figure 1 is a perspective view of a lamp having the preferred arrangement and embodying my invention, and Fig. 2 is an elevation of a lamp with a modified arrangement of the carbons.

A is the glass globe of the lamp, and B is the glass support or inside part. As will be well understood, the glass support B, after having the carbons mounted thereon, is inserted in the globe A and is fused thereto, and the globe is then exhausted and sealed, forming a vacuum-chamber entirely of glass.

C D are the carbon filaments, the filament C being slightly longer than the filament D. These filaments are straight or simple filaments, as distinguished from coiled filaments, and are made in the form of loops. The leading-in wires 1 2 of the lamp pass through and are sealed into the glass support B. One end of the filament D is connected to the wire 1, and one end of the carbon filament C is connected to the wire 2. The other ends of the carbon filaments are connected by a short bridge-wire, 3, from which a supporting-wire, *a*, runs down to the part B of the lamp, and is stuck to it by softening the glass. The course of the current through the lamp is then by wire 1 to the carbon D, through this carbon to the bridge-wire 3, to carbon C, through carbon C to the wire 2, and out of the lamp. Thus the carbons are connected in series, and the advantage is obtained of the high resistance due to the bringing of the total length of the two carbons into series.

At the center of the carbon loops C D is a bridge, *b*, of insulating material. This is preferably a filament or thread of glass or other form of silica, which is connected to the carbon filaments at its ends by small quantities of carbon paste, *c*, the effect of which is to reduce the temperature at these points and prevent the fusion of the filamentary bridge of insulating material. The filamentary bridge *b* is bent into a loop, *d*, at its center, so as to be capable of yielding lengthwise.

By the preferred arrangement shown in Fig. 1 the carbon loops are placed at right angles to each other, although other arrangements may be employed—such, for instance, as that shown in Fig. 2, in which the carbon filaments are located in the same plane, one being outside the other.

What I claim as my invention is—

1. In an incandescing electric lamp, the combination of two carbon filaments located, within the same lamp-globe and having circuit-connections at their ends, with a bridge of insulating material connecting such filaments at a point between their ends, substantially as set forth.

2. In an incandescing electric lamp, the combination of two carbon filaments connected in series and located within the same globe, with a bridge of insulating material connecting such carbon filaments at a point between their ends, substantially as set forth.

3. In an incandescing electric lamp, the combination of two uncoiled or straight carbon filaments located within the same globe and having circuit connections at their ends, with a bridge of insulating material connecting such filaments at a point between their ends, substantially as set forth.

4. In an incandescing electric lamp, the combination of two loop shaped carbon filaments arranged at right angles to each other and having circuit-connections at their ends, with a bridge of insulating material connecting such carbon filaments at a point between their ends, substantially as set forth.

5. In an incandescing electric lamp, the combination of two carbon filaments, each connected at one end with a leading in wire of the lamp, a conducting-connection between the other ends of the carbon filaments, a support from this conducting-connection to the glass-work of the lamp, and a bridge of insulating material connecting such filaments at a point between their ends, substantially as set forth.

6. In an incandescing electric lamp, the combination, with two carbon filaments, of a filamentary bridge of insulating material connecting such filaments at a point between their ends, substantially as set forth.

7. In an incandescing electric lamp, the combination, with two carbon filaments, of a yielding bridge of insulating material connecting such filaments at a point between their ends, substantially as set forth.

8. In an incandescing electric lamp, the combination, with two carbon filaments, of a bridge of insulating material connecting such filaments at a point between their ends, the mass of carbon being enlarged at the ends of such bridge to reduce the temperature of the filaments at those points, substantially as set forth.

9. In an incandescing electric lamp, the combination, with two carbon filaments, of a bridge of insulating material connecting such filaments at a point between their ends and secured to the filaments by carbon paste, substantially as set forth.

10. In an incandescing electric lamp, the combination, with two carbon filaments, of a filamentary bridge of glass secured to such filaments at a point between their ends by means of carbon paste and bent so as to be capable of yielding to permit the expansion and contraction of the carbon filaments, substantially as set forth.

This specification signed and witnessed this 2d day of February, 1888.

THOS. A. EDISON.

Witnesses:

WILLIAM PELZER,
E. C. ROWLAND.

(No Model.)

T. A. EDISON.

PROCESS OF MAKING CARBON FILAMENTS.

No. 390,462. Patented Oct. 2, 1888.

Fig. 1.

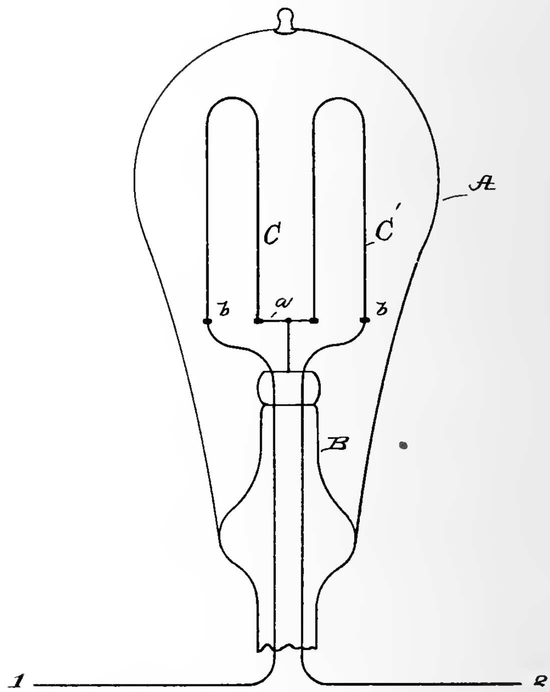


Fig. 2.

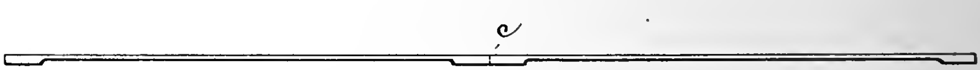


Fig. 3.

Witnesses:
E. C. Rowland.
William Pelzer

Inventor:
Thomas A. Edison.
By his Attorneys
Dyer & Seely

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY.

PROCESS OF MAKING CARBON FILAMENTS.

SPECIFICATION forming part of Letters Patent No. 390,462, dated October 2, 1888.

Original application filed November 9, 1882, Serial No. 76,382. Divided and this application filed March 2, 1888. Serial No. 265,891. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, a citizen of the United States, residing at Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Processes for Making Carbon Filaments, (Case No. 764, division of Case No. 510,) of which the following is a specification.

In my application for patent, Case No. 202, (Serial No. 2,180,) I describe an incandescing electric lamp having as the incandescing conductor two or more carbon filaments connected in series, the advantage of such a lamp being the exceedingly high resistance which is obtained by the use of two or more filaments in series and the consequent saving in conductors by reason of the higher electro-motive force that may be employed with such a lamp. It is essential in such a lamp that the two or more carbon filaments should have the same resistance per unit of radiating-surface in order that the filaments at every point in their length will be raised to the same degree of incandescence by the flow of the current therethrough. I have found that if it is attempted to produce this uniformity of resistance per unit of radiating-surface by "flashing" the filaments—that is, by raising them to incandescence when surrounded by hydrocarbon—the resistance of the filaments is enormously decreased and the advantage of using two filaments in series is substantially lost, since the increase in resistance which can be obtained by the use of two flashed carbon filaments is not sufficiently greater than the resistance of one unflashed filament to warrant the change to a more expensive form of lamp.

The object of my invention is to produce a method or process by which the two or more carbon filaments designed for use in series in one lamp-globe can be made of unflashed carbons and will have the same resistance per unit of radiating-surface.

My carbon filaments are made by carbonizing natural fibrous vegetable material, such as various woods, but preferably bamboo. In order to insure precise similarity in the two or more filaments intended for use in the same lamp, such filaments are made from a strip cut lengthwise of the fibers and of the total length of the two or more filaments, which strip is first reduced to the proper filamentary size and is then cut into lengths before or after carbonization. The two or more filaments are given the same cross-sectional area, and by being obtained from a continuous length of the same fibers they will have the same structural characteristics, or, in other words, will be of the same density, which might not be the case if the filaments were taken from laterally different parts of the material. The filaments should then be carbonized together and under precisely the same conditions of heat, strain, and pressure. This is accomplished by carbonizing them together in the same mold.

In the accompanying drawings, forming a part hereof, Figure 1 is a view of a lamp containing two similar unflashed carbon filaments connected in series, and Figs. 2 and 3 are views of strips from each of which two filaments are made.

In Fig. 1, A is the inclosing-globe, and B the inner stem of an incandescing electric lamp, and 1 2 are the leading-in wires sealed in the glass of the stem B. Two similar unflashed carbon filaments, C and C′, are shown connected together in series at *a* and attached to the leading-in wires at *b b*. To produce such filaments a strip, Figs. 2 or 3, is cut lengthwise from the bamboo or other fibrous material employed, so that the same fibers of the bamboo shall run throughout the length of the two filaments. This strip is reduced to the proper size for the filaments, so that they will have a uniform cross-section throughout their incandescing portions, and then the strip is cut in two at the middle at the point *c*. The two filamentary blanks are then carbonized under the same conditions by placing them together in the same mold, or the filament may be divided by breaking it in two at the center after carbonization.

I do not claim in this application the combination, with the inclosing-globe and the leading-in wires of an incandescent electric lamp, of two or more unflashed carbonized filaments having the same resistance per unit of radiating-surface inclosed within such globe and connected in series with said leading-in wires, since such a construction is covered by my application for patent, Case No. 510, Serial No. 76,382, of which this case is a division.

What I claim as my invention is—

The process herein described of producing similar unflashed carbon filaments for use in series as the incandescing conductor of an electric lamp, consisting in forming two or more filamentary blanks for carbonization by cutting from a natural fibrous vegetable material, lengthwise of the fibers thereof, a strip of the length of two or more of such blanks, reducing such strip to the proper filamentary size, carbonizing such blanks together under the same conditions, and dividing the blank transversely into two or more blanks before or after carbonization, substantially as set forth.

This specification signed and witnessed this 20th day of February, 1888.

THOS. A. EDISON.

Witnesses:

WILLIAM PELZER,

E. C. ROWLAND.

(No Model.) 2 Sheets—Sheet 1.

T. A. EDISON.

SYSTEM OF ELECTRIC LIGHTING.

No. 391,595. Patented Oct. 23, 1888.

Fig 1.

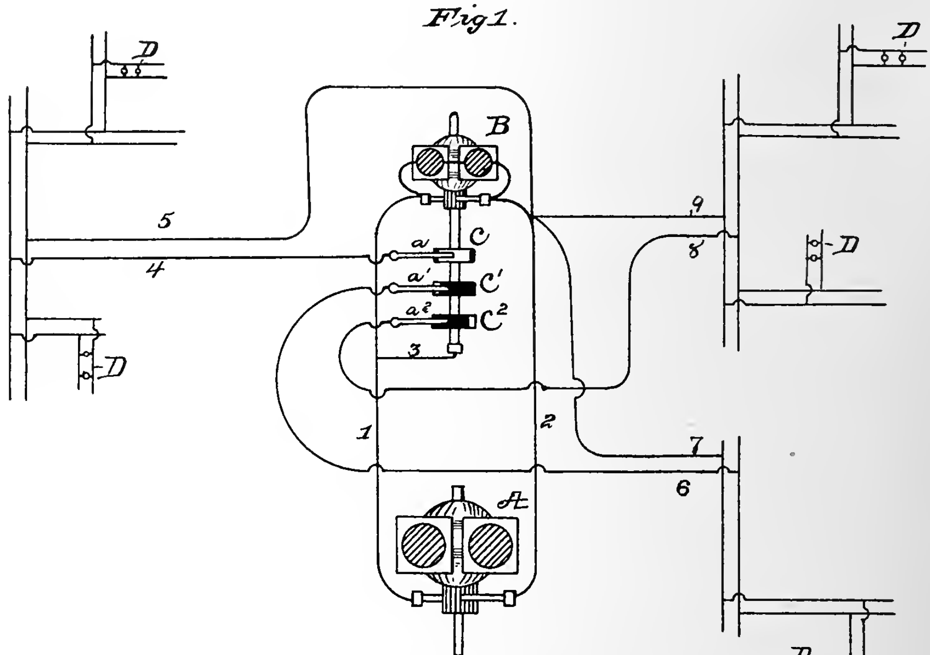
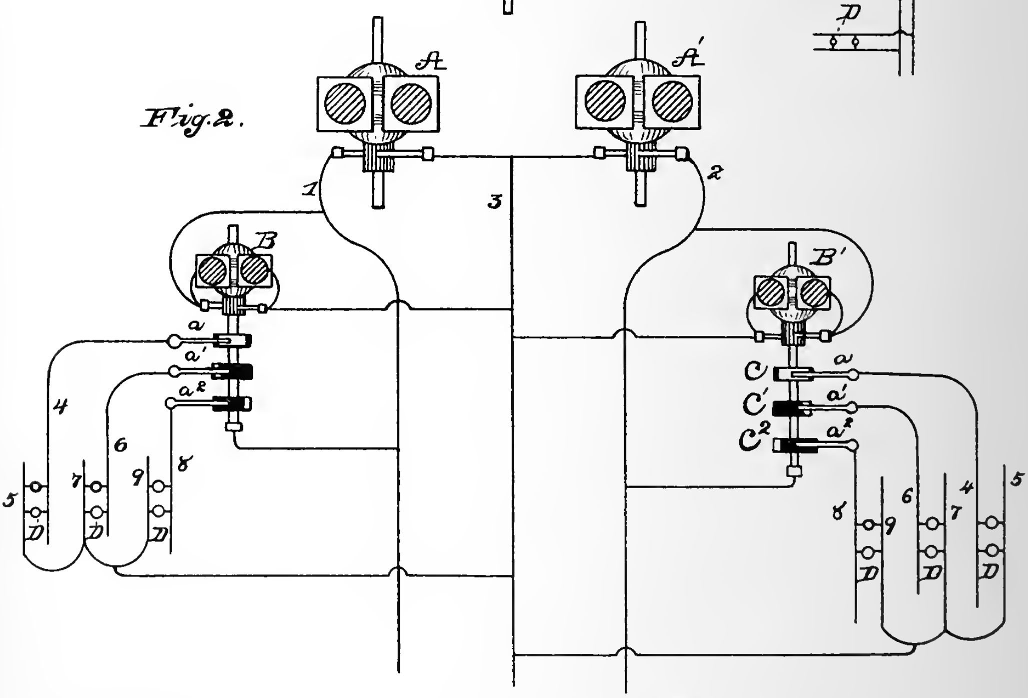


Fig. 2.



ATTEST:
E. C. Rowland.
A. W. Kiddle.

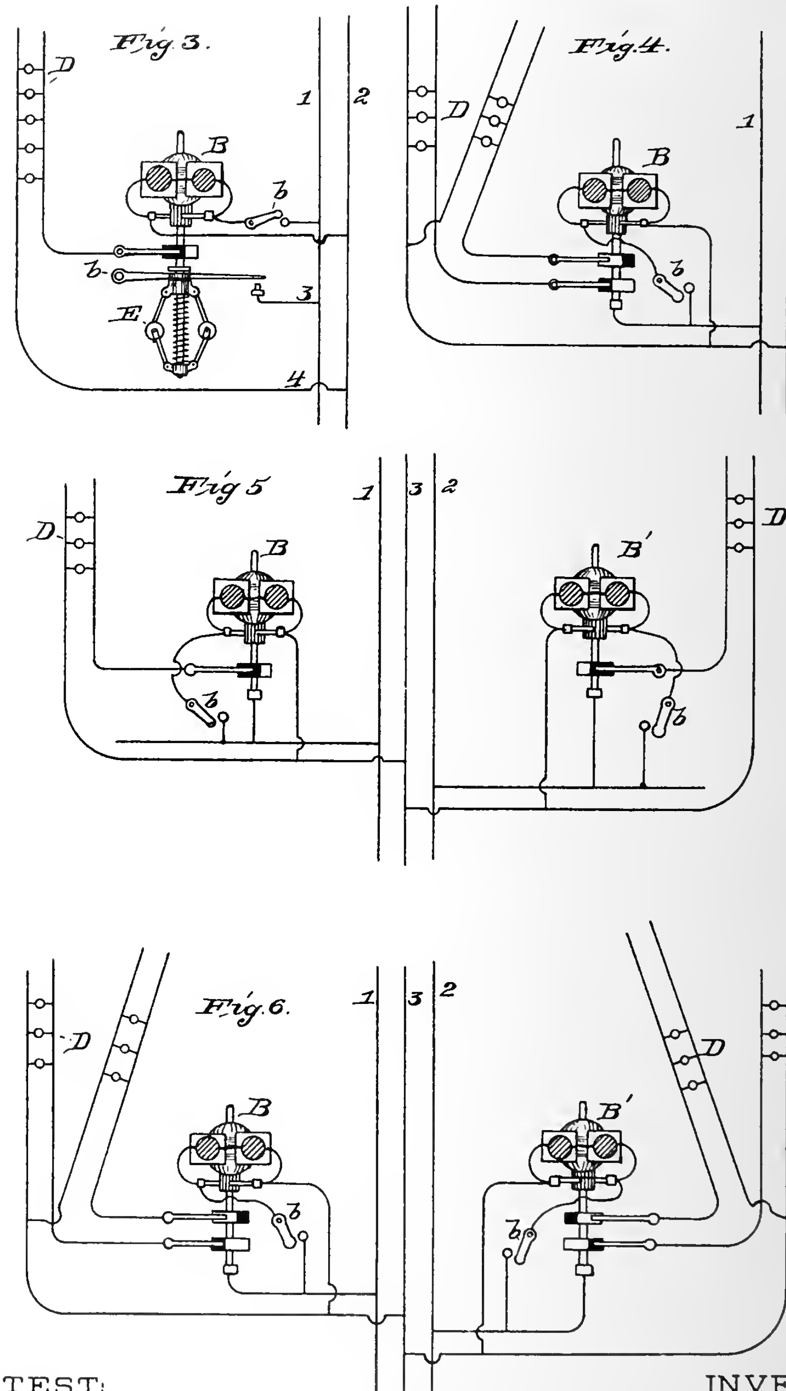
INVENTOR:
Thomas A. Edison,
By Rich^d N. Dyer,
Atty.

(No Model.) 2 Sheets—Sheet 2.

T. A. EDISON.

SYSTEM OF ELECTRIC LIGHTING.

No. 391,595. Patented Oct. 23, 1888.



ATTEST:

E. C. Rowland.
A. W. Kiddle.

INVENTOR:

Thomas A. Edison,
By Richd N. Dyer
Atty.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

SYSTEM OF ELECTRIC LIGHTING.

SPECIFICATION forming part of Letters Patent No. 391,595, dated October 23, 1888.

Application filed August 7, 1884. Serial No. 139,961. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a certain new and useful Improvement in Systems of Electric Lighting, (Case No. 628,) of which the following is a specification.

The object I have in view is to produce a system of electric lighting wherein high-tension currents can be used upon the main conductors or feeders and incandescing electric lamps located in independent multiple-arc circuits and requiring a continuous current of lower tension can be supplied, enabling the use of smaller conductors and making it possible to economically supply lamps at greater distances from the source of electrical energy than when a simple multiple-arc arrangement is employed.

The invention is based upon the discovery that the electrical energy consumed by an incandescing electric lamp may be controlled independent of the tension of the current and the resistance of the lamp (provided the tension of the current is greater than the lamp requires when constantly in circuit) by interrupting the flow of current to the lamp, and the light can be made to appear constant to the eye by making such interruptions of the current with sufficient rapidity. Thus an incandescing lamp requiring when constantly in circuit a current of definite tension to maintain it at normal incandescence may be supplied from a circuit having a current of two or more times that tension, provided the circuit through the lamp is interrupted, so that current will flow for only a fraction of the time through the lamp, that fraction being inversely the number of times the tension used is a multiple of that required when the lamp is constantly in circuit, or approximately that proportion.

In carrying out my invention for a general system I propose to run the circuit of high tension to one or more points within the district intended to be supplied, and there divide the current between two or more circuits containing incandescing electric lamps or other translating devices by means of a rapidly-acting circuit-controller, which will throw the current first through one lamp-circuit and then through another, keeping each lamp-circuit complete for a fraction of the time only. This circuit-controller is preferably a revolving shaft carrying circuit-controlling wheels upon which rest suitable springs or brushes, and this shaft is preferably operated by an electro-dynamic motor located in the high-tension circuit. Each lamp-circuit will be broken at a number of points to reduce the spark. The high-tension circuit may be a simple circuit or a compound circuit—such as is used in my compensating system—and in the latter case each part of the compound circuit will be treated the same as a simple circuit. The points at which the high-tension current will be divided may be centers of consumption, from which main conductors will run to house-circuits in the vicinity, the locality being divided between two or more circuits of main conductors, according to the tension used; or the lamps of each building may be divided between two or more circuits and a motor working a commutator and placed in the high-tension circuit be located in the building itself.

Instead of dividing the lamps of a house between two or more circuits, they may be placed in one circuit, and a local circuit-controlling motor may be used in the house, which will interrupt the flow of current to the desired extent. The economy of this last arrangement would be dependent upon the fact that the numerous local circuit-controlling motors would not work synchronously. All of these arrangements are adapted for use with a compound or compensating high-tension circuit as well as with a simple high-tension circuit, and the different arrangements may be used together in the same system, if desired.

Each circuit-controlling motor is preferably provided with a speed-governor controlling the lamp circuit or circuits controlled by such motor, and closing such lamp circuit or circuits only after the motor has attained normal speed, and breaking such circuit or circuits when the speed drops below the normal limit. This will prevent the breaking of the lamps, and is especially applicable to local motor circuit-controllers in houses, but may also be used to advantage on motors at stations to prevent damage when the lamp-switches are closed before the motors attain normal speed.

In the accompanying drawings, forming a

part hereof, Figure 1 is a view, principally in diagram, of a system with a simple high-tension circuit embodying the invention; Fig. 2, a similar view, the high-tension circuit being a compound circuit; Fig. 3, a similar view showing local circuit-controlling motor controlling a single lamp-circuit; Fig. 4, a similar view with local circuit-controlling motor controlling two circuits; and Figs. 5 and 6, views showing the arrangements of Figs. 3 and 4 applied to a compensating system.

With reference more particularly to Fig. 1, A is a dynamo or magneto-electric machine operated by a water-wheel, steam-engine, or other prime motor and having a high electromotive force—for instance, three hundred volts. From this machine extends the high-tension circuit 1 2, and included in this circuit is the distant electro-dynamic motor B. The shaft of this motor carries three circuit-controlling wheels, C C′ C^2, the periphery of each of which is one-third metal and two-thirds insulation. Upon these wheels rest brushes or springs *a a′* a^2. The wheels C C′ C^2 are so arranged upon the motor-shaft or the brushes *a a′* a^2 are so arranged to bear upon the wheels that when one brush is on metal the other two brushes are on insulation. The motor-shaft is connected by conductors 3 with one side of the high-tension circuit 1 2, while between the brushes *a a′* a^2 and the other side of circuit 1 2 extend lamp-circuits 4 5, 6 7, and 8 9, in which are included incandescing electric lamps D. The circuits 4 5, 6 7, and 8 9 form a locality at a central point in which the motor B is located. The lamps D require, when constantly in circuit, an electro-motive force of one hundred volts to maintain normal incandescence. The energy of circuit 1 2 is divided between the three lamp-circuits by the circuit-controller, each lamp-circuit being completed for one-third of the entire time, and the motor has a sufficiently high speed to make the incandescence of the lamps constant to the eye. Other motors may be arranged in circuit 1 2, controlling lamp-circuits the same as motor B.

In Fig. 2 is shown the invention applied to a system wherein the high-tension circuit is a compound circuit composed of main conductors 1 2 and a compensating conductor, 3, supplied by two machines, A A′, each having, for illustration, an electro-motive force of three hundred volts. The motors B B′ are on opposite sides of the compound circuit and control each three lamp-circuits, as shown.

In Fig. 3 the high-tension circuit 1 2 extends to the houses, and house-circuits 3 4 are taken directly therefrom. The motor B controls the house-circuit, keeping it complete for a fraction of the time, that fraction depending upon the tension of the current in 1 2. A speed-governor, E, also controls the lamp circuit, closing the lamp-circuit when the motor attains normal speed and opening it when the speed drops below the normal limit. This feature is applicable to all locations of the circuit-controlling motors. A hand-switch, *b*, is used to stop and start the motor when desired.

In Fig. 4 the motor B is a local house-motor and the lamps are divided between two circuits, while in Figs. 5 and 6 the arrangements of Figs. 3 and 4 are shown applied to a compound high-tension circuit.

What I claim is—

1. The combination of two or more branch circuits, each containing a translating device or devices requiring current of a certain tension when constantly in circuit, and a main circuit on which is maintained a current of higher tension than that so required by the translating devices, each of said branch circuits being connected with the main circuit through a circuit-controller, which rapidly opens and closes the circuit alternately, substantially as set forth.

2. The combination of two or more branch circuits, each containing a translating device or devices requiring current of a certain tension when constantly in circuit, and a main circuit in which is maintained a current whose tension is as many times that so required for the translating devices as there are branch circuits, each of said branch circuits being connected with the main circuit through a circuit-controller, which rapidly opens and closes the circuit alternately, substantially as set forth.

3. The combination of two or more branch circuits, each containing a translating device or devices requiring current of a certain tension when constantly in circuit, a main circuit having a current of higher tension than that so required by the translating devices, and a circuit-controller for each of said branch circuits by which it is rapidly closed and opened alternately, said circuit-controllers being arranged to keep each circuit closed during such a fraction of the entire time as one is of the number of the branch circuits, substantially as set forth.

4. The combination, with a high-tension supply-circuit, of a translation-circuit containing incandescing electric lamps or other translating devices, and connected with said supply-circuit and a circuit-controller operated by the current and acting to rapidly interrupt the flow of current in the translation-circuit, substantially as set forth.

5. The combination, with a high-tension supply-circuit, of a translation-circuit connected therewith, and a circuit-controller operated by an electro-dynamic motor and acting to rapidly interrupt the flow of current in the translation-circuit, substantially as set forth.

6. The combination, with a high-tension supply-circuit, of a translating-circuit connected therewith through a continuously-acting circuit-controller which keeps the translation-circuit complete for a portion of the time only, and another circuit controller for the trans-

lation-circuit closing such circuit only after the circuit-controller has attained normal speed, substantially as set forth.

7. The combination, with a high-tension supply-circuit, of a translation-circuit connected therewith, a circuit-controller operated by an electro-dynamic motor and keeping the translation-circuit complete for a portion of the time only, and another circuit-controller for the translation-circuit operated by the speed of the motor and acting to close the translation-circuit only after the motor has attained normal speed, substantially as set forth.

This specification signed and witnessed this 16th day of July, 1884.

THOS. A. EDISON.

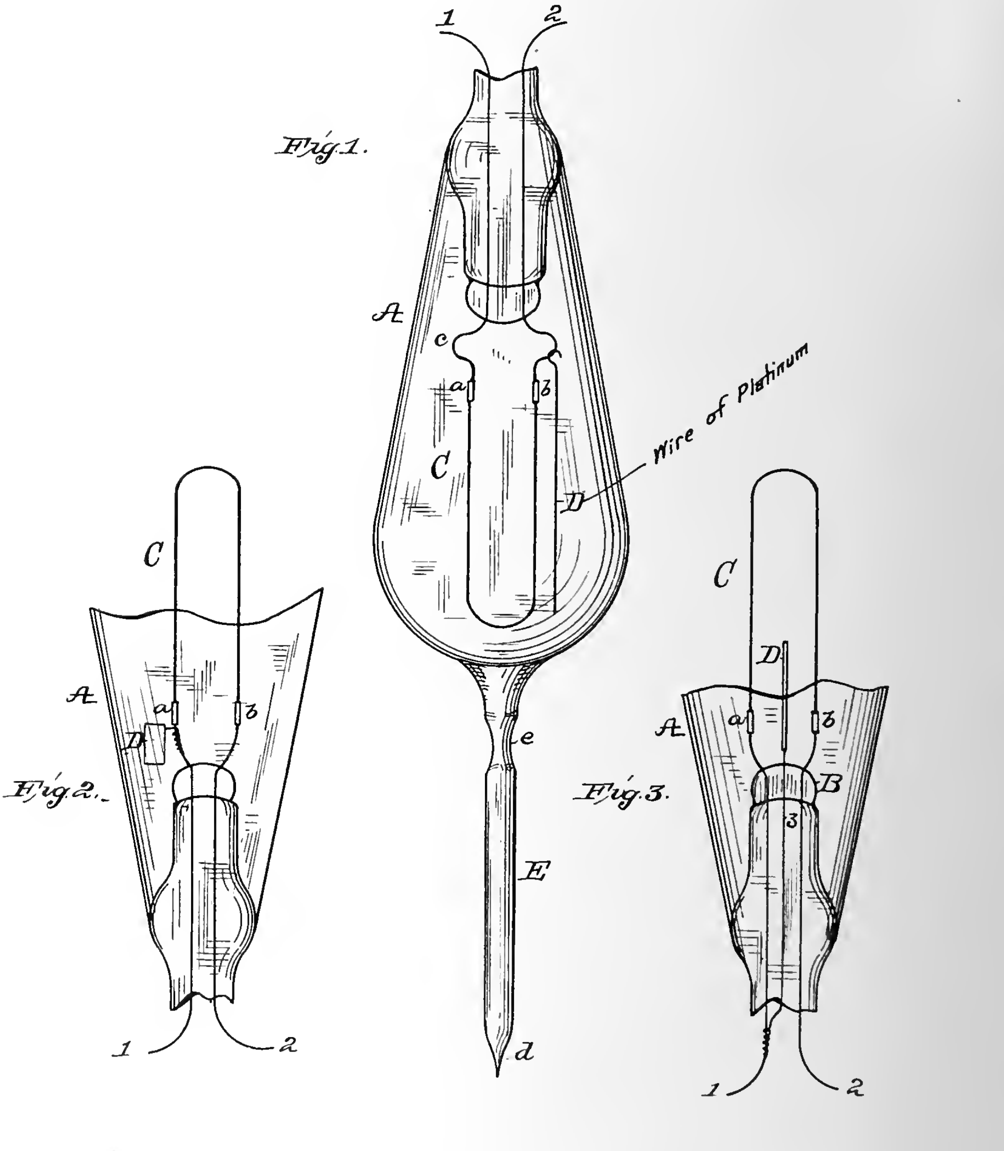
Witnesses:
ALFRED W. KIDDLE,
EDWARD C. ROWLAND.

(No Model.)

T. A. EDISON.

INCANDESCENT ELECTRIC LAMP.

No. 391,596. Patented Oct. 23, 1888.



ATTEST:

E. C. Rowland.
Paul D. Dyer.

INVENTOR:

Thomas A. Edison,
By Rich^d N. Dyer.
Att'y.

N. PETERS, Photo-Lithographer, Washington, D. C.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY.

INCANDESCENT ELECTRIC LAMP.

SPECIFICATION forming part of Letters Patent No. 391,596, dated October 23, 1888.

Application filed October 2, 1884. Serial No. 144,547. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in the Manufacture of Incandescing Electric Lamps, (Case No. 633,) of which the following is a specification.

In the process of driving the occluded gases from the incandescing conductor and clamps, which consists in heating the same by passing an electric current therethrough while the lamp is being exhausted, an electric arc frequently springs across between the metallic terminals of the incandescing conductor within the lamp, resulting in the destruction of the lamp. In the manufacture of incandescing electric lamps the arcing of the lamps on the pumps occurs frequently, and since this occurs when such lamps are nearly completed the loss from this source is considerable.

The object of my present invention is to prevent this action. I find it can be accomplished by enlarging the area of that metallic terminal within the lamp which is positive with relation to the current the lamp receives while upon the pump, and upon which the blue halo appears while driving out the occluded gases. I prefer to do this in such a manner that the enlarging part can be removably attached to the terminal, and after it has performed its office detached and removed from the lamp without destroying the vacuum; but the enlarging part may be arranged to be left within the lamp, connected with the lamp-terminal or not, as will be better understood by reference to the accompanying drawings, in which—

Figure 1 is a view of a lamp prior to final sealing, with a removable enlarging-piece attached to one terminal. Fig. 2 shows the enlarging-piece permanently attached to one terminal; and Fig. 3 shows an enlarging piece located permanently within the lamp, but adapted to be disconnected from the terminal.

The lamp-globe A is shown as having the tubular carbon and wire support B, which is usual in my lamps. The leading-in wires 1 2 terminate in metallic clamps *a b*, to which are connected the ends of the loop-shaped carbon filament C, these clamps and the wires within the lamp forming the metallic terminals of the carbon filament within the lamp. The wires 1 2 (or one of them) may be bent laterally, as shown at *c* in Fig. 1, or they may be otherwise formed to receive the hook end of the terminal-enlarging piece D, which is preferably a wire of platinum or carbon. This is introduced through the exhaust-tube E by a suitable tool and hung upon one of the wires 1 2 at the bend *c*. The lamp is mounted upon the pump, the wire upon which D is hung being connected to the positive post of the heating-current circuit. After the process of exhausting the lamp and driving out the occluded gases is completed the tube E is sealed off at *d*. This is the condition in which the lamp is shown in Fig. 1 of the drawings. By manipulation of the lamp the wire D is shaken from its position and drops into tube E, when the lamp can be given a final sealing at *e*, leaving wire D in the tube E, which is detached from the lamp.

An enlarging-piece, D, may be hung upon each terminal; but since the enlarging of the negative terminal has no useful effect I prefer to enlarge the positive terminal only.

In Fig. 2 the enlarging-piece D is attached permanently to one terminal. This is made the positive terminal when the lamp is mounted on the pump for exhaustion; but afterward, in the use of the lamp, this enlarged terminal must be made the negative terminal, in order to prevent the destructive electrical carrying which I have found will occur if the lamp is used with the enlarged terminal as the positive one. Both terminals may be enlarged to the required degree to prevent arcing while upon the pump; but the enlarging of the negative terminal having no effect it is not desirable to do so.

In Fig. 3 the enlarging-piece D is not connected within the lamp to either terminal, but is mounted upon a separate wire, 3, sealed into the tubular support B. The wire 3 is connected outside the lamp with the positive wire when the lamp is mounted upon the pump, and the effect is the same as if connected to the terminal within the lamp. It forms an enlargement of the positive terminal within the lamp and prevents the springing of an electric arc, as before explained. After exhaustion of the lamp the enlarging area D is removed, so far as its electrical effect is concerned, from the vacuum-chamber by disconnecting wire 3 from the other wire, such wire remaining disconnected from any wire during the use of the lamp, it not being connected to either plate upon the lamp-base.

What I claim is—

1. The combination of the inclosing-globe, the filament, the leading-in wires, and an enlarged terminal for one end of the filament, substantially as set forth.

2. The combination of the inclosing-globe, the filament, the leading-in wires, and a conducting-piece connected with one terminal of the filament, so as to enlarge the area of such terminal, substantially as set forth.

This specification signed and witnessed this 24th day of September, 1884.

THOS. A. EDISON.

Witnesses:

WM. H. MEADOWCROFT,
PAUL D. DYER.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY, ASSIGNOR TO THE EDISON PHONOGRAPH COMPANY, OF NEW JERSEY.

PROCESS OF MAKING PHONOGRAM-BLANKS.

SPECIFICATION forming part of Letters Patent No. 393,462, dated November 27, 1888.

Application filed May 7, 1888. Serial No. 273,038. (No specimens.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, a citizen of the United States, residing at Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Processes of Making Phonogram-Blanks, (Case No. 768,) of which the following is a specification.

As has been made known by my prior applications for patents, the phonogram-blank which I prefer to employ is one made entirely of wax or a wax composition in the form of a cylinder having a cylindrical outer surface and a tapering bore. These blanks I mold from the wax composition, as described in prior applications; but the excessive contraction of the wax in cooling makes it impossible to give such blanks by molding the precise size externally and internally that they should have for use upon my phonograph. I have attempted to reduce these molded blanks to the exact size for use both by pressing them in a finishing-die and also by cutting them both externally and internally with proper tools. These methods of finishing the blanks have, however, objections, which it is the object of my present invention to overcome.

By my present invention I first mold the blank from the wax composition, making it slightly larger than the finished blank, and I then finish the blank by cutting it both externally and internally with heated knives or cutters. These knives or cutters are suitably heated to a temperature slightly below the melting-point of the wax composition; but the rapidity of the cutting operation is such that the wax body of the blank does not melt. For the heated cutting-tools I employ, first, a tapering reamer, which is heated by the introduction of steam into its hollow body and is revolved rapidly. The molded blank is pushed onto this reamer and withdrawn from it by a continuous motion of the hand, so that the reamer by the combined cutting and heating action turns out the bore of the blank to the precise size desired. The second tool is a revolving tapering mandrel having the exact taper of the finished bore of the blank and a heated cutting-knife, which is mounted to be readily moved toward and away from the mandrel. The blank is placed upon the mandrel and the heated cutting-knife advanced and withdrawn, it being held sufficiently long in its most advanced position to permit the mandrel, which revolves rapidly, to make at least one revolution. This tool by the combined heating and cutting action reduces the external surface of the blank to a true cylinder. The blank is then removed from the mandrel and is ready for use upon the phonograph.

By the use of the heated cutting-tools I find that the wax blanks can be cut rapidly and accurately, and that the surface of the blanks is left perfectly smooth and in good condition for receiving the sound-record and reproducing the sound therefrom. I also preferably heat the wax blanks before cutting by a hot table, oven, or chamber approximately to the temperature of the cutting-tools, so that the blanks will not crack by uneven expansion during the cutting. This is particularly necessary in the case of the reamer, since the blank comes into contact with the tool over a considerable surface. With the heated turning-off tool, however, since only the edge of the knife comes into contact with the wax, the previous heating of the blanks may be dispensed with, although it can be employed.

Any suitable forms of heated cutting-tools can be employed for the purpose, although the cutting-tools shown and described in my applications of even date herewith (Cases Nos. 769 and 770, Serial Nos. 273,039 and 273,040) are preferred by me.

My phonogram-blank being made entirely of the wax composition I employ the heated cutting-tools both upon the bore of the blank and upon its external surface; but it is evident that the invention herein is also applicable to the finishing of the external recording-surfaces of phonogram-blanks, which are composed of a wax coating upon a backing of paper or other suitable material.

What I claim as my invention is—

1. The process of finishing the wax recording-surfaces of phonogram-blanks, consisting in cutting such surfaces with heated cutting-tools, substantially as set forth.

2. The process of finishing cylindrical phono-

gram-blanks made entirely of wax, consisting in cutting such blanks both externally and internally with heated cutting tools, substantially as set forth.

3. The process of making cylindrical phonogram-blanks entirely of wax, consisting in first molding the hollow blanks and then cutting the blanks both externally and internally by heated cutting-tools, substantially as set forth.

This specification signed and witnessed this 28th day of April, 1888.

THOS. A. EDISON.

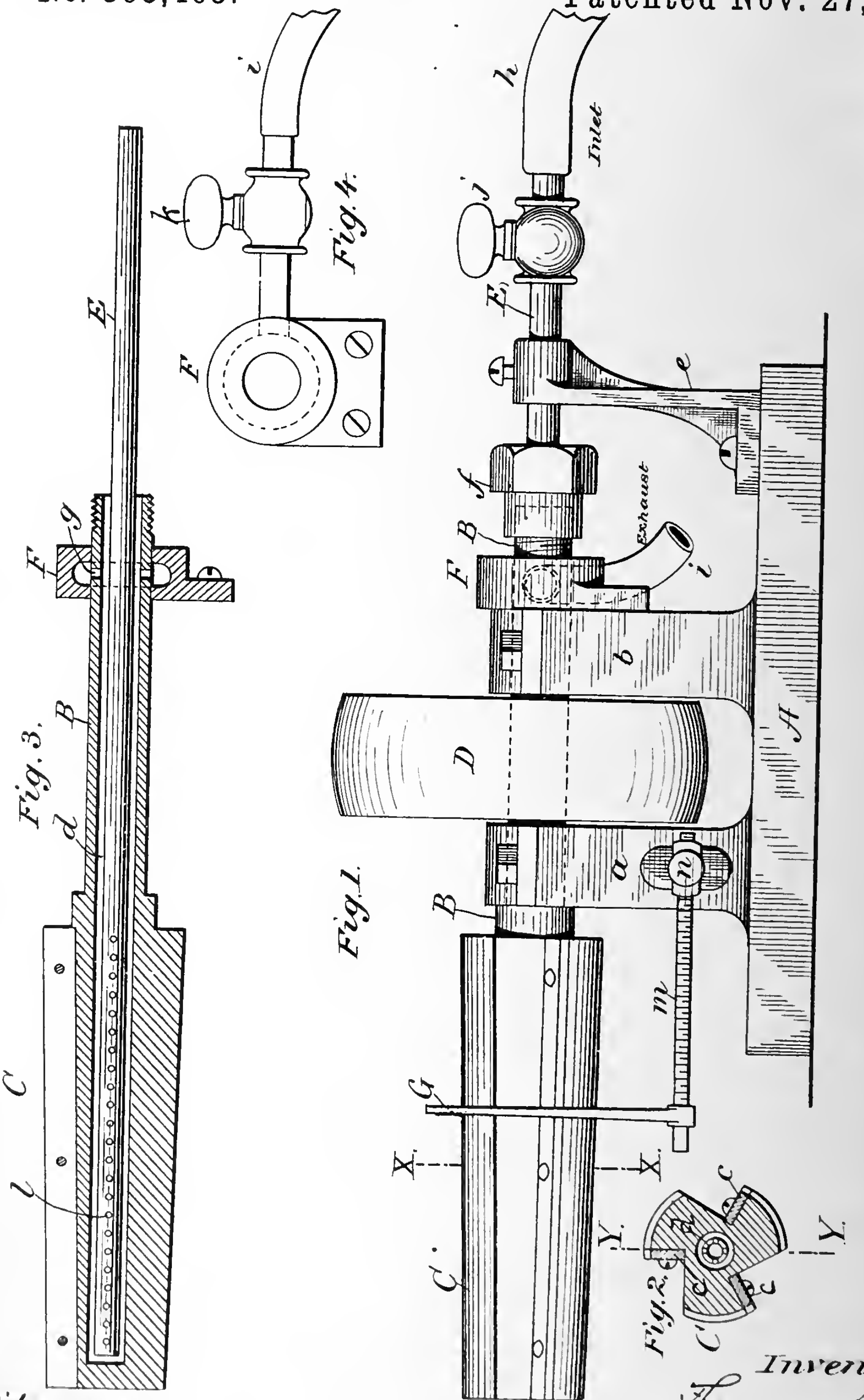
Witnesses:
WILLIAM PELZER,
A. W. KIDDLE.

(No Model.)

T. A. EDISON.

MACHINE FOR MAKING PHONOGRAM BLANKS.

No. 393,463. Patented Nov. 27, 1888.



Witnesses:
J. A. Hindle
William Pelzer.

Inventor:
Thomas A. Edison
By
Dyer & Seely.
Attorneys.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY, ASSIGNOR TO THE EDISON PHONOGRAPH COMPANY, OF NEW JERSEY.

MACHINE FOR MAKING PHONOGRAM-BLANKS.

SPECIFICATION forming part of Letters Patent No. 393,463, dated November 27, 1888.

Application filed May 7, 1888. Serial No. 273,039. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, a citizen of the United States, residing at Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Machines for Making Phonogram-Blanks, (Case No. 769,) of which the following is a specification.

As has been made known by my prior applications for patents, the phonogram-blank which I prefer to employ is one made entirely of wax or a wax composition in the form of a cylinder having a cylindrical outer surface and a tapering bore. These blanks I first mold from the wax or wax composition; but owing to the excessive contraction of the wax in cooling the blanks are somewhat distorted and do not have the accurate shape and size required. Hence it becomes necessary to mold the blanks slightly larger than the size for the finished blanks and then to reduce them by cutting to the proper size and shape, both externally and internally. I have found that the use of the ordinary cutting-tools at ordinary temperatures for this purpose is objectionable. In my application of even date herewith, (Case No. 768, Serial No. 273,038,) I have described a method of finishing these blanks consisting in cutting them externally and internally with heated knives or cutters.

The object of my present invention is to provide a proper tool for reaming out the wax phonogram-blank, so as to make its bore accurately of the size and shape desired.

In the accompanying drawings, forming a part hereof, Figure 1 is a side elevation of the improved reamer. Fig. 2 is a cross-section on the line *x x*. Fig. 3 is a longitudinal section through the reamer and its shaft on the line *y y*; and Fig. 4 is an elevation of the exhaust-outlet for the heating medium.

A is a suitable base or table, from which rise pedestals *a b*, in which is journaled the shaft B, carrying the tapering reamer C. Upon the shaft between the pedestals is the pulley D, by means of which power is applied to the reamer for revolving it rapidly. The reamer C is made tapering, it having the exact size and shape it is desired to give the bore of the wax phonogram-blank. It is provided with cutting-knives *c*. The shaft B and reamer C are made hollow, the passage or channel *d* extending entirely through the reamer, but being closed at the small end of the reamer. Into the channel *d* is introduced centrally a stationary pipe, E, which is rigidly held by a bracket, *e*, rising from the base A, out of contact with the sides of the channel *d*, so that the reamer C and shaft B can be revolved while the pipe E is held at rest. The shaft B terminates between the pedestal *b* and bracket *e*, and is provided with a stuffing-box, *f*, which closes the opening *d* around the pipe E at this point. Secured to the outer face of the pedestal *b* is a box or chamber, F, which fits closely around the shaft B, such shaft being provided with a number of perforations, *g*, where it is covered by this box. The pipe E and the box F are connected with leading-pipes *h i*, provided with stop-cocks *j k*. A heating medium, which is preferably steam, but may be hot water or hot air, is supplied to the pipe *h* and passes into the pipe E at its other end within the reamer C, and then passes out of such pipe E through its open end and through the perforations *l* in such pipe E into the channel *d* around the pipe E, and thence returns through such channel *d* to the perforations *g*, and out of such perforations into the box F, and thence out by the pipe *i*, the flow of the heating medium being controlled by the stop-cocks *j k*. Thus the reamer can be maintained at the precise temperature desired.

To determine the extent to which the wax phonogram-blank will be pushed upon the reamer, I provide a gage-arm, G, which passes over the reamer and is screwed to an arm, *m*, held by a set-screw, *n*, to the side of the pedestal *a*. By means of the set-screw *n* the gage-arm G can be set to any point desired. The arm *m* may have a scale marked upon it to indicate the position to which the gage-arm is set. This enables me to ream out phonogram-blanks of different lengths.

The hollow cylindrical wax phonogram-blanks are taken in the hand and are pushed onto the reamer and withdrawn from it by a continuous motion, the reamer being brought up to the desired temperature and the combined action of heating and cutting rapidly and smoothly reaming out the bore of the blank.

The wax blanks are preferably heated by a hot table, oven, or chamber approximately to the temperature of the reamer before being cut by the reamer, in order to prevent cracking by unequal expansion.

What I claim as my invention is—

1. A revolving reamer having cutting knives or edges, and provided with means for heating it, substantially as set forth.

2. A revolving reamer having cutting knives or edges, and made hollow, in combination with pipe-connections for introducing a heating medium into the hollow reamer, substantially as set forth.

3. The combination, with a revolving shaft, B, and reamer C, made hollow, of a stationary pipe, E, and the box F, substantially as set forth.

This specification signed and witnessed this 28th day of April, 1888.

THOS. A. EDISON.

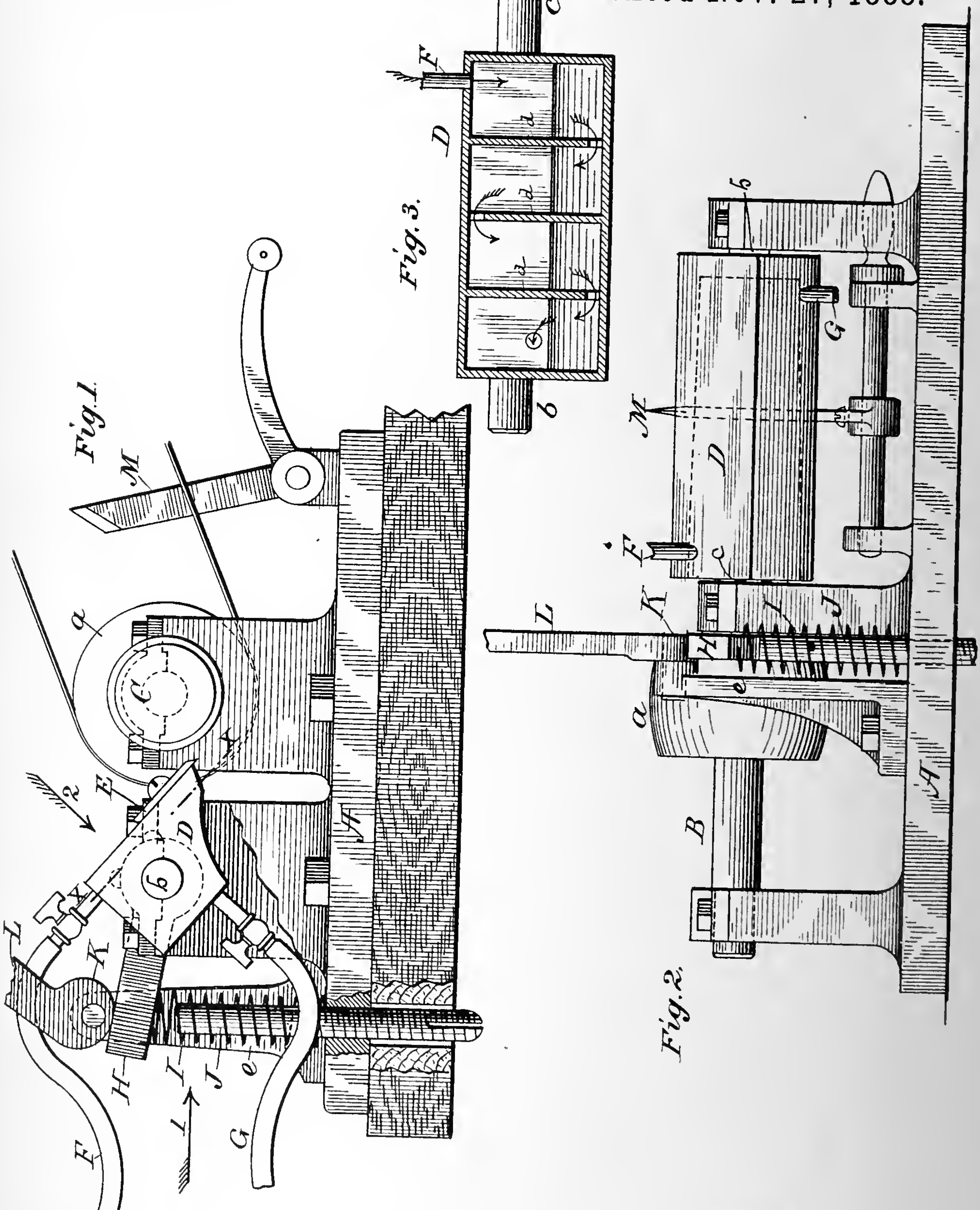
Witnesses:
WILLIAM PELZER,
A. W. KIDDLE.

(No Model.)

T. A. EDISON.

MACHINE FOR MAKING PHONOGRAM BLANKS.

No. 393,464. Patented Nov. 27, 1888.



Witnesses:
J. A. Hundle
William Pelzer.

Inventor:
Thomas A. Edison
By
Dyer & Seely.
Attorneys.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY, ASSIGNOR TO THE EDISON PHONOGRAPH COMPANY, OF NEW JERSEY.

MACHINE FOR MAKING PHONOGRAM-BLANKS.

SPECIFICATION forming part of Letters Patent No. 393,464, dated November 27, 1888.

Application filed May 7, 1888. Serial No. 273,040. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, a citizen of the United States, residing at Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Machines for Making Phonogram-Blanks, (Case No. 770,) of which the following is a specification.

As has been made known by my prior applications for patents the phonogram-blank which I prefer to employ is one made entirely of wax or a wax composition in the form of a cylinder having a cylindrical outer surface and a tapering bore. In finishing the outer surfaces of these blanks I have found that the cutting of the wax with ordinary tools at ordinary temperatures is objectionable.

In an application for patent of even date herewith (Case No. 768, Serial No. 273,078) I have described a method of finishing the wax surfaces of phonogram-blanks, consisting in cutting such surfaces with heated knives or cutters.

The object of my present invention is to provide a suitable machine for this purpose.

In the accompanying drawings, forming a part hereof, Figure 1 is an end view of the machine. Fig. 2 is a side elevation looking in the direction of arrow 1 in Fig. 1, and Fig. 3 is a section of the heating-box on line x x, looking in the direction of arrow 2 in Fig. 1.

A is a suitable base or table carrying bearings on which the shaft B is mounted. Outside of the bearings is the mandrel C, and between the bearings the pulley *a*, by which the mandrel is rotated. This mandrel C is adapted to receive the cylindrical phonogram-blank made of wax or having a wax-coated external surface. Parallel with the mandrel C is arranged a box, D, having trunnions *b* *c*, which are mounted in bearings in suitable supports rising from the base A, and is adapted to be swung on such trunnions. Upon the upper forward edge of the box D is secured a cutting-knife, E, which, by the swinging of the box D on its trunnions, is moved toward and away from the mandrel C. The box D is provided with inlet and outlet pipe connections F G, made flexible to permit of the movement of the box D, and having stop-cocks, as shown. These pipes supply a heating medium—such as steam, hot water, or hot air—to the box D, such medium being caused to have a circuitous route through the box D by means of the partitions *d*, as shown in Fig. 3. To the trunnion *c* of the box D is secured a rearwardly-projecting arm, H, which is pressed upwardly by a spring, I, and is limited in its downward movement by an adjustable stop, J, which may be a screw passing upwardly through the base A. Bearing on the upper side of the arm H, at its outer end, is a cam, K, carried by the end of a hand-lever, L, which is pivoted to a bracket, *e*, rising from the base A. The cam K limits the upward movement of the arm H, and hence limits the extent of withdrawal of the knife E from the mandrel C, which withdrawal is effected by the upward pressure of the spring I, while the adjustable stop J, by limiting the downward movement of the arm H, also limits the forward movement of the knife E. It will thus be seen that by adjusting the stop J the precise position to which the knife E will be advanced by turning the cam K by means of the handle L will be fixed. The heating medium being supplied to the box D and regulated by the stop-cocks, such box will be brought to the desired temperature, which is slightly below the melting-point of the wax or wax composition. The phonogram-blank will be pushed upon the mandrel C, and such mandrel will be started revolving, when by a quick movement of the handle L the heated knife E will be thrown forward against the wax surface of the phonogram-blank, and the blank will be turned true by the combined action of heating and cutting, when the blank will be removed from the mandrel and another substituted in its place.

The machine may be provided with a swinging knife, M, for cutting the phonogram-blanks into two or more lengths; but such a knife is not an essential feature of the machine.

What I claim as my invention is—

1. The combination, with a revolving mandrel, of a heated cutting-tool for turning off the external surface of a wax phonogram-blank mounted on such mandrel, substantially as set forth.

2. The combination, with a turning man-

drel, of a moving box having pipe connections for supplying it with a heating medium, a knife mounted upon such box, and a handle for moving the box toward and away from the mandrel, substantially as set forth.

3. The combination, with a turning mandrel, of a pivoted box, pipe-connections for supplying a heating medium to said box, a cutting-knife mounted upon the box, and a handle for turning said box so as to move the knife toward and away from the mandrel, substantially as set forth.

4. The combination, with a revolving mandrel, of a pivoted box, pipe-connections for supplying a heating medium to the box, a knife mounted on the box, a handle swinging said box so as to move the knife toward the mandrel, and a spring turning the box in the opposite direction to move the knife away from the mandrel, substantially as set forth.

5. The combination, with a turning mandrel, of a pivoted box carrying a knife and having pipe-connections for supplying it with a heating medium, a handle swinging the box, so as to move the knife toward the mandrel, and an adjustable stop limiting the forward movement of the knife, substantially as set forth.

6. The combination, with a turning mandrel, C, of a swinging box, D, carrying a knife, E, and having pipe-connections F G, the arm H, the cam K, turned by handle L, the spring I, and the adjustable stop J, substantially as set forth.

This specification signed and witnessed this 28th day of April, 1888.

THOS. A. EDISON.

Witnesses:

WILLIAM PELZER,

A. W. KIDDLE.

(No Model.)

T. A. EDISON.

METHOD OF PREPARING PHONOGRAPH RECORDING SURFACES.

No. 393,465. Patented Nov. 27, 1888.

Fig. 1.

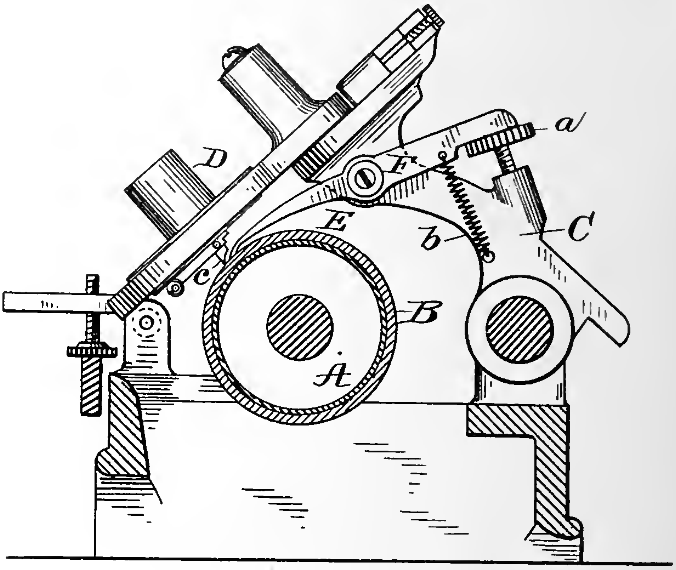


Fig. 3.

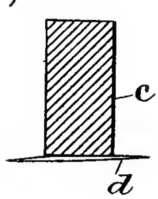


Fig. 2.

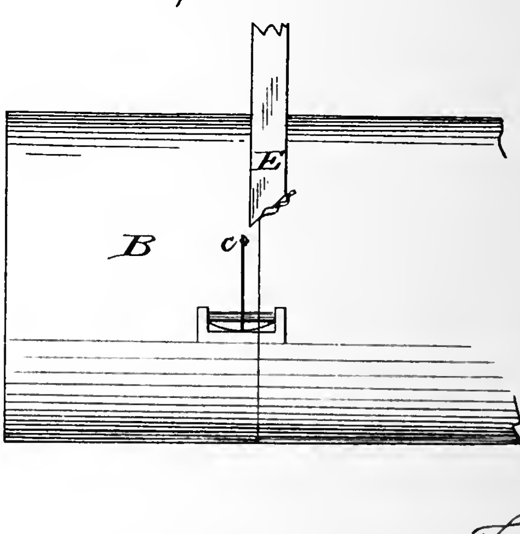
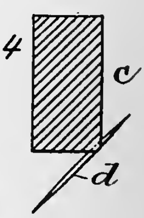


Fig 4



Witnesses.
E. C. Rowland.
William Pelzer.

Inventor,
Thomas A. Edison
By his Attorneys Dyer & Seely

N. PETERS, Photo-Lithographer, Washington, D. C.

United States Patent Office.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY, ASSIGNOR TO THE EDISON PHONOGRAPH COMPANY, OF NEW JERSEY.

METHOD OF PREPARING PHONOGRAPH RECORDING-SURFACES.

SPECIFICATION forming part of Letters Patent No. 393,465, dated November 27, 1888.

Application filed July 7, 1888. Serial No. 279,323. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in the Method of Preparing Phonograph Recording-Surfaces, (Case No. 785,) of which the following is a specification.

In my phonograph I employ a removable phonogram-blank having a recording-surface of a yielding material. I prefer to use a wax or a wax composition for the purpose, and I also prefer to make the entire blank of the wax or wax composition. These blanks after being mounted in the machine have their recording-surface turned true by a knife which is carried by the rocking holding-arm and the point of which is preferably in close proximity to the recording-point. The blanks used with my machine are also preferably adapted to have their surfaces turned off by this same cutting-tool for the purpose of using them a number of times, an old record being removed to make place for a new one. I have heretofore employed as the cutting-tool a knife with its cutting-edge parallel with the axis of the phonogram-cylinder and practically at right angles to the track of record. I have discovered that wax and similar yielding materials, by reason of their elasticity and the cohesion of the particles, are not turned off smoothly by the tool, but that microscopic cracks or breaks in the surface are formed which are parallel with the edge of the cutting-tool. To these cracks or breaks I attribute, in a measure, the production of foreign sounds by the record. These cracks or breaks are not as deep as the track made by the recording-point, but since the recording-point meets at the one time the resistance due to material of the full depth of its incision and at another time (when crossing a crack or break in the surface) a lesser body of material I have found that the record produced is correspondingly affected, having irregularities causing false vibrations in the reproducer. I have found that the effect of these cracks or breaks is greatly modified and the trouble arising from them largely overcome by so cutting or turning off the surface of the blank that the cracks will be oblique to the track of record or the direction of relative movement of the surface and the recording-point. The improved effect, I think, is due to the fact that when the cracks are oblique the recording-point does not meet the crack across the full width of its advancing edge at one time, but only across a portion of such edge, and the disturbance is more gradual and is extended over a greater time.

In the accompanying drawings, forming a part hereof, Figure 1 is a vertical transverse section of a phonograph provided with a turning-off tool; Fig. 2, a view showing the phonogram-blank being cut by the tool and illustrating the relative positions of the cutting-tool and the recording-point; and Figs. 3 and 4 are views on an exaggerated scale showing the relation between the recording-point of the phonograph and the cracks in the recording-surface.

A is the revolving phonogram-cylinder, having the wax phonogram-blank B carried thereby.

C is the rocking holding-arm carrying the recorder D and the cutting-tool E. This tool is a knife mounted on the end of a lever, F, pivoted to the arm C. The end of the lever F in rear of the pivot passes over the head of an adjusting-screw, *a*, while a spring, *b*, draws it downwardly against said screw. The point of the knife E is oblique, as shown in Fig. 2, the cracks produced in the wax recording-surface by it being oblique to the track of record made by the point *c* of the recorder.

In Figs. 3 and 4 is shown in horizontal section the recording-point *c*, while *d* represents the cracks in the recording-surface. If those cracks are parallel with the advancing edge of the recording-point, as shown in Fig. 3, the recording point will meet the cracks at the same time across the full width of its advancing edge, while if the cracks are oblique, as in Fig. 4, only a portion of the advancing edge of the recording-point will be in the crack at any one time, and the disturbing effect of the crack will be distributed over a greater space of time, and hence will be more gradual.

It will be understood that the cutting-tool is to be used either alternately with the recorder or simultaneously therewith. In the latter case the cutting-tool is placed somewhat in advance of the recording-point in the direction of longitudinal movement of said point, as is illustrated in Fig. 2.

I do not claim in this application the recording-point and cutting-tool adapted to be operated simultaneously, this being claimed in my application filed May 29, 1888, Serial No. 275,441.

In my application No. 784, Serial No. 279,322, filed July 7, 1888, I have claimed the phonograph provided with a turning-off tool having a cutting-edge oblique to the track of record. This application relates to the method of preparing phonograph recording-surfaces by means of an oblique cutting-edge. It is obvious that the method might be carried into effect without mounting the cutting-tool upon the phonograph itself, since such tool might be employed in any suitable machine, such as a lathe or any modification of a lathe.

What I claim is—

1. The method of preparing phonograph recording-surfaces, consisting in turning off such surfaces by a tool having a cutting-edge acting obliquely to the track of record, substantially as set forth.

2. The method of preparing phonograph recording-surfaces of wax or a wax composition, consisting in turning off such surfaces by a tool having a cutting-edge acting obliquely to the track of record, substantially as set forth.

This specification signed and witnessed this 30th day of June, 1888.

THOS. A. EDISON.

Witnesses:

WILLIAM PELZER,

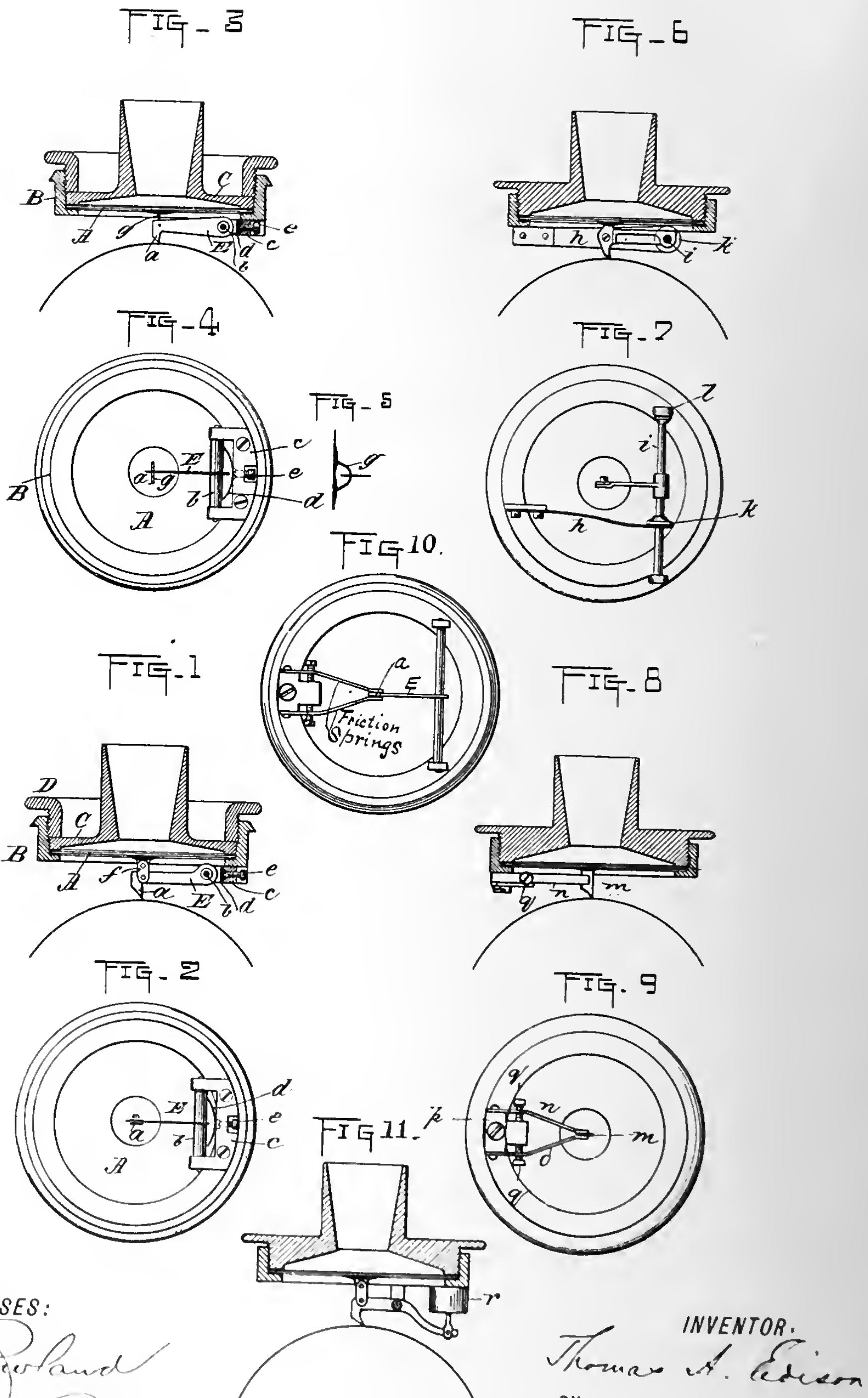
A. W. KIDDLE.

(No Model.)

T. A. EDISON.

PHONOGRAPH RECORDER.

No. 393,466. Patented Nov. 27, 1888.



WITNESSES:

E. C. Rowland

William Pelzer.

INVENTOR.

Thomas A. Edison.

BY

Dyer & Seely.

ATTORNEYS.

N. PETERS, Photo-Lithographer, Washington, D.C.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY.

PHONOGRAPH-RECORDER.

SPECIFICATION forming part of Letters Patent No. 393,466, dated November 27, 1888.

Application filed July 17, 1888. Serial No. 280,207. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, a citizen of the United States, residing at Llewellyn Park, in the county of Essex, in the State of New Jersey, have invented a certain new and useful Improvement in Phonograph-Recorders, (Case No. 789,) of which the following is a specification.

In experimenting with my phonograph I have discovered that imperfections are produced in the record made by the machine by reason of the momentum of the recorder-diaphragm and attached parts; also by reason of lost motion when the recording-point is mounted on a pivoted lever, as I prefer to mount it, and also by reason of the straining of the diaphragm, due to the attachment of the recording-point to such diaphragm, and due to the differences in the directions of movement of the recording-point and the diaphragm. These imperfections in the record become audible, as scratching and other foreign noises, when the sounds are reproduced.

The object I have in view is to overcome these defects in phonograph-recorders, with the result of making the reproduced sounds more clear, and also permitting the employment of a more sensitive reproducer.

In constructing my phonograph-recorder I make a positive connection between the diaphragm and the recording-point, so that there will be no loss of movement in communicating the vibrations of the diaphragm to the recording-point. The recording-point is mounted upon a rigid lever or arm which takes the lateral thrust of the recording-point and relieves the diaphragm from the strain due to said thrust. This rigid carrying-lever is also preferably a short lever, and is mounted to turn in bearings, so that the movement of the recording-point will be oblique to the recording-surface for the purpose of making the recording-waves more abrupt at one end than at the other.

In the preferred construction of my phonograph-recorder the lever carrying the recording-point is pivoted, as just stated, one or more of the pivotal bearings being friction-bearings having a considerable pressure exerted upon them, so that the movements of the lever, the recording-point, and the diaphragm will be retarded by the friction-bearings, thus overcoming the momentum of the parts. The lever is also made extremely light by making it from a thin plate, it having sufficient width to give the desired rigidity which is required to take the lateral thrust of the recording-point. The friction at the bearings of the pivotal lever is preferably obtained by means of a spring placed under tension, and this spring-tension is also preferably adjustable, so that the requisite amount of pressure can be obtained. The pressure of the spring on the bearings of the lever also serves to take up any lost motion. To prevent the positive attachment of the indenting-point with the diaphragm from straining the diaphragm, I make the connection one which is capable of yielding in the direction of the length of the carrying-lever. This connection is preferably a link pivoted to the lever, as well as to a block, cemented or otherwise secured to the diaphragm. Where the recording-point is supported directly from the diaphragm, no supporting lever or arm being employed, the retardation necessary to overcome the momentum may be produced by means of friction-springs which embrace the recording-point bearing against its opposite sides. This way of applying the friction may also be used when the recording-point is mounted upon an arm or lever. Instead of employing friction-springs for producing the retardation a dash-pot may be employed for the purpose. It will be seen that all these retarding devices are non-resilient and constant in their action and do not change the character of the vibrations of the diaphragm, which are given it by the sound-waves, but only serve to retard the movement and thus to overcome the momentum. The elastic or resilient dampening devices that have heretofore been used with diaphragms of phonographic apparatus produce quite a different effect from the non-resilient retarding devices, since by reason of their resiliency they change the character of the diaphragm vibrations and produce false movements which serve to injure rather than improve the character of the record.

In the accompanying drawings, forming a part hereof, Figure 1 is a vertical section of the preferred form of my recorder. Fig. 2 is a bottom view of the same. Fig. 3 is a vertical section of the recorder, showing a modification of the connection between the carrying-lever and the diaphragm. Fig. 4 is a bottom view of the recorder of Fig. 3. Fig. 5 is a section through the center of the diaphragm of the recorder of Figs. 3 and 4, showing in elevation the connection between the carrying-lever and the diaphragm. Fig. 6 is a vertical section of a recorder showing a modified way of producing the retarding-friction. Fig. 7 is a bottom view of the recorder of Fig. 6. Fig. 8 is a vertical section of a recorder having the recording-point supported from the diaphragm. Fig. 9 is a bottom view of the recorder of Fig. 8. Fig. 10 is a bottom view of a recorder having the recording-point supported by a lever and having the friction-springs bearing directly on the point; and Fig. 11 is a side view of a recorder showing the employment of a retarding dash-pot.

With reference to Figs. 1 and 2, which show the preferred form of my phonograph-recorder, the diaphragm A of my recorder is preferably a thin plate of microscope-glass which is clamped between plates B C by means of the adjusting-ring D, the edges of the glass diaphragm being protected by rubber rings. The recording-point *a* is preferably mounted upon or forms part of a lever, E, which is made from thin plate metal in order to give it lightness. This lever E is mounted upon a long bearing-pin, *b*, which is pivoted in the ends of a yoke, *c*, secured rigidly to the bottom of the ring B. Between the back of yoke *c* and the bearing-pin *b* is a semi-elliptical spring, *d*, which bears against the bearing-pin *b* and is adjusted in its tension by means of a screw, *e*, passing through the back of the yoke and setting against the center of the spring. The lever E is connected with the center of the diaphragm by means of a link, *f*, which is pivoted to the lever and is also pivoted to a small metal block which is cemented to the center of the diaphragm.

The tension of the spring *d* produces considerable friction at the bearings of the pin *b*, and hence the movements of the diaphragm, the recording-point, and the carrying-lever are retarded by this friction, and the momentum of these parts is thereby overcome. All lost motion at the bearings is also taken up by means of the tension of this spring. The pivoted link *f* forms a positive connection between the recording-point and the diaphragm, so that the movements of the diaphragm are communicated positively to the recording-point. At the same time this link *f* is yielding in the direction of the length of the carrying-lever, so that the diaphragm will not be strained by the difference in direction of movement of the recording-point and the diaphragm. This positive connection, which is yielding at right angles to the direction of movement of the diaphragm, also prevents the straining of the diaphragm, which would be due to cementing a rigid attachment to it. It will be seen that if the link *f* were rigidly connected with the lever E the effect would be to strain the diaphragm in cementing this rigid connection to it, since the diaphragm would be pressed in by the link in securing the cement, and when it resumed its normal position there would be a strain between the diaphragm and the connection.

In Figs. 3, 4, and 5 is shown the same instrument as that just described in connection with Figs. 1 and 2, with the exception that the link *f* is supplanted by an arch, *g*, of wire, which is cemented at two points to the diaphragm and passes through the end of the lever E. This arch is practically rigid in the direction of the movement of the diaphragm, thus forming a positive connection between the diaphragm and the recording-point, while it is capable of yielding in the direction of the length of the lever E, thus preventing the strain of the diaphragm.

In Figs. 6 and 7 the friction is produced by means of a spring, *h*, which is secured to one side of the bottom of the ring B. It crosses such ring and has a forked end which embraces the long bearing-pin *i*, and bears with considerable pressure against a friction-disk, *k*, upon such bearing-pin. This pressure of the spring *h* on the disk *k* forces the bearing-pin *i* longitudinally against its bearing *l* at one end, which may be provided with a friction washer of leather or other suitable material. In this recorder the recording-point is shown as directly connected with the diaphragm by cement, which construction may be employed, but is not as efficient as the yielding positive connection before described.

In Figs. 8 and 9 is shown a recorder having the recording-point *m* supported directly by the diaphragm, there being no lever or arm to take the lateral thrust. The retardation is produced by means of two friction-springs, *n o*, which are secured to a block, *p*, attached to the ring B of the recorder, and embrace at their inner end the recording-point *m*, upon the opposite sides of which they bear with considerable pressure, so that the recording-point in moving will be retarded by the friction of the springs on its sides. Adjusting-screws *q* may be used to adjust the pressure of these friction-springs. The same way of producing the friction may be employed with recording-points mounted upon levers, as shown in Fig. 10. This form does not take up the lost motion at the pivots of the lever; but the friction being applied directly to the recording-point the retarding action is effectively produced.

In Fig. 11 a small dash-pot, *r*, connected with the outer end of the lever carrying the recording-point, is employed to retard the momentum of the parts.

As before stated, it will be observed that all the retarding devices are non-resilient in their action and afford a constant resistance to the movement of the parts at every point, in this respect differing widely from the dampening devices that have been heretofore employed.

What I claim as my invention is—

1. In phonograph-recorders, the combination, with the diaphragm, of the recording-point connected therewith, and a non-resilient retarding device for overcoming the momentum of the diaphragm and attached parts by constantly retarding the movement in both directions, substantially as set forth.

2. In phonograph-recorders, the combination, with the diaphragm, of the recording-point attached thereto, a lever or arm by which said recording-point is carried, and a non-resilient retarding device for overcoming the momentum of the diaphragm and attached parts by constantly retarding the movement in both directions, substantially as set forth.

3. In phonograph-recorders, the combination, with the diaphragm, of the recording-point connected thereto, and a pivoted lever carrying such recording-point and having one or more friction-bearings, substantially as set forth.

4. In phonograph-recorders, the combination, with the diaphragm, of the recording-point connected thereto, a pivoted lever carrying said recording-point, and a spring producing friction at the bearings of the lever and taking up the lost motion, substantially as set forth.

5. In phonograph-recorders, the combination, with the diaphragm, of the recording-point connected thereto, a pivoted lever carrying the recording-point, and an adjustable spring-friction exerted upon said lever, substantially as set forth.

6. In phonograph-recorders, the combination, with the diaphragm, of the recording-point, a lever or arm carrying such recording-point, and a positive connection between the recording-point and the diaphragm, such connection being constructed to yield in the direction of the length of the carrying-lever, substantially as set forth.

7. In phonograph-recorders, the combination, with the diaphragm, of the pivoted lever carrying the recording-point, and the link connecting such lever with the diaphragm and pivoted at both ends, substantially as set forth.

This specification signed and witnessed this 14th day of July, 1888.

THOS. A. EDISON.

Witnesses:

WILLIAM PELZER,
A. W. KIDDLE.

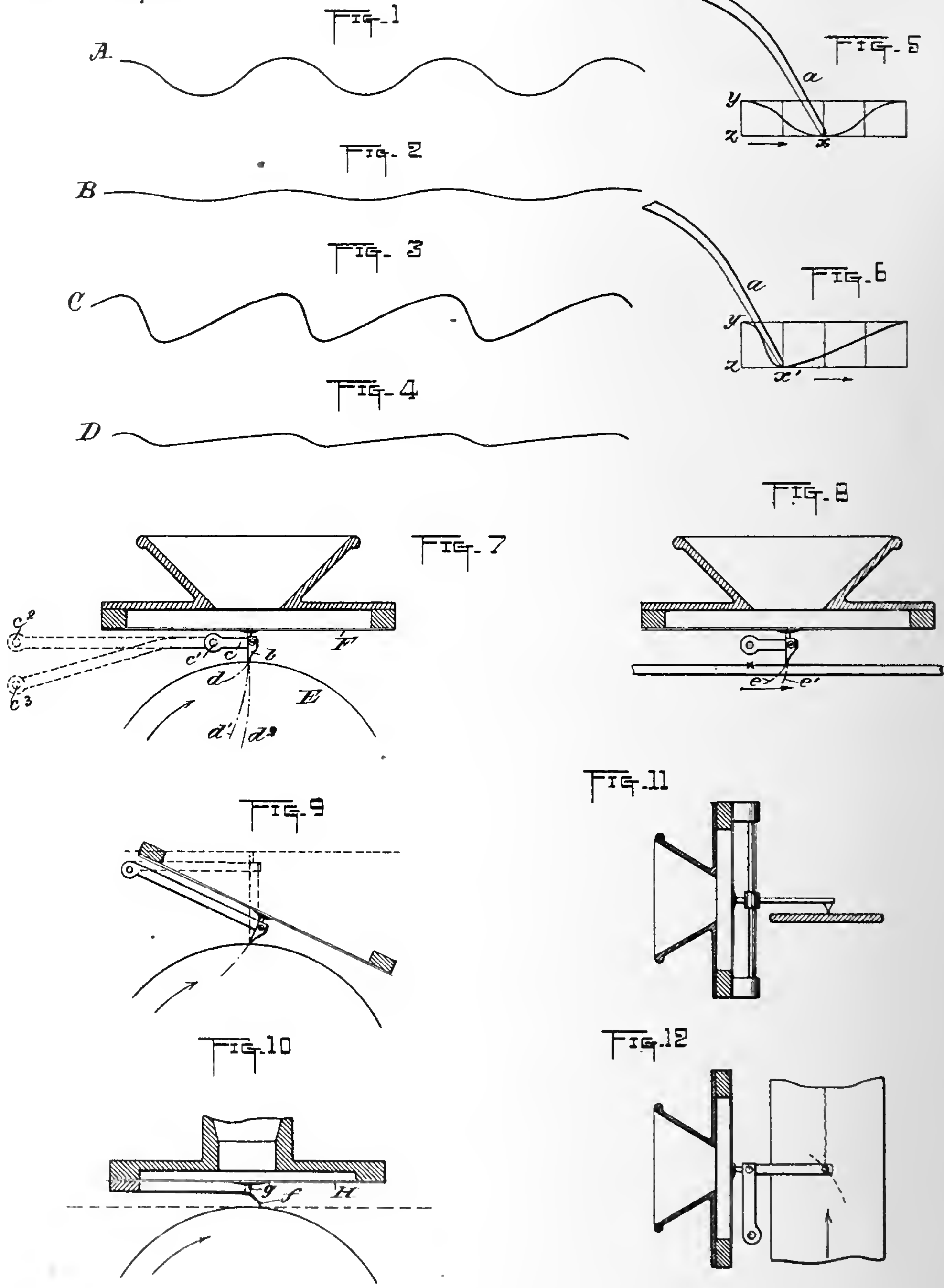
(No Model.)

3 Sheets—Sheet 1.

T. A. EDISON.

METHOD OF RECORDING AND REPRODUCING SOUNDS.

No. 393,966. Patented Dec. 4, 1888.



WITNESSES:
E. C. Rowland
William Pelzer.

INVENTOR.
Thomas A. Edison.
BY
Dyer & Seely
ATTORNEY

(No Model.) 3 Sheets—Sheet 2.

T. A. EDISON.

METHOD OF RECORDING AND REPRODUCING SOUNDS.

No. 393,966. Patented Dec. 4, 1888.

FIG. 13

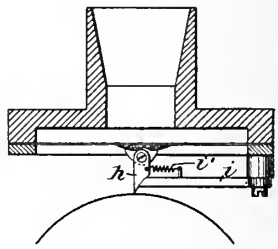


FIG. 14

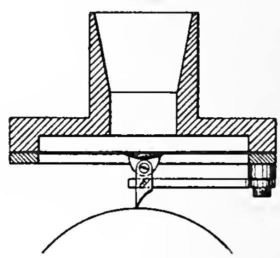
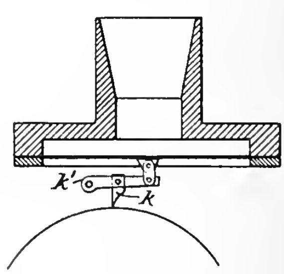


FIG. 15



WITNESSES:

E. C. Rowland.

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INVENTOR

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ATTORNEYS.

(No Model.) 3 Sheets—Sheet 3.

T. A. EDISON.

METHOD OF RECORDING AND REPRODUCING SOUNDS.

No. 393,966. Patented Dec. 4, 1888.

FIG. 16

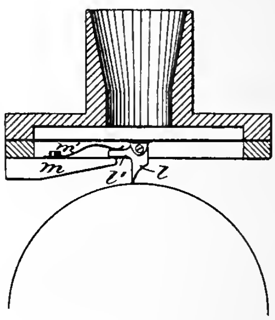
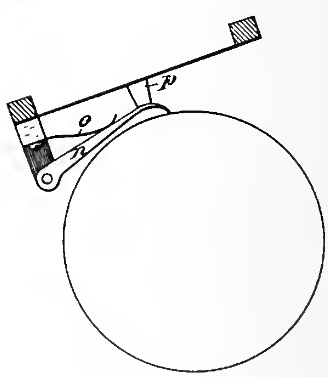


FIG. 17



WITNESSES:

E. C. Rowland

William Pelzer.

INVENTOR.

Thomas A. Edison.

BY

Dyer & Seely.

ATTORNEYS

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY.

METHOD OF RECORDING AND REPRODUCING SOUNDS.

SPECIFICATION forming part of Letters Patent No. 393,966, dated December 4, 1888.

Application filed July 17, 1888. Serial No. 280,204. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, a citizen of the United States, residing at Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in the Art of Recording and Reproducing Sounds, (Case No. 786,) of which the following is a specification.

As is well understood, the phonograph invented by me, and the various modifications of my early instruments that have been made by others as well as by myself, operate to record speech, music, and other sounds by impressing a solid or semi-solid material with wave-lines corresponding with the sound-waves, the sounds being reproduced from these recorded wave-lines by causing them to vibrate an elastic solid, such as a diaphragm.

To illustrate by reference to a usual form of the apparatus, a diaphragm carrying an indenting-point is held so that the point will form a groove in the surface of a moving body of suitable material, such as a cylinder of wax. The vibrations of the diaphragm cause the indenting-point also to vibrate and to correspondingly vary the depth of the groove, thus forming the wave-line, from which the sound is reproduced by drawing the surface again under the same or a different point attached to a diaphragm.

All phonographs heretofore made have been unsatisfactory in the respect that they lacked clearness and loudness of articulation. This I have found is due more particularly to the fact that they failed to bring out clearly the hissing sounds, thus making words which depend upon such sounds for their characteristics generally unintelligible, except by aid of the context. An examination of such phonograph-records microscopically shows that the recorded waves are symmetrical in shape, each wave rising and falling on the same gradual sinuous curve. The waves for the hissing sounds also appear longer and of less depth, and hence more gradual in their rise and fall, than those for vowel sounds.

In my investigations and experiments with telephonic apparatus of various kinds I have observed that the loudness of the sound produced in a telephone-receiver by a current impulse is dependent upon the sharpness of the impulse rather than upon its strength. The circuit from a hundred cells of battery can be closed through a telephone-receiver without producing sound, providing the wave is made one having a gradual and uniform rise by placing a suitable magnet in the circuit to taper the wave by its self-induction, while a sharp impulse from a single cell will produce a noise in the receiver which can be heard for some distance. Hence I have concluded that the imperfection of phonograph-records arises from the symmetrical and gradual rise and fall of the recorded waves, and especially of the recorded waves representing hissing sounds, which do not move the reproducing-diaphragm with sufficient abruptness to reproduce the sound-waves with clearness. To overcome this difficulty I modify the form of the recorded waves, so that instead of being a simple sinusoidal symmetrical curve with the greatest depth at the center of each recorded wave, the recorded waves will be more abrupt at one end than at the other. This I accomplish by controlling the movement of the recording-point with reference to the relative movement of such point and the recording-surface. Instead of acting perpendicular to the line of advancing movement, the recording-point moves oblique to such line, so that in one direction the recording-point moves to some extent with the recording-surface and in the other direction such point moves to some extent against or opposite to the movement of the recording-surface. By regulating these relative movements I have found that the recorded waves can be given the desired abruptness at one end—*i. e.*, the point of greatest depth of the recorded wave can be transferred from the center of the wave to near either end. I have found it preferable to make this abruptness at the end rather than at the beginning of each wave, since in the former case the reproducing-point passes down the gradually-declining side of the wave to its extreme depth, and then rises suddenly at the end of the wave without producing audible disturbances of the recorded sound, while in the former case false sounds are produced, which I attribute to the jumping of the reproducing-point off of the abrupt corner of the recorded wave and its striking the bottom of the wave with sufficient force to rebound, making false vibrations which are audible.

This invention of modifying the form of the recorded waves, so as to give abrupt movements of the reproducing-point, is capable of being carried out in practice in a great variety of ways, a few only of which are shown by the drawings for purposes of illustration, and these, for clearness, are shown principally in diagram, the general features of the apparatus being well understood.

Figures 1 and 2 represent on an exaggerated scale, respectively, the form of the recorded waves for vowels and hissing sounds in phonograph-records heretofore produced. Figs. 3 and 4 represent on an exaggerated scale the form of the recorded waves for vowels and hissing sounds produced by the employment of this invention. Figs. 5 and 6 are views illustrating the dynamic effects of the pure and modified waves. Fig. 7 is a view, principally in diagram, illustrating a suitable arrangement for the recorder indenting-point, with dotted lines to show the effect of changing the location of the pivot of the lever which carries such indenting-point. Fig. 8 is a view similar to Fig. 7, but showing a flat instead of a cylindrical recording-surface. Fig. 9 is a view illustrating the accomplishment of the same end by arranging the recorder oblique to the recording-surface. Fig. 10 is a view illustrating the use of a reproducer with records such as would be produced by the arrangements of Figs. 7, 8, and 9. Figs. 11 and 12 are a vertical section and top view, respectively, of a recorder acting parallel with the recording-surface and employing this invention. Figs. 13 to 16, inclusive, are views in vertical section of other forms of the recorder adapted to carry out the invention, and Fig. 17 is a vertical section of a slightly-different reproducer from that shown in Fig. 10.

The sinuous line A, Fig. 1, represents the recorded wave-line heretofore produced in phonographs for vowel sounds. It will be observed that the waves have the greatest depth at the center of their length, and that they rise symmetrically in each direction from the central point. The sinuous line B, Fig. 2, is a similar representation of the wave-line for hissing sounds and on the same scale. It will be seen that these waves also have their greatest depth at their centers, but that they are longer and have less depth than the waves for vowel sounds, and hence are much more gradual. Since the loudness of the sounds produced by the phonograph-reproducer depends upon the sharpness of the impulses, it is evident that these hissing sounds will be very feeble. In fact, in many cases they are not audible at all, and words depending on them for their characteristics are not reproduced with clearness of articulation.

Now it will be seen that if the form of the waves in recording is changed, so as to transfer the point of greatest depth from the center to near the end of each wave, the impulse produced by the recorded waves in the passing of the reproducing-point over them will be greatly sharpened. The lines C and D, Figs. 3 and 4, represent recorded waves of this modified character and such as are produced by the employment of this invention.

The difference in the action of the gradual and abrupt waves I suppose to be explained by the application of the simple laws of dynamics. In Fig. 5, which shows a pure wave-record, the reproducing-point a is lifted the distance $y\ z$ while the recording-surface is traveling the distance $x\ z$. In Fig. 6, which shows a modified or sharpened wave-record, the reproducing-point is lifted the same distance, $y\ z$, while the recording-surface is traveling the shorter distance, $x'\ z$. Assuming the same rate of travel for the recording-surfaces, the distance $x'\ z$ being one-half of $x\ z$, it will be seen that in the second case double the energy will be exerted in lifting the recording-point the same distance, and hence, without increasing the depth of the waves, the sound effects are increased.

To modify the recorded waves and make them different in form from the sound-waves producing the record by making them abrupt at one end, I control the relations between the recording-point and the recording-surface. I find that by giving the parts such a relation that the reciprocating movements of the indenting-point are oblique to the line of movement of the recording-surface, rather than substantially perpendicular to it, the proper effect is produced, the greater the degree of obliquity the more abrupt being the recorded waves, the greatest depth of each wave being moved nearer to the end of the wave. This may be done in a variety of ways by fixing the location of the pivot of the lever carrying the indenting-point and by changing the angular position of the recorder.

In Fig. 7 the recording-surface E is represented as a revolving cylinder. The recorder-diaphragm is shown at F. The recording-point b is connected with the center of the diaphragm, and is mounted on a lever, c, pivoted at the point c'. This lever is short and its pivot is located above the indenting-point, considering the recording-point as acting on the top of the recording-surface. The direction of movement of the indenting-point is represented by the line d. It will be seen that as the point moves forward into the recording-surface it will advance against the movement of the surface and the effect will be a prolongation of the first part of the recorded wave, while when the point retracts it will move with the surface and the effect will be to shorten and make abrupt the second part of the recorded wave. If the lever c were pivoted at c^2, the movement of the indenting-point would be as represented by line d'. If the pivot were at c^3, the movement of the point would be represented by line d^2. Either of these two latter movements of the indenting-point would be substantially perpendicular to the recording-surface and the desired modification of the wave-record would not be produced. The point-carrying lever should be short and have its pivot within the edge of the diaphragm, and the pivots should also be above the point to secure the proper results, or the equivalent of these conditions should be secured. The shorter the lever and the farther the distance of the pivot above the point the more oblique will be the movement of the point. The proper conditions can be obtained by advancing in either of these directions—*i. e.*, if the pivot is put a sufficient distance above the point, the lever may be longer and may extend beyond the diaphragm, while if the lever is made exceedingly short the distance of the pivot above the point may be greatly lessened. The effect of bringing the pivot into the same plane as the point is shown in Fig. 7 by the line d^2 and in Fig. 8 by the line e'. In Fig. 8 the same arrangement is illustrated as in Fig. 7, with the exception that a flat recording-surface, G, is shown instead of the cylinder. The line of movement of the recording-point is shown at e, while if the pivot of the lever should be located at the recording-surface at the point marked by a cross the line of movement of the recording-point would be, as at e', substantially perpendicular to the recording-surface, and hence not effective for the purposes of my invention. By changing the angular position of the diaphragm with relation to the recording-surface a long lever carrying the indenting-point can be employed, as shown in Fig. 9; but this is obviously equivalent to placing the pivot farther above the point, as shown by the dotted lines in this figure.

The reproducer, Fig. 10, may be a fine wire point, f, connected with the diaphragm H by a solid block of india-rubber, g. The reproducing-point is bent downwardly into an inclined position, and is adapted to follow the records produced by the recorders of Figs. 7, 8, and 9.

In Figs. 11 and 12 is illustrated the use of the invention with recorders having points reciprocating in the plane of the recording-surface, instead of in a plane perpendicular to such surface.

In Fig. 13 the recording-point h is pivoted to the center of the diaphragm. A rigid arm, i, projecting from the ring or frame of the recorder, rests at its end against the beveled side of the recording-point, which is held against the arm by a spring, i'. This arrangement, it will be seen, will give the recording-point a movement oblique to the recording-surface. In Fig. 14 the same object is accomplished by connecting the rigid arm with the indenting-point by a pin and oblique slot.

In Fig. 15 the recording-point k is mounted upon the carrying-lever k', between the pivot of the lever and its connection with the diaphragm.

In Fig. 16 the recording-point l is pivoted on the diaphragm and has a tail-piece, l', which rests on a rigid arm, m, against which it is held by a spring, m'.

In Fig. 17 the reproducer, instead of having for its point a spring-wire, as in Fig. 10, has such point formed on the end of a pivoted lever, n, thrown forward by a spring, o, which keeps the diaphragm under tension. The lever n is connected with the center of the diaphragm by a solid block, p, of india-rubber, cork, or other suitable material.

The improvement in the art hereinbefore explained removes the element of uncertainty which has heretofore existed in the construction of phonographs, and enables successful phonographs to be made of an endless variety in design and differing widely in detail, which has not heretofore been possible, since the correct principle of construction has not before been known.

What I claim is—

1. The improvement in the art of recording sounds for reproduction, consisting in impressing a suitable recording-surface with waves corresponding with the sound-waves, but made abrupt at one end, substantially as set forth.

2. The improvement in the art of recording sounds for reproduction, consisting in impressing a suitable recording-surface with waves corresponding with the sound-waves, but made abrupt at the last end of the waves, substantially as set forth.

3. The improvement in the art of recording sounds for reproduction, consisting in vibrating an indenting-point correspondingly with the sound-waves, but oblique to the relative line of movement of the recording-surface, whereby the recorded waves will be more abrupt at one end than at the other, substantially as set forth.

4. The improvement in the art of recording sounds for reproduction, consisting in vibrating an indenting-point correspondingly with the sound-waves, but oblique to the relative line of movement of the recording-surface, the oblique movement being such that the indenting-point moves forward against the movement of the recording-surface and backward with such movement, whereby the recorded waves will be more abrupt at their end than at their beginning, substantially as set forth.

5. The improvement in the art of reproducing sounds, which consists in the employment of actuating-waves that are more abrupt at one end than at the other, substantially as set forth.

This specification signed and witnessed this 14th day of July, 1888.

THOS. A. EDISON.

Witnesses:

WILLIAM PELZER,

A. W. KIDDLE.

(No Model.)

T. A. EDISON.

METHOD OF RECORDING AND REPRODUCING SOUNDS.

No. 393,967. Patented Dec. 4, 1888.

Fig. 2.

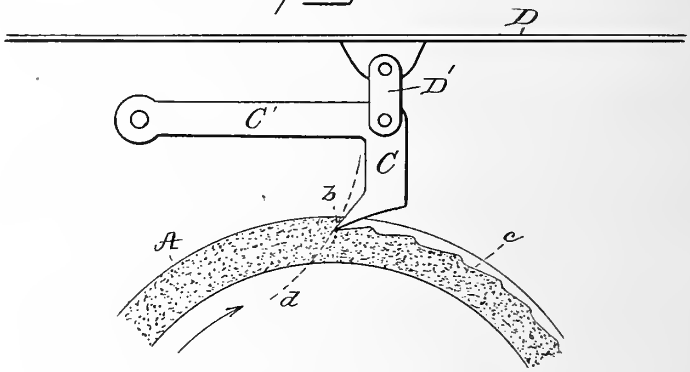


Fig. 1.

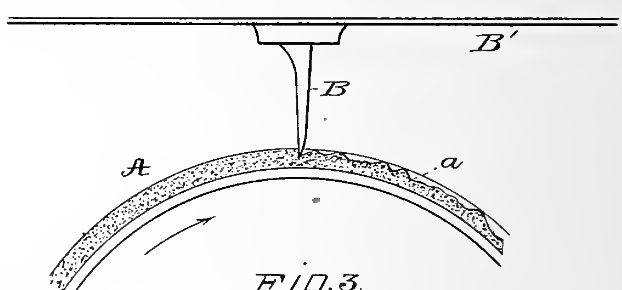


Fig. 3.

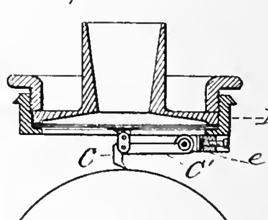
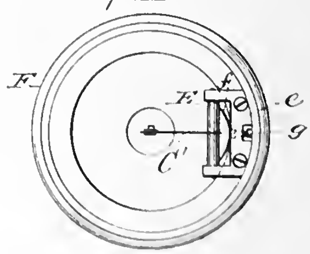


Fig. 4.



WITNESSES:

E. C. Rowland.

William Pelzer.

INVENTOR,

Thomas A. Edison,

BY

Dyer & Seely,

ATTORNEYS.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY.

METHOD OF RECORDING AND REPRODUCING SOUNDS.

SPECIFICATION forming part of Letters Patent No. 393,967, dated December 4, 1888.

Application filed July 17, 1888. Serial No. 280,209. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, a citizen of the United States, residing at Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Phonographs, (Case No. 791,) of which the following is a specification.

For the recording-surface of my phonograph (*i. e.*, the phonogram-blank) I employ a solid material, such as a wax composition or a mixture of metallic soaps capable of being indented by the recording-point. In recording sounds a groove is formed in the material by means of an indenting-point connected with the diaphragm of the recorder, and this groove varies in depth accordingly as the indenting-point is advanced or withdrawn by the vibrations of the diaphragm, thus forming the wave-record from which the sounds are reproduced, as is well understood.

Heretofore the recording-point used has been constructed so that in forming the groove it removed the material by a scraping action. This was due to the fact that the advancing edge of the recording-style used was perpendicular to the recording-surface or receded from the perpendicular, the result being a scraping rather than a true cutting of the material. The scraping action I have found to be productive of false vibrations, which become a part of the record, and which are audible as scratching and other foreign noises when the sounds are reproduced. I have found that this difficulty is overcome by employing a recording-point made as a true cutting-tool with a cutting-edge in advance of the stock of the tool. It might be supposed that a cutting-tool would be unsuitable for the recording-point, and that the heel of the tool would strike the bottom of the groove and prevent the formation of a perfect record, or obliterate the record as made by smoothing or pressing out the indentations more or less; but I have found that the movement of the recording-surface is sufficient to keep the heel of the tool clear of the indentations. This adaptability of the cutting-tool form for the recording-point I consider is also due in a measure to the fact that the recording-point in my phonograph is arranged to act more or less obliquely to the recording-surface, so that the recorded waves will begin gradually and end abruptly. This oblique movement may be accomplished in any of the ways described in my application No. 786, (Serial No. 280,204, filed July 17, 1888,) in which this particular matter is more fully explained. The recording-point in its forward movement advancing against the movement of the recording-surface, the cutting-tool will clear itself just to the extent that its movement advances from the perpendicular, and thus the speed of the recording-surface will be supplemented in the respect of serving to keep the heel of the tool clear by the oblique movement of the cutting-tool. The waves, being abrupt, need not be as deep, and hence there is less difficulty in clearing the tool.

In my phonograph the cutting-tool recording-point is carried by a lever which takes the lateral thrust of the tool and relieves the diaphragm of the strain due to that thrust. This carrying-lever is also pivoted so as to produce the oblique movement of the recording-point before referred to. It also is made light, is provided with friction-bearings to overcome the momentum of the diaphragm and attached parts and to take up lost motion, and it is also positively connected with the diaphragm by a pivoted link or other form of connection which will yield in the direction of the length of the lever, so as to prevent the straining of the diaphragm. While I prefer to employ these several details, yet it is evident that the cutting-tool can be used with phonograph-recorders of various constructions, and hence I do not wish that feature of my invention, except when specially indicated by the claims, to be limited to the details stated. The cutting of the record in the material of the recording-surface, instead of scraping it, makes a clean smooth record, free from imperfections, producing scratching or other foreign noises in the reproducer.

In the accompanying drawings, forming a part hereof, Figure 1 is a view, on an exaggerated scale, illustrating the formation of a record by a scraping-style, as heretofore. Fig. 2 is a similar view illustrating the use of this invention. Fig. 3 is a vertical section of my phonograph-recorder complete, and Fig. 4 is a bottom view of the recorder.

A is the recording-surface, which may be considered as a wax composition capable of being indented by the recording point or style. It is given a movement in the direction of the arrows, Figs. 1 and 2.

Heretofore the recording-style B has had its advancing edge perpendicular to the recording-surface or receding from it, as shown in Fig. 1. This produced the record *a* by a scraping action. By my invention the recording-point C, Fig. 2, is a cutting-tool having a cutting-edge, *b*, in advance of the stock of the tool. This produces the record *c* by a true cutting action. The style B is attached directly and only to the diaphragm B′, and hence the wave-record *a* is composed of waves having a symmetrical rise and fall with the deepest part of each wave at its center. The point C is mounted on a pivoted lever, C′, connected with the diaphragm D by a pivoted link, D′. The direction of movement of the cutting-edge of the recording-point C is described by the dotted circle *d;* hence it will be seen that the recording-point C acts obliquely to the recording-surface and produces recorded waves, which begin gradually and end abruptly. It will be seen that such is the character of the wave-record *c*. By the movement of the recording-surface and the oblique action of the recording-point the heel of the cutting-tool, forming the recording-point, is kept clear in operation.

From the description that has already been given and an inspection of Figs. 3 and 4 it will be readily understood how my phonograph-recorder is constructed. The lever C′ is carried by a bearing-pin, E, which is pivoted in a yoke, *e*, secured to the annular frame F of the recorder. A spring, *f*, bears against the pin E, and is adjusted in its tension by a screw, *g*. This produces a friction at the bearings of the pin E, which overcomes the momentum of the diaphragm and attached parts by retarding their movement, and also takes up all lost motion at the bearings. The spring-friction produces a non-resilient and constantly-acting retarding device. The pivoted link D′ prevents the diaphragm from being strained by the differences in movement of the diaphragm and the recording-point by reason of the fact that the link, due to its pivots, yields in the direction of the length of the carrier-lever, while it forms a positive connection between the recording-point and the diaphragm.

I do not claim in this application the machine or apparatus herein described, but only the method of operation, I having been required by the Commissioner of Patents to embody the apparatus in a separate application for Letters Patent.

What I claim is—

1. The method of recording sounds for reproduction, consisting in impressing sound-vibrations upon a cutting recording-point and thereby cutting in the recording-surface the record corresponding to the sound-waves in contradistinction to the formation of such sound-records by a scraping action.

2. The method of recording sounds for reproduction, consisting in impressing sound-vibrations upon a cutting recording-point, and directing the vibrations of such recording-point obliquely to the recording-surface and thereby cutting in the recording-surface a sound-wave record having waves more abrupt at one end than at the other in contradistinction to the formation of such sound-records by a scraping action.

This specification signed and witnessed this 14th day of July, 1888.

THOS. A. EDISON.

Witnesses:

WILLIAM PELZER,

A. W. KIDDLE.

(No Model.)

T. A. EDISON.

PHONOGRAPH RECORDER.

No. 393,968. Patented Dec. 4, 1888.

Fig. 2.

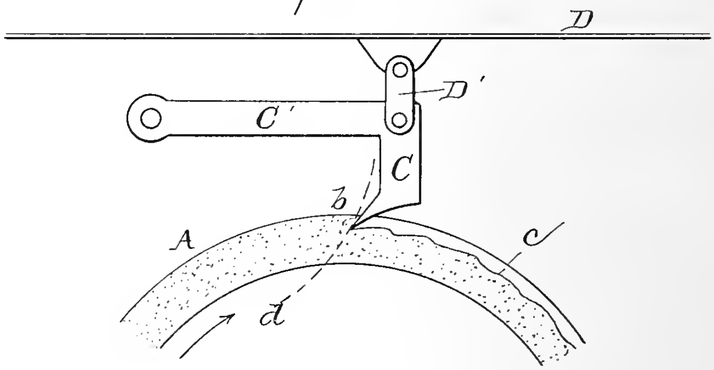


Fig. 1.

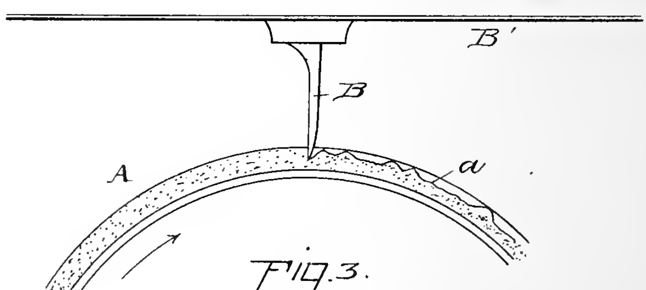


Fig. 3.

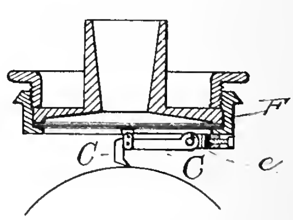
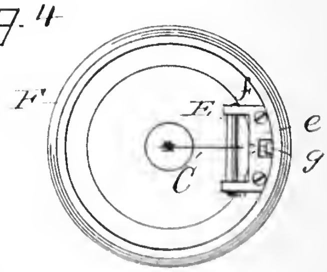


Fig. 4.



WITNESSES:

E. C. Rowland.

William Pelzer.

INVENTOR.

Thomas A. Edison.

BY

ATTORNEYS.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY.

PHONOGRAPH-RECORDER.

SPECIFICATION forming part of Letters Patent No. 393,968, dated December 4, 1888.

Original application filed July 17, 1888, Serial No. 280,209. Divided and this application filed November 5, 1888. Serial No. 290,023. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, a citizen of the United States, residing at Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Phonographs, (Case No. 813,) of which the following is a specification.

In my application filed July 17, 1888, Serial No. 280,209, of which this application is a division, is set forth a method of recording sound-vibrations by cutting the record in the recording-surface as distinguished from impressing such record by a scraping action, and also an apparatus for carrying such invention into effect. In that application the method only is claimed, the Commissioner of Patents having required me to embody the apparatus in a separate application.

For the recording-surface of my phonograph (*i. e.*, the phonogram-blank) I employ a solid material—such as a wax composition or a mixture of metallic soaps capable of being indented by the recording-point. In recording sounds a groove is formed in the material by means of an indenting-point connected with the diaphragm of the recorder, and this groove varies in depth accordingly as the indenting-point is advanced or withdrawn by the vibrations of the diaphragm, thus forming the wave-record from which the sounds are reproduced, as is well understood.

Heretofore the recording-point used has been constructed so that in forming the groove it removed the material by a scraping action. This was due to the fact that the advancing edge of the recording-style used was perpendicular to the recording-surface or receded from the perpendicular, the result being a scraping rather than a true cutting of the material. The scraping action I have found to be productive of false vibrations, which become a part of the record, and which are audible as scratching and other foreign noises when the sounds are reproduced. I have found that this difficulty is overcome by employing a recording-point made as a true cutting-tool with a cutting-edge in advance of the stock of the tool. It might be supposed that a cutting-tool would be unsuitable for the recording-point and that the heel of the tool would strike the bottom of the groove and prevent the formation of a perfect record, or obliterate the record as made by smoothing or pressing out the indentations more or less; but I have found that the movement of the recording-surface is sufficient to keep the heel of the tool clear of the indentations. This adaptability of the cutting-tool form for the recording-point I consider is also due in a measure to the fact that the recording-point in my phonograph is arranged to act more or less obliquely to the recording-surface, so that the recorded waves will begin gradually and end abruptly. This oblique movement may be accomplished in any of the ways described in my application No. 786, (Serial No. 280,204,) in which this particular matter is more fully explained. The recording-point in its forward movement advancing against the movement of the recording-surface, the cutting-tool will clear itself just to the extent that its movement advances from the perpendicular, and thus the speed of the recording-surface will be supplemented in the respect of serving to keep the heel of the tool clear by the oblique movement of the cutting-tool. The waves, being abrupt, need not be as deep, and hence there is less difficulty in clearing the tool.

In my phonograph the cutting-tool recording-point is carried by a lever, which takes the lateral thrust of the tool and relieves the diaphragm of the strain due to that thrust. This carrying-lever is also pivoted so as to produce the oblique movement of the recording-point, before referred to. It also is made light, is provided with friction-bearings to overcome the momentum of the diaphragm and attached parts and to take up lost motion, and it is also positively connected with the diaphragm by a pivoted link or other form of connection which will yield in the direction of the length of the lever, so as to prevent the straining of the diaphragm.

While I prefer to employ these several details, yet it is evident that the cutting-tool can be used with phonograph-recorders of various constructions, and hence I do not wish that feature of my invention, except when specially indicated by the claims, to be limited to the details stated. The cutting of the record in the material of the recording-surface instead of scraping it makes a clean smooth record free from imperfections producing scratching or other foreign noises in the reproducer.

In the accompanying drawings, forming a part hereof, Figure 1 is a view, on an exaggerated scale, illustrating the formation of a record by a scraping-style as heretofore. Fig. 2 is a similar view illustrating the use of this invention. Fig. 3 is a vertical section of my phonograph-recorder complete, and Fig. 4 is a bottom view of the recorder.

A is the recording-surface, which may be considered as a wax composition capable of being indented by the recording point or style. It is a given a movement in the direction of the arrows, Figs. 1 and 2.

Heretofore the recording-style B has had its advancing edge perpendicular to the recording-surface or receding from it, as shown in Fig. 1. This produced the record *a* by a scraping action. By my invention the recording-point C, Fig. 2, is a cutting-tool having a cutting-edge, *b*, in advance of the stock of the tool. This produces the record *c* by a true cutting action. The style B is attached directly and only to the diaphragm B′, and hence the wave-record *a* is composed of waves having a symmetrical rise and fall with the deepest part of each wave at its center. The point C is mounted on a pivoted lever, C′, connected with the diaphragm D by a pivoted link, D′. The direction of movement of the cutting-edge of the recording-point C is described by the dotted circle *d*; hence it will be seen that the recording-point C acts obliquely to the recording-surface and produces recorded waves which begin gradually and end abruptly. It will be seen that such is the character of the wave-record *c*. By the movement of the recording-surface and the oblique action of the recording-point the heel of the cutting-tool, forming the recording-point, is kept clear in operation.

From the description that has already been given and an inspection of Figs. 3 and 4 it will be readily understood how my phonograph-recorder is constructed. The lever C′ is carried by a bearing-pin, E, which is pivoted in a yoke, *e*, secured to the annular frame F of the recorder. A spring, *f*, bears against the pin E, and is adjusted in its tension by a screw, *g*. This produces a friction at the bearings of the pin E, which overcomes the momentum of the diaphragm and attached parts by retarding their movement, and also takes up all lost motion at the bearings. The spring-friction produces a non-resilient and constantly-acting retarding device. The pivoted link D′ prevents the diaphragm from being strained by the differences in movement of the diaphragm and the recording-point by reason of the fact that the link, due to its pivots, yields in the direction of the length of the carrier-lever, while it forms a positive connection between the recording-point and the diaphragm.

What I claim is—

1. A phonograph-recorder having for its recording-point a cutting-tool with a cutting-edge in advance of the stock of the tool, substantially as set forth.

2. In a phonograph-recorder, the combination, with the diaphragm, of a cutting-tool recording-point connected with the diaphragm and mounted to move obliquely to the recording-surface, substantially as set forth.

3. In a phonograph-recorder, the combination, with the diaphragm, of a cutting-tool recording-point connected with the diaphragm, and a non-resilient constantly-acting retarding device for retarding the movement of such point in both directions, substantially as set forth.

4. In a phonograph-recorder, the combination, with the diaphragm, of a cutting-tool recording-point connected with the diaphragm, a lever carrying such point, and a positive connection between the point and the diaphragm, which connection is constructed to yield in the direction of the length of the lever, substantially as set forth.

This specification signed and witnessed this 31st day of October, 1888.

THOMAS A. EDISON.

Witnesses:

WILLIAM PELZER,
E. C. ROWLAND.

(Model.)

T. A. EDISON.

PHONOGRAPH RECORDER.

No. 394,105. Patented Dec. 4, 1888.

Fig. 1.

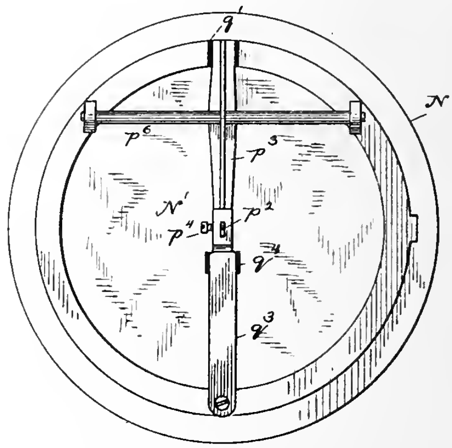
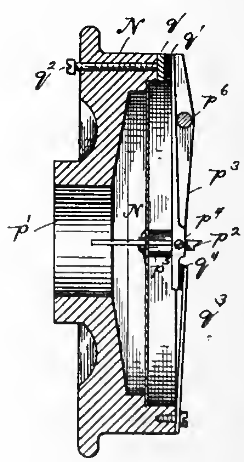


Fig. 2.



Witnesses.
E. C. Rowland.
William Pelzer.

Inventor.
Thomas A. Edison

By his Attorneys
Dyer & Seely.

United States Patent Office.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY, ASSIGNOR TO THE EDISON PHONOGRAPH COMPANY, OF NEW JERSEY.

PHONOGRAPH-RECORDER.

SPECIFICATION forming part of Letters Patent No. 394,105, dated December 4, 1888.

Original application filed November 26, 1887, Serial No. 256,189. Divided and this application filed March 2, 1888. Serial No. 265,887. (Model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, a citizen of the United States, residing at Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Phonograph-Recorders, (Case No. 760, division of Case No. 741,) of which the following is a specification.

The object I have in view is to produce an efficient recording instrument for phonographs; and my invention consists in the several novel features and combinations, as fully hereinafter explained, and pointed out by the claims.

In the accompanying drawings, forming a part hereof, Figure 1 is a bottom or rear view of the recorder on an enlarged scale, and Fig. 2 a sectional view of the same.

N is a metal plate forming the body of the recorder. It has an opening, p', passing centrally through it, to which the speaking-tube of the phonograph is applied. The back of the plate N is recessed to form a circular chamber, on a shoulder in which is placed the diaphragm N′, which is preferably made of celluloid or some other light material, and is placed in the recess at the back of the plate N, but is left free at its edges. The recording-point p^2 is secured to the center of the diaphragm by wax or in any other suitable way. This point is constructed of a thin plate of steel, which is cut or ground to a point on one edge, and is beveled backwardly away from that edge, so as to give a support for the indenting-point and prevent vibration of that point in operation. This point passes through the end of the lever p^3, and is secured therein by a set-screw, p^4, the point being surrounded between the lever and the diaphragm by a small tube, p^5, of rubber or other suitable material. The lever p^3 is rigid in its construction, and is mounted upon a cross-pin, p^6, of considerable length, which is journaled at its ends at the sides of the plate N. The lever p^3 extends beyond the pivoting-pin p^6, and rests at its outer end against a block, q, which is faced with a piece of pure india-rubber, q'. This block is set in a recess in the edge of the plate N, and is adjusted forward by a screw, q^2. The adjustable block q and its elastic face q' form a yielding limiting-stop for the movement of the indenting-point. The other end of the lever p^3 extends beyond the indenting-point p^2, and receives inward pressure from a spring, q^3, which is secured to the rim of the plate N, opposite to the block q, and presses the lever p^3 and the indenting-point inwardly, so as to give the center of the diaphragm a slight inward bend, producing an initial strain upon the diaphragm. Between the end of the spring q^3 and the lever p^3 a piece of india-rubber, q^4, is placed. The lever p^3, being rigid in its construction and in its support by the long bearing, prevents any vibration of the indenting-point, while the adjustable limit-stop formed by the block q and rubber q' limits the movement of the diaphragm to a small compass.

This construction of recorder I have found exceedingly effective in use. The diaphragm is highly sensitive and responds accurately to speech-vibrations. The movement of the indenting-point is quite free within exceedingly small limits, but the resistance to its movement increases enormously as the extent of the movement is increased; hence the importance of the fundamental tones in the operation of the instrument is reduced, while the hissing tones, which produce movements of a small extent, are given an undue importance in the record. This makes the reproduced sound clear and intelligible, since the hissing sounds are brought out clearly and can be distinguished from the scraping noises of the instrument.

It will be observed that the diaphragm is under constant tension, and can have no movement at all except that which is permitted by the elasticity of the yielding limit-stop q'. Heretofore the diaphragm of the phonograph-recorder and the indenting-point have not been limited in their forward movement except by the capacity of the diaphragm for vibration. This has permitted strong waves, owing to great momentum and the small amount of energy stored up as a retracting force, to give abnormal and untruthful vibrations to the diaphragm. With my present recorder the diaphragm does not force the lever forward into space, but compresses matter always in contact—viz., the rubber q'; hence nearly all the work is stored up in the compression of q' to effect the return movement, and the momentum becoming a small factor compared to the power stored up, the diaphragm is not given untruthful vibrations. This principle of construction of the recorder I have termed a "closed" or "constrained" system of movement as distinguished from the open or free system of movement heretofore employed.

What I claim is—

1. A phonograph-recorder having, in combination, a diaphragm, an indenting-point secured to the center of said diaphragm, a rigid lever and spring acting to force the point back against the diaphragm, and a yielding limit-stop limiting the outward movement of the diaphragm, substantially as set forth.

2. A phonograph-recorder having, in combination, a diaphragm, an indenting-point moved by such diaphragm, and a limiting-stop limiting the outward movement of the diaphragm and indenting-point, substantially as set forth.

3. A phonograph-recorder having, in combination, a diaphragm, an indenting-point moved by such diaphragm, and a yielding limiting-stop limiting the outward movement of the diaphragm and indenting-point, substantially as set forth.

4. A phonograph-recorder having, in combination, a diaphragm, an indenting-point moved by such diaphragm, and an adjustable limiting-stop limiting the outward movement of the diaphragm and indenting-point, substantially as set forth.

5. A phonograph-recorder having, in combination, a diaphragm with free edges, an indenting-point secured to the center of the diaphragm, a rigidly-constructed pivoted lever connected with said indenting-point at one end and resting against an adjustable yielding limit-stop at the other end, and a spring pressing the lever inwardly, so as to put the diaphragm under an initial strain, substantially as set forth.

6. A phonograph-recorder having, in combination, a diaphragm, an indenting-point moved by the diaphragm, a rigidly-constructed lever carrying such indenting-point, and a long pivotal bearing for such lever, substantially as set forth.

This specification signed and witnessed this 20th day of February, 1888.

THOS. A. EDISON.

Witnesses:
WILLIAM PELZER,
E. C. ROWLAND.

(Model.)

T. A. EDISON.

PHONOGRAPH REPRODUCER.

No. 394,106. Patented Dec. 4, 1888.

Fig. 1.

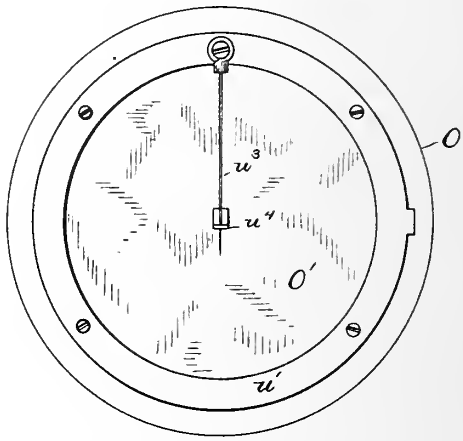
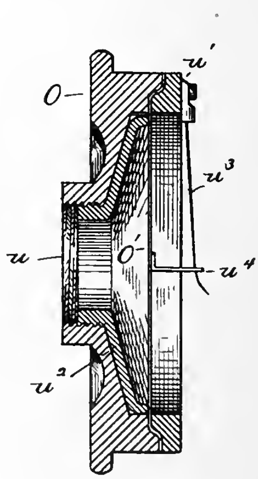


Fig. 2.



Witnesses.
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Inventor.
Thomas A. Edison.

By his Attorneys
Dyer & Seely.

United States Patent Office.

THOMAS A. EDISON, OF LLEWELLYN PARK, NEW JERSEY, ASSIGNOR TO THE EDISON PHONOGRAPH COMPANY, OF NEW JERSEY.

PHONOGRAPH-REPRODUCER.

SPECIFICATION forming part of Letters Patent No. 394,106, dated December 4, 1888.

Original application filed November 26, 1887, Serial No. 256,189. Divided and this application filed March 2, 1888. Serial No. 265,888. (Model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, a citizen of the United States, and a resident of Llewellyn Park, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Phonograph-Reproducers, (Case No. 761, division of Case No. 741,) of which the following is a specification.

The object I have in view is to produce an efficient reproducing-instrument for phonographs; and my invention consists in the several novel features and combinations, as fully hereinafter explained, and pointed out by the claims.

In the accompanying drawings, forming a part hereof, Figure 1 is a bottom or rear view of the reproducer on an enlarged scale, and Fig. 2 a sectional view of the same.

O is a metal plate forming the body of the reproducer. It has an opening, u, passing centrally through it, to which the listening-tube of the phonograph is applied. The plate O is recessed at its back, and has stretched across it a diaphragm, O′, which is preferably a thin animal membrane. This diaphragm is secured in place by a ring, u', which is secured to the back of the plate O, while the diaphragm is stretched by another ring, u^2, which has a neck screwing into the opening u of the plate, and is capable of being turned by a tool, so as to stretch the diaphragm O′ more or less. To one edge of the ring u' is secured a fine spring-wire, u^3, which is long enough to reach from the point where it is secured to the center of the diaphragm, and has its inner end turned downwardly, as shown, to follow the spiral line of indentations upon the phonogram. The inner end of this spring-wire u^3 is attached to the center of the diaphragm by a strip, u^4, of rubber. The tendency of the spring-wire is to bend away from the diaphragm, so that it strains the small rubber strip u^4 and places the diaphragm under an initial tension. The movement of the point of the wire u^3 in reproducing is so slight that the strain is never wholly removed from the rubber strip u^4, and hence the diaphragm is always under tension, which tends to draw it outwardly at the center. This makes the instrument exceedingly sensitive and capable of reproducing sounds accurately. The end of the wire u^3 being rounded and burnished, it will not obliterate the phonogram-record, even though that record is made in quite soft material.

I have found that by connecting the reproducing-point with the diaphragm by a strip of elastic material—such as rubber held under tension—the proper wave motion is transmitted to the diaphragm, but the scratching noises which seem to require molecular transmission are largely obliterated.

What I claim is—

1. A phonograph-reproducer having, in combination, a diaphragm and a reproducing-point connected with the diaphragm by a strained elastic strip, substantially as set forth.

2. A phonograph-reproducer having, in combination, a diaphragm and reproducing-point, a spring tending to throw the reproducing-point away from the diaphragm, and an elastic strip connecting the point with the diaphragm, whereby a spring-tension will always exist between the point and the diaphragm, substantially as set forth.

3. A phonograph-reproducer having, in combination, a diaphragm and a spring-wire secured at its outer end and projecting toward the center of the diaphragm and turned to form a reproducing-point, said spring-wire tending to spring away from the diaphragm, and a strip of india-rubber connecting the end of the spring-wire to the center of the diaphragm, substantially as set forth.

4. A phonograph-reproducer having, in combination, a diaphragm of animal membrane, a reproducing-point, a spring tending to throw the reproducing-point away from the diaphragm, and an elastic strip connecting said point with the center of the diaphragm, substantially as set forth.

5. A phonograph - reproducer having, in combination, a diaphragm of animal membrane, a ring for stretching such diaphragm, a reproducing - point, a spring tending to throw the reproducing-point away from the diaphragm, and an elastic strip connecting said reproducing-point with the diaphragm, substantially as set forth.

This specification signed and witnessed this 20th day of February, 1888.

THOS. A. EDISON.

Witnesses:
WILLIAM PELZER,
E. C. ROWLAND.

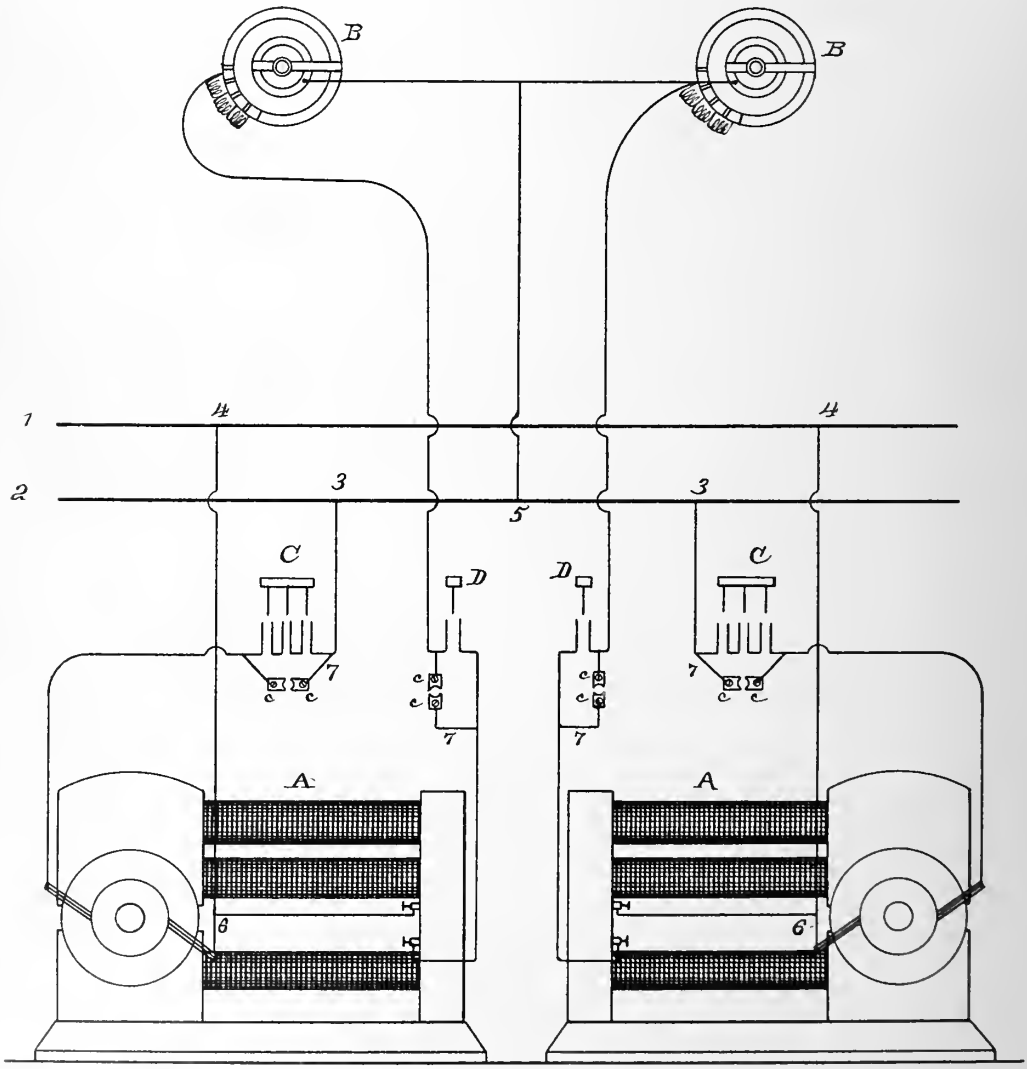
(No Model.) 2 Sheets—Sheet 1.

T. A. EDISON.

CIRCUIT CONTROLLER FOR DYNAMO ELECTRIC MACHINES.

No. 395,123. Patented Dec. 25, 1888.

Fig. 1.



ATTEST:

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H. W. Seely

INVENTOR:

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By Richd. N. Dyer

Atty.

N. PETERS, Photo-Lithographer, Washington, D. C.

(No Model.) 2 Sheets—Sheet 2.

T. A. EDISON.

CIRCUIT CONTROLLER FOR DYNAMO ELECTRIC MACHINES.

No. 395,123. Patented Dec. 25, 1888.

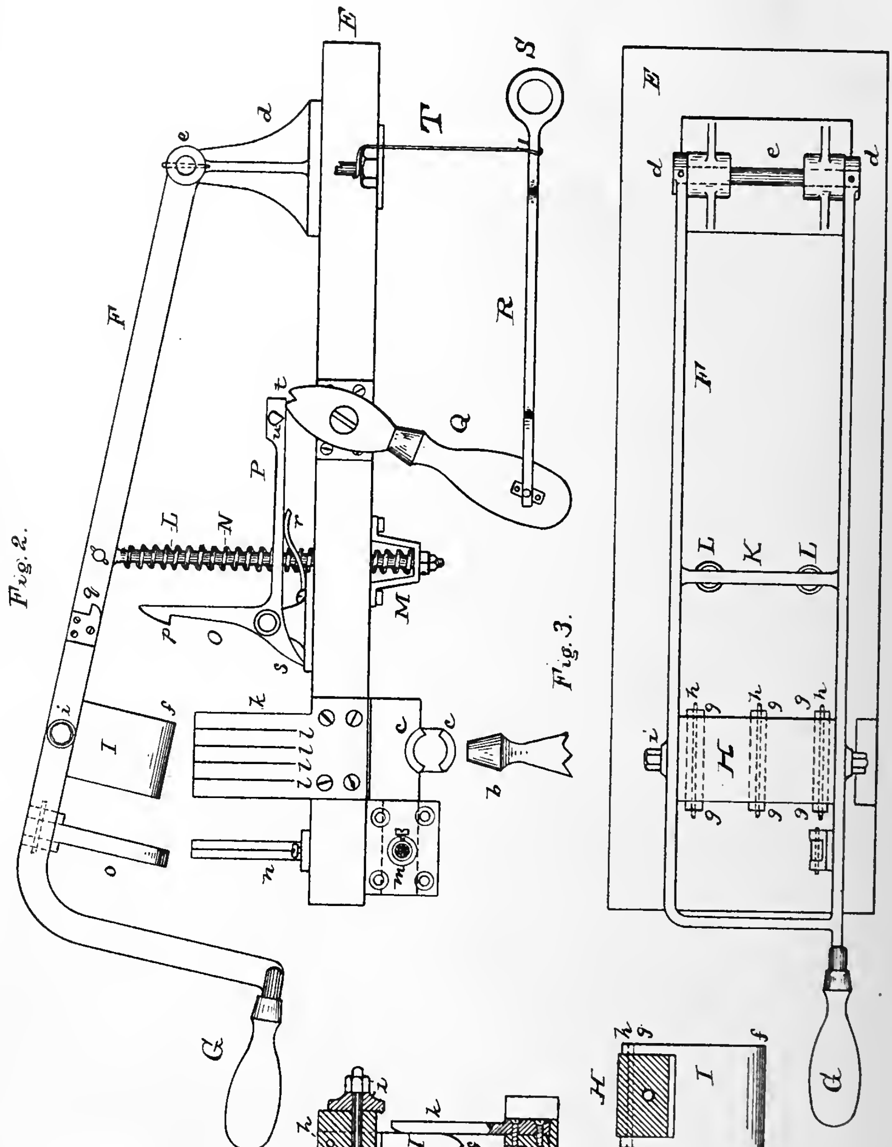

Fig. 2. Fig. 3.

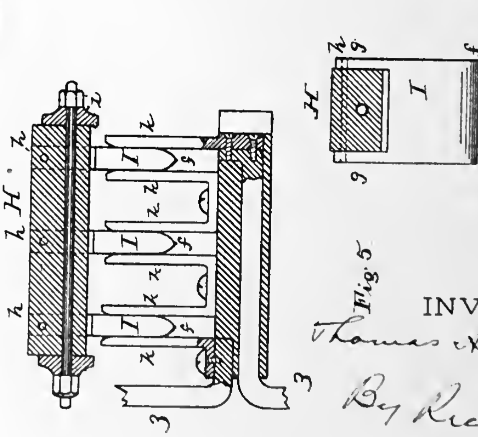

Fig. 4. Fig. 5.

ATTEST:

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W. W. Dealey

INVENTOR:

Thomas A. Edison,

By Rich'd N. Dyer

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N. PETERS, Photo-Lithographer, Washington, D. C.

UNITED STATES PATENT OFFICE.

THOMAS A. EDISON, OF MENLO PARK, NEW JERSEY, ASSIGNOR TO THE EDISON ELECTRIC LIGHT COMPANY, OF NEW YORK, N. Y.

CIRCUIT-CONTROLLER FOR DYNAMO-ELECTRIC MACHINES.

SPECIFICATION forming part of Letters Patent No. 395,123, dated December 25, 1888.

Application filed March 16, 1883. Serial No. 88,355. (No model.)

To all whom it may concern:

Be it known that I, THOMAS A. EDISON, of Menlo Park, in the county of Middlesex and State of New Jersey, have invented a new and useful Improvement in Circuit-Controllers, (Case No. 543,) of which the following is a specification.

The object of this invention is to provide a simple and efficient switch or circuit-breaker especially adapted for connecting and disconnecting the dynamo-electric machines employed for generating current in multiple-arc systems of electrical distribution. Each of such machines has its armature and its field-magnet in separate multiple-arc circuits from the same main conductors. When such a generator is removed from circuit it is necessary to break both its field and armature circuits and to break the latter before the former, for if the armature was left in circuit after the field-magnet was cut out the current from the other machines would pass through such armature and burn out its coils. And in connecting the machine the field-circuit should be closed somewhat in advance of the armature-circuit so that the generation of current may begin immediately upon the closing of the latter. It is desirable also that the breaking or closing of both circuits should be accomplished by the same movement.

My invention therefore consists mainly in a circuit-breaker adapted to break two circuits by the same movement, and also to break one of such circuits before the other, such circuit-breaker being also provided with means for locking it when closed and for instantaneously releasing it and breaking the circuit when desired, means for preventing spark and heating at the contacts, and means for maintaining, if desired, a constant field of force in each generator, such means being in addition to the closing of the field-circuit before the armature-circuit by the circuit-controller, the construction of the whole apparatus being such as to insure efficient action in all respects.

Said invention is illustrated in the annexed drawings, in which—

Figure 1 is a diagram illustrating the connections; Fig. 2, an elevation of a circuit-breaker; Fig. 3, a top view of the same; Fig. 4, a sectional view illustrating the contacts for making and breaking the armature-circuit, and Fig. 5 a view of one of the contact-plates.

A A are dynamo-electric machines and 1 2 are main conductors. The armature of each machine is in a multiple-arc circuit, 3 4, from said main conductors and the field-magnets of each are in a circuit, 5 6. Each of said field-circuits contains an adjustable resistance, B, for regulating the generation of current.

In Fig. 1, C C are switches for the armature-circuits and D D for the field-circuits. While in this figure the armature and field switches are shown separately for clearness, it is to be understood that they are parts of the same mechanism and are operated by the same movement, as will be hereinafter set forth. Around the switch in each circuit is formed a shunt, T, which is opened and closed by the withdrawal or insertion of a plug, *b*, between contact-plates *c c*. These plugs are termed "guard-plugs" and are inserted to prevent heating at the circuit-breaking contacts. The field guard-plug may in addition be used for the purpose of maintaining a constant field. Such plug would be inserted sometime before the circuit-controller is closed, so that current may pass through the field and raise it to its normal strength before the armature-circuit is closed. The plug may be kept in circuit after the circuits are broken. The armature guard-plug must, however, be withdrawn before breaking the circuits.

The circuit-controlling mechanism for the field and armature circuits of a generator is mounted on a suitable insulating-base, E. Near one end of said base are placed suitable standards, *d d*, supporting a shaft, *e*, on which is pivoted the frame F, which is provided with a handle, G. A cross-piece, H, of insulating material, is held by a rod, *i*, passing across said frame and through said cross-piece. The latter carries the contacts for making and breaking the armature-circuit. Each of said contacts is a metal plate, I, having its end *f* rounded or beveled off and its upper portion forked, forming the two parts *g g*, one passing on each side of the cross-piece H. A pin,

h, passes through the forked extremities and the cross-piece H, forming a pivot, so that the contact-plate has a slight swinging movement. These contact-plates, when the frame F is pressed down, enter between contacts mounted on the base E. These are metal plates k k, set upright on the base, so that the movement of the contact-plates I opens and closes circuit at three points, thus diminishing the spark. The conductor 3 of the armature-circuit is broken at this point, its ends being attached to the two end plates, k, one part of said conductor passing through the base E, as shown. Each plate k is divided, as shown at l l, into several parts, so that such plates are elastic and will make good contact at every point with the plates I. The upper and inner edges of the plates k are beveled, so that the plates I can readily enter between them, such plates I also being pivoted, as described, for the same purpose. The wire 6 of the field-circuit is also broken, and one terminal is connected at the point m, from whence a conductor passes through base E to contact-plate n. Only one of such contact-plates is shown; but it is understood that a similar one is placed behind it. A contact-piece, o, carried by the frame F, makes and breaks connection between these contact-plates. A shunt, 7, around the contacts k k runs to the plates c c, and the guard-plug b is inserted between these plates for the purpose above mentioned. A similar guard-plug is provided for the field-circuit. The contact-piece o is, as shown, somewhat longer than the plates I, so that the field-circuit is closed somewhat before and broken somewhat after the armature-circuit. Attached to another cross-piece, K, of the frame F are two rods, L L, which pass through the base E and terminate in brackets M beneath said base. Each of such rods is surrounded by a spiral spring, N, which opposes the downward movement of frame F.

A spring-catch, O, is provided for holding the frame F when the latter is pressed down, the projection p engaging with the projection q upon said frame, the spring r pressing against the arm P to throw the projection p into operative position, and the arm s acting to limit the movement of said arm P. Sometime before the circuit-controller is closed the field guard-plug may be inserted, so that when it is desired to connect the machine the field will already have reached its normal intensity. After the circuit is closed the lever Q, pivoted on base E, is thrown over, so that the notch t on such lever engages with the plate u on the arm P and prevents said arm from being pushed down. The arm R is then swung around until the ring S comes opposite the contact-plates c c, and the guard-plug b is passed through such ring and between said contact-plates. It is therefore rendered necessary to withdraw the guard-plug before the armature-circuit is broken, this arrangement being provided so that the circuit through the armature cannot be maintained after the field-circuit is broken, as otherwise the main conductors might be short-circuited.

The breaking of the circuits is accomplished after the armature guard-plug is withdrawn by throwing the notch t off from plate u and then pressing down arm P, which throws projections p and q out of engagement when the springs N throw the frame F up and break first the armature and then the field circuit.

The hooked wire T, or other suitable device, is used to support the arm R when the circuit is broken.

It is evident that this circuit-breaker may be used in any situation where it is desired to control two or more circuits by the same movements.

What I claim is—

1. The combination, with two or more dynamo-electric machines, each having its field-coils and its armature-coils in separate derived circuits from the same main conductors, of a circuit-breaker for each machine, controlling both its field and armature circuits by the same movement and breaking the latter before the former, substantially as set forth.

2. The combination, with a circuit-breaker for the field-circuit of a dynamo-electric machine, of a guard-plug in a shunt around the same, substantially as set forth.

3. In a circuit-controller, the combination, with two or more stationary contact-plates, of a pivoted arm carrying one or more pivoted or swinging contact-plates for closing circuit between said stationary plates, substantially as set forth.

4. In a circuit-controller provided with a guard-plug, the combination, with the arm carrying contact-plates, of a locking device for keeping the circuit closed, means for releasing said device, and means for preventing the operation of such releasing means before the withdrawal of the guard-plug, substantially as set forth.

5. In a circuit-controller provided with a guard-plug, the combination, with the spring-catch for locking the contact-carrying arm when the circuit is closed, of the arm for preventing the movement of said catch, said arm being held in position by the guard-plug and being operative only after the withdrawal of such guard-plug, substantially as set forth.

6. In a circuit-controller, the pivoted frame carrying swinging contact-plates, in combination with upright terminal plates between which said swinging plates enter to close circuit, substantially as set forth.

This specification signed and witnessed this 13th day of February, 1883.

THOMAS A. EDISON.

Witnesses:
H. W. SEELY,
EDWARD H. PYATT.