Feb. 12, 1935. L. P. HYNES 1,991,280

ELECTRIC HEATER

Filed Dec. 1, 1930 5 Sheets-Sheet 1

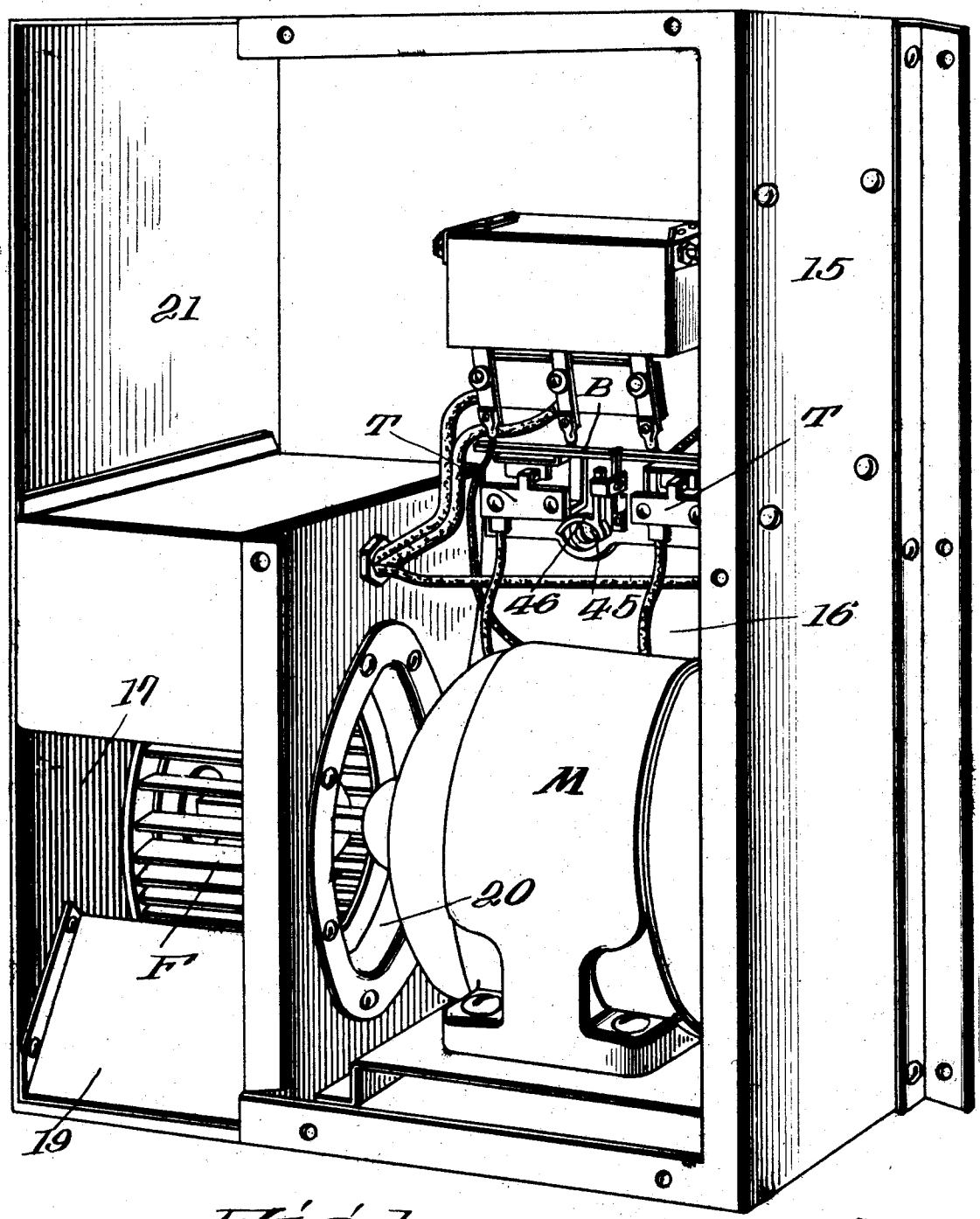


FIG. 1.

Inventor
Lee P. Hynes

By E. M. Bentley

Attorney

Feb. 12, 1935. L. P. HYNES 1,991,280

ELECTRIC HEATER

Filed Dec. 1, 1930 5 Sheets-Sheet 2

Fig. 2.

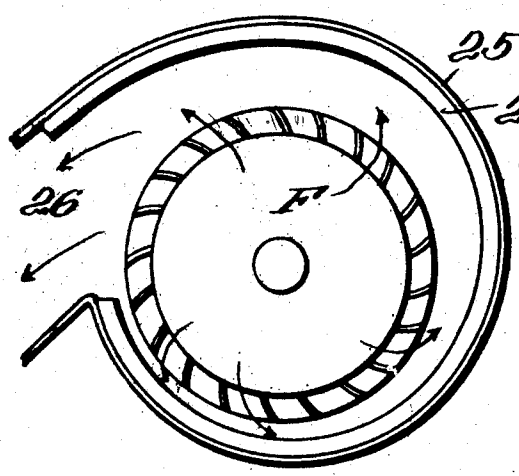


Fig. 3.

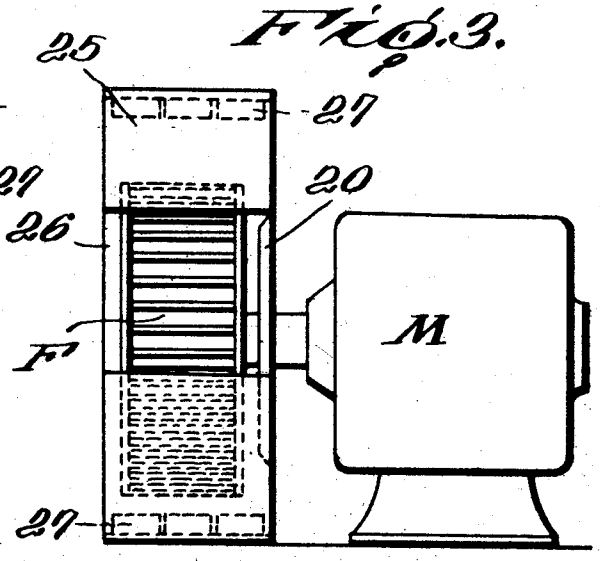


Fig. 4.

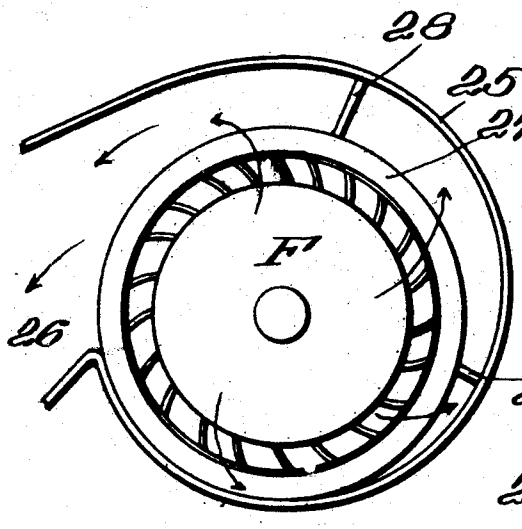
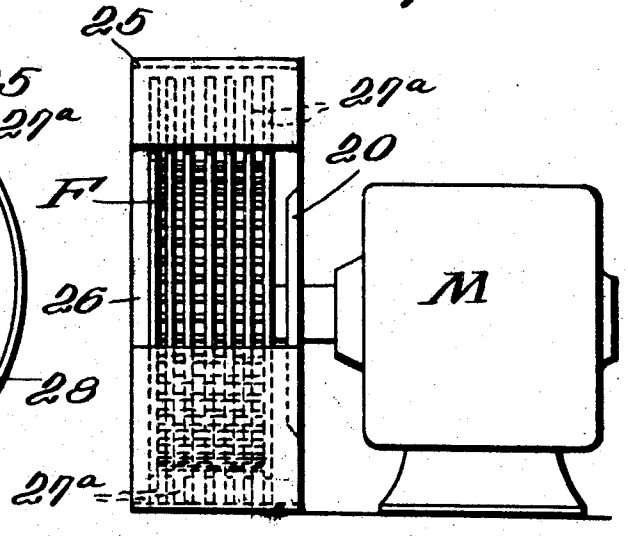


Fig. 5.



Lee P. Hynes Inventor

By E. M. Bentley

Attorney

Feb. 12, 1935. L. P. HYNES 1,991,280

ELECTRIC HEATER

Filed Dec. 1, 1930 5 Sheets-Sheet 3

Fig. 6.

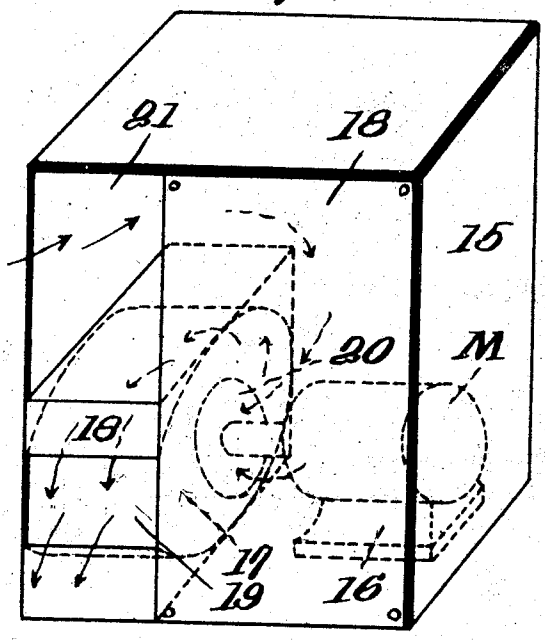


Fig. 7.

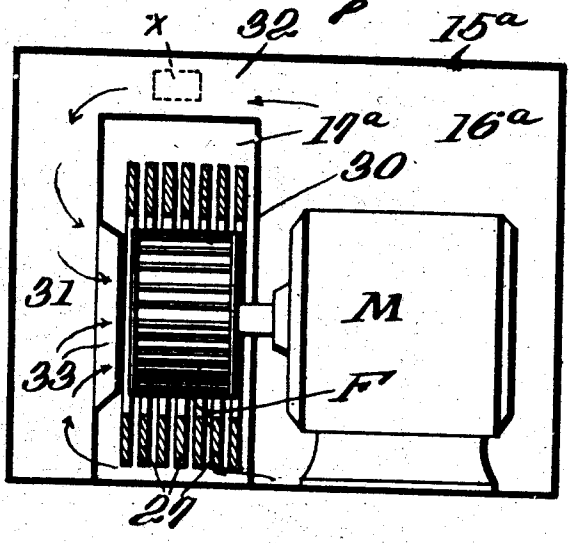


Fig. 8.

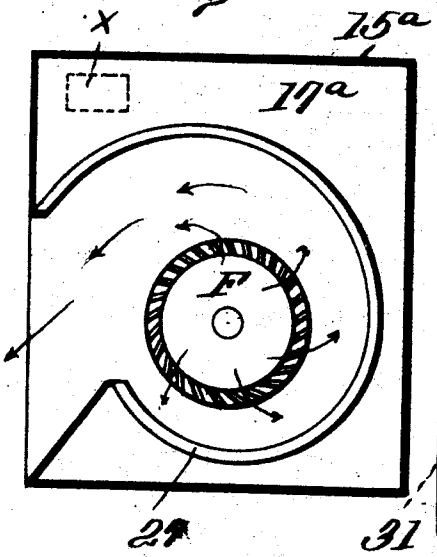
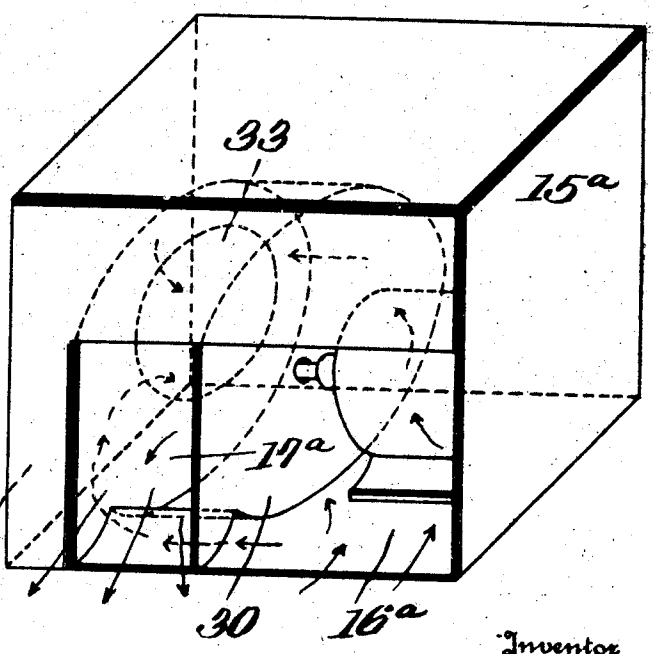


Fig. 9.



Inventor

Lee P. Hynes

By E. M. Bentley

Attorney

Feb. 12, 1935. L. P. HYNES 1,991,280

ELECTRIC HEATER

Filed Dec. 1, 1930 5 Sheets-Sheet 4

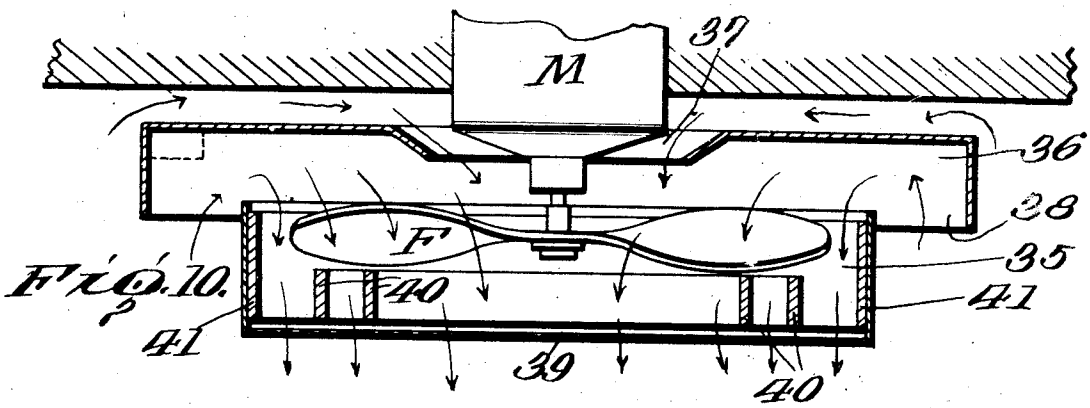


Fig. 10.

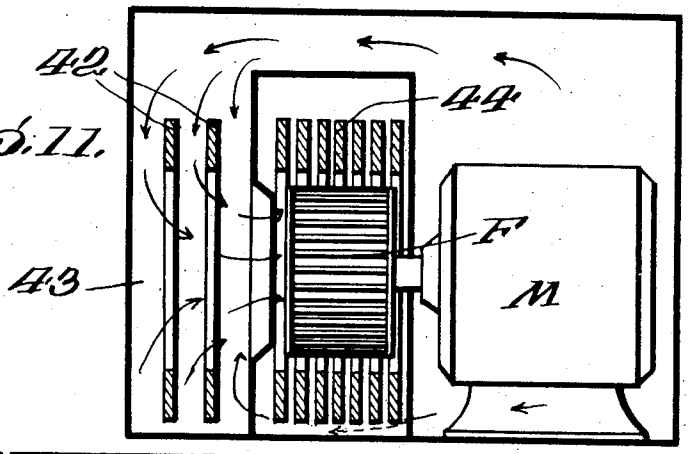


Fig. 11.

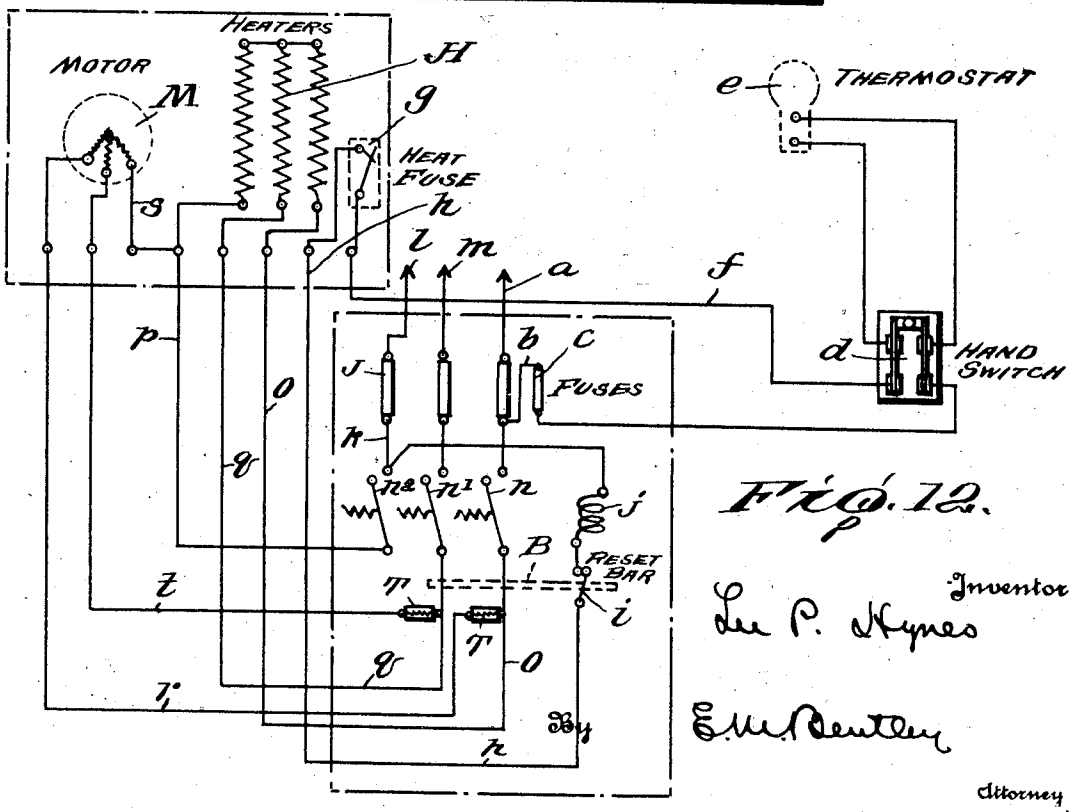


Fig. 12.

Inventor
Lee P. Hynes

By E. M. Bentley

Attorney

Feb. 12, 1935. L. P. HYNES 1,991,280

ELECTRIC HEATER

Filed Dec. 1, 1930 5 Sheets-Sheet 5

FIG. 13.

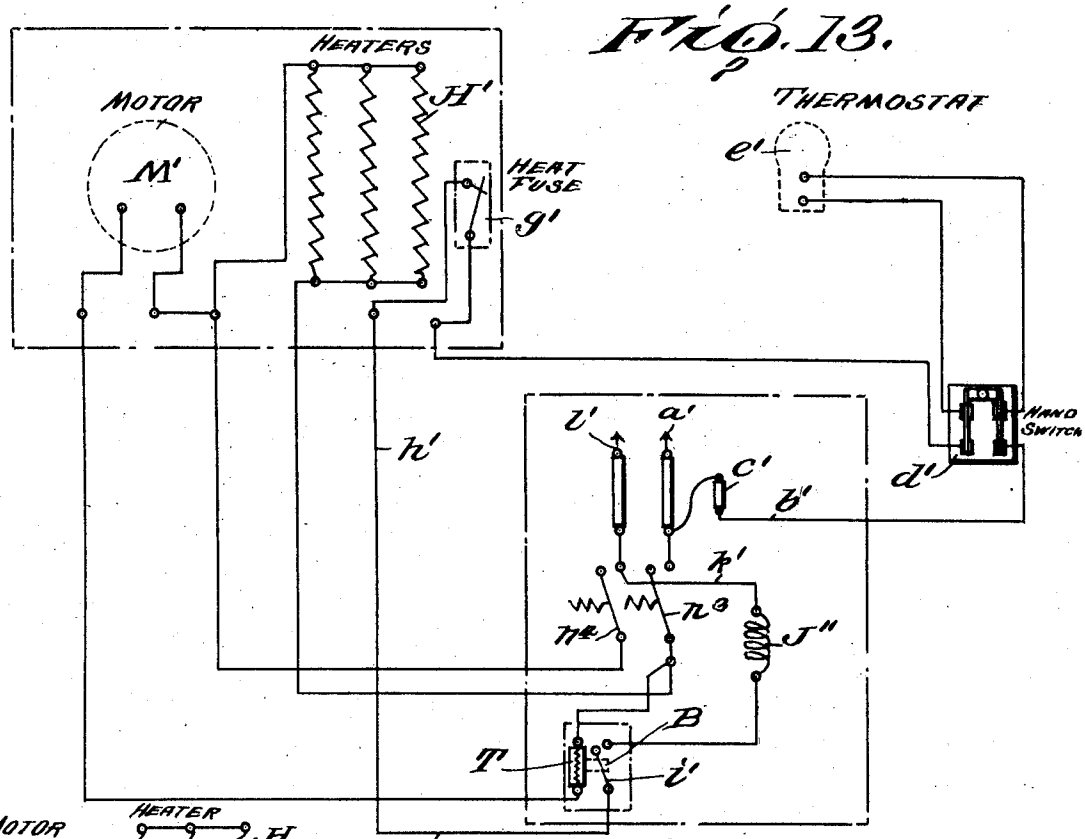
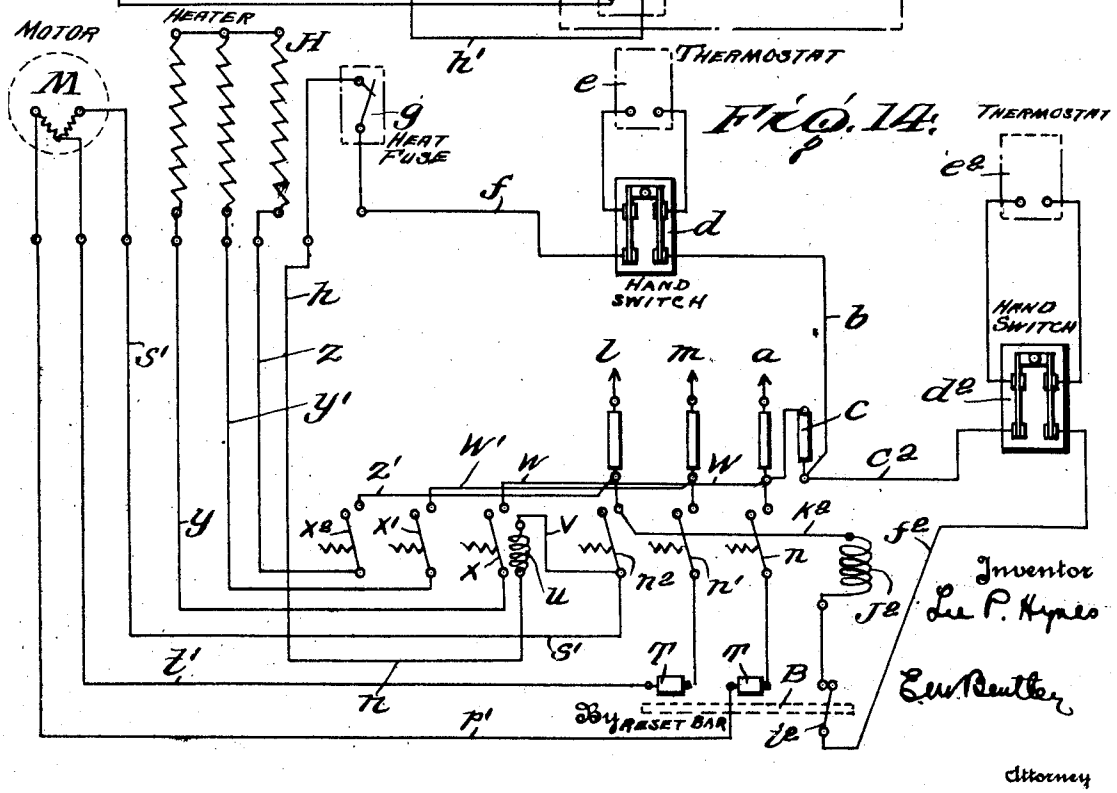


FIG. 14.



Patented Feb. 12, 1935 1,991,280

UNITED STATES PATENT OFFICE

1,991,280

ELECTRIC HEATER

Lee P. Hynes, Philadelphia, Pa.

Application December 1, 1930, Serial No. 499,368

28 Claims. (Cl. 219—39)

This invention is an electric heater of the type wherein heating elements are located within a casing, through which air is forced by a fan, so as to insure a circulation of heated air.

In the operation of electric heating apparatus of the type above mentioned, there is always danger that the heater will destroy itself by building up a destructive temperature, if the fan for any reason fails to operate. One of the objects of the invention is to overcome this objectionable condition, by providing safety means for automatically shutting off the current to the heater, if for any reason there is a failure of the motor circuit or an undue rise of temperature within the heating chamber.

With a three phase motor, it is undesirable to put the motor circuit through the usual emergency fuse, commonly placed in the heater circuit as a last resort protection. This is because it is not good practice to allow the heater to build up excessive temperatures within the casing, to the degree necessary to blow the heat fuse. In other words, the heat fuse should be an emergency feature of last resort, in case all other safety factors fail, and therefore not utilized in any other way. Aside from this, however, there are conditions which might damage the motor, but which would not be prevented by any form of temperature fuse located in the heating chamber. For instance, some external fuse on the line might blow, or some loose connection might produce a single phase condition on the three phase motor, in which event the motor would be damaged and burned out, unless the circuit was cut off in a short time. In view of the above, a further object of the invention is to provide a safety control, not dependent upon the heat fuse normally employed as a final safety factor, but so constructed and arranged that the circuits to the heater and to the motor will be automatically broken, in the event of a failure of the motor circuit, or an overheating of the heater coil, or both. A further object is to provide a heater of the character mentioned equipped with a heater of low storage capacity, so that the normally employed heat fuse may be placed close to the heater coils, and set at a relatively small margin above its normal temperature, thereby insuring much better protection. A further object is to provide a simple and novel form of heater.

The invention will be hereinafter fully set forth and particularly pointed out in the claims.

In the accompanying drawings:—

Figure 1 is a perspective view illustrating an electric heating apparatus constructed in accordance with the invention. Figure 2 is a diagrammatic sectional view. Figure 3 is a diagrammatic front elevation illustrating a novel form of electrical heater. Figures 4 and 5 are similar views illustrating a modified form of heater. Figure 6 is a diagrammatic perspective view illustrating the circulation of the air through the heater. Figures 7, 8 and 9 are diagrammatic views illustrating a modified system of air circulation. Figures 10 and 11 are diagrammatic views illustrating other modifications of the heating device. Figures 12 and 13 are diagrammatic views illustrating the heater and fan circuits for three phase and single phase motors, respectively, with the safety control means applied thereto. Fig. 14 is a similar view illustrating a modified circuit.

Referring to the drawings, and particularly to Figures 1 and 6, 15 designates a casing which may be constructed of any suitable or desired material, and provided with a motor chamber 16 and a heating chamber 17. The front of the motor chamber is closed by a suitable cover 18, which is shown broken away in Figure 6. The front wall of the heater chamber is provided with an outlet opening 19, and the wall between the two chambers is provided with an air inlet opening 20, through which the shaft of motor M extends, so as to rotatably support the fan or blower F, within chamber 17. Air enters the casing 15 through the opening 21 formed in the space above the heater chamber 17, and passing through the motor chamber 16 is introduced into the heating chamber through the opening 20 (see Figure 6). It will be noted that a certain amount of the radiated heat from the heating elements is intercepted by the wall between the chambers, and transmitted by said wall to the air within the chamber 16 before it passes to the heating chamber through the opening 20. The said wall also serves to protect the motor from the radiant heat.

Any preferred form of electrical heater may be employed, but a desirable form is illustrated in Figures 2 to 5, both inclusive. Referring to said figures, the fan F is placed within the usual type of scroll casing 25, provided with an outlet opening 26, normally registering with the outlet opening 19 of the casing, the inlet opening 20, above mentioned, being in the side of the casing. Located inside of the scroll casing 25 are heating elements 27, which, in the forms illustrated in Figures 2 and 3 each consisting of a plurality of flat electric heater elements arranged edge to edge in parallel relation, in such manner as to conform to the contour of the inner surface of the scroll casing 25, and also to partially encircle

the periphery of the fan F. In operation, as the fan is revolved by the motor, air is drawn in through the opening 20, and is then thrown outwardly at all points by the centrifugal force, so that the outthrown air will impinge upon the heating elements and become heated, being finally driven out through the opening 26. By placing the thin heating elements 27 around the inside of the scroll, they are exposed to the direct impinging air current and rapidly heat the air.

In the form illustrated in Figures 4 and 5, the heating elements 27^a are similarly arranged flat units, supported by suitable arms 28, within the casing 25, and concentric with respect to the fan F. By means of this arrangement, the fan causes air currents to move in a radial direction between the heater elements and in contact with the heated surfaces thereof, before being discharged into the atmosphere.

An advantage of either type of heater thus far described is that the heating elements radiate a considerable amount of heat into the fan wheel itself, because radiant heat is not absorbed directly by the air. All of the radiant heat that escapes from the internal curve of the heater elements strikes directly toward the center, into the rapidly moving fan wheel, which becomes an ideal medium for transferring the heat to the air, because the wheel has every portion of its exposed area under a maximum frictional contact with the air travelling through the heating chamber.

In the modifications illustrated in Figures 7, 8 and 9 the casing 15^a is divided into the motor chamber 16^a and heating chamber 17^a, but the wall 30 between said chambers is closed, except for an opening just large enough for the passage of the motor shaft. The motor, fan and heating elements may be arranged according to any of the forms described in connection with the preceding figures. In Figure 7, however, the heating means is shown as consisting of a plurality of parallel circular disks having central openings through which the fan extends. The disks are laterally spaced with respect to each other but axially with respect to the heater chamber, so that their flat surfaces are radially positioned with respect to the fan shaft. In Figure 8 the heater elements 27 are of the same type as those illustrated in Figures 2 and 3.

As will be more readily understood from Figure 7, the heating chamber 17^a is located between the motor chamber 16^a and an air circulating chamber 31, which connects the motor chamber 16^a by a passage 32. The wall between the circulating chamber 31 and the heating chamber 17^a is provided with an opening 33 through which air is introduced into the heating chamber. By this arrangement, the air enters the motor chamber 16^a, and passes around the heater chamber through passage 32 to the chamber 31, and thence through opening 33 into the heating chamber. The heated air is expelled in the usual way, being preliminarily heated before it enters the heating chamber. By this arrangement, a highly satisfactory transfer of heat at low heater temperatures is accomplished, because it allows a concentrated heat source without wasting space. The forms of heater thus far described also have the advantage that the fuse X, normally placed in the heater circuit, as a safety factor, may be placed within the casing which houses the various parts. It should also be observed that the heating elements 27, which are shown in Figures 2 and 3 as forming a lining for the inner surface of the scroll casing 25, are shown in Figure 8 as themselves constituting the scroll without the surrounding casing 25.

In Figure 10 is shown another modified form of heater for attachment to ceilings, or other overhead supports. In this form the heater chamber 35 is formed of a suitably shaped casing depending from an air supply chamber 36 of larger diameter, suspended from a ceiling or other support in any desired manner. The motor M is also suitably supported so that one end extends through an opening 37 in the top wall of chamber 36, which is spaced from the ceiling, as shown. The fan F is mounted on the motor shaft and positioned to operate within the heater chamber 35. The heater consists of a plurality of annular heater elements 40 and 41 arranged concentrically with respect to each other, and with respect to the axis of the motor shaft, being spaced apart so that air circulated by the fan may pass between the respective heater elements. In other words, the surfaces of the heater units extend parallel with each other and with the axis of the fan, the element 41 in effect constituting an annular wall of a heating chamber which is located concentrically around the fan. It will be observed that the elements 41 are positioned so as to enclose the fan, while the elements 40 are positioned below the fan. The heaters 40 may be omitted without departing from the spirit of the invention. In operation, air is drawn through the opening 37 and also through the peripheral space 38 between the chamber 36, and the heater ring 41, and is discharged downwardly in a manner which is obvious from the drawings. A suitable screen 39 covers the lower part of casing 35. The upper wall of chamber 36 is so positioned as to intercept radiant heat from the heating means within the chamber. A two-fold result is thereby obtained, first, to protect the motor from the radiant heat of the heating elements, and second, to pre-heat the air flowing over and in contact with said wall, before it passes through the opening 37 into the heater chamber. By surrounding the fan with the heater means 41, radiant heat is also transmitted to the fan and transferred thereby to the air current passing through the heating chamber. It is to be understood that Figure 10 is purely diagrammatic, and no attempt has been made to illustrate the details of structure by means of which the various parts are supported, it being obvious to those skilled in the art that this may be done in various ways.

In Figure 11 is another modification in which additional heating elements 42 are placed within the inner chamber 43 leading to the fan chamber 44. By this arrangement, the air is heated as it is drawn into the fan chamber.

It will be noted that in the forms illustrated in Figures 1, 6, 7, 8, 9 and 10, the various chamber walls around the heater are naturally heated by the radiant heat thrown out by the heater units which are exposed within the heating chamber, so that the air entering the fan chamber or heating chamber is pre-heated by passing over and in contact with said walls before being drawn into the heating chamber. In each instance, the fan is also heated by radiant heat from the heater units, and a part of this heat is also transferred to the air stream as it sweeps over the fan blades.

Referring to Figure 12, the motor M is of the three phase type. The lead-in wire *a*, which is connected with a suitable source of energy is

provided with a branch *b* which leads through a fuse *c* to a manual switch *d*, located within a suitable control box diagrammatically illustrated. Included in the heater circuit is a standard type thermostat *e*, which is connected with the switch *d*, so that while said switch is in circuit closed position, the thermostat will control the circuit. From the switch *d* a conductor *f* leads through a standard type of heat fuse *g* to protect the heater circuit, and thence by a conductor *h* through the safety switch *i*, to the coil *j* which forms part of an electromagnetic device controlling switches *n*, *n'* and *n2*, the functions of which will be later described. A wire *k* leads from the coil *j* to the outlet terminal *l*.

The terminal *a* is also connected by means of the switch *n* with the heater through wire *o*, the return wire *p* leading to the outlet terminal *l* through switch *n2*. The terminal *m* is connected by the switch *n'* to the heater through the conductor *q*, and the return is also through wire *p*, switch *n2* and terminal *l*. The arrangement is such that while current is passing through the magnetic coil *j*, the switches *n*, *n'* and *n2* are maintained in circuit closing position, against the tension of springs tending to open them, so that the heater is in circuit with the source of energy.

The conductors *q* and *o* are also connected by branch wires *r* and *t* respectively, with the motor M, the return being through wire *s*, which connects with the conductor *p*, and through the switch *n2* to the terminal *l*. The branch wires *r* and *t* are provided with thermally responsive devices T, which control the operation of the safety switch *i*, and through said switch the magnetic coil *j*. Any preferred type of thermal control safety device may be employed, but it is preferred to use a well known thermal overload relay device now on the market and illustrated conventionally in Figure 1 of the drawings. In this device the thermal overload relay is of the melting alloy type having a mica insulated heating element of nichrome wire or ribbon. The alloy is contained in a cup or cylinder 45 back of the heating element into which the stem of a control ratchet 46 extends. This ratchet normally engages a reset bar B, which is connected to the safety switch *i*. Said bar is normally under spring tension tending to move the bar and the switch in a direction to open the circuit, and the ratchet is arranged to normally hold the bar in a neutral position against the spring tension. When an overload occurs, the thermal unit gradually rises in temperature finally melting the alloy and allowing the stem of the ratchet wheel to turn, releasing the reset bar B, so that the spring tension applied to said bar will cause it to move the switch *i* to the circuit breaking position, thereby deenergizing the coil *j* and permitting the switches *n*, *n'* and *n2* to move to open circuit positions.

In operation, with the circuit closed through the switch *d*, the device is of course under the control of the thermostat *e*, so that the operation of the motor is governed by the temperature of the room. If, however, the motor should stop for any reason, as for instance the blowing of an external fuse on the line, or some loose connection, or a break in one of the conductors, a condition would be created which would throw the motor out of operation, whereupon the tendency of the heater is to build up the temperature to a destructive point. In a short time the heater temperature builds up sufficiently to melt the alloy, and thereby releases the bar B, thereby effecting the opening of all circuits. After repairs have been made or the defective condition otherwise corrected, the thermal alloy having cooled, the switches may be reset by moving the bar B back until it is reengaged by the ratchet.

In Figure 13 the same thermal control is shown as applied to a single phase motor. In this arrangement the terminal *a'* is connected through the fuse *c'* and wire *b'*, with the switch *d'* and and thermostat *e'*, fuse element *g'*, and return wire *h'*, safety switch *i'*, magnetic coil *j'*, wire *k'*, and terminal *l'*, all in the same manner as the corresponding parts in Figure 11. The terminals *a'* and *l'* are also connected by switches *n3* and *n4*, the switch *n4* controlling the return from the heater. The thermal relay element T is connected with the switch *n3* by means of a wire leading to the motor, both the motor and the heater circuits returning through the switch *n4* and the terminal *l'*. The operation of the parts is identical in the two systems, the only difference being in the number of poles in the control and the number of wires to the heater.

In the form of the invention illustrated in Figure 14, the lead-in wire *a*, branch *b*, fuse *c*, manual switch *d*, thermostat *e*, conductor *f*, fuse *g*, return conductor *h* and terminal *l* are the same as in the form illustrated in Figure 12. The conductor *h* is connected with the terminal *l* through a magnetic coil *u*, conductor *v* and switch *n2*. The terminal *a* is also connected by a conductor *w*, switch *x* and conductor *y* to one of the coils of the heater H, the return being through conductor *z*, switch *x2* and conductor *z'* to the terminal *l*. In a similar manner the terminal *m* is connected by a conductor *w'*, switch *x'* and conductor *y'* to another coil of the heater, the return being through the conductor *z*, switch *x2*, conductor *z'* to terminal *l*. It will be observed that the magnetic coil *u* controls the operation of the switches *x*, *x'* and *x2*, so that while said coil is energized the circuit is closed to the heater, and upon deenergizing of said coil the circuits to the heater are automatically broken. It will also be observed that the coil *u* is controlled by the switch *n2*.

In addition to the thermostat and hand switch above described, a second thermostat *e2* and hand switch *d2* are provided, for controlling the circuits to the fan motor M. The switch *d2* is connected with the terminal *a* by a conductor *c2*, and the thermostat *e2* is suitably connected with the switch *d2* in an obvious manner. Leading from the switch *d2* is a conductor *f2*, connected by a safety switch *i2* with one terminal of a magnetic coil *j2*, the other terminal of said coil being connected by wire *k2* with the terminal *l*. Said coil *j2* controls switches *n*, *n'* and *n2* in a manner similar to the control described in connection with Figure 12. The switch *n'* connects the terminal *a*, by means of conductor *t'* with the motor M, the return being through wire *s'*, switch *x*, wire *w* and terminal *l*. The terminal *m* is connected by switch *n'*, through conductor *t'*, with the motor M, the return being through wire *s'*, switch *n2* to terminal *l*. The thermally responsive devices T are placed between the switches *n*, *n'* respectively and the conductors *r'* and *t'* respectively, the control device including the reset bar B, being practically the same as that described in connection with Figure 12.

From the foregoing, it will be noted that separate magnetically-controlled switches are provided for the fan motor and the heater coils respectively, but that they are so interlocked that

each one is controlled by a separate thermostat or by a separate hand switch, as desired. It will be observed, however, that under no conditions can the heaters receive current unless the motor is running, but that on the contrary, the motor and the fan may run without heat. This will appear from the operation which is as follows:—

The thermostat *e* is preferably placed at the heater inlet and may be set for any desired temperature, and controls its circuit in the same manner as described in connection with Figure 12. The thermostat *e2* is located in the room where a uniform temperature is to be maintained, and operates at whatever temperatures it is set for, to stop and start the fan, by energizing or deenergizing the coil *j2*, as the case may be. If the room temperature drops to the predetermined minimum, assuming the switch *d2* to be closed, the circuit is closed so that current flow is from terminal *a*, conductor *b*, fuse *c*, conductor *c2*, switch *d2*, thermostat *e2*, conductor *f2*, safety switch *i2*, coil *j2*, conductor *k2* and terminal *l*. The closing of this circuit energizes the coil *j2*, thereby closing the switches *n*, *n'* and *n2*.

While the circuit is closed through the switches *n*, *n'*, *n2*, a branch circuit to the heater is also maintained from terminal *a* by means of conductor *w*, switch *x*, and conductor *y*, the heater, and returned by conductor *z*, switch *x2*, conductor *z'* to terminal *l*. At the same time, the terminal *m* is connected with the heater by means of conductor *w'*, switch *x'*, conductor *y'* and returned through conductor *z*, switch *x2*, conductor *z'* to terminal *l*.

Should the temperature rise above the predetermined medium in the vicinity of the fan, the circuit will be broken by the thermostat *e*, thereby deenergizing the coil *v*, and permitting the switches *x*, *x'* and *x2* to automatically move to open circuit positions, thereby shutting off all current flow to the heater. The fan motor, however, is unaffected by this operation. Again, assuming that the fan motor and the heaters are normally operating with all the circuits closed, if the room temperature rises to a predetermined normal position the thermostat *e2* operates to break the circuit through the coil *j2*, and deenergizing of said coils permits the automatic breaking of the circuits through the switches *n*, *n'* and *n2*, thereby opening the circuits to the heater coils. As soon as the circuit is broken at switch *n2*, the coil *v* is deenergized, thereby permitting the switches *x*, *x'* and *x2* to move to circuit breaking positions, thereby opening the circuits to the fan. Assuming the parts to be in normal operating positions with the circuits closed, if there is an overheating, such as effects the operation of the thermally responsive control, the bar B will break the circuit by moving switch *i2* to open circuit position, thereby deenergizing the coil *j2* and breaking the circuits at switches *n*, *n'* and *n2*. The moving of the switch *n2* to open circuit position automatically deenergizes the coil *u* and breaks the circuits to the heaters through switches *x*, *x'* and *x2*.

What I claim is:—

1. In an electric heater, a fan chamber wall formed of a plurality of flat members, each member being constructed and arranged as a complete heater unit independent of the other units, said heater elements being arranged laterally with respect to each other and axially with respect to the chamber.

2. In an electric heater, a fan chamber wall formed of a plurality of flat members, each member being constructed and arranged as a complete heater unit independent of the other units, said units being arranged edge to edge and in parallel relaiton.

3. In an electric heater, a fan chamber wall formed of a plurality of flat members, each member being constructed and arranged as a complete heater unit independent of the other units, said heater elements being arranged laterally with respect to each other and axially with respect to the chamber, said heating elements being provided with exposed flat surfaces so positioned as to reflect heat radially into the chamber.

4. In an electric heater, a fan chamber wall provided with a plurality of parallel flat annular heating elements arranged in concentric relation, said heating elements being also arranged laterally with respect to each other and axially of the chamber.

5. In an electric heater, a fan chamber wall formed of a plurality of flat electric heater elements arranged in parallel relation, said heater elements being arranged laterally with respect to each other and axially with respect to the chamber, and means constructed and arranged to control the flow of conducted and radiant heat to an air stream traveling over both surfaces of said wall.

6. In an electric heater, a fan chamber wall formed of a plurality of flat electric heater elements arranged edge to edge and extending in lines parallel to the direction of air flow through said chamber.

7. In an electric heater, a casing having a heating chamber, a plurality of parallel flat heater elements within said chamber, said heating elements being arranged laterally with respect to each other and axially with respect to the chamber, in such manner as to provide a fan chamber, a fan within said fan chamber, a motor within said casing, and a wall in said heating chamber located between the motor and the heating elements so as to intercept radiant heat which tends to pass to the fan motor.

8. In an electric heater, a casing having a fan chamber wall provided with a plurality of parallel electric heater units concentric with the axis of the fan, said heater units being arranged laterally with respect to each other but axially of the chamber, a fan within said chamber, a motor for said fan, and a wall interposed between the fan and the motor and positioned to intercept radiant heat.

9. In an electric heater, a casing, a fan chamber within the casing, parallel flat electric heater elements within said fan chamber, said heating elements being arranged laterally with respect to each other but axially with respect to the chamber, and also constructed and arranged to heat a portion of the chamber wall by radiation, a blower located within said fan chamber, a motor for said fan, and means within said casing constructed and arranged to direct a stream of air over the heated surface of the fan chamber, and thence through the fan chamber in direct contact with said heater elements.

10. In an electric heater, a casing, a fan chamber within the casing, a plurality of flat parallel electrically heated air directing members within the fan chamber, said heater members being arranged laterally with respect to each other but axially with respect to the chamber, and also constructed and arranged to heat a portion of the chamber wall by radiation, a blower located

within said fan chamber, a motor for said fan, and means within said casing constructed and arranged to direct a stream of air over the heated surface of the fan chamber and thence through the fan chamber in direct contact with said heater elements.

11. In an electric heater, a casing, a fan chamber within the casing, a plurality of flat heater elements surrounding said fan and arranged in parallel relation, said heater elements being arranged laterally with respect to each other but axially with respect to the chamber, and also constructed and arranged to heat a portion of the chamber wall by radiation, a blower located within said fan chamber, a motor for said fan, and means within said casing constructed and arranged to direct a stream of air over the heated surface of the fan chamber and thence through the fan chamber in direct contact with said heater elements.

12. In an electric heater, a casing, a fan chamber within the casing, laterally spaced flat heater elements within said fan chamber, said heater elements being arranged laterally with respect to each other but axially with respect to the chamber, and also constructed and arranged to heat a portion of the chamber wall by radiation, a blower located within said fan chamber, a motor for said fan, and means within said casing constructed and arranged to direct a stream of air over the heated surface of the fan chamber and thence through the fan chamber in direct contact with said heater elements.

13. In an electric heater, a casing, a fan chamber within said casing, a plurality of parallel electric heater elements within said fan chamber, said heater elements being arranged laterally with respect to each other but axially with respect to the chamber, and also constructed and arranged to heat a portion of the chamber wall by radiation, a blower located within said fan chamber and positioned to be heated by radiation from said heater elements, a motor for the fan, and means within said casing constructed and arranged to direct an air stream over the heated surface of the fan chamber and thence through the fan chamber in direct contact with said heater elements and said fan.

14. In an electric heater, a casing, a fan chamber within said casing, a plurality of flat parallel heater elements within said fan chamber, said heater elements being arranged laterally with respect to each other but axially with respect to the chamber, and also constructed and arranged to heat a portion of the chamber wall by radiation, a blower located within said chamber, a motor for said fan, means within said casing constructed and arranged to direct an air stream over the heated surface of the fan chamber, and thence through the fan chamber in direct contact with the heater elements, and a shield interposed between the heating elements and the motor and positioned to intercept radiant heat from said heater elements.

15. In an electric heater, a scroll-shaped chamber for a centrifugal fan having its periphery formed of a plurality of flat members, each member being constructed and arranged as a complete heater unit independent of the other units, said units being supported edge to edge and interposed between the side walls of the chamber.

16. In an electric heater, a casing, a fan mounted to rotate within said casing, a plurality of flat parallel annular electric heater elements located within said casing and concentric to the fan wheel, said heater elements being arranged laterally with respect to each other but axially with respect to the chamber, said fan being constructed and arranged to discharge air radially over said heating elements, and partitions arranged to intercept radiant heat and conduct it to an air stream passing through said casing.

17. In an electric heater, a fan chamber having a curved wall constructed of thin flat heater strips arranged in parallel relation to direct the air flow, an air intake chamber, a motor within said intake chamber, and means constructed and arranged to direct a flow of cool air over the motor, the outer surface of the curved fan chamber and into the fan chamber on the side opposite the motor and then around the inside of the fan chamber wall to an outlet.

18. In an electric heater, a casing, a wall composed of thin curved flat heater members dividing the casing into chambers, a rotor within the inner chamber having surfaces exposed to radiant heat from said wall and adapted to create an air stream, and means constructed and arranged to direct the air stream from the other chamber over the outside surface of the electrically heated wall, over the surface of said rotor, then over the inside surface of the electrically heated wall.

19. In an electric heater, a casing, a heating chamber within the casing formed of a scroll-shaped wall composed of thin flat heater strips arranged in parallel relation, a centrifugal fan wheel within said heating chamber, a partition within the casing spaced from the surface of the heating chamber at a position to intercept radiant heat therefrom, and means cooperating with said fan and constructed and arranged to force an air stream over the exterior of said heater strips and to cause the air stream to then pass over the inside surfaces of said heater strips.

20. In an electric heater, a casing, a heating chamber within the casing, the wall of which is constructed of a plurality of thin flat electric heating members arranged in parallel relation, a centrifugal fan wheel in heat-receiving proximity to said heating members, partitions within said casing spaced from the heating members and positioned to direct the flow of an air stream through said casing, said partitions being so positioned that the air stream will absorb heat therefrom.

21. In an electric heater, a casing, an internal fan chamber of scroll shape, the wall of which is formed of a plurality of parallel flat heater elements, a centrifugal fan wheel within said fan chamber, means for directing an air stream over the exterior of said heater surfaces before it is drawn into said fan chamber, and means constructed and arranged to intercept radiant heat rays and to conduct their heat energy into the air stream.

22. In an electric heater, a casing, annular flow directing partitions composed of flat parallel electric heating elements and forming a fan chamber, a fan within said chamber, a motor for said fan, said motor and said fan being concentric to the axis of the annular members, and means constructed and arranged to direct an air stream over both sides of the heating members and the interior walls of said casing.

23. In an electric heater, a casing having an inlet chamber, a heating chamber provided with parallel walls formed of annular flat electric heater elements, a fan within said heating chamber, means constructed and arranged to direct

the air flow over both sides of each wall, means to intercept radiant heat and to convey it to the air stream, and means to heat the air before and after passing the fan wheel.

24. In an electric heater, a casing having an air chamber and a heating chamber in communication with each other, a fan within the heating chamber, and electrical heating means also within the heating chamber, said heating means being spaced from and surrounding the fan, said heating means and said fan being so relatively positioned, constructed and arranged that radiant heat emanating from the heating means is absorbed by the fan and transferred by the fan to the air stream passing through the chambers.

25. In an electric heater, a heater chamber having an air inlet opening in one wall thereof, a motor positioned outside of said chamber and having a shaft projected through said opening, a fan mounted on said shaft and located within said chamber, and heating means within the chamber and so positioned as to surround the fan, said heating means and said wall being so relatively positioned, constructed and arranged that radiant heat from the heater means is intercepted by said wall and transmitted to the air flowing in contact with said wall and entering said chamber through said opening.

26. In an electric heater, a chamber having air inlet and air outlet openings, a motor located outside of the chamber and having its shaft extended into the chamber, a fan mounted on the motor shaft and located inside of said chamber, a plurality of thin flat circular heater rings supported within the chamber in positions parallel with each other and concentric to the fan, and a wall positioned to shield the motor from radiant heat emanating from said heater rings, said fan, said heater rings and said shield being so positioned, constructed and arranged that air flowing through said chamber will pass radially over the surfaces of the heater rings and also pass over other surfaces which are heated by radiant heat, so as to conduct the radiant heat into the air stream.

27. An electric heater comprising a motor, a fan driven thereby, a cylindrical electrically heated wall spaced concentrically around the periphery of the fan in such manner as to constitute a fan chamber, said fan and said wall being so relatively positioned that the fan blades will intercept radiant heat emanating from said wall, means for guiding a flow of cool air around the motor into the fan chamber, means for shielding the motor from radiant heat emanating from said wall, said last mentioned means being so positioned as to heat the air flow as it enters the fan chamber, and a protection enclosure for the motor fan and cylindrical wall, said enclosure having air inlet and air outlet openings.

28. An electric heater comprising a casing having a wall provided with an air inlet opening, a motor located adjacent said inlet opening and having its shaft projected therethrough, a fan mounted on said shaft, a heating chamber of annular cross section located within said casing, means for heating the wall of said heating chamber, said heated wall being located concentrically around the fan in such spaced relation that the fan will absorb radiant heat emanating from said heated wall and transmit it to the inflowing air, means associated with said air inlet opening for causing the entering air to create a cooling airflow over the motor, said casing wall, the heated wall of the heating chamber and the fan motor being so positioned with respect to each other that the casing wall protects the motor from radiant heat emanating from said heated wall and transfers said heat to the entering air stream, and a protective closure wall for said casing.

LEE P. HYNES.