ELEMENTARY ELECTRO-TECHNICAL SERIES

ELECTRIC HEATING

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CHAPTER VI.

ELECTRIC HEATERS.

One of the commercial uses to which electricity has lately been applied has been the artificial heating of air in buildings on a comparatively small scale. While this method of obtaining artificial warmth has not yet reached such economy as to permit it to be economically applied to the heating of the air of large buildings, yet the convenience arising from the facility with which the electric current can be led to the electric heater, the comparatively small size and portability of the latter, the readiness with which the current can be turned on and off, the safety of the apparatus, its freedom from fumes or dirt, and the ease with which it can be managed, have attracted no little attention, and its use, in certain directions, is rapidly increasing. While there is, perhaps, little probability in the near future of large electric plants being erected whose current shall be entirely employed for the production of heat, as in warming buildings, nevertheless, electric heaters are likely to be extensively employed in connection with already existing systems of electric distribution for light and power.

Electric heaters are to-day in common use in electric street railway cars, and this is for the same reason that electric lights are employed in these cars. Were it not for the fact that the cars obtain their propelling power from the electric current, it is not at all likely that electrically lighted and electrically heated cars would have come into the general use they have to-day; although in parlor cars on steam railroads, electric incandescent lamps are sometimes employed as luxuries.

Electric heaters, designed for the artificial warming of air, though made in a great variety of forms, consist essentially of a metallic conducting wire, generally of galvanized iron, or German silver, loosely coiled so as to possess a comparatively extended radiating surface, and commonly supported in the air.

In order to obtain a sufficiently extended surface for radiation and convection, and also to obtain the desired electric resistance in the coil, within a limited space, it is usual to wind the wire in a loose spiral around a form or block of earthenware, porcelain, or other similar, non-inflammable material.

We have seen that a definite relation

exists between a given amount of electric energy and the heat energy it is capable of producing. It has been ascertained that one joule of work, expended in producing heat, will raise the temperature of a cubic foot of air about $\frac{1}{18}$ ° F., and, therefore, an activity of one joule-per-second, or one watt, can raise the temperature of one cubic foot of air $\frac{1}{18}$ ° F. per second.

A simple form of cylindrical electric heater for hot air is shown in Fig. 21. It consists of a metallic strip, wound spirally on an insulated frame. Here, as in all forms of air heater, the design is to obtain as large a surface exposed to the air as possible. Since the metal strip employed is comparatively thin, the total mass or weight of the metal in the heater is comparatively small, and the conductor is rapidly heated by the passage of the cur-

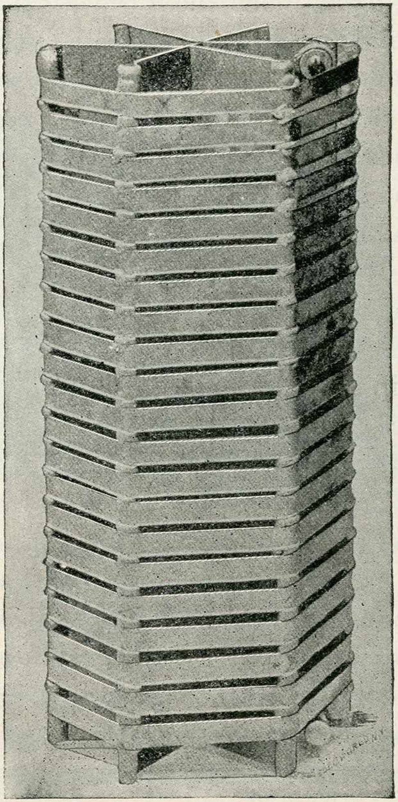

FIG. 21.—CYLINDRICAL ELECTRIC HEATER.

rent. But since the surface exposed to the air is great, the heating coil never acquires an excessively high temperature. An electric heating coil best serves its purpose when it rapidly imparts its heat to the surrounding air, never itself acquiring a dangerously high temperature.

The heating coil or conductor in an electric heater is not always in the form of a strip. It sometimes takes the form of a wire or spiral, either bare, or placed within a metallic frame.

Fig. 22 represents a form of electric heater or radiator resembling in appearance an ordinary steam or hot water radiator. Here the coils of the electric conductor are placed within the metallic frame. The exact length and dimensions of the heater coils will depend upon the amount of heat required, and on the electric pressure employed in the building. The same coil will, however, give practically the same amount of heat when con-

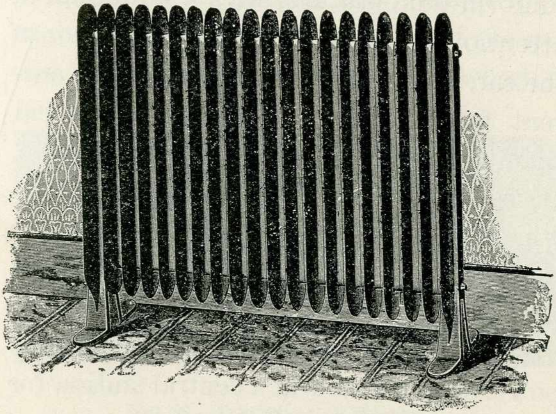

FIG. 22.—ELECTRIC RADIATOR.

nected with the same pressure of either alternating or continuous current.

The advantages of an electric heater are especially marked when employed in cars propelled by electricity. Indeed, the necessity for utilizing all the available space in a street car for the accommodation of passengers, and for maintaining a uniform temperature, with a minimum of attention required from the conductor of the car, renders the use of the electric current for heating even more economical than the use of a stove. This, of course, arises largely from the fact that the stove which can, in practice, be placed in the limited space allotted to it in a car, must necessarily be very uneconomical, moreover, the large scale on which electric power is generated in a central station for propelling the cars, reduces the cost of the electric energy so much that the electric heating of the car actually compares very favorably in economy with what would be required to heat it as effectively by the direct burning of coal in a stove.

Fig. 23 represents a form of *electric car* *heater*, in front elevation, and Fig. 24, the back and interior of the same heater, showing the electric coil in position. Four or six of these heaters are employed in each car, according to the size of the car and the climate of the locality in which it

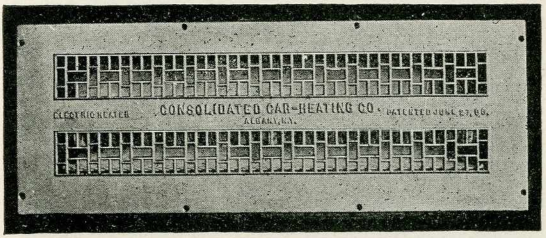

FIG. 23.—ELECTRIC CAR-HEATER.

runs. The heater is placed in a hole or gap made in the riser, or vertical partition, below the car seat. A cast-iron plate, furnished with grid openings, placed in the front of the heater and opening into the car, serves the double purpose of preventing the dress of the passengers from coming into contact with the heated coils, and for permitting the ready escape of the air through the apparatus.

An inspection of Fig. 24 will show that the heating coil, employed in this particular form of car heater, consists of a close

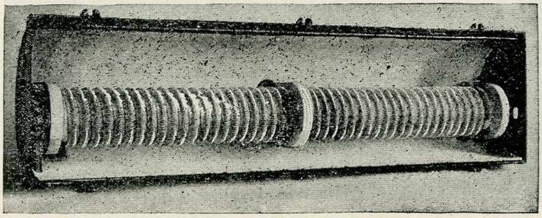

FIG. 24.—BACK AND INTERIOR OF ELECTRIC CAR-HEATER.

spiral conductor, which is spirally wound around a grooved porcelain tube, and is supported at the centre and at the two ends by porcelain washers. The back of the heater is formed of sheet iron, suitably provided with asbestos lining.

Heaters employed on electric railroad circuits take their current from the mains at a constant pressure, generally 500 volts. In order to vary the current passing

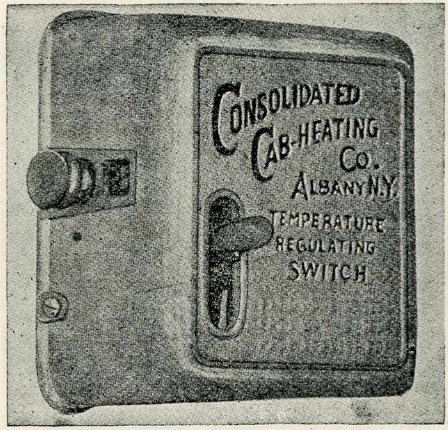

FIG. 25.—CAR-HEATER REGULATING SWITCH.

through the four or six heaters generally employed in each car, a switch is used, by means of which the separate heater coils can be connected in series, or in parallel-series, or some of them cut out from the circuit, thus permitting the amount of heat to be readily varied in order to meet the requirements of the

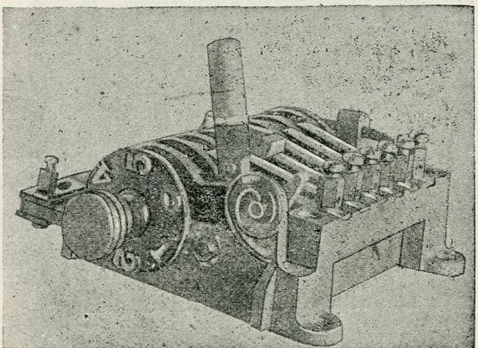

FIG. 26.--SIDE INTERIOR VIEW OF CAR-HEATER REGULATING SWITCH.

weather. Fig. 25 shows a form of *regulating switch* of this character intended to produce five different strengths of current, and, therefore, five different rates of producing heat in the car. The side view of the interior of the switch is shown in Fig. 26; the front view of the interior of the switch in Fig. 27. This switch consists of a number of contact springs,

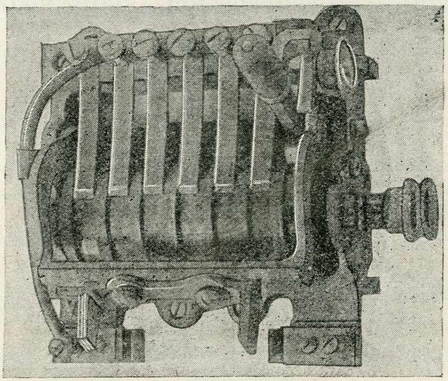

FIG. 27.—FRONT INTERIOR VIEW OF CAR-HEATING REGULATING SWITCH.

whereby, through the motion of a lever attached to the barrel, the proper connections can be made for coupling the coils in the five different arrangements required.

The connections from the switch to the trolley wire and the ground through the various heaters, is shown in Fig. 28. In position No. 1 all the coils are connected in series, so that the current has to pass through each in succession. This position

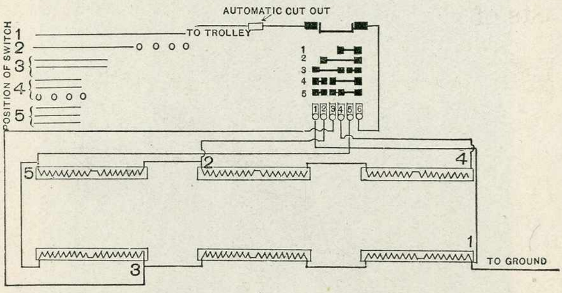

FIG. 28.—DIAGRAM OF WIRING FOR SIX ELECTRIC HEATER EQUIPMENT.

corresponds to the minimum current strength, about 2 amperes, and, therefore, to the minimum thermal activity, or rate of developing heat; namely, about one kilowatt. In position 2, two heaters are entirely cut out of the circuit, so that the resistance of the series being diminished, the current strength and activity in the remainder are increased, and the four active heaters will supply more heat to the car than the six heaters in the first case, the current being nearly 3 amperes, and the activity nearly 1500 watts. In the third position, the six heaters are connected in two series of 3 each, so that the current strength in each series is about twice that in the first position, or about $3\frac{1}{2}$ amperes in each series; *i. e.*, 7 amperes or 3.5 KW. in the combination. The fourth position connects two sets of two heaters and cuts out two heaters entirely. This gives about 4 amperes in each series, or 8 in the combination, representing 4 KW. In the fifth position, three rows of two heaters are employed, the current in each row being 4 amperes, or

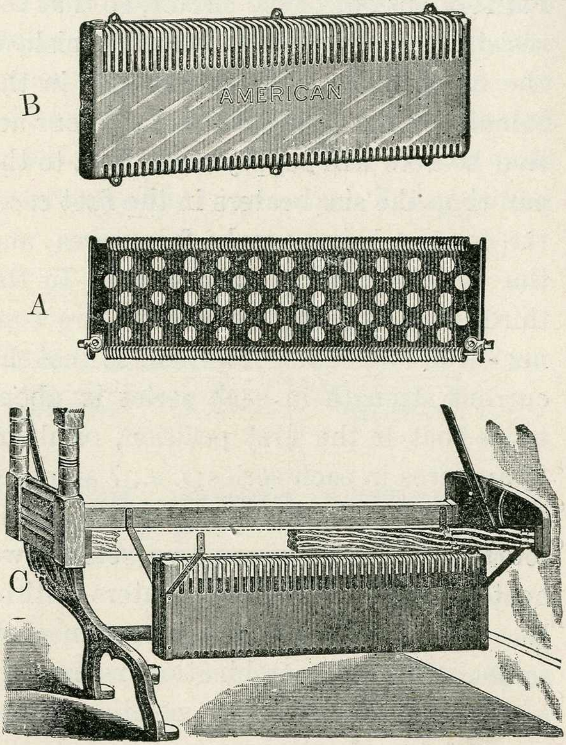

FIG. 29.—CAR-HEATER.

12 amperes in all, and the activity about 6 KW.

Another form of car-heater is shown in Fig. 29. Here the heating coil shown at *A*, consists of a wire wrapped in one long spiral around the insulated grid or frame. The heating coil is enclosed in a perforated iron cover shown at *B*, while at *C*,

Fig. 30.—Portable Air Heater.

the coil with its cover is shown in position below the car seat. Here the air enters the heater from the lower apertures and issues from those above, after passing over the heated wires, *Portable electric heaters*, as their name indicates, are so constructed that they may be readily carried and temporarily attached in any room where electric supply is obtainable. These are made in a

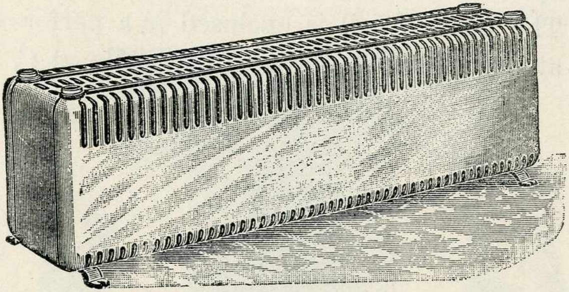

FIG. 31.—PORTABLE ELECTRIC HEATER.

variety of forms, but the principle in all cases is the same. A wire of suitable length and size is enclosed in the heater and free access given to it from the surrounding air. A form of cylindrical heater is represented in Fig. 30. Other forms of portable heaters are shown in Figs. 31, 32, 33 and 34. That shown in Fig. 33 is 26 in. long, 7 in. in height, and $10\frac{1}{2}$ in. wide, and is provided with three switches to regulate the temperature. A

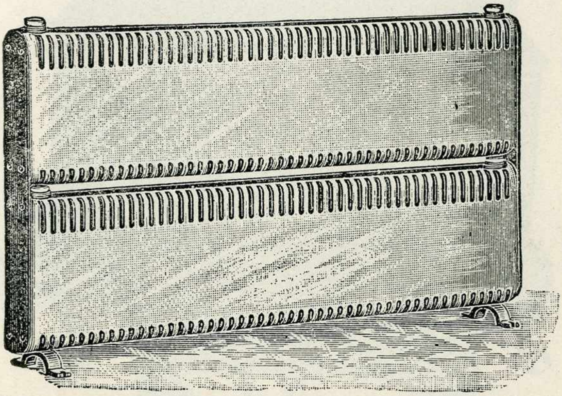

FIG. 32.—PORTABLE HEATER.

flexible attachment of the conductors to the heater is shown in Fig. 34. Fig. 35 represents a small stationary heater intended for attachment to a wall, corresponding, it may be, in position, to the ordinary hot-air register.

Figs. 36 and 37 show a form of electric heater suitable for office or house work.

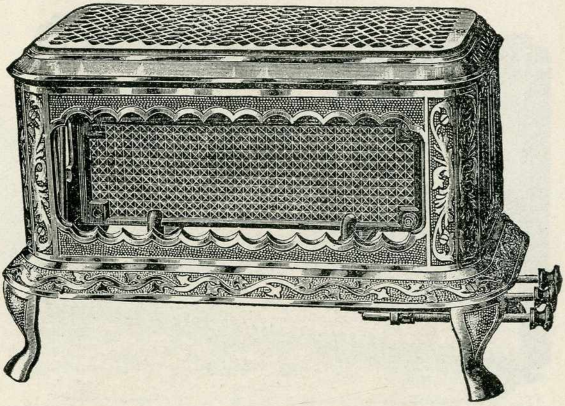

FIG. 33.—PORTABLE HEATER.

Fig. 36 shows the exterior, and Fig. 37, the interior of the apparatus. The heating coils, six in number, are essentially of the same type as those employed in connection with the car-heaters represented

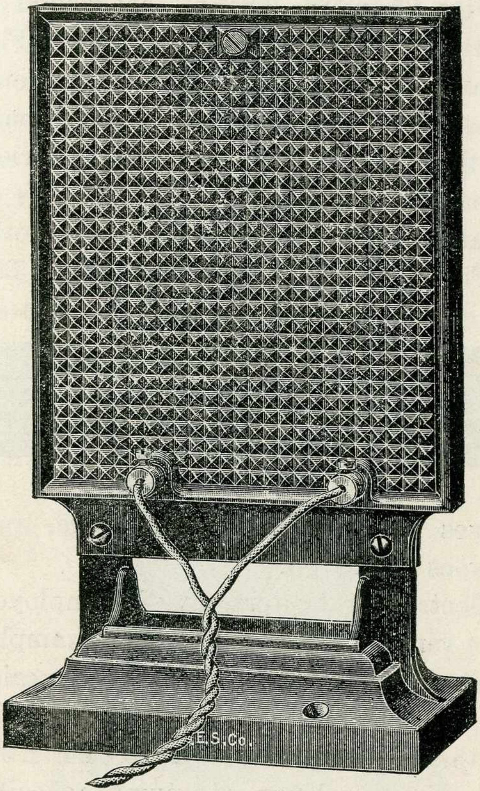

FIG. 34.—ATMOSPHERIC HEATER.

in Figs. 23 and 24. The coils are wound on vertical porcelain frames, as shown in Fig. 37, and are sometimes provided with a temperature-regulating switch in such a manner that they may be connected in series, or parallel-series, and so produce less or greater activity. The stove case shown in Fig. 36, is made of Russia iron. The air enters at the bottom of the heater,

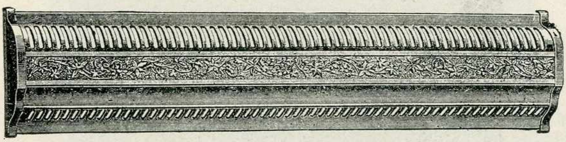

FIG. 35.—WALL HEATER.

passes up over the heated wire, and escapes at the top.

Electric air heaters may be employed for a variety of purposes, as, for example, for drying out the interiors of large caissons or tanks. A form of heater suitable for this purpose is represented in Fig. 38. It consists, as shown, of a number of coils,

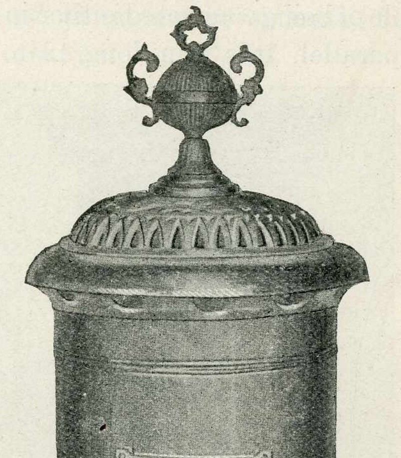

Fig. 36.—Portable Electric Heater.

capable of being connected either in series or in parallel. It is 33 in. long, 12 in. wide,

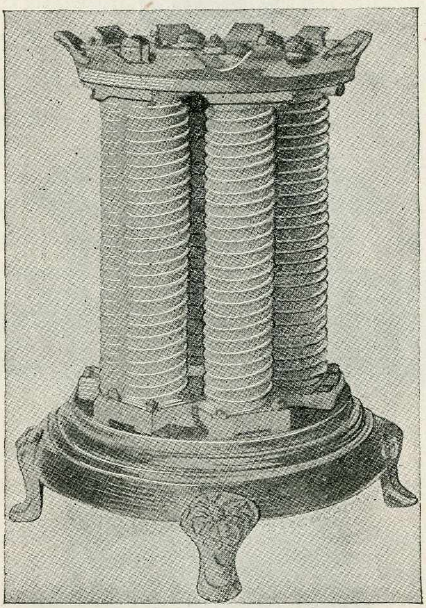

FIG. 37.—PORTABLE ELECTRIC HEATER, INSIDE VIEW.

7 in. in height, and is intended for a pressure of 110 volts with a maximum current

strength of 42 amperes; *i. e.*, a maximum activity of 4.62 KW.

As we have already seen, the product of the drop of pressure in a conductor and the current strength, equals the thermal activity in the conductor. Since in a heating coil, the drop is entirely of this

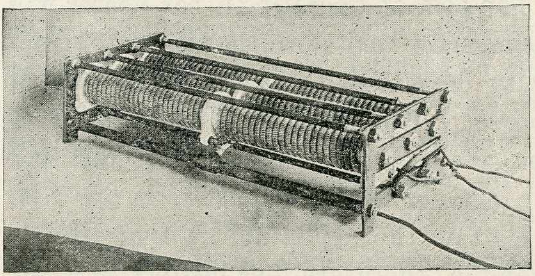

FIG. 38.—TANK HEATER.

nature, it is evident that all the energy of the current passing through the coil must appear in the circuit as heat, and all of this heat energy must be given to the external air on the cooling of the coil. Consequently, neglecting that small portion which is dissipated by conduction to the walls or floor, an electric air heater, as a device for converting electric energy into heat energy, may be regarded as a nearly perfect machine.

The cost of operating a car-heater will necessarily vary with the amount of activity developed in the car, and this, of course, will depend upon the number of amperes passing through the coils and the manner in which the coils are connected by the regulating switch. If, for example, there are four heaters in a car, and their resistance is 62.5 ohms each, then, when they are connected in series, the total resistance of the heating circuit will be say, 250 ohms. Assuming the pressure to be uniformly maintained at

500 volts, the current strength will be 2 amperes, and the thermal activity 1000 watts, or 1 KW. If the coils are connected in two rows of two each, the increased current which would flow through them would increase the resistance of each coil, by increasing its temperature, but assuming, for the sake of simplicity, that this increase of resistance is negligible, then the resistance of the coils, connected in two rows of two, will be 62½ ohms, and a current of 8 amperes will pass, making the activity 4000 watts, or four times as great as in the preceding case. It is, of course, impossible to determine from these figures alone what the temperature in the car will be, since the air is being renewed by ventilation, and by the occasional opening of the car door. Moreover, the temperature produced will vary with the temperature of the external air, the

speed of the car, and with the direction and intensity of the wind. Consequently, in practice, it is necessary to provide for a variable production of heat so as to meet the requirements of a variable climate. It is found that the average amount of current required to warm the car, except in extremely cold climates, is three amperes at a pressure of 500 volts, or $1\frac{1}{2}$ kilowatts. The cost of a KW. hour, when supplied from a large power station to an extended system of cars, is usually a little over one cent and a half, per kilowatt-hour delivered. At this estimate, the average cost of heating a car in the winter is about 2.25 cents per hour, or 40.5 cents per car-day of 18 hours. The cost is stated to vary from 25 cents to 50 cents per car-day of 18 hours, according to the number of cars and the nature of the weather. It has been stated, from actual measurement in Boston, that cars having two doors, 12 windows and 850 cubic feet of space can be heated to an average temperature elevation of 25° F. above the external air during severe wintry weather by an expenditure of 2.5 KW.

Leaving out of consideration, however, the cost of the electric heating of a car, the advantages this method possesses over heating by a coal or oil stove are considerable. A stove fails to produce that uniform temperature so necessary to the comfort of the passengers, the centre of the car being more powerfully heated than the ends. The electric heater warms the air near the floor of the car, where warmth is most agreeable. Moreover, the electric heater requires practically no attention, does not necessitate the removal of dust, ashes or coal, and occupies no paying space. Consequently, where electric cars are used, the electric heater is coming into extended use, not only on account of its greater popularity, but also on account of its convenience.

When it is desired to apply heat directly to the surface of the body, for such medical treatment as would ordinarily employ hot water bags, the object can be much more conveniently obtained by a suitably constructed electric heater than by any method which depends for its heat on material warmed while away from its body, since, in all such cases, the cooling of the material necessitates its repeated renewal. An electric heater, suitable for local application to the body, and called a *flexible electric heater*, is shown in Fig. 39, because constructed of materials which enable it to be brought into intimate contact with the surface to be heated. The heating coils *B*, are formed of German silver wire arranged as shown in the figure, placed on asbestos cloth and suitably insulated. The space

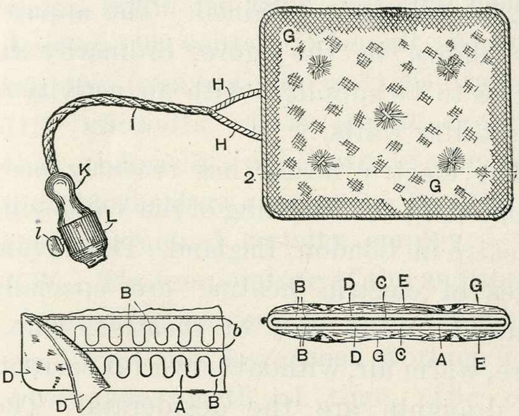

FIG. 39.—FLEXIBLE ELECTRIC HEATER.

surrounding the wires is filled with a solution of silicate of soda, which, on hardening, acts as a cement to hold the different parts together. A cushion, or flexible mass, is then made by packing mineral wool, or asbestos fibre, around the heating conductor and covering the mass with a suitable cover of cloth. The advantage of such a heater is that the heat can be readily maintained. The apparatus shown in the figure, ordinarily requires to be supplied with an activity of about fifty watts.

The electric heater has recently been adopted for the warming of the Vaudeville Theatre in London, England. The advantages of electric heating are specially marked in the case of theatres, where pure, warm air, without powerful currents or draughts are the desiderata. The heaters are two feet long and one foot wide. Twelve of these are attached to the skirtings round the walls, and twelve to the partition in front of the orchestra. Four large portable heaters are also employed with flexible attachments for use either in the centre of the theatre or at the sides. Each fixed heater takes a current of nearly 3 amperes, at 100 volts pressure, or develops an activity of nearly 300 watts, while the large, portable heaters develop 1200 watts. When all are working, the total activity is 11,400 watts or 11.4 kilowatts. It is stated, however, that, ordinarily, only two of the large portable heaters require to be used, so that the actual activity employed is 9 KW. The temperature of the auditorium is stated to be raised 20° F. by these heaters after they have been working for a reasonable length of time. The price charged being 8 cents per kilowatt-hour the cost of heating is 72 cents per hour, and to warm the theatre for four hours, $2.88.

It is similarly proposed to warm the stage by electric heaters to prevent the inrush of cool air into the auditorium when the curtain is raised.

To secure these results, it is only necessary to heat the air of the stage to practically the same temperature as that of the auditorium.

The advantages possessed by electric heating, already pointed out, are so marked in the case of the theatre, that with the general introduction of electric lighting into such buildings, their electric heating, either independently of or in conjunction with other methods of heating, is a possibility of the near future.

CHAPTER VII.

ELECTRIC COOKING.

ALTHOUGH, so far as its general electrical construction is concerned, an electric stove differs in no respect from an electric air heater, yet, there is this essential difference in the operation of these two pieces of apparatus; namely, that while the electric heater is so arranged as readily to impart its heat to a large volume of air in its neighborhood, the electric stove is so arranged that it can only impart its heat to a small volume of air confined in its interior. Consequently, for a given amount of heat produced, the air surrounding an electric heater acquires a temperature much lower than that within the stove.

Suppose any heating coil be taken, as, for example, the coil shown in Fig. 40, already described in connection with a car-heater in Fig. 24. Let us suppose that this coil has a resistance of 40 ohms (hot). If a current of three amperes be sent through it, the drop in the coil will be $3 \times 40 = 120$ volts, and the electric ac-

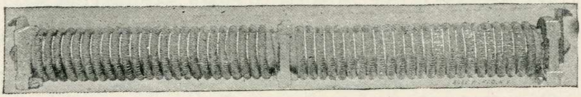

FIG. 40.—HEATING COIL.

tivity in the coil $3 \times 120 = 360$ watts, or nearly half a horse-power. This amount of heat is capable of raising the temperature of 20 cubic feet of air 1° F. per second. If this heater were placed at work in a closed chamber, the temperature acquired by the contained air would depend upon the volume of air. A large volume of air would acquire a lower temperature than a small volume of air. But the temperature attained would not depend only upon the volume of air in the chamber, but also upon the ability of the chamber to retain its heat, that is, to allow no heat to escape by conduction, radiation, or by convection, or open passages such as doors, windows, etc. For example, if the walls of the chamber were of cast iron, the temperature attained by the air within the chamber would be much lower than if the walls were thickly lined with some non-conductor, such as asbestos or felt. If, therefore, we know the volume of air in a chamber and also the rate at which heat escapes from it through walls or apertures, we have all the data necessary for the determination of the resulting temperature of the contained air.

An electric oven consists essentially of a small chamber, the air in which is practically isolated, the walls being nearly air-tight and lined with some non-conducting material, so as to retain the heat. Fig. 41 shows a form of electric oven provided with a wooden external case, lined on the inside with asbestos or felt, and covered on the inside with bright, tin plate, which being a good reflector, tends to prevent heat from being conducted through the walls. Two electric heating coils are shown within at *A* and *B*, respectively, one at the top and the other at the bottom of the oven. By means of the switch, shown at the right hand of the drawing, either or both can be operated. A thermometer is inserted through a small hole in the top of the oven, to show the temperature of the contained air.

Fig. 42 shows another form of electric

oven with three separate compartments and provided with a switch for operating

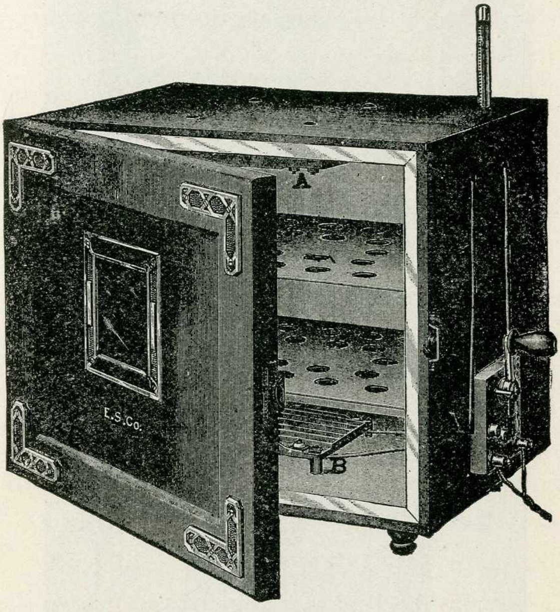

FIG. 41.—ELECTRIC OVEN.

the same. The large compartment is about 13 inches wide.

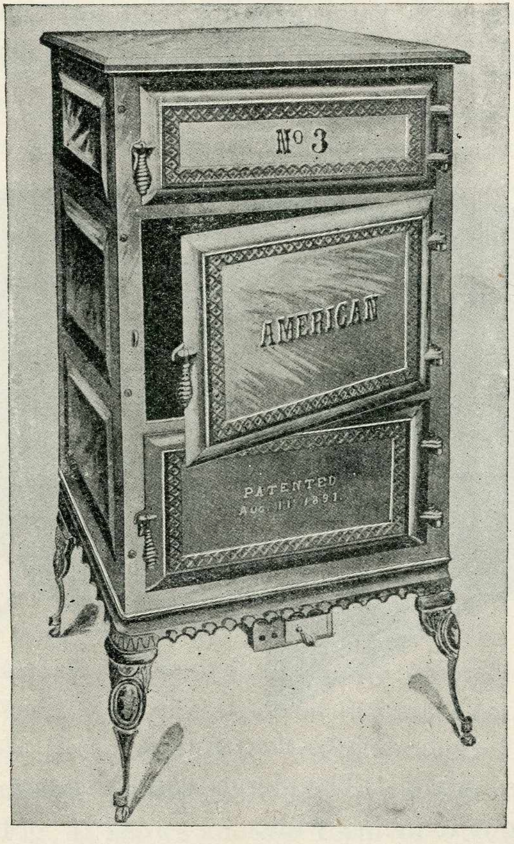

FIG. 42.—ELECTRIC OVEN.

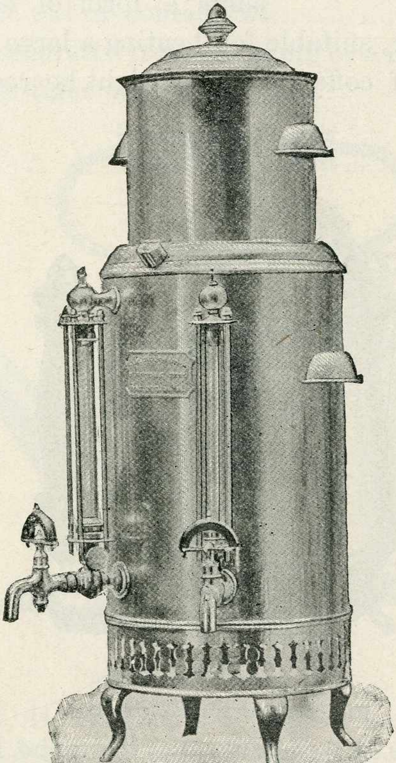

FIG. 43. ELECTRIC COFFEE HEATER.

Fig. 43 represents a form of electric heater, suitable for heating a large quantity of coffee such as might be required

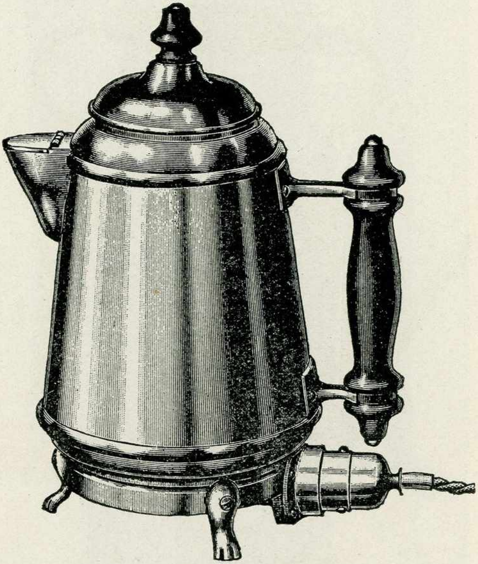

FIG. 44.—ELECTRIC COFFEE-POT.

for use in a restaurant. Here the heater coil is situated in the base of the apparatus, out of contact with the liquid, being separated from the same by a metallic, water-tight jacket.

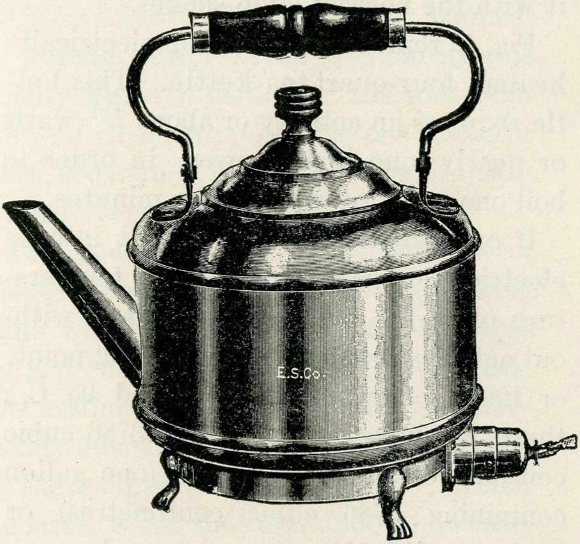

Fig. 45.– Electric Kettle.

Fig. 44 represents a form of coffee-pot intended to be heated electrically from a pressure of 50 or 100 volts, absorbing, approximately, an activity of 500 watts. The electric heater coil is contained in the base of the pot. A flexible cord connects it with the nearest lamp socket.

Fig. 45 represents a form of electrically heated, four-quart tea-kettle. This kettle requires an activity or about 700 watts or nearly one horse-power, in order to boil one quart of water in ten minutes.

If one gallon of water be put into an electric tea-kettle, at say, a temperature of 41° F. (5° C.) and be raised, without actually boiling, to the boiling point, or 100° C., it would be elevated 95° C.; there would be, consequently, 3786 cubic centimetres elevated 95° C., (one gallon containing 3786 cubic centimetres) or $3786 \times 95 = 359,575$ water-gramme-degrees-centigrade of heat produced. But one *calorie*, or a water-gramme-degree-centigrade, requires an expenditure of 4.18

joules, so that the work required to be done in raising a gallon of water to the temperature of its boiling point, would be $359,575 \times 4.18 = 1,503,000$ joules. The cost of electric power in large quantities is usually about 8 cents per kilowatt-hour (*i. e.*, one KW. supplied for one hour, or 3, 600, 000 joules), and, in very small quantities, 15 cents per kilowatt-hour.

At 8 cents per KW. hour, the cost of raising one gallon of water to the boiling point would be $3\frac{1}{2}$ cents. At 15 cents per KW. hour, the cost would be $6\frac{1}{4}$ cents. This assumes, however, that all the electrically developed heat is utilized in raising the temperature of the water, which of course, is not the case since some heat is lost. For example, if we start with cold water in a cold kettle, the metal in the kettle will have to be heated before its heat can be communicated to the water, and, although in an air heater, any heat, so absorbed in the mass of metal of the heater would be returned to the air; in a water heater, this would not necessarily be returned to the water heated; beside, during the time required for the heating of the water, which would be about fifteen minutes for one gallon, the air outside the kettle would be warmed and would carry away some of the heat. The proportion of useful heat developed to total heat developed; or, as it is called, the *efficiency* of the kettle, would probably be about 70 per cent. Therefore, the actual cost of heating a gallon of water would be, approximately, $3\frac{1}{3} \times \frac{100}{70} = 4\frac{3}{4}$ cents at 8 cents per kilowatt-hour, or nearly 9 cents at 15 cents per kilowatt-hour.

It is evident, from the preceding figures, that at the present price of electric power, the electric water heater could not be economically employed on a large scale. It is to be remembered, however, that these prices are for power obtained from a central station generating electricity from coal, through the intervention of steam engines, boilers and dynamos. With water power, the cost would, probably, be much less, and even with steam power, where it is employed under the particular conditions applying to street-car driving, on a large scale, the cost to the central station of a KW. hour is only about $1\frac{1}{2}$ cents.

The cost of power developed for street-car propulsion is less than that of power developed for electric lighting for several reasons. Among others, to its being more continuously used, and to its being manufactured on a larger scale for street railway purposes than for lighting purposes.

Fig. 46 represents a form of electric chafing dish in which the electric heat is generated from a resistance coil, placed in a water-tight compartment at the base, where the wires enter. The apparatus is designed to hold about one quart of water,

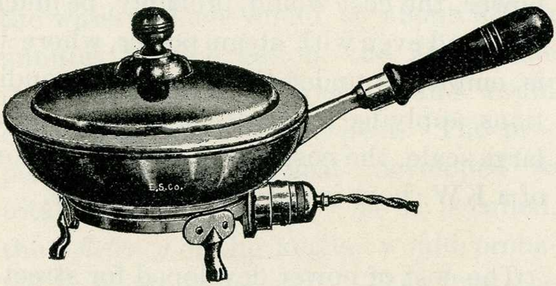

FIG. 46.—ELECTRIC CHAFING DISH.

and requires to be supplied with an activity of about 500 watts.

Fig. 47 represents an electrically heated stewing-pan for holding two quarts and designed for a supply of 700 watts.

It will be evident, from an inspection of the preceding figures, that, excepting the electric stove, all the different types of electric cooking apparatus are practically of the same construction. In each, an electric heating coil, embedded in a water-

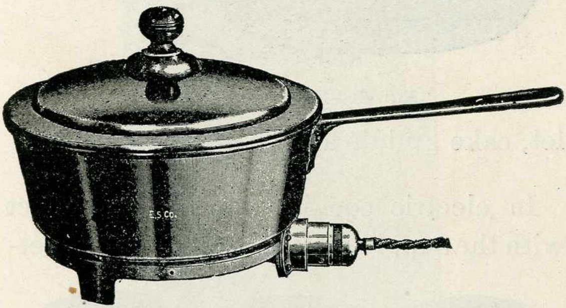

FIG. 47.—ELECTRIC STEWPAN.

tight manner, in a suitable part of the apparatus, supplies the heat that would otherwise be obtained from the ordinary coal stove or range. For the sake, however, of showing the convenience with which an electric heating coil or coils can be made to serve the necessities of the culinary art, Figs. 48, 49 and 50, representing respectively an electric skil-

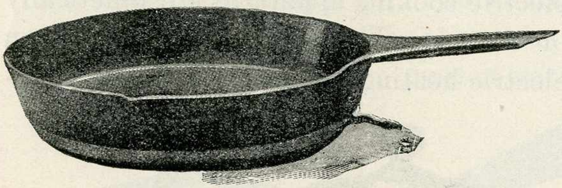

FIG. 48.—ELECTRIC SKILLET.

let, cake griddle and cooker, are shown.

In electric cooking apparatus contact with the supply mains is sometimes effect-

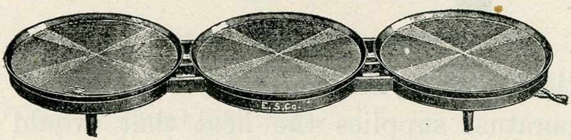

FIG. 49.—PANCAKE GRIDDLES.

ed by the ordinary screw plug. It is preferable, however, when much work of this character is to be done, to employ

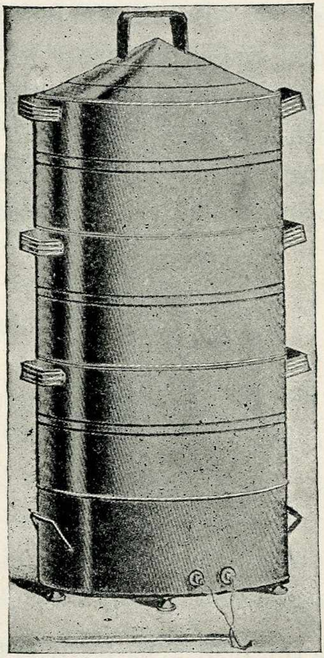

FIG. 50.—ELECTRIC STEAM COOKER.

special connectors for this purpose. Two forms of *plug-switches* for such purposes are shown in Fig. 51. One of these is for attachment to the wall, and consists of a disc of wood, or hard rubber, with a slot containing a pair of separate springs connected with the supply mains. The insertion plug fits into the socket and connects two terminals from the flexible cord

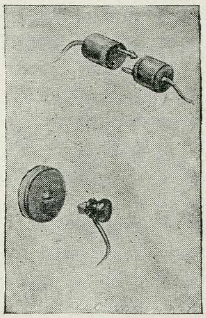

FIG. 51.—PLUG SWITCHES.

leading to the heater with the spring clip, thereby establishing the circuit.

The other switch shows a very convenient method for connecting together two pairs of flexible cords. Each flexible cord terminates in a cylindrical block of wood or rubber in which is a pin and hole. The pin is connected with one terminal and the spring metal lining of the hole with the other terminal of the supply mains. The opposite plug is similarly fitted and the two are united by placing the pins into the respective holes and pressing the two together.

Although much remains to be accomplished in the way of improvements in electric cooking apparatus, especially in the direction of producing suitable heating coils that will last indefinitely without deterioration or short-circuiting, yet it will be evident that the advantages arising from the use of electricity in the kitchen are sufficiently great to warrant the belief that this practical use of electricity will rapidly grow. An ideal kitchen, such as is capable of being furnished by apparatus already in existence, is

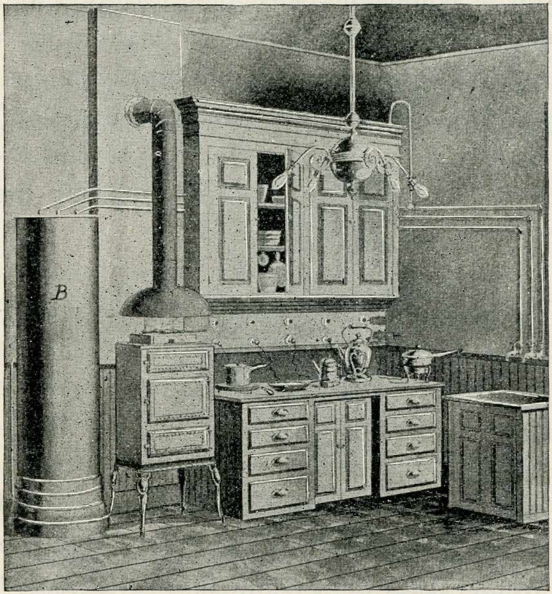

FIG. 52.—ELECTRIC KITCHEN.

shown in Fig. 52. Here an electrically heated oven is provided with a hood, not to carry off the smoke of the fuel, but the odors from the cooking viands. A switchboard enables the utensils on the table to be connected with the supply mains as desired. *B*, is a hot-water boiler in which water can be readily heated electrically.

As we have already pointed out, the electric heater, considered as a device for transforming electric energy into heat energy, may be regarded as an extremely efficient apparatus. This cannot be asserted to the same degree of electric cooking apparatus, since, in such apparatus, some of the heat is lost; *i. e.*, diverted from the material to be cooked, and supplied to the surrounding metal, air or water. Since, however, all electric heat is usually obtained by burning coal in a central station, the cost of the electric heat on a large scale is considerably greater than the cost of the heat necessary for the same amount of cooking by the direct use of fuel in an ordinary range.

The larger the scale on which cooking is carried out, the greater the economical advantage of an ordinary fuel range over an electric range.

Under all circumstances, however, the electric heater is the more convenient and the more cleanly apparatus, and, when employed on a small scale for cooking, is often more economical than a coal range. Consider, for example, the ease of preparing a cup of coffee by electric heating. Here, there is only required the generation of an amount of heat slightly in excess of that required to bring the water to the boiling point. Contrast this with the amount of fuel required to bring a cooking range to the temperature at which it can boil water. As regards convenience everything is in favor of the

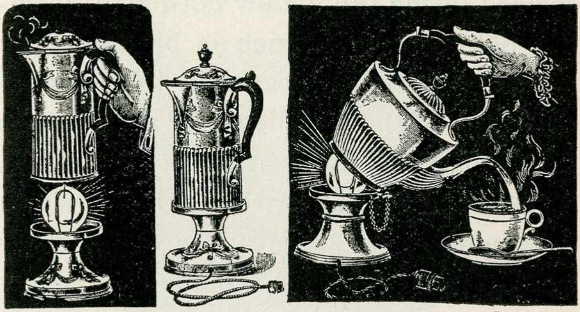

FIG. 53. —SIMPLE ELECTRIC HEATER.

electric heater, since it requires only the closing of an electric circuit, which may be even done from another room, while bringing the range into use, requires the lighting of a fire.

A simple form of electric heater is represented in Fig. 53. Here the heat is obtained from an incandescent lamp, of size proportionate to the requirements of each case. As will be seen, the lamp is placed inside the hollow bottom of a coffee pot or kettle, which is blackened so as to absorb the heat. In this way 75 per cent. of the heat liberated by the lamp is utilized in the heating of the water. It is claimed that in the form shown, a 50-candle-power lamp, of say 200 watts activity, will heat 2½ pounds of water to the temperature of boiling point in 25 minutes, and that when the water is at its boiling point it can be maintained at this temperature by the activity of a 16-candle-power lamp (about 50 watts), and in some cases even less.

Beside the uses we have already

pointed out, of comparatively small electric currents for heating in connection

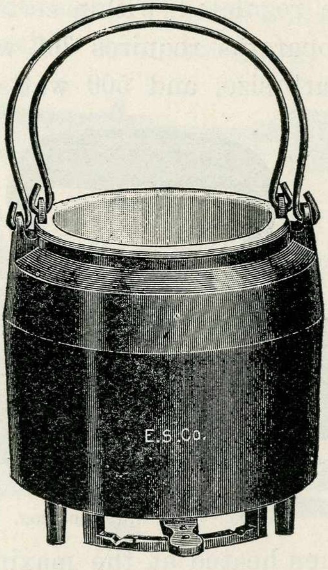

FIG. 54.—ELECTRICALLY HEATED GLUE-POT.

with heaters in cooking apparatus, a number of others might be mentioned. For example, Fig. 54 represents an electrically heated glue-pot, with a switch at the base, whereby the strength of current may be regulated within certain limits. This apparatus requires 700 watts for a one quart size, and 500 watts for pint

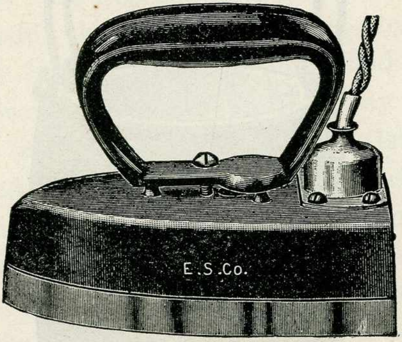

FIG. 55. —ELECTRIC SAD IRON.

size, when heated at the maximum rate. A much smaller activity is necessary to keep the glue hot when once melted.

Fig. 55 represents a sad iron, requiring about 250 watts for its operation, Fig. 56, a sealing-wax heater, and Fig. 57, a curling-tong heater. The sad iron is operated by a flexible cord attachment, but some

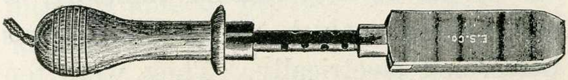

FIG. 56.—SEALING WAX HEATER.

forms are made in which the sad iron is free from electric connections and is merely laid upon an electrically heated

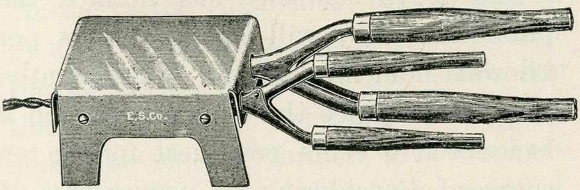

FIG. 57. —ELECTRIC CURLING-TONGS HEATER.

plate in order to acquire its heat by conduction.

As an illustration of what can be effected in the direction of electric cooking we may mention a banquet recently given in London, England, by the directors of an electric lighting company, to 120 guests, in which all the cooking was performed electrically. They were ten courses, which required for their preparation a total expenditure of energy of 60 kilowatt-hours, or on an average of one half a kilowatt-hour per guest.

The above company has notified the public that they will charge 8 cents per kilowatt-hour for cooking. Consequently, this would place the expense of such a banquet at 4 cents per guest for the ten courses. Considering the convenience of the process this charge cannot be regarded as exorbitant.

An electrically cooked banquet was not a possibility in the time of Franklin, yet a banquet at which electricity played no insignificant part is thus humorously described by him in a letter written in 1769: "Chagrined a little that we have been hitherto able to produce nothing in the way of use to mankind; and the hot weather coming on, when electrical experiments are not so agreeable, it is proposed to put an end to them for this season, somewhat humorously, in a party of pleasure on the banks of the Schuylkill. Spirits, at the same time, are to be fired by a spark sent from side to side through the river, without any other conductor than the water; an experiment which we some time since performed, to the amazement of many. A turkey is to be killed for our dinner by the electrical shock, and roasted by the electrical jack, before a fire kindled by the electrical bottle; when the healths of all famous electricians, in England, Holland, France, and Germany, are to be drank in electrified bumpers, under the discharge of guns from the electrical battery."

It may be of interest to our readers to note in this connection, that Dr. Franklin was not devoid of imagination, as may be gathered from a remark he makes concerning the turkey and other birds so killed:

"He conceited himself that the birds killed in this manner ate uncommonly tender."