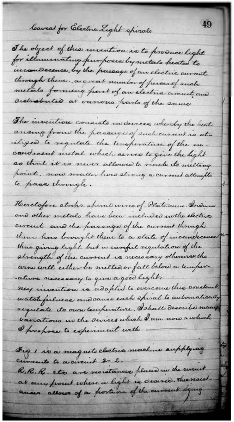
–1427–

Draft Caveat: Electric Lighting



[Menlo Park, September 10, 1878?][1]

Caveat for Electric Light spirals 1

The object of this invention is to produce light for illuminating purposes by metals heated to incandecence by the passage of an electric current through them, a great number of pieces of such metals forming part of an electric circuit and distr~~a~~ibuted at various parts of the same

The invention consists in devices whereby the heat arising from the passage of such current is utilized to regulate the temperature of the incandecent metal which serves to give the light so that it is never allowed to reach its melting point, now matter how strong a current attempts to pass through.

Heretofore strips, spiral wires of Platinum, Iridium and other metals have been included in the electric circuit and the passage of the current through them has brought them to a state of incandecence thus giving light but a careful regulation of the strength of the current is necessary otherwise the wire will either be melted or fall below a temperature necessary to give a good light.[2]

My invention is adapted to overcome this constant watchfulness and cause each spiral to automatically regulate its own temperature. I shall describe many variations in the devices which I am now or which I propose to experiment with—

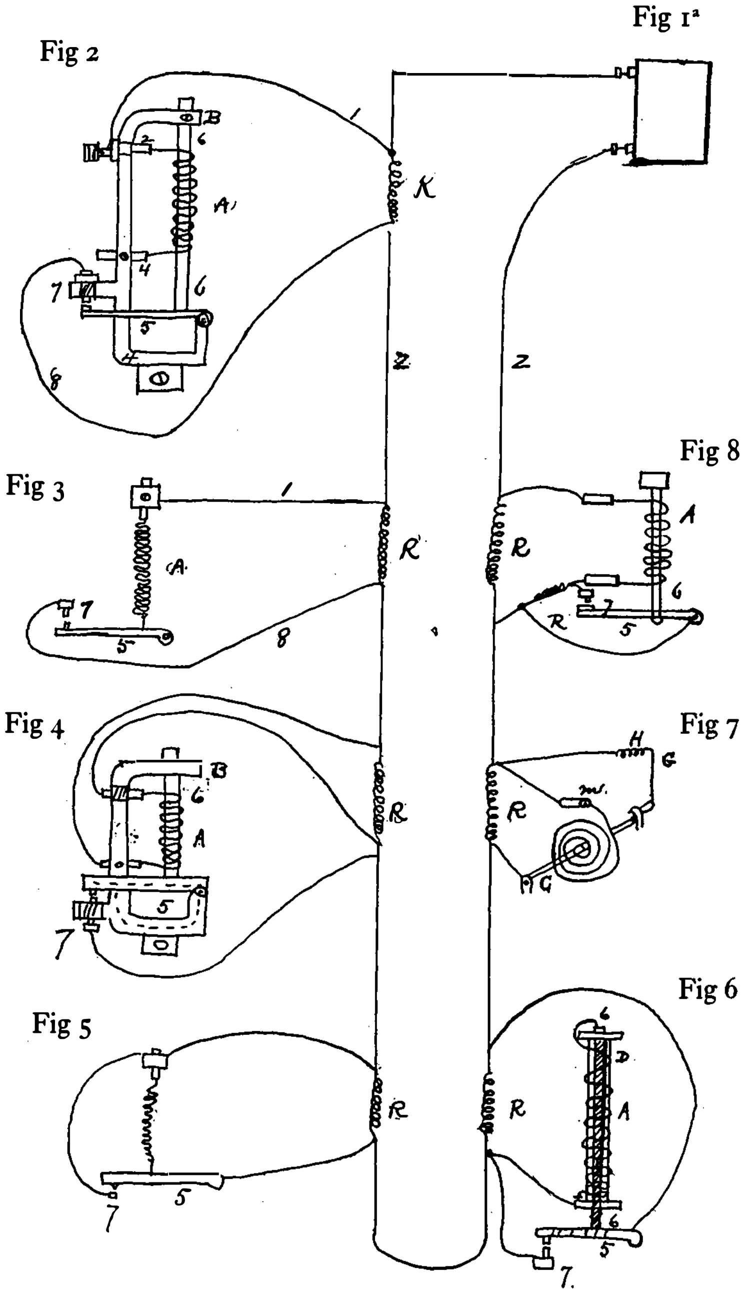


Fig 1 is a magneto electric machine supplying currents to a circuit Z-Z.[3]

R.R.R. etc are resistances placed in the circuit at any point where a light is desired. their resistances allows of a portion of the current being shunted through a metalic spiral wire sheet or other conductor which is to be made incandecent;

In figure 2. is shown one form of electric lamp A is a platinum or iridium wire (it may be made of[b] any metal or conductor having a high melting point or be made in a form of a sheet or volute spiral) 6 is a rod preferably of Zinc or other expansible material and this is secured firmly at B and passes through the centre of the spiral A. It connects at the other extremity with a lever 5 and serves to give a downward motion to the same when the rod 6 is expanded by the heat of the spiral on the end of the lever 5 is a platina point which in its normal position rests against the platina pointed screw 7— 4 is the frame of the instrument and is of metal, the current passes through wire 1 to the rod (insulated) 2 thence down the spiral to the rod 5 and frame 4 thence to the screw 7 to wire 8 back to the resistance R. The resistance of the latter is such that it allows of a powerful current to pass within this derived circuit heating the spiral A to incandecence as the spiral approaches its melting point the rod 6 expands and carries the rod 5 away from the screw 7 and opens the circuit. the temperature of the spiral immediately falls as well as that of the rod .6. when these contract and causes the lever to again come in contact with the screw 7. and the spiral again approaches its melting point. the lever 5 which is springy or rather elastic is so adjusted in relation to the screw 7. that within 200 degrees of temperature of the melting point of the metal of the spiral .A. the lever leaves the screw, hence no matter what amount of current is used the heat of the spiral acts upon devices to regulate its temperature and preservation hence an excess of current sufficient to fuse the spiral unprovided with the regulator may be used successfully.

In fig. 3. is shown another modification in this case the connections and operation is the same except that the expansion of the spiral[b] itself is used to give motion of the lever 5.

I[n] fig 4. The circuit is arranged in such a manner that when the lever 5 is thrown downward by the expansion of the rod .6. It comes in contact with the point 7. and forms a second derived circuit[b] thus weakening the current in the derivation containing the spiral and reducing its[b] temperature

In figure 5 the operation is the same except the expansion of the spiral[b] itself gives motion to the lever 5.

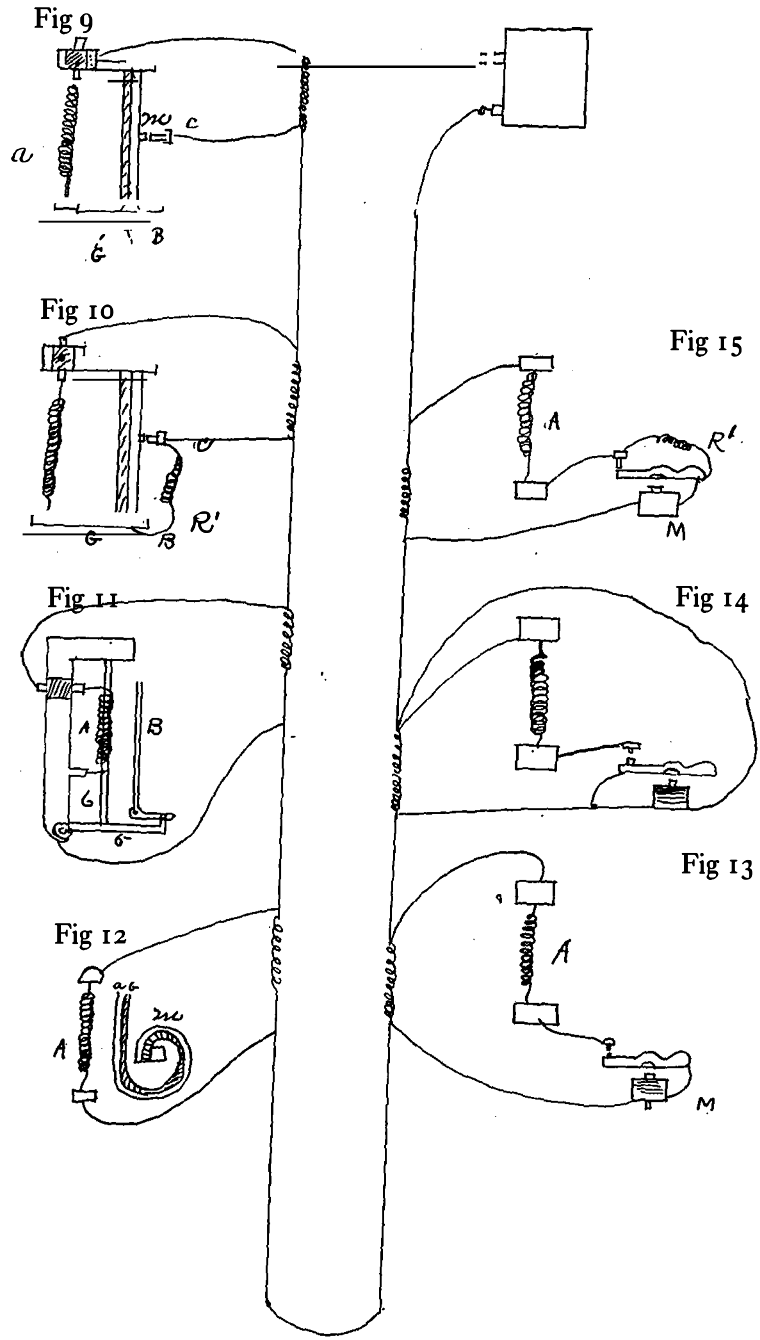


Fig 9
a
m
c
G
B
Fig 10
R'
G
B
Fig 11
A
B
G
Fig 12
A
a b
m
Fig 15
A
R'
M
Fig 14
Fig 13
A
M

In figure 6. a glass tube d passes through the centre of the spiral—A. through this tube passes the expanding rod 6. The operation is the same as in figure 4 but it is a more convinient device.

In fig 7 is shown the wire to be rendered incandescent coiled in the form of a volute spiral the inner end secured to a shaft C the other end to a permanent fixture m. the shaft has a lever I which approaches or receedes from a platina pointed screw H. when the temperature rises or falls. Its[b] operation is the same as fig 5.

In figure 8 The expansion of the rod 6 and downward movement of the lever 5 places in the derivation containing the heated spiral A. an extra resistance[4] R′ which lowers its temperature by weakening the current—

In[b] fig 9. A is the spiral. M two strips of metal fastened together g being steel and B Zinc (any two substances one of which expands more than the other may be used) These are placed in close proximity to the spiral. in their normal condition B is in contact with the screw C. and the spiral a is heated when it approaches its melting point the strips bow out and connection is broken between B and C the spiral cools and B comes again in contact with C and so on—

In figure 10 the operation is the same except that the circuit is not entirely broken a resistance R′ being included in the circuit when[b] B seperates from C.

In figure 11 the expanding rod 6. gives motion through a compound lever to a cooling bar B. which approaches and cools the spiral as the rod 6 expands.

In figure 12 a double strip .M. secured[5] at X expands and approaches and cools the spiral A as ~~fast~~ its temperature rises.

In figure 13 an electro magnet .M. adjusted to respond to a current of little less strength than would melt the spiral is included[b] in the shunt with it. hence when the current is increased from any cause to melt the spiral the circuit opens.

In fig 14. shows the same thing except the magnet is included in a permanent derivation

In figure 15. the magnet M instead of entirely opening the circuit throws a resistance R′ into the circuit to weaken it

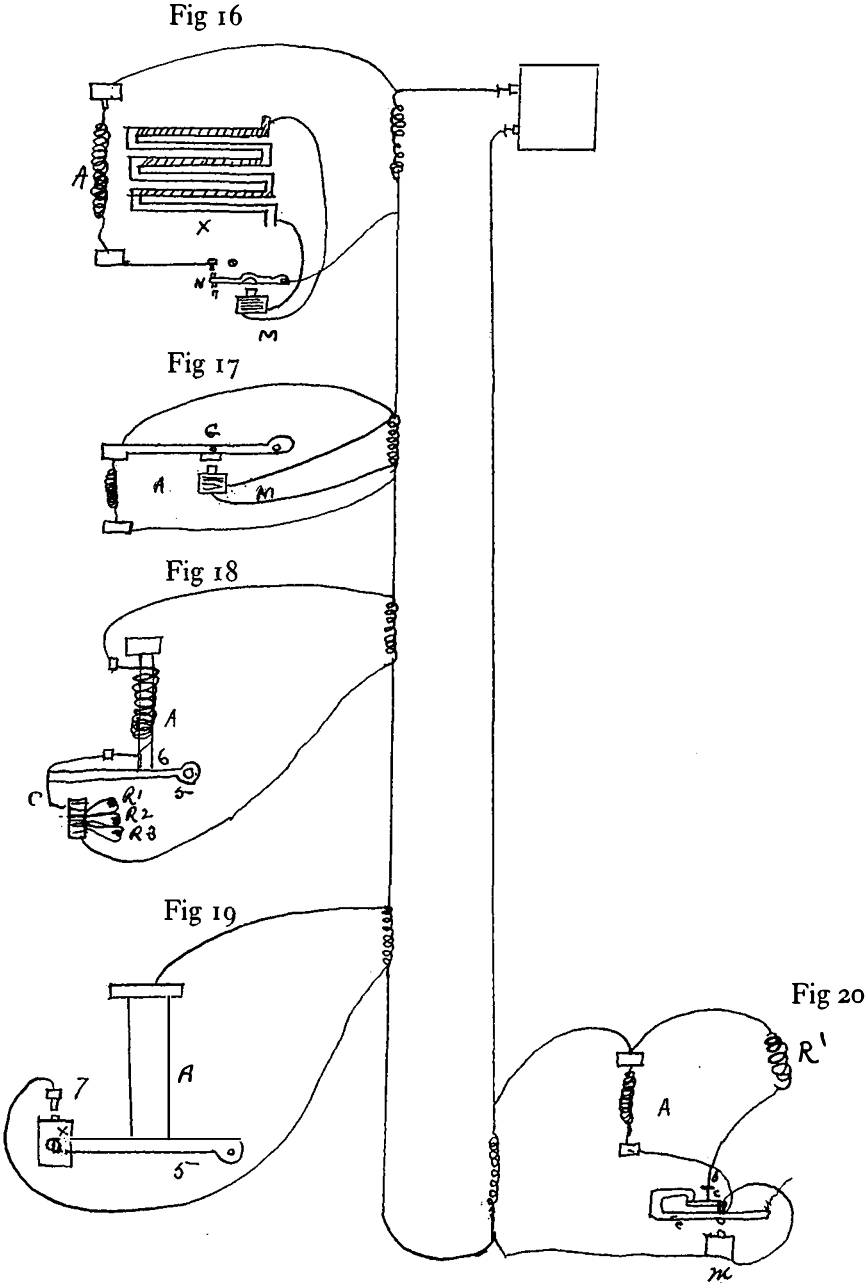


Fig 16
Fig 17
Fig 18
Fig 19
Fig 20

In figure 16 a thermoelectric pile X is placed in close proximity to the heated spiral the current from it actuates a magnet M whose lever N and point O opens and closes the shunt containing the spiral A, when the temperature of the spiral becomes too high the current generated by the thermopile causes the magnet M to attract its lever and open the derivation of the spiral A. its temperature lowers the thermo current weakens and the lever N comes[b] in contact with O and so on—

In fig 17. the lever G of the magnet closes up the spiral when the current increases.

Fig[b] 18 shows the expansion rod 6 throwing in resistances $R^1 R^2 R^3$ on its downward motion. thus weakening the current.

In figure 19. a sheet of platina or other substance is used for giving light by the passage of the current. hung to the bottom is the lever 5 carrying a large weight X on its extreme end.[6] In its normal position the point on X is in contact with 7. but when A becomes too hot its expansion is sufficient to seperate X from 7 and it immediately cools only to make contact and break the circuit again—

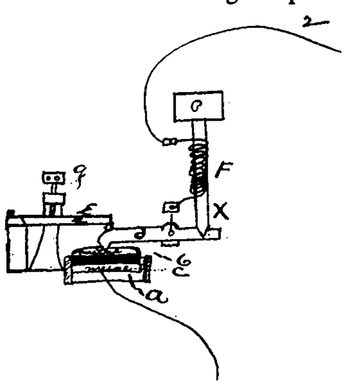
In fig 20 a magnet M. similar to an ordinary Duplex transmitting sounder is included in the derivation when the lever is unattracted the spiral A is[b] in circuit through the lever e and spring C. when the current is increased from any cause the magnet lever is attracted throwing A out of circuit and bringing in a resistence R′ (equal to A) in circuit. this device is not strictly a regulator but is only useful for experimenting where it is deserable to have some device[b] to prevent destruction of the spiral

ADDENDUM[c]

[Menlo Park,] September 13 1878

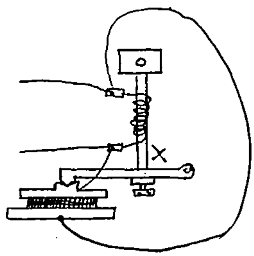
Extension of Caveat for Electric Light Spirals

Fig 21



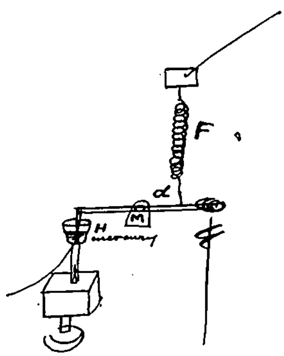
In figure 21. C is a button of finely divided conducting matter that varies its resistance by pressure. This button is placed between two metallic armatures[7] A & B. D is a lever which is pressed down upon the armature B by the spring E aided by the screw .g. X is a rod of material quite expansible by heat this is secured permanently at the top and rests upon the lever D at the bottom. F is the platina spiral. The current passes from wires[8] 1 to the armature .a. through the button to[9] 6 thence through the lever d to the spiral F out again. when the spiral is heated by the passage of the current the rod X expands and decreases the pressure of the lever d[b] on the button. resistance is put in circuit by this lessened pressure and the temperature of the spiral decreased. hence by adjusting the rod X and spring e the spiral may be brought to any required temperature.

Fig 22



In figure 22 The arrangement is somewhat different. the expansion of the rod X by the heat of the spiral increases the pressure and decreases the resistance of the button hence cuts off more current from the spiral, thus reducing its temperature.

Fig 23



In figure 23 is shown a spiral F which when it expands throws up the lever, d & breaks contact in the mercury cup .H.

The device may be arranged to short circuit the spiral F when the lever touches the mercury the spiral being placed in the other side of the fulcrum m.

Fig 24

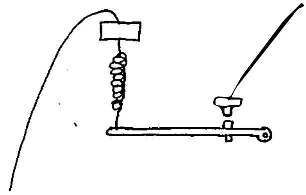


Fig 24 shews the expansion of the spiral opening its own circuit and the contact point being placed near the fulcrum to gain power.

Fig 25

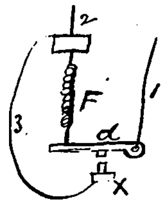


Fig 25 shows it arranged to short circuit the spiral when the temperature is to high the point X may be provided with a spring so that the spiral will not be affected when pressing the lever downward as it would if a rigid point were used.

Fig 26

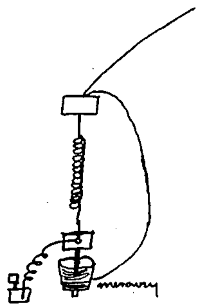


Fig 26 shews a spiral with slight weight short circuiting it-self in a cup of mercury or on a spring.

Fig 27

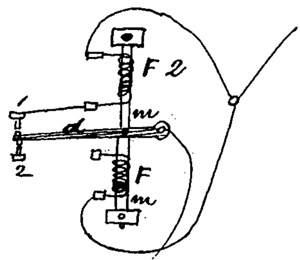
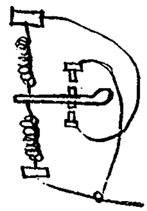


Fig 27 shews a double spiral[10] F1 & F2 with lever d con-nected to the expanding rods m and m^1 arranged with contact points 1 and 2 so that[b] when f^2 is incandescent m will be expanded and the lever d will leave 1[b] and pass the current to F which in its turn will become incandescent and pass it back to f^2

Fig 28



In fig 28. This same principle is shewn with short-circuiting connections

Fig 29.

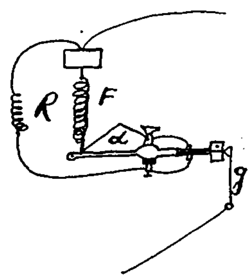


Fig 29 shews a spiral making[b] a lever having two contact[11] 1 and 2 on its extremity insulated from each other. a spring .g is either in contact with one or the other as the spiral is expanded or contracted thus opening or closing the circuit through the spiral or through a resistance R equal to it but of large wire to prevent heating.

Fig 30

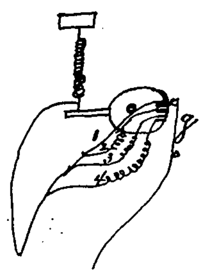


Fig 30 shews a similar arrangement except that as the spirals tends to elongate more and more it is checked by throwing in constantly increasing resistances 1. 2. 3. & 4

Fig 31[b]

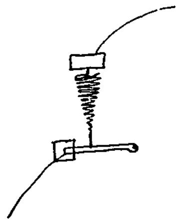


Fig 31 shews a spiral which when not heated has a portion of its spiral touching each other and thus out of action upon the passage of the current more and more spirals and consequently resistance is thrown in circuit by the expansion of the same

Fig 32

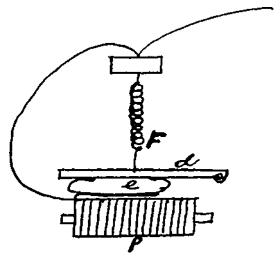
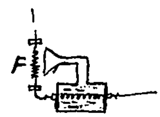


Fig 32 shows a method of gradually increasing the power of the shunt on short circuit. P is a cylinder wound with wire offering considerable resistance. E is a spring which when just touching P comes in contact with but few spirals and as the temperature of the spiral increases the spring e flattens and comes in contact with more convolutions hence shunting more and more current from F

Fig 33



In figure 33 a draft of air. gas or steam set up by the immersed spiral (plate may be used in the water to produce gas by decomposition) in the liquid. augmentation in the current[b] increases the gas and cools the spiral F.

Fig 34

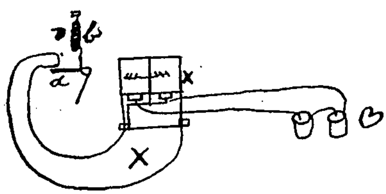


Fig 34 shows an electric or other engine with a fan to produce a draft of air to cool the spirals the draft being regulated by the lever d closing the draft tube .X.

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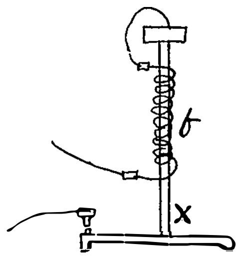

Fig 35 shews the passage of the current through both the spirals F and expanding lever X thus working it by both direct and radiant heat. the short circuiting device may be used in this arrangement.

Fig 36[12]

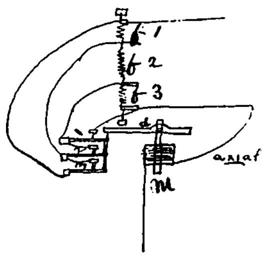

Fig 36 shows (3) Three spirals in the same circuit with the spirals is an axial magnet—M with a lever d working springs 1. 2 and 3. when no current passes the springs 1. 2. & 3 short circuit the spirals Fl F2 F3 when current is closed the magnet causes the lever 1 to cut in circuit spiral F3 if the current strengthens the power of the magnet is increased and causes spring 2 to leave it contact point and cut in spiral F2 and so on. the resistance of the spirals be sufficient to reduce the strength of the current. one spiral might be used and several resistances connected to the springs 1. 2. & 3

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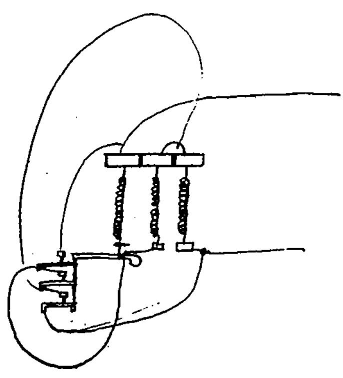


Fig 37 shows a similar principle: the power of the expansion of the spiral being used

38

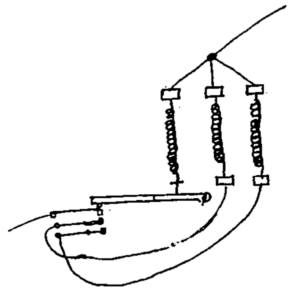


Fig 38 is similar in principle.

Fig 39

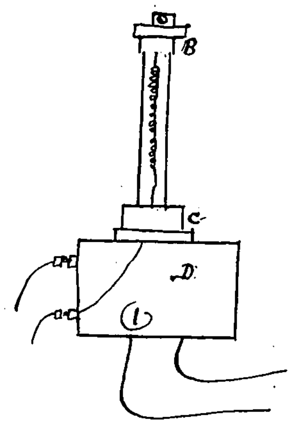


Fig 39 shows a spiral F placed in a glass tube to prevent radiation and allowing the spiral to become incandescent with less current than it would if placed in the open air C & B are caps preferably of some non[b] conductor of heat.

Fig 40[13]

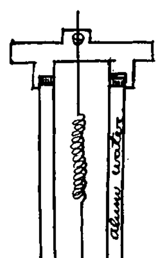


Fig 40 shows double tubes the spaces between being filled with a solution of Alum in water to further decrease conduction and radiation of heat.

Fig 41

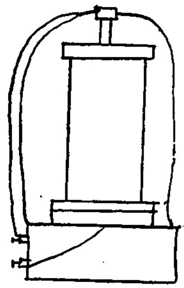


Fig 41 shews a sheet of metalic foil instead of spiral.

Fig 42

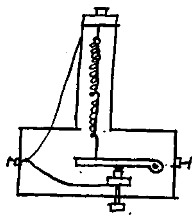


Fig 42 shews a spiral with self regulator inclosed in a glass tube.

Fig 43

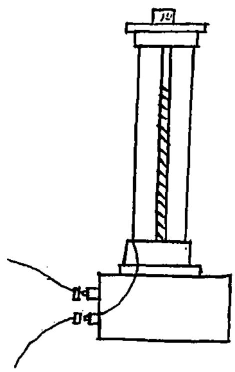


Fig 43 shows a spiral wound around a pencil of lime or similar substance to accumulate heat and thus render the spiral incandescent with much less strength of current—

Fig 44

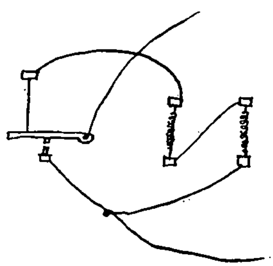
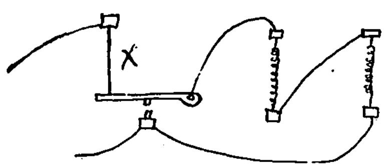


Fig 45[14]



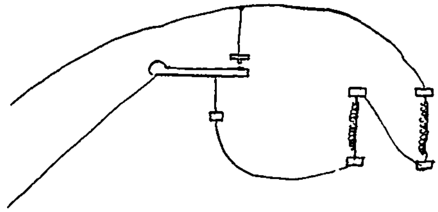


Fig 44 & 45 shews several spirals regulated by a general regulator; for instance if there are 100 spirals in a building they may be arranged with three[b] or four regulators instead of making each spiral ~~to~~a regulator— a straight wire is used as at .X—which is not liable to change like the spiral. The regulation takes place at much lower temperature than on the spirals— I will mention that these spirals may derive the current from the main wire by being placed in derived circuits, or placed directly in the circuit or the ends of all connected to one pole and all the other ends to the other pole;[15]

I will also mention that any source of electric power, such as a battery or magneto machine of the usual construction may be used, but I am now engaged in experimenting on an improved magneto Electric machine. I use a large tuning fork each prong being provided with a steam cylinder and valve which serves to keep the prongs in continuous vibration by steam power and providing the prongs with electro magnets faceing other Electro magnets and with suitable contact points obtain powerful induced current by the rapid approach and recessetion of the magnets[16]

I shall probably claim

1st Regulating the temperature of conductors heated by the passage of an Electric current by their own expansion or the expansion of adjacent bodies by the radiant energy of the heated body substantially as set forth

2d The method of reducing the temperature of a body heated by Electricity by causing its expansion to shunt the electricity from it and reduce the amount

3d A magneto Electric machine composed of a tuning fork or reed kept in continuous vibration by steam power as set forth and magnets and their commutators for the purpose set forth.

4th I claim the various devices herein described to carry out my invention in a practical manner for its various uses.

Df (copy), NjWOE, Lab., Cat. 997:49 (*TAEM* 3:376). Written by William Carman. [a]Drawings are on six separate pages. [b]Obscured overwritten letters. [c]Addendum is a Df (copy), written by William Carman.

1. The first part of this caveat was probably drafted on 10 September, the same day that its first lamp design appears in the experimental record (Doc. 1426). Edison had apparently begun thinking about the designs on 8 September, the same day he visited William Wallace's shop, when he made at least 12 drawings that were probably intended for a caveat. Only four of these survive; numbered 9–12, they are figures 14, 15, 16, and 18 of the caveat (NS-78-005, Lab. [*TAEM* 7:813]). No original text survives. The text and drawings for the first 20 figures were certainly done before 13 September, when Edison made the drawings (and presumably wrote the text) for figures 21–40 as an "Extension of Caveat for Electric Light spirals."

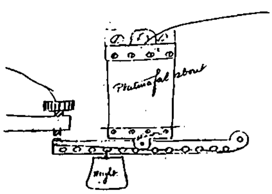
2. A table summarizing prior electric light research is given in Friedel and Israel 1986, 115. It is derived from Bright 1972, 35–54.

3. Edison had very limited experience with electric generators prior to this time. He first saw a Gramme dynamo in England in 1873 (Doc. 346) and no doubt saw J. B. Fuller's magnetoelectric generator between 1875 and 1877 when it was used in experiments on telegraph circuits in New York City (Doc. 634). However, there is no evidence that Edison himself had experimented with these or any other generators prior to the drafting of this caveat. Drawings of his 1877 experiments, like this caveat, show a box labeled "magneto machine" to represent a generator, but his actual power source was a bichromate battery (see *TAEB* 3:540; Doc. 1044).

4. At lower left, labeled "R."

5. "X" is not shown.

6. On 14 September, Edison drew an alternative design for a foil burner in which the position of the weight on the lever could be adjusted. Charles Batchelor then gave John Kruesi instructions to make lamps of this design with one and two contact points. Vol. 16:18–19, Lab. (*TAEM* 4:498–99).



Charles Batchelor instructed John Kruesi to make this lamp and another with weighted platinum foil burners.

7. The label on armature B looks like a "6"; it is probably a misread "b". Text on the two armatures is "metal" and "metal."

8. The bottom wire is 1, but it is unlabeled.

9. "6" is armature B (see note 7).

10. Spirals are labeled "F" and "F2."

11. The labels for contact points 1 and 2 are missing from the drawing.

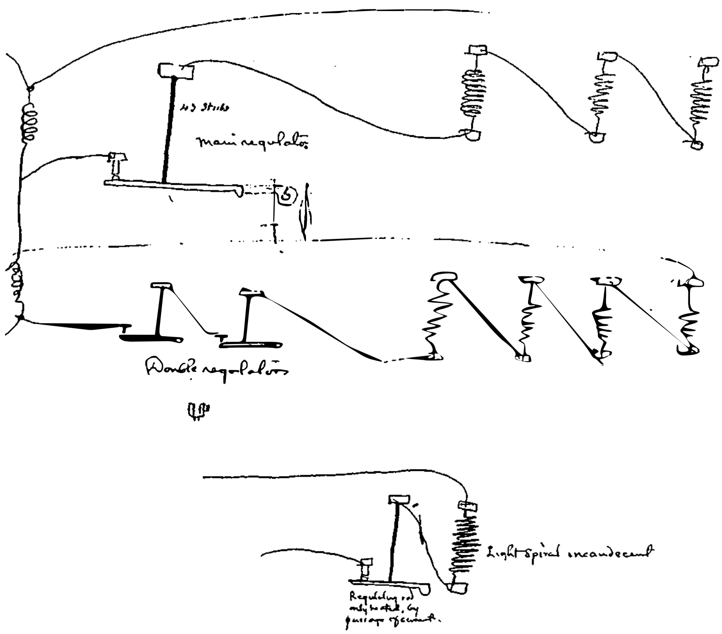
12. Text is "axial."

13. Text is "alum water."

14. The unnumbered drawing included here appears on the first page of drawings for Edison's second draft caveat (Doc. 1456), which follows the drawings for this caveat in Cat. 997. This drawing is directly related to the design of figures 44 and 45 and is unrelated to the designs of the second caveat.

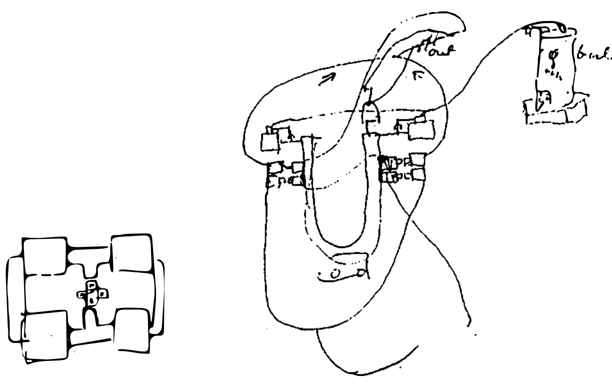
15. On 14 September, Edison drew the design shown here, using what appears to be No. 43 Stubbs steel as the straight wire. He also showed another arangement with two such regulators as well as one with the "regulating rod only heated by passage of current." Vol. 16:17, Lab. (*TAEM* 4:497).

Edison drawings of electric light regulator designs.

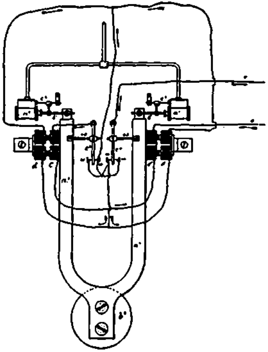


16. The following day Edison sketched some ideas about generators, including a tuning-fork generator (Vol. 16:16, Lab. [*TAEM* 4:496]). The tuning-fork design, labeled "Magneto machine with fork," modified his tuning-fork motor to create a direct-current generator (see Docs. 782, 800, and 802). Steam from the boiler (right) drives two double-acting pistons, located on opposite sides of the tuning fork near the top of each prong, vibrating the fork. As the electromagnets attached

Two of Edison's early sketches of dynamos; one shows a steam-driven tuning fork.



to the prongs of the fork moved to and from their matched pair of electromagnets, they induced currents in the stationary coils. In this way, Edison hoped to take advantage of his idea that a tuning fork might prove to be an efficient translator of energy. Since the current from this generator would be of alternating polarities, he used a commutator consisting of a single interrupter, shown directly above the right prong of the fork, to prevent one of the polarities from being sent out over the line, producing an intermittent unidirectional current. By passing the current through the electromagnets on the fork he created a dynamo (positive feedback) effect. Edison refined this design into the tuning-fork generator shown in his U.S. Patent 218,166 by 25 October (Vol.



Edison's patent drawing for a tuning fork dynamo (U.S. Pat. 218,166)

14:158, Lab. [*TAEM* 4:609]), although he didn't execute the application until 3 December. In the patent he showed that two interrupters could be used as a commutator to change the "alternate current . . . into one of continuity in the same direction." He also noted that the fork "may be two meters long (more or less) and heavy in proportion."

Another of the 14 September drawings represents a general layout found in many dynamo designs, particularly those of Gramme (see, e.g., King 1962c, 380–87 [figs. 63–71]). The four squares in the drawing represent coils of wire for the field magnet and the sections between them a continuous iron or steel core; the extensions toward the middle would be the poles of the resulting electromagnet. The central cross shape (marked "N," "S," "S," "N," clockwise from the top) indicates where an armature would rotate. As with the tuning-fork design, machines of this configuration could be either generators or electric motors, depending on the nature of their armatures and the various electrical and mechanical connections.