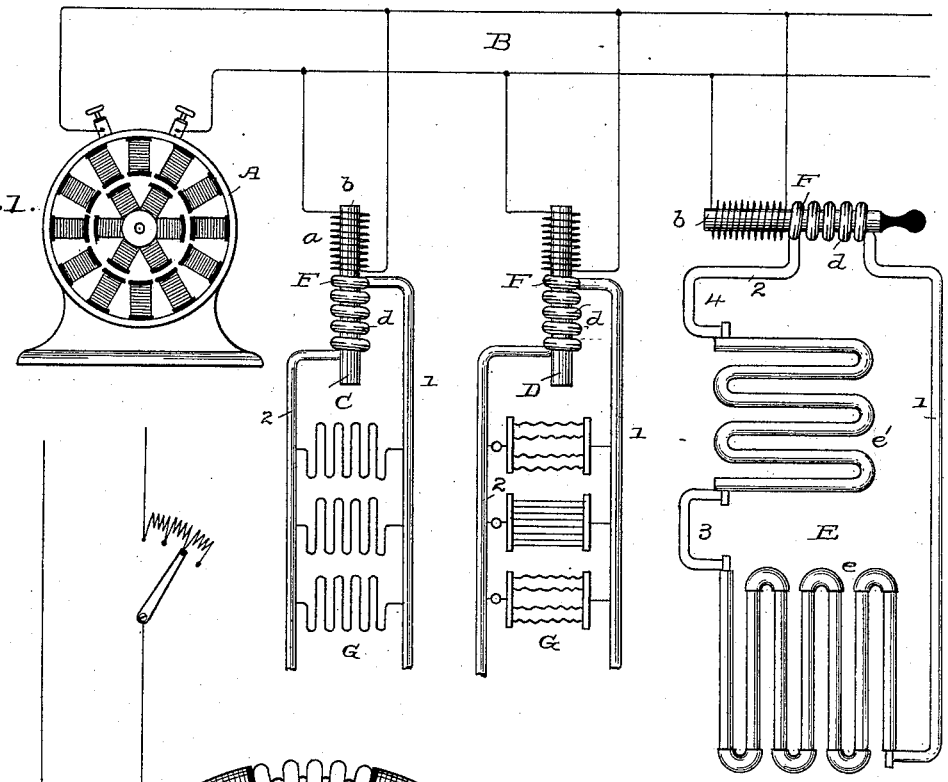
(No Model.) 4 Sheets—Sheet 1.

E. E. RIES.

HEATING BY ELECTRICITY.

No. 381,815. Patented Apr. 24, 1888.

Fig. 1.



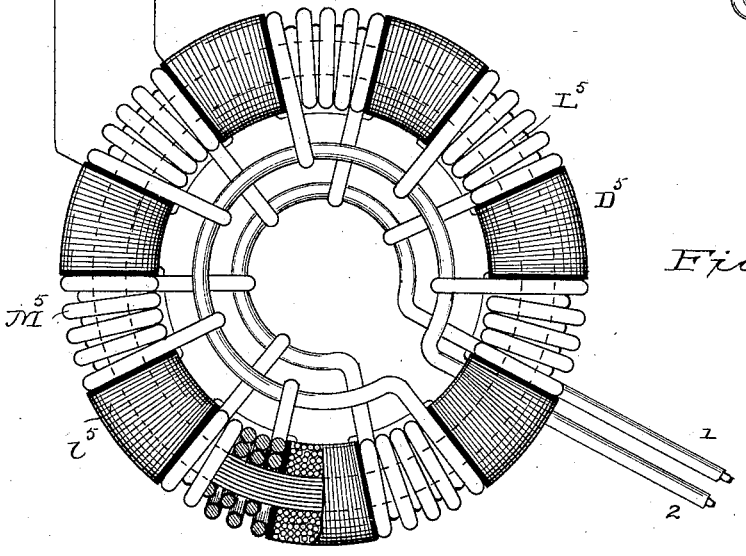


Fig. 2.

Witnesses.

H. A. Lamb.

Geo. H. Campbell.

Inventor

Elias E. Ries

By his Attorney

Frankland & Jamus.

(No Model.) 4 Sheets—Sheet 2.

E. E. RIES.

HEATING BY ELECTRICITY.

No. 381,815. Patented Apr. 24, 1888.

Fig. 3.

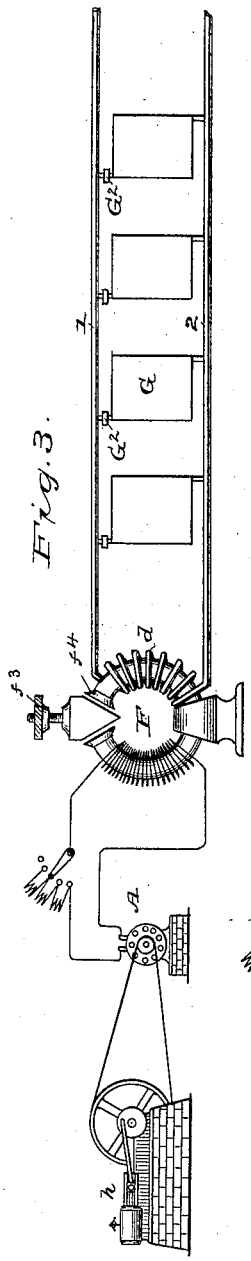


Fig. 4.

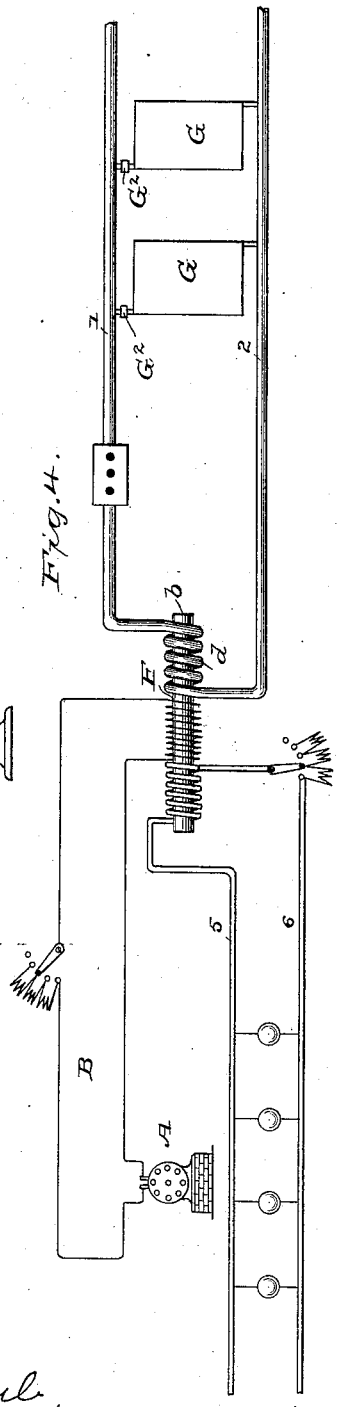
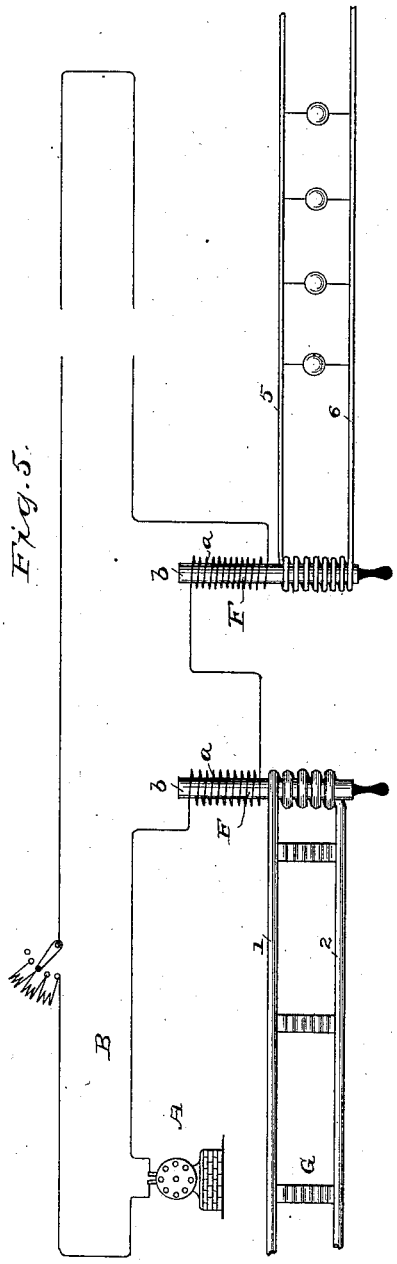


Fig. 5.



Witnesses.
H. A. Lamb,
A. V. Henderson.

Inventor,
Elias E. Ries.
By his Attorney
Frankland James.

(No Model.) 4 Sheets—Sheet 3.

E. E. RIES.

HEATING BY ELECTRICITY.

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Fig. 6.

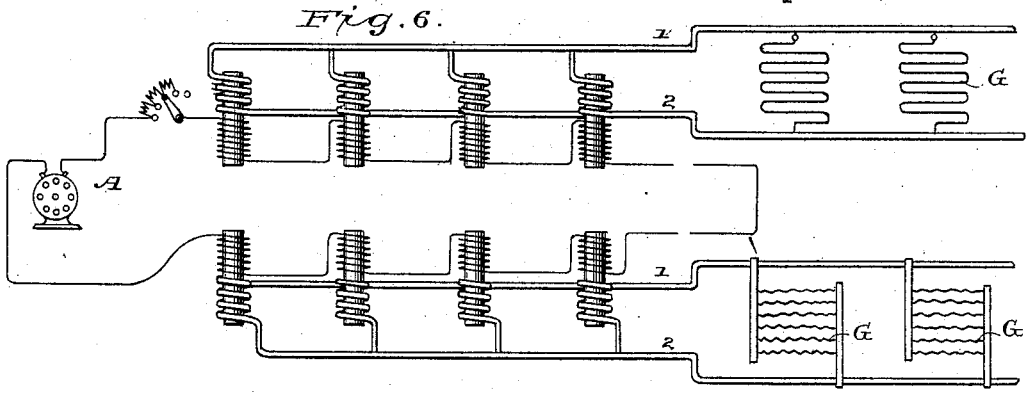


Fig. 12.

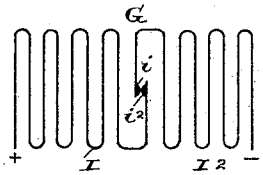


Fig. 7.

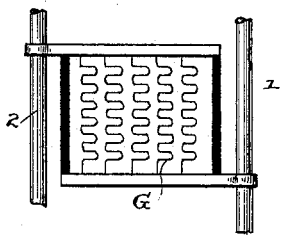


Fig. 14.

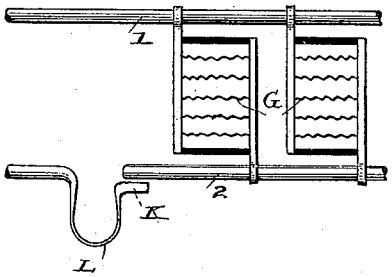


Fig. 13.

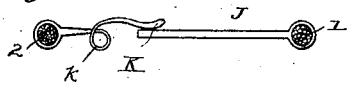


Fig. 8.

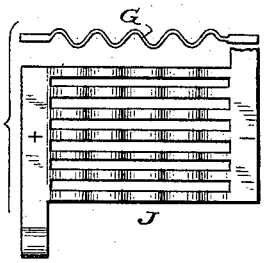


Fig. 10.

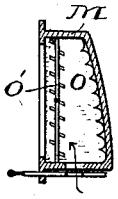


Fig. 9.

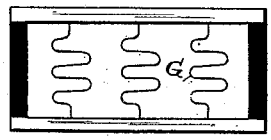


Fig. 11.

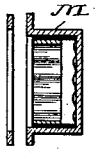
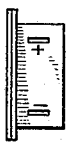


Fig. 11a



Witnesses.
H. A. Lamb.
A. H. Henderson.

Inventor.
Elias E. Ries.
By his Attorney
Frankland James.

(No Model.) 4 Sheets—Sheet 4.

E. E. RIES.

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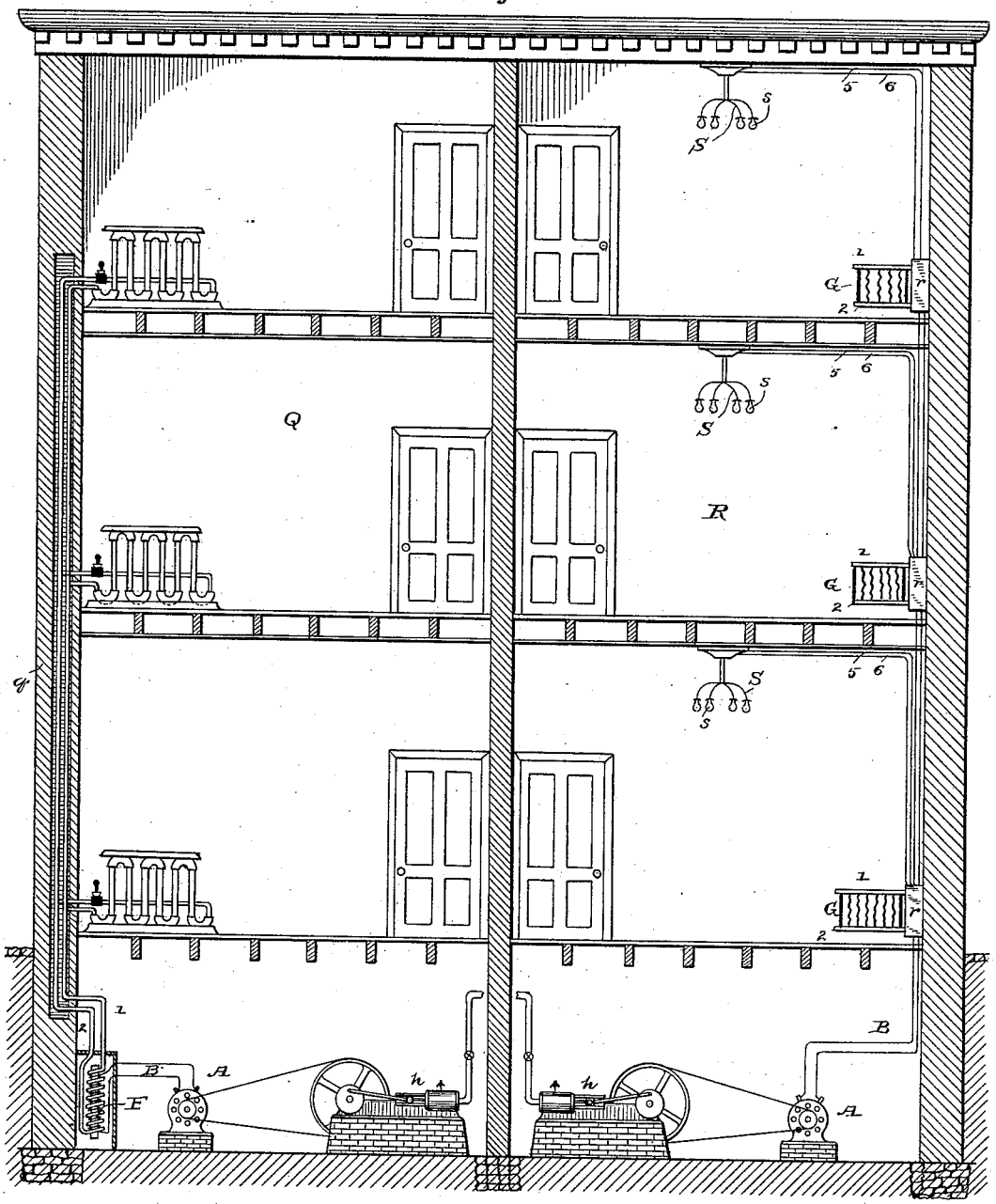
Fig. 15.



Witnesses.
H. A. Lamb.
A. N. Henderson.

Inventor.
Elias E. Ries.
By his Attorney
Frankland James.

UNITED STATES PATENT OFFICE.

ELIAS E. RIES, OF BALTIMORE, MARYLAND, ASSIGNOR OF ONE-HALF TO ALBERT H. HENDERSON, OF SAME PLACE.

HEATING BY ELECTRICITY.

SPECIFICATION forming part of Letters Patent No. 381,815, dated April 24, 1888.

Application filed February 9, 1887. Serial No. 227,044. (No model.)

To all whom it may concern:

Be it known that I, ELIAS E. RIES, a citizen of the United States, residing at the city of Baltimore, in the State of Maryland, have invented certain new and useful Improvements in Heating by Electricity, of which the following is a description.

My invention relates to a new and improved method of heating by means of electricity.

The various attempts made to produce heat by electricity in commercially practical quantities have not hitherto been conspicuously successful, and I will proceed in the following description to explain the correct principles upon which such an undertaking is successfully carried out by means of my invention.

In order to produce heat in sufficiently large quantities for heating buildings, &c., the electrical current used must have very large volume and also low electro-motive force—qualities which have not heretofore characterized currents produced in commercial quantities for heating purposes, for the reason that the tension of even an ordinary battery-current is too high as compared with its quantity, and dynamo-electric generators produce electric force depending upon their armature-speed and strength of their magnetic field, and as their greatest commercial efficiency is at high speed it would be impracticable, or at least unprofitable, to reduce the speed simply to obtain a very low electro-motive force. A single cell of primary battery produces an electro-motive force of two volts, and according to my system an electro-motive force of two volts and over involves a great waste of energy, as by my methods a current of two volts having an intensity of twenty-five ampères can be converted substantially into a current of one-half volt pressure and one hundred ampères intensity, thereby obtaining a heating capacity four times as great for the same expenditure of the same amount of energy. If the necessary resistance of the heating devices can be made sufficiently low, the heating effects possible can be still further increased.

My method of electric heating is applicable to a vast number of domestic and other uses, and I find it practicable to include in my heating-circuits such well-known devices as even the radiating-pipes of the present steam and hot-water heating systems. The low-tension heating-currents above referred to, and which I employ in my electric-heating system, are preferably produced by induction from any suitable primary source of electricity by means of an induction coil or transformer, the primary circuit of which is usually of comparatively fine wire and the secondary of very large wire having few convolutions and extremely low resistance. The primary coils in this case are connected with a source of comparatively high tension alternating electric currents, and the currents thus flowing around the core of the transformer induce in the low-resistance secondary coils currents of very low electro-motive force, but of extremely large volume or heating capacity. The heat-developing apparatus, radiators, or electric heaters, hereinafter more fully described, are preferably connected in parallel order between the large conductors forming the external or working circuit of the secondary coils, and the heaters are generally located in the most favorable position for heating the room or building. The transformer should therefore, as a rule, be placed as near as possible to the point from which the heat is distributed, on account of the costliness of such large conductors.

One method of carrying out my invention is to provide a central station with generators of the alternating type and to lead the high-tension circuit-wires from there through the entire district covered, the necessary leads being carried to the buildings along the circuit where the primary coils of the transformers are connected preferably in parallel, but, if desired, may be connected in series, multiple series, or any other economical relationship, according to the length of the circuit, the principle being to utilize a high-tension current on a small line-wire as fully as possible. Isolated plants will be arranged to give the most economical results. The secondary coils of the transformers are connected with their heating devices and multiplied in number in accordance with the exact nature of the work to be performed. In this manner I obtain very economical translations of the current from very high to very low potential in an extremely economical man-

ner, and one which will admit of further development, as circumstances may require. I also use transformer-coils of varying qualities in the same building where it is desired to produce light as well as to heat the building by electricity.

The advantages of such a system as that alluded to in the foregoing must be numerous and great in that a heating apparatus adaptable to all the ordinary uses of heat can be placed where wanted permanently or temporarily at very small expense and with very little trouble, the apparatus being placed and the connection being made to the nearest working-circuit. No fan-blowers, chimneys, or ventilators are required to carry off products of combustion, foul gas, or vitiated air, and the system includes regulating devices by which the development of heat can be increased or diminished, as required, and also thermostatic cut-outs or automatic switches, by means of which the production of heat is altogether stopped when the desired limit of temperature has been reached, thus providing a safeguard and rendering the system at once economical, convenient, and health-promoting, and safe against danger of accidents.

In the drawings accompanying this specification I have shown apparatus capable of carrying out my system, but cannot be limited to the particular construction or arrangement of the devices shown in the said drawings.

In a concurrent application I have shown and described my improved methods as applied to the heating of railway-cars. Other special applications of my improved method of heating will form the subjects for subsequent applications for Letters Patent.

In the drawings, Figure 1 is a diagrammatic representation of a central-station generator, its working-circuit, and three consuming-stations where the translating apparatus is located. Fig. 2 shows the construction of the inductional transformer. Fig. 3 is a theoretical diagram showing a complete heating-outfit. Figs. 4 and 5 are modifications thereof, showing arrangements whereby different qualities of current can be produced by the same generator. Fig. 6 is also a diagram and shows a number of transformers, the primary coils of which are arranged in series with the generator, their secondaries being connected in multiple arc to heating-circuits, also shown. Fig. 7 shows a radiator for use in my system, and Figs. 8 and 9 are different forms thereof. Figs. 10, 11, and 11ª are heaters designed to be sunk in walls or panels; and Figs. 12, 13, and 14 are various forms of thermostatic cut-outs. Fig. 15 illustrates two adjoining houses heated and lighted according to my invention.

Similar letters indicate corresponding parts throughout.

The central-station plant (indicated in Fig. 1) consists of a generator, A, of the alternating-current type, which is to be driven by suitable power. (Not shown.) The working circuit B, extending from said generator, is shown as being tapped at six points, various forms of heating apparatus used in connection therewith at three of said points being shown in diagram at C, D, and E. The inductional transformers F, diagrammatically represented for the sake of illustration only, consist of the primary coils *a*, wound upon an iron core, *b*, secondary coils *d*, of very large copper wire, being also wound upon said cores in proper relation to the aforesaid primary coils. The said secondary coils extend from the transformer by conductors 1 and 2, between which are connected heating devices G, which in diagrams C and D are shown as being connected in multiple arc. The conductors 1 and 2 of the secondary circuits are, on the contrary, made of very large wire, preferably of copper, offering an extremely low resistance to the passage of the current, and, as hereinafter shown, several secondary coils are connected together in parallel to still further reduce the resistance of the secondary circuit, enabling me to produce by the aid of one or more inductional transformers a current of lower potential than has ever yet been produced on a commercial scale for heating purposes, which current possesses unusual and very great heating powers. The heat-developing devices, which I will hereinafter term "heaters," G, are composed of very thin broad strips of good conducting metal, preferably copper, which, while offering an ample passage for the current, are highly heated thereby and give out said heat into the surrounding chamber, a sufficient number of said heaters being connected with each local circuit to attain the desired results. In many instances where buildings are already heated by steam or hot water there exist heat-radiating devices, which can be utilized according to my system, and may, for example, be connected up as shown at E, where two sets of iron radiator-pipes, *e e'*, preferably filled with a heat-absorbing substance—as, for instance, water saturated with sodium chloride to prevent freezing, or a filling of sand or other refractory material—are united in multiple series by means of the copper conductors 3 4. In connection with this diagram I have also shown that the core *b* of the transformer F is rendered adjustable, so as to develop more or less current in the secondary circuit, and thereby afford means for regulating the same.

The transformer D^5, or device by means of which I convert an alternating current of high tension into a heating-current of very low tension, is shown in a conventional form in several of the figures of the drawings, and consists, preferably, as is more fully shown in Fig. 2, of a magnetic body or core, L^5, of layers of iron plates, upon which is wound a series of primary coils, b^5, of comparatively fine wire, and interposed between the said primary coils, in suitable relation thereto, are secondary coils M^5 of very large wire of low resistance, calculated to emit a current of very large volume, but low potential. In Fig. 6 I have

shown the primary coils all connected in series and the secondary coils in multiple arc, thereby materially reducing the resistance of the secondary circuit, while at the same time the greatest inductive effects are obtained from the high-tension small-quantity primary current.

The electro motive force of the transformer-current can be increased or diminished by adjusting the magnetic resistance of the core of the transformer by means of the screw f^3.

In Fig. 3 I have shown a heating plant complete—that is to say, a steam-engine, *h*, operating an alternating-current generator, A, the current from which passes to an inductional transformer, F, the secondary circuit *d* of which extends by conductors 1 and 2, between which are connected heaters G, provided with regulating devices G^2. This is substantially the apparatus shown in one of the houses to be described, and, while to a large extent conventional, illustrates the extreme simplicity of my system.

The arrangement shown in Fig. 4 includes an alternating-current generator and an inductional transformer, F, which, however, in this case is provided with two secondary coils, one of which, *d*, is similar to the one just described, and is provided with heaters G. The other is provided with conductors 5 6 of low resistance as compared with the primary coil, but not as low as the coils and conductors of the heating-circuit, and in this circuit I place the desired number of incandescent lamps, so that I may have heating and lighting at the same time or at different times, if so desired, but in the same immediate locality—as, for example, in the room of a house, as shown in the house R, referred to hereinafter.

The diagram Fig. 5 differs from that just described in that while both heating and lighting circuits are shown they are supplied by separate transformers, which are, however, designed to be arranged in convenient proximity to each other. In order to obtain current of the lowest possible potential and greatest possible heating quality, I find it advisable to construct the transformers with few coils of very large wire in the secondary circuits, and therefore to attain large results I find it convenient to connect the primary coils of the group of transformers in series, and to connect all of their secondary coils, or any desired portion thereof, in multiple arc into the heating-circuit, substantially as shown in the diagram Fig. 6.

The inductional transformer F may be of any suitable or desirable construction, substantially as shown in Fig. 3, in which special provision is made for producing a large heating effect in the secondary circuit with an extremely low electro-motive force. The core of the transformer (shown conventionally in Fig. 3) is composed of a number of iron wires or strips suitably insulated and terminating in enlarged pole-pieces f^4, between which a wedge-shaped adjustable connecting-piece, f^3, may be moved to open or close the magnetic circuit as required for controlling the electro-motive force of the induced current. I do not, however, limit myself to the specific details of construction shown. In this manner I am enabled to produce from a single high-tension current of alternating polarity by means of inductional transformers, the primary coils of which may or may not be arranged in series, as is most convenient and desirable, by using a sufficient number thereof, secondary currents of almost any degree of quantity and at as low a potential as I may require for the particular application to which such electric currents are applied under my present invention.

The heating devices are formed of thin strips of refractory metal, which is at the same time a good conductor. Copper, brass, bronze, or other metal will fully answer the purpose, although I do not confine myself to their use. Where a very large heating-surface is required, I prefer to use iron or other metal having less specific conductivity than those just mentioned, but enlarged to such an extent that its actual resistance is substantially similar to that of other radiators located in the same parallel circuit. These strips *g* are exposed to the atmosphere and arranged in frames or boxes in any convenient or desirable manner, and then connected in multiple arc between the conductors 1 and 2 of the heating-circuits. In order to prevent overheating and its consequent dangerous possibilities, I take advantage of the well-known property of metals to expand when heated and arrange coils or folds in such manner that when the desired limit of temperature has been reached the circuit of that particular heater will be opened until it has cooled off.

In Fig. 12 is shown a pair of strips, $I\,I^2$, the extremities of which are in close proximity and provided with contacts $i\,i^2$, of platina, carbon, or refractory conducting metal. Normally these contacts are together, and the circuit of the heater, as a whole, is completed therethrough; but when an excessive or sudden increase of temperature is reached the expansion of the folds of metal will separate the contacts and cut the heater out of circuit until the temperature is sufficiently reduced.

In Fig. 13 is shown a heater, J, which may be similar to that shown in Fig. 8. This heater is attached to the heating-conductor 1, and to the opposite conductor, 2, is secured a metallic tongue, K, part of which is in the form of a coil, *k*. Normally the tongue K rests upon the heater J and completes its circuit; but when overheated the coil *k* will, by expansion, raise the tongue K and break circuit. In Fig. 14 a similar device is shown, the tongue K being provided with a large flattened loop, L, instead of the coil *k*.

In Fig. 10 is shown a metallic box, M, intended to be let into a wall or panel or floor, and more especially where a supply of air can be obtained, as in an opposite wall. The

box is interiorly provided with a reflecting-plate, O, which is located against its rear wall, and its front is formed of a number of metallic slats, O′, punched up from a single plate of suitable metal, and between which the air passes in the direction of the arrow and comes out heated by contact therewith. Figs. 11 and 11ª also show a box; but in this instance it is a simple radiator, and not arranged for action with a current of air.

The adjoining houses shown in Fig. 15 embody two of the many forms in which my system can be actually applied. In the house marked Q is shown a system similar to that in the diagram Fig. 3, the conductors 1 and 2 being carried up through the wall *q* in a suitable flue and tapped on each floor for connection with heaters, those shown being steam-heating coils, connected and acting as electric radiators, their supply of current being furnished by a generator, A, in the basement, the current from which is converted by the transformer or transformers F, shown in proximity thereto. In the house (marked R) the generating devices remain the same, and are practically those shown in Fig. 3; but I have illustrated here the facility with which interior lighting is accomplished as well as heating. The main (high-tension) circuit B in this case extends throughout the house, and on each floor is placed an inductional transformer, which is not shown, but which may be similar to the one shown in Fig. 4, and is contained within the box *r*, from which extend heating-conductors 1 2, between which are connected heaters G in the manner already described. Additional circuit-wires, 5 6, arranged substantially as shown in the diagrams Figs. 4, 5, extend to conveniently-placed chandeliers S, from which depend incandescent lamps *s*.

For the purposes of this specification "low resistance" may be defined as a resistance not exceeding five ohms, although in practice I find that a resistance of even one-tenth of an ohm or less in the heat-radiators produces very excellent and economical results.

In the foregoing specification I have undertaken to explain and in the accompanying drawings to illustrate forms of apparatus and devices capable of carrying out my invention; but I do not limit myself to the forms shown and described, as my invention is capable of application and modification in many other ways without departing from its scope or nature.

The alternating-current generator hereinbefore referred to may be separately excited, as explained, or arranged to be self-excited, a portion of the currents generated being straightened and used to energize the field-magnets.

The increased resistance of the radiator-strips when highly heated will act to control the further supply of current thereto and serve to reduce the amount passing therethrough, which will economize current by rendering a larger supply available at other points.

The art or method of producting heat from electric currents, as described and set forth, is also fully described and claimed as such in a separate application filed by me March 9, 1888, Serial No. 266,710. The application to culinary and domestic purposes of the herein-described methods of producing heat electrically forms the subject of separate applications for Letters Patent, filed April 11, 1888, Serial Nos. 270,245 and 270,246.

Having described my invention, what I claim, and desire to secure by Letters Patent, is—

1. In a system of heating by electricity, the combination, with suitable low-resistance supply-conductors, of one or more exposed heat-developing conductors arranged in multiple arc between the supply-conductors, substantially as described.

2. In a system of heating by electricity, the combination, with suitable low-resistance supply-conductors, of one or more exposed heat-developing metallic conductors arranged in multiple arc between the supply-conductors, substantially as described.

3. In a system of heating by electricity, the combination, with the heating-circuit, of an inductional transformer the primary coils of which are in circuit with the supply-conductors, secondary conductors extending therefrom and carrying electric currents of low electro-motive force but large volume, and heat-developing translating devices connected in multiple arc between said secondary conductors and consisting of thin strips of conducting metal of small cross-section and large surface area, substantially as described.

4. The combination of conductors of very low resistance, a suitable source of alternating currents of electricity, and metallic heat-developing radiators of large surface, but inferior conductivity, having greater superficial area than said low-resistance conductors, but of lesser conductivity, in circuit therewith, substantially as described.

5. A system of heating by electricity, consisting, essentially, of a source of alternating current, an inductional transformer having its primary in circuit with said source, and the secondary circuit of which is of very low resistance, and conductors consisting of exposed heat-radiating metallic bodies of comparatively low resistance connected between the secondary circuit-conductors in multiple arc, substantially as described.

6. An inductional transformer comprising one or more primary coils and a plurality of secondary coils, the primary coils being connected with a source of alternating or intermittent electric currents, and the secondary coils supplying their currents direct to separate working-circuits, including, respectively, electric lamps and exposed heat-developing conductors, substantially as described.

7. The combination, with an electric circuit of varying intensity and heat-radiating devices included therein, of an automatic cut-off con-

sisting of a bent or folded metallic strip arranged to be operated by an abnormal increase of current in the heating devices to open the circuits thereof, substantially as described.

8. In a system of heating by electricity, the combination, with the heating-conductors, of heat-radiating devices consisting of a pair of strips of metal folded to form expansible radiators, the inner extremity of each being provided with a terminal, which terminals are normally held in contact by the resilience of the metal, but adapted to be separated, and the radiator-circuit opened by the expansion of the metal under excessive heat, substantially as described.

9. In a system of heating by electricity, the herein-described radiating devices, consisting, substantially, of the combination, with the supply-conductors, of one or more thin strips of corrugated or fluted metal adapted to be heated by the passage therethrough of an electric current, as set forth.

10. In a system of heating by electricity, the herein-described heating and ventilating device, consisting, substantially, of an inclosing-case having one or more adjustable air-inlets, supply-conductors, and heat-radiating conducting-strips connected between said supply-conductors in multiple arc and arranged to heat and deflect the passing current of air, substantially as described.

11. In a system of heating by electricity, the combination, with the supply-conductors, including the primary coils of an inductional transformer, and the secondary conductors, carrying electric currents of large heating capacity, of a radiating-frame between said secondary conductors, consisting of a number of thin strips or bands of corrugated or fluted metal arranged to be heated by the passage therethrough of said currents, substantially as described.

12. In a system of heating by electricity, the combination of a source of alternating or interrupted current, an inductional transformer in circuit with said source of current, a heating-circuit of low resistance supplied with current from the secondary coil or coils of said transformer, exposed heat-radiating conducting-bodies connected in parallel order between the conductors of the heating or secondary circuit, and a thermostatic cut-out for opening the circuit whenever the heat developed therein exceeds a predetermined temperature, substantially as described.

In testimony whereof I hereto affix my signature in presence of two witnesses.

ELIAS E. RIES.

Witnesses:
W. C. DUVALL,
FRANKLAND JANNUS.