Feb. 4, 1941. E. L. WIEGAND 2,230,440

ELECTRICAL HEATING MEANS

Filed Sept. 7, 1939 4 Sheets-Sheet 1

Fig. 1.

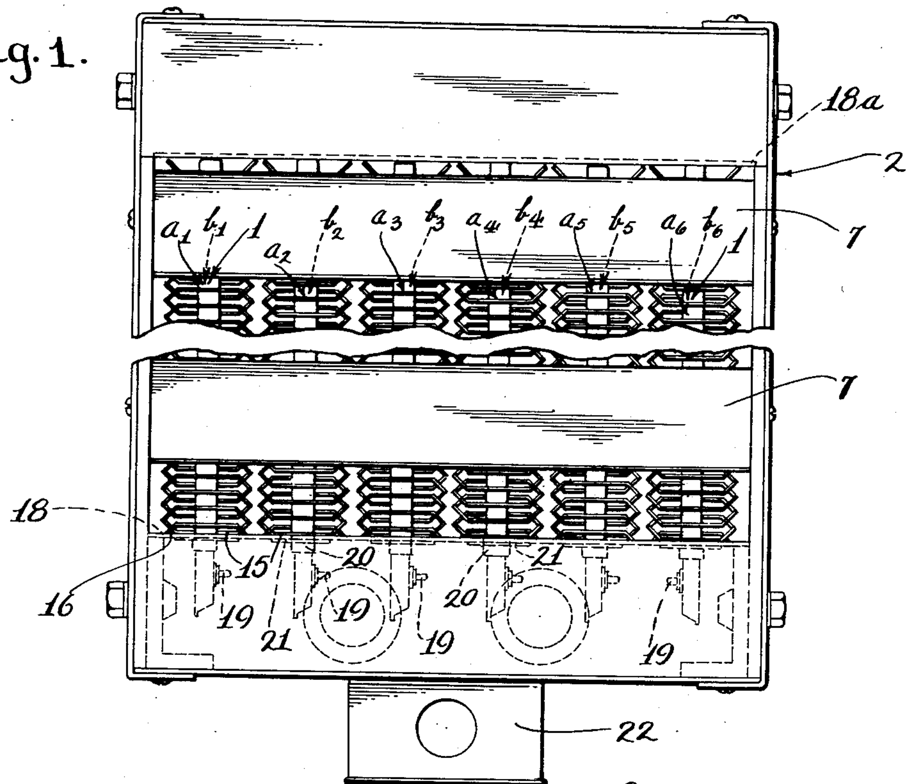
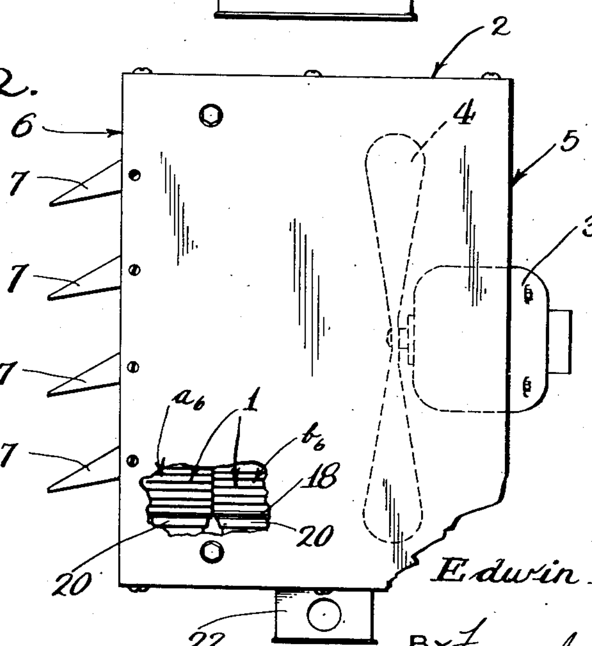


Fig. 2.



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ELECTRICAL HEATING MEANS

Filed Sept. 7, 1939 4 Sheets-Sheet 2

Fig. 3.

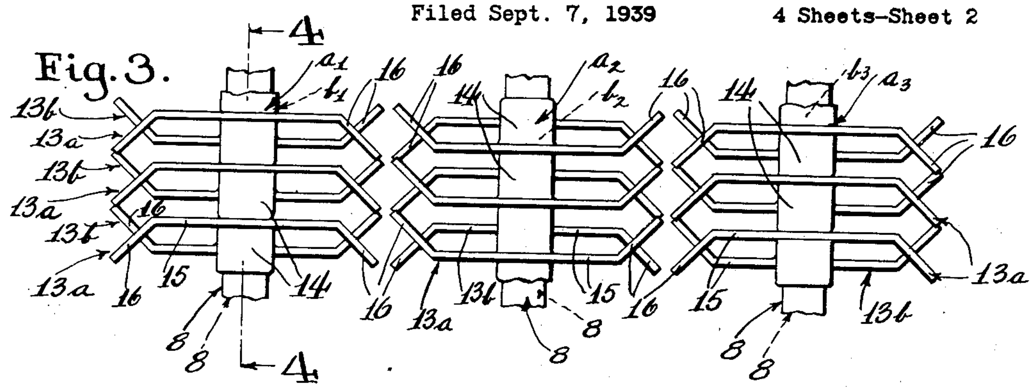


Fig. 4.

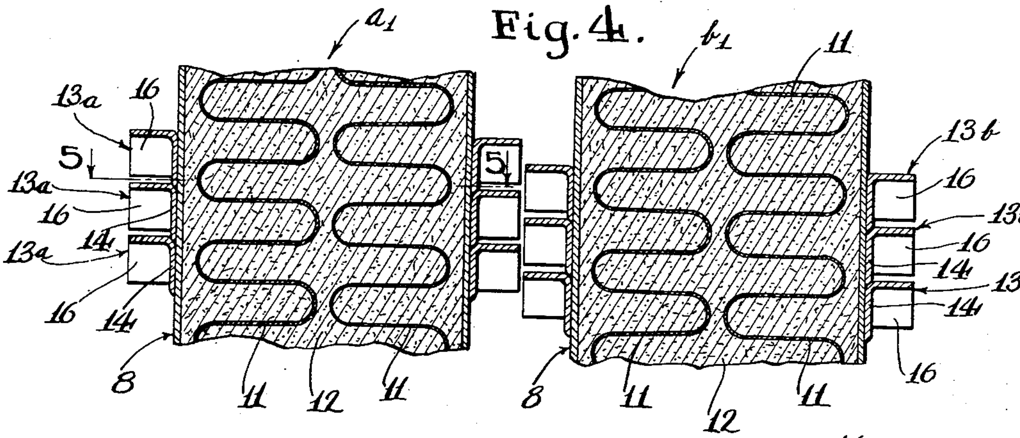


Fig. 5.

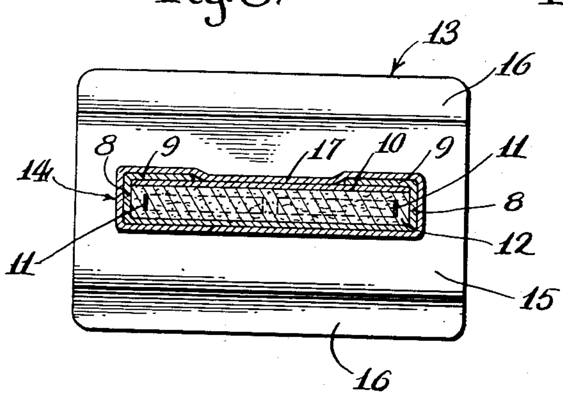
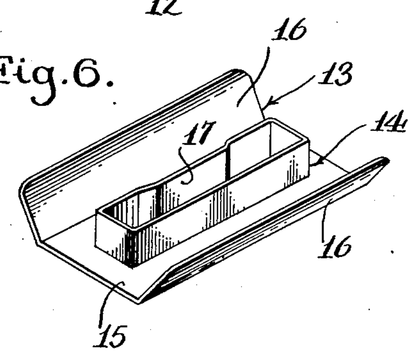


Fig. 6.



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ELECTRICAL HEATING MEANS

Filed Sept. 7, 1939　　4 Sheets-Sheet 3

Fig. 7.

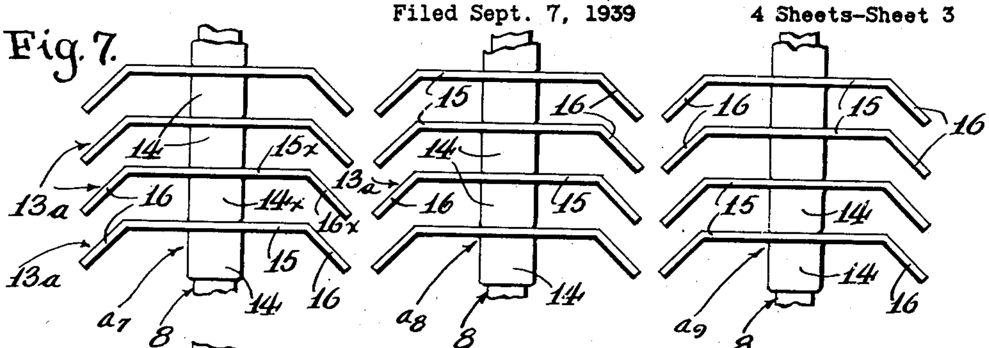


Fig. 8.

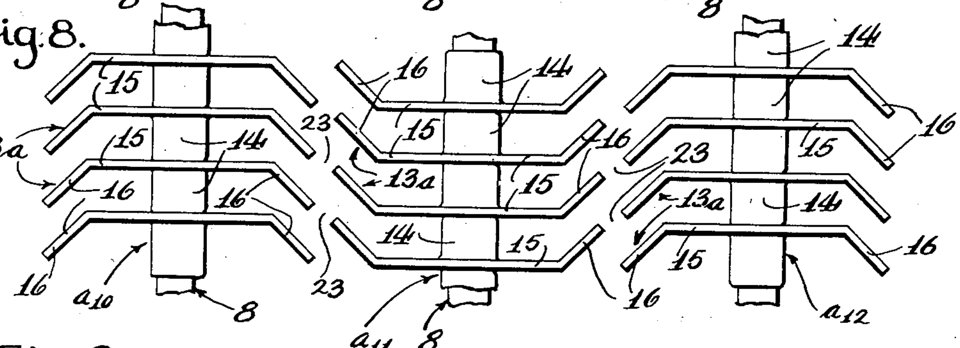


Fig. 9.

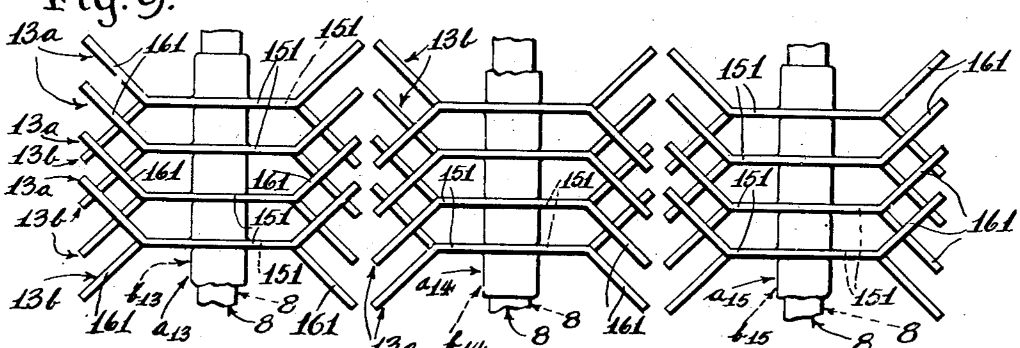
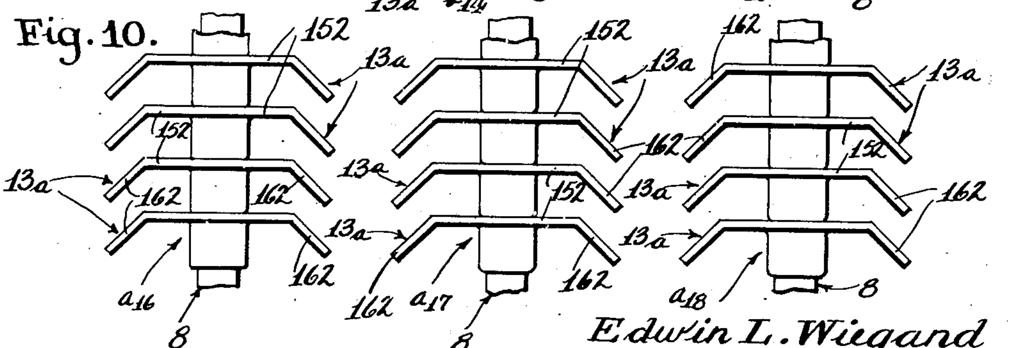


Fig. 10.



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Feb. 4, 1941. E. L. WIEGAND 2,230,440

ELECTRICAL HEATING MEANS

Filed Sept. 7, 1939 4 Sheets-Sheet 4

Fig. 11.

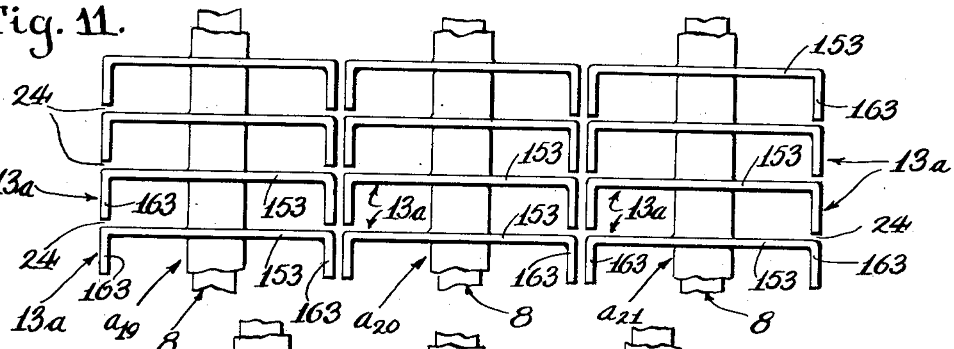


Fig. 12.

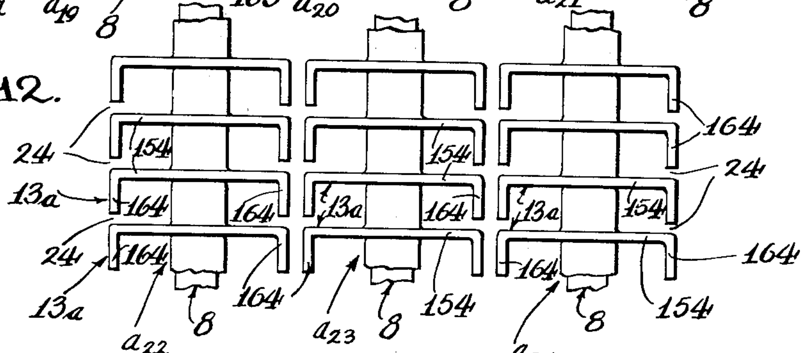


Fig. 13.

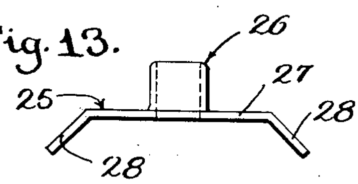


Fig. 14.

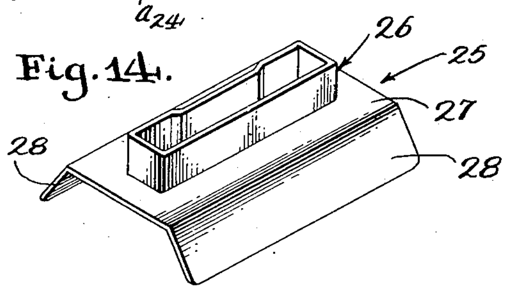
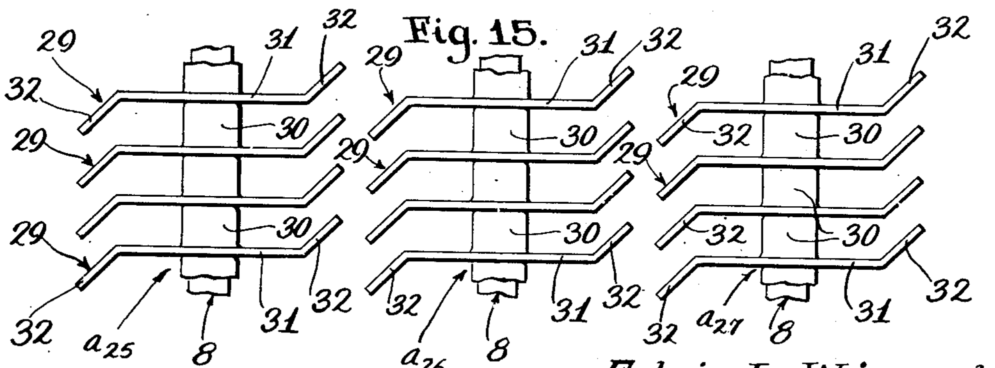


Fig. 15.



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Patented Feb. 4, 1941

2,230,440

UNITED STATES PATENT OFFICE

2,230,440

ELECTRICAL HEATING MEANS

Edwin L. Wiegand, Pittsburgh, Pa.

Application September 7, 1939, Serial No. 293,766

19 Claims. (Cl. 219—39)

My invention relates to electrical heating means and is particularly adapted for embodiment in heating elements and electrical heating apparatus of the fluid convection or forced fluid convection type, and the principal object of my invention is to provide new and improved electrical heating means of these types.

In the drawings accompanying this specification, and forming a part of this application, I have shown, for purposes of illustration, several forms which my invention may assume. In these drawings:

Figure 1 is a fragmentary front elevation of a blower heater embodying the invention,

Figure 2 is a side elevation of the blower heater shown in Figure 1, on a smaller scale than Figure 1, certain parts being broken away,

Figure 3 is a fragmentary front elevation, on an enlarged scale, of several of the finned heating elements forming part of the blower heater shown in Figure 1,

Figure 4 is a section taken on the line 4—4 of Figure 3, looking in the direction of the arrows,

Figure 5 is a section taken on the line 5—5 of Figure 4, looking in the direction of the arrows,

Figure 6 is a perspective view of a fin element which may be used for providing the fins of the finned heating elements,

Figure 7 is a fragmentary front elevation, similar to Figure 3, of another embodiment of a plurality of finned heating elements which may be used in place of the embodiment shown in Figure 3,

Figures 8, 9, 10, 11, and 12 are views similar to Figure 7 showing still other embodiments respectively,

Figure 13 is a front elevation of a fin element of an embodiment different from that shown in Figure 6,

Figure 14 is a perspective view of the fin element shown in Figure 13, and

Figure 15 is a fragmentary front elevation of a plurality of finned heating elements, illustrating still another embodiment.

Referring to Figures 1 and 2, there are here shown a plurality of finned heating elements 1 mounted in a housing 2, here shown as of generally rectangular cross-section. In the rear of the housing 2 is mounted, in any suitable way, an electric motor 3 for driving a fan 4. The fan 4 is adapted to draw in air through the open rear end 5 of the housing 2 and blow this air through the heating elements 1 and out of the front end 6 of the housing. The front end 6 of the housing 2 is here shown as provided with a desired number of louvres 7 which may be used to regulate the air stream issuing from the front end of the housing.

In the blower heater shown in Figures 1 and 2 the finned heating elements 1 comprise a row of six finned electrical heating elements a_1, a_2, a_3, a_4, a_5, a_6, disposed in spaced side-by-side relation in a general plane transverse to the stream of air provided by the fan 4. It will of course be understood that the blower heater need not comprise six heating elements but may comprise any other desired number of heating elements. The blower heater illustrated in Figures 1 and 2 is further shown as comprising another row of six heating elements b_1, b_2, b_3, b_4, b_5, b_6, disposed in side-by-side relation in a general plane to the rear of and generally parallel to the plane in which the heating elements a_1 through a_6 are disposed. The heating elements in the row b_1 through b_6 are spaced in side-by-side relation similarly to the row of heating elements a_1 through a_6, so that the heating elements a_1 through a_6 are in general front to back alinement with the heating elements b_1 through b_6 respectively, and in general alinement with the air stream provided by the fan 4. It will be understood that any desired number of rows of heating elements, each row in a different plane transverse to the air stream, may be utilized. On the other hand, only one row, of any desired number of heating elements, in a plane transverse to the air stream may be provided.

Referring now to Figure 3, there are here shown fragments of three of the heating elements, a_1, a_2, a_3, of the front row of heating elements of the blower heater of Figures 1 and 2, and three of the heating elements, b_1, b_2, b_3, of the row of heating elements immediately to the rear of the heating elements a_1, a_2, a_3. Each heating element is here shown as comprising a metallic sheath 8 of oblong generally rectangular cross-sectional outline, as shown in Figure 5. It will be evident that the heating elements are so disposed that wide sides of the sheaths of adjacent heating elements face each other, so that the narrow sides of the sheaths are transverse to the air stream.

The sheath 8 is here shown as comprising a sheet metal channel the marginal portions 9 of which are bent over a cover plate 10, but the sheath may be of any other suitable form. Disposed within the sheath 8 is a resistor 11, here shown as comprising a strip or ribbon of resistance material disposed in zig-zag fashion and insulated from the sheath by any suitable insulating material 12 in which the resistor is embedded. It will be understood that the resistor 11 may be a wire helix instead of a zig-zag ribbon, or it may be of any other suitable form.

The sheath 8 of each heating element is provided with a plurality of fin elements, such as 13, Figure 6, spaced longitudinally of the sheath, and these fin elements are here shown as comprising a collar 14 having integral therewith at one end thereof a flange here shown as comprising a root portion 15 of oblong rectangular form, generally symmetrical with the collar 14, and defining a plane at right angles to the axis of the collar. The flange further comprises end portions 16, extending in a general direction transverse to the general plane of the root portion 15 and in this instance in a direction away from the root portion 15 generally the same as the direction in which the collar 14 extends from the root portion 15. In the particular instance illustrated, the end portions 16 each make an angle of 45° with the root portion, but I do not limit myself to this particular angle.

The collar 14 of the fin elements, as most clearly seen in Figures 5 and 6, has a portion of one wide side pressed inwardly to form an inwardly embossed portion 17 which substantially fits in the groove formed by the gap between the edges of the bent-over marginal portions 9 of the metallic sheath 8 of the heating element, the embossed portion 17 being in contact with the cover plate 10. Constructing the collar in this fashion is however not essential. In general, the collar 14 of a fin element is made so generally complementary to the cross-sectional outline of the metallic sheath of a heating element that the collars of the fin elements may be telescoped snugly over the metallic sheath 8 as is apparent from Figures 3, 4, and 5. As shown in Figure 4, the unflanged or free end of a collar 14 of one of the fin elements is adapted to nest to a certain desired degree in the slightly flaring opening of the flanged end of the adjacent fin element.

Referring again to Figure 3, the fin elements associated with the heating elements of the "a" row of heating elements have been designated with the reference character 13*a*, and the fin elements associated with the "b" row of heating elements have been designated with the reference character 13*b*. Referring now more particularly to the heating element a_1 of Figure 3, it will be noted that the fin elements 13*a* are mounted on the metallic sheath 8 of this element in such a way that the end portions 16 of the fins or flanges extend in a generally downward direction from the respective root portions 15 of the flanges. On the other hand, referring to the heating element a_2, the fin elements 13*a* are mounted on the metallic sheath 8 of the heating element a_2 so that the end portions 16 of the fins or flanges extend in a generally upward direction from the root portions 15 of these flanges. Referring to the element a_3, the fin elements 13*a* are mounted on the metallic sheath 8 of the element a_3 in the same manner as in the case of the element a_1 and consequently, in the "a" row of heating elements the directions of the end portions 16 alternate from one direction to the other from one element to the next adjacent. In the instance of Figure 3 the root portions 15 of the fin elements of adjacent heating elements of the "a" row are in staggered relation.

In the "b" row of heating elements, which row, as stated, is to the rear of the "a" row, the directions of the end portions 16 of the fins of the fin elements 13*b* also alternate from element to element, but the alternations of the rear row are out of phase with the alternations of the front row, the end portions 16 of the fins on the heating element b_1 extending upwardly with respect to their root portions 15, with the result that the directions in which the end portions 16 of the fins extend from their respective root portions 15 not only alternates with reference to heating elements in the same general plane transverse to the direction of the air stream, but also alternates with reference to heating elements which are aligned with the air stream in front to back relation. Furthermore, the fin elements 13*b* are in staggered relation, front to back, with respect to the fin elements 13*a*, so that in front elevation, as viewed in Figure 3, the root portions 15 of the fin elements 13*b* are intermediate the root portions 15 of the fin elements 13*a*. Considering, first, a set of end portions 16 at a given side of the fin elements 13*b* of the heating element b_1, and, second, the set of end portions 16 at the corresponding side of the fin elements 13*a* of the element a_1, it will be noted that the first set of end portions extends in the general plane of row "b" in a direction transverse to the direction in which the second set extends in row "a". Consequently, such corresponding sets of end portions are in crossed relation, front to back. In like manner other corresponding sets of end portions 16 are in crossed relation, front to back.

In order to secure the relations between the fin elements of the respective heating elements hereinbefore described, the finned heating elements may be mounted in the housing 2 in any suitable way, or the fin elements 13 may be mounted on the sheaths 8 of the heating elements in any suitable way. In the embodiment of Figure 1 it will be noted that the lowermost fin element of the heating element b_1 has its root portion 15 resting on a plate 18 mounted in the housing 2. On the other hand, the lowermost fin element of the heating element a_1 has the tips of its end portions 16 resting on the plate 18. In this instance the end portions 16 of the lowermost fin element of the heating element a_1 may be trimmed slightly so as to secure the desired position of the heating element a_1 with respect to the heating element b_1. If desired, the end portions 16 of the lowermost fin element of the heating element a_1 may be left untrimmed and be bent outwardly slightly to secure the same result, or any other expedient may be adopted for securing the desired staggered relation between the fin elements. The unfinned lower ends of the heating elements may be disposed in slots or openings (not shown) in the plate 18, these slots or openings serving to space the heating elements a desired distance from each other. As herein used the expression spacing of the heating elements means the distance between the median planes of the body portions or sheaths 8 of adjacent heating elements. The minimum spacing of the heating elements is governed by a desired gap between the ends of adjacent sets of end portions 16. The unfinned upper ends may be similarly disposed in slots or openings in an upper plate 18*a*. If desired, a flanged collar 20 may be provided on each heating element, the flange 21 of the collar being underneath the plate 18, as may be seen in Figures 1 and 2. These flanged collars 20 may be provided to cooperate with the adjacent endmost fin elements on the respective heating elements to prevent longitudinal movement of the respective elements with respect to the mounting plate 18, but such flanged collars are not essential.

Each heating element is in this instance shown as provided with a pair of terminals 19 at the lower end thereof, one terminal of each element of the "a" row being indicated in Figure 1. The terminals on each element are suitably connected to the respective resistor 11. Current may be led to the terminals 19 of the heating elements through an outlet box 22 by means of conductors (not shown).

Before discussing the advantages of the constructions and arrangements hereinbefore described, it may be pointed out that in order to secure a large surface for contacting with a current of air, it is desirable that there be a comparatively large number of fin elements per unit length of an electrical heating element and that the fin elements be comparatively thin. For example, the number of fin elements per inch length of the heating element may be as many as four, or more, and the material of which the fin elements are made may be approximately twenty-five thousandths (.025) of an inch thick. These figures are however given merely by way of illustration and it will be apparent as the description proceeds that my invention is not limited to particular numbers or dimensions. Particularly with comparatively thin fin elements it is difficult to maintain a sufficiently rapid flow of heat by conduction from the sheath 8 of the heating element out to the outermost tip of a fin element. Accordingly, it is not profitable to extend a plane fin outwardly from the sheath of the heating element indefinitely because an unduly extended fin heated only by conduction will have its end portions soon cooled in a steam of air to a point where the absorption of heat from the fin is not sufficient to warrant such extension of the fin. Stated in other words, there is in such case too great a disparity between the temperature of the tip of the fin and the root of the fin, and the difference in temperature between the air stream and the tip of the fin is too small. Furthermore, the capacity of a finned electrical heating element cannot be increased at will, because at higher temperatures a large share of the heat is radiant heat, and a stream of air cannot be heated efficiently by radiant heat. A danger point is consequently reached where, even if the finned heating element is placed in a blast of air, the element will eventually burn out by reason of the fact that the air cannot carry away the heat as fast as it is generated in the resistor of the heating element. The manner in which I have provided against these difficulties may be best understood by reference first to one of the simpler embodiments of my invention.

Referring first to Figure 7 a plurality of finned heating elements a_7, a_8, a_9, is here shown, the fin elements 13a on these heating elements being of the same construction as shown in Figures 5 and 6, but in this instance the fin elements are so mounted on the sheaths 8 of the heating elements that the root portions 15 are in alinement and the end portions 16 of the fin elements all extend downwardly from the respective root portions 15 of the fin elements. It is of course evident that if desired one or more rows of heating elements, the same as shown in Figure 7, may be disposed in spaced planes to the rear of the row of heating elements visible in Figure 7, the fin elements of the heating elements being either in alinement with each other, front to back, or in staggered relation.

Considering an end portion 16 of any one of the fin elements 13a of the heating element a_7, for which purpose one of these end portions has been designated 16x, it will be apparent that this end portion, 16x, will intercept radiant heat radiated laterally outwardly from the body of the heating element, that is, more specifically, heat radiated laterally outwardly from the wide face of the collar 14x. Thus, while heat is fed to the root portion 15 of a fin element principally by conduction from the body portion of the heating element heat is fed to the end portion 16x of the fin element principally by radiation from the body portion of the heating element. The heat radiated to the end portion 16x of course heats that end portion and raises its temperature, thereby reducing the general difference in temperature as between the end portion 16x and the root portion 15x, in other words, the tendency is towards equalization of these temperatures. By optimum selection of the lateral extent of the root portion 15x measured from a wide side of the sheath 8 to the junction of the root portion with the end portion 16x, depending upon temperature conditions for one thing, heat may also be fed from the end portion 16x into the root portion 15x at the junction of the root portion with the end portion, thereby tending towards equalization of the temperatures of the parts of the root portion 15x nearest and furthest from the sheath 8. By raising the temperature of the end portion 16x, heat is readily and efficiently abstracted therefrom by the stream of air passing along that end portion. The same is of course true regarding the more efficient heating of the root portion and the consequent more efficient abstraction of heat therefrom. In general, by constructions and arrangements which will satisfy the desideratum that parts of the fin element are sufficiently heated which would not otherwise be sufficiently heated, heat is readily and efficiently abstracted by the air stream from the finned heating element as a whole. Any radiant heat radiated laterally outwardly from the collar 14x to the end portion 16x which is not absorbed by the end portions 16x, may be reflected downwardly to the upper side (as viewed in Figure 7) of that end portion 16 which is immediately below the end portion 16x, where it may be absorbed, and then dissipated by the air stream. It is of course obvious that each of the fin elements 13a functions in the same manner as hereinbefore described.

My invention accordingly provides a heating element which may be safely operated at a given electrical input, whereas the same element would burn out if operated at the same input without my invention. On the other hand, heating elements of much greater capacity than hitherto are made feasible by reason of the rapid dissipation of heat possible with my invention.

The invention has the further advantage that, where heating elements are to be used in side-by-side relation, as in a blower heater for example, the end portions 16 of the fin elements also intercept radiant heat which would otherwise be radiated from the body portion of one heating element to the body portion of an adjacent heating element. Accordingly, it is possible not only to increase the individual capacity of a given heating element but also, if desired, to decrease the spacing of the heating elements of a row of heating elements, thereby increasing the total number of heating elements which may be disposed in a given space, or in a given housing of a blower heater, thereby greatly increasing the heating capacity of the blower heater.

Referring now to Figure 8, there is here shown a row of a plurality of finned heating elements a_{10}, a_{11}, a_{12}, which row is constructed and arranged substantially the same as the front row (a_1 through a_6) of heating elements of Figure 3, but in Figure 8 it may be considered that, if desired, there is a row of finned heating elements, constructed and arranged the same as the row of finned heating elements visible in Figure 8, but behind and in alinement with that row, front to back. On the other hand, a row of finned heating elements constructed and arranged the same as the row shown in Figure 8 may be disposed to the rear of the row shown in Figure 8 and staggered front to back with respect to each other. In this instance while the fin elements would be staggered, front to back, with respect to each other as in Figure 3, corresponding sets of end portions 16 would not cross as in the instance of Figure 3.

Considering the right hand set of end portions 16 of the fin elements 13*a* of the heating element a_{10} and the adjacent left hand set of end portions 16 of the fin elements 13*a* of the heating element a_{11}, it will be noted that these adjacent sets extend in the same general direction in the general plane defined by the heating elements. The result is that the outer faces of one set of end portions 16 are directed toward the outer faces of the adjacent set of end portions 16. Accordingly, heat that may be radiated by or reflected from the outer faces of one set, through gaps between the sets, such as a gap 23, is intercepted by the other set.

In the embodiment shown in Figure 9 there is a row of heating elements a_{13}, a_{14}, a_{15}, each heating element being provided with fin elements 13*a*. Behind the row of heating elements a_{13}, a_{14}, a_{15} is another row of heating elements b_{13}, b_{14}, b_{15}, each heating element being provided with fin elements 13*b*. The fin elements 13*a* and 13*b* are similar to the fin elements 13 of Figures 5 and 6 but have root portions 151 of less lateral extent than that of the root portions 15, and end portions 161 which are longer than the end portions 16. The arrangement of the heating elements of Figure 9 is generally similar to the arrangement shown in Figure 3, but in Figure 9 the root portions 151 of the fin elements 13*a* are in side-to-side alinement, whereas in Figure 3 the root portions 15 of the fin elements 13*a* are in staggered relation side-to-side. Also, in Figure 9 the root portions 151 of the fin elements 13*b* of the heating element b_{13} are in front to back alinement with the root portions 151 of the fin elements 13*a* of the heating element a_{13}; the same applies with respect to the pairs of heating elements b_{14}, a_{14} and b_{15}, a_{15}. It will be noted that a given set of end portions 161 of the fin elements 13*a* is in crossed relation with respect to the corresponding set of end portions 161 of the fin elements 13*b*, as is the case in Figure 3, but due to the greater length of the end portions 161, a given end portion 161 of a fin element 13*a* is in front to back crossed relation with two end portions 161 of two fin elements 13*b*, instead of only one, as in Figure 3. In general, constructing and arranging the fin elements so that the end portions of the fin elements are in crossed relation gives a desirable amount of turbulence to the air stream, better effecting abstraction of heat from the fin elements by the air stream.

In the embodiment shown in Figure 10 there is a row of finned heating elements a_{16}, a_{17}, a_{18}, each heating element being provided with fin elements 13*a*, similar to the fin element 13 shown in Figures 5 and 6, but of different proportions, the root portions 152 being of less lateral extent than the root portions 15, but the end portions 162 being of substantially the same length as the end portions 16. It will be noted that the spacing of the heating elements a_{16}, a_{17}, a_{18} is the same as of the heating elements in Figures 3 through 9, but that the free space between the end portions 162 of the fin elements of one heating element and the adjacent end portions 162 of an adjacent heating element is greater. Under certain circumstances, depending for example on the amount of heat to be dissipated, or the velocity of the air stream, or other factors, it may be desirable and satisfactory to utilize the less extensive fin elements shown in Figure 10. It will be obvious that in principle the mode of operation of the less extensive fin elements, such as shown in Figure 10, is the same as already described, particularly in connection with Figure 7. Furthermore, under such circumstances it may be desirable to utilize heating elements with the less extensive fin elements shown in Figure 10, but instead of retaining the wider spacing of the heating elements there shown, the heating elements may be brought closer together, so that adjacent end portions of the fin elements of adjacent heating elements are closely spaced as in Figures 3 through 9. Thereby a greater number of heating elements may be disposed in the same space and, for a given capacity of a single heating element, the total amount of heat dissipated may, in this way also, be further increased. This is made possible not only by reason of the fact that heat is more efficiently and rapidly abstracted by the air stream from an individual heating element but because inter-radiation of heat from an individual heating element to an adjacent heating element is substantially prevented by reason of the intercepting end portions of the fin elements.

Figure 11 shows an embodiment in which a plurality of heating elements a_{19}, a_{20}, a_{21} is disposed in side-by-side relation, each heating element being provided with fin elements 13*a* which are similar to the fin element 13 of Figure 6, but in this instance have their end portions 163 bent so as to extend at right angles to their root portions 153, instead of at 45°, as in the case of Figure 6. The end portions 163 are here shown as of substantially the same length as the end portions 16 of the fin elements shown in Figures 3, 7, and 8, for example, but the root portions 153 have greater lateral extent than have the root portions of the fin elements of Figures 3, 7, and 8. However, by reason of the fact that the end portions 163 extend at right angles to the root portions 153 the spacing of the heating elements a_{19}, a_{20}, a_{21} may be, and in Figure 11 is shown, less than the spacing of the heating elements of the embodiments of Figures 3, 7, and 8.

Figure 12 shows an embodiment, similar to Figure 11, in which a plurality of heating elements a_{22}, a_{23}, a_{24} is disposed in side-by-side relation, each heating element being provided with fin elements 13*a* which are similar to the fin elements 13a of Figure 11 but in this instance, while the end portions 164 are of substantially the same length as the end portions 163, the root portions 154 have less lateral extent than have the root portions 153. Consequently, the spacing of the heating elements a_{22}, a_{23}, a_{24} may be, and in Figure 12 is shown, less than the spacing of the heating elements a_{19}, a_{20}, a_{21} of Figure 11.

In embodiments in which the end portions of the fin elements extend at right angles to the root portions, as in Figures 11 and 12, it is desirable that there be a space, such as 24, left between the end of each end portion (163 or 164) of a fin element and the surface of the adjacent fin element. Such an equivalent space is of course necessarily present in the other embodiments hereinbefore described.

In Figures 13 and 14 is shown an embodiment of a fin element 25 comprising a collar 26, similar to the collar 14 of the fin element 13 of Figures 5 and 6, and having also a flange comprising a root portion 27 and end portions 28. The root portion 27 is here shown as similar to the root portion 15 but the end portions 28, while they each make an angle of 45° with the root portion 27, extend in a direction away from the root portion 27 generally opposite from the direction in which the collar 26 extends from the root portion 27. A plurality of fin elements, such as shown in Figure 14, may be used in place of fin elements such as shown in Figure 6, to build up finned heating elements similar to those shown in Figures 1 through 10, wherever it may be found desirable. It may also be found desirable under some conditions to utilize a finned heating element provided with fin elements such as shown in Figure 6 and to utilize adjacent thereto a finned heating element provided with fin elements such as shown in Figure 14.

In the embodiment shown in Figure 15 there is shown a row of heating elements a_{25}, a_{26}, a_{27}, each heating element being provided with fin elements 29. Each fin element 29 has a collar 30 similar to the collar 14 of the fin element shown in Figure 6, and a flange comprising a root portion 31 similar to the root portion 15, and end portions 32. One of the two end portions 32 of a given fin element 29 extends in a general direction away from the associated root portion the same as the direction in which the respective collar 30 extends away from the root portion, while the other end portion 32 extends in a general direction away from the root portion opposite from the direction in which the collar extends away from the root portion. By comparison with the type of construction and arrangement shown in Figure 8 it will be apparent that the same type of construction and arrangement may be arrived at by the use of fin elements such as shown in Figure 15. It will be noted that in arriving at the construction and arrangement of Figure 8, utilizing fin elements such as shown in Figure 6, the fin elements must be telescoped over the heating element sheath 8, collar first in the case of heating element a_{10}, for example (assuming that the terminals 19 of the heating element are at the lower end as viewed in Figure 8), and flange first in the case of the adjacent heating element, a_{11}, for example. On the other hand, in the construction and arrangement of Figure 15 the fin elements may be telescoped over the heating element sheaths 8 either all collar first or all flange first as desired.

It also will be apparent that finned heating elements such as shown in Figure 15 may be utilized in constructions and arrangements such as shown in Figures 3 and 9, so as to secure the crossed relation of the end portions of the fin elements, front to back. To secure such an arrangement with finned heating elements of the type shown in Figure 15 all that is necessary is to provide another row of such finned heating elements to the rear of the row shown, the heating elements in the rear row being simply turned 180° about their longitudinal axes, with respect to the front row.

It will be apparent that the construction shown in Figure 15, as well as in the constructions heretofore described, the finned heating elements may be so constructed and arranged that the root portions of the fin elements of a given heating element are staggered with respect to the root portions of the fin elements of a laterally adjacent heating element, or, if there is a heating element in front to back alinement with a given heating element, the root portions of the fin elements of these heating elements may be staggered, or both these conditions may obtain.

Whereas in the type of construction shown in Figures 11 and 12, the length of the end portions 163 or 164 is limited by the length of the respective collars, that is by the longitudinal spacing of the fin elements, the length of the end portions of the fin elements shown in Figures 3, 7, 8, 10, and 15 is not so limited but may be increased to a desired extent, as it has been increased, for example, in the construction shown in Figure 9.

As examples of good proportioning of the parts, the following may be given. Assuming that in a construction such as in Figure 7 the pitch of the fin elements 13a per inch length of the heating element 8 is four and that the transverse dimension of a collar 14 is approximately 3/8 of an inch, a suitable length for an end portion 16 is approximately 5/16 of an inch, or more, while the total width of the root portion 15, measured from its junction with one end portion 16 to its junction with the other end portion 16, is approximately 1 3/16''. The heating elements a_7, a_8 may then be spaced a minimum distance, of approximately 1½ inches, but may be spaced a greater distance, as already explained. Referring to Figure 11 and again assuming that the pitch of the fin elements 13a per inch length of the heating element 8 is four and that a collar is 3/8 of an inch across, a suitable maximum length for an end portion 163 is approximately 15/64 of an inch, while the root portion 153, measured from its junction with one end portion 163 to its junction with the other end portion 163, is approximately 1 3/16 inches. The heating elements a_{19}, a_{20} may then be spaced a minimum distance of approximately 1¼ inches but may, of course, be spaced a greater distance. The foregoing dimensions are given merely by way of example and it will be apparent that these dimensions may be varied as has been explained in connection with comparisons hereinbefore made between, on the one hand, the fin elements of Figures 7 and 11 and, on the other hand, the other illustrated embodiments.

From the foregoing it will be apparent to those skilled in the art that each of the illustrated embodiments of my invention provides a new and improved electrical heating means, and accordingly, each accomplishes the principal object of my invention. On the other hand, it also will be obvious to those skilled in the art that the illustrated embodiments of my invention may be variously changed and modified, or features thereof, singly or collectively, embodied in other combinations than those illustrated, without departing from the spirit of my invention, or sacrificing all of the advantages thereof, and that accordingly, the disclosure herein is illustrative only, and my invention is not limited thereto.

I claim:

1. An electrical heating element, comprising: an elongated body portion, and fin means for dissipating heat from said body portion; said body portion including a metallic sheath, a resistor disposed in and insulated from said sheath; said fin means including parts spaced longitudinally of said body portion, at said body portion, and extending transversely with respect to said body portion, adjacent free end portions of said fin means being spaced from each other and from adjacent said parts and so constructed and arranged as to intercept heat radiated laterally from said body portion.

2. An electrical heating element, comprising: an elongated body portion, and fin means for dissipating heat from said body portion; said body portion including a metallic sheath, a resistor disposed in and insulated from said sheath; said fin means including parts spaced longitudinally of said body portion, at said body portion, and extending transversely with respect to said body portion, adjacent free end portions of said fin means being spaced from each other and from adjacent said parts a distance less than the spacing of said parts.

3. Heating apparatus, comprising: at least two electric heating elements, each having an elongated body portion and fin means for dissipating heat from said body portion, each said body portion including a metallic sheath and a resistor disposed in and insulated from said sheath, and said fin means including fin parts spaced longitudinally of said body portions respectively and extending transversely of said body portions respectively; said heating elements being disposed in side-by-side relation in a general plane; and adjacent fin means, of adjacent heating elements, each having a set of end portions extending transversely of the respective said fin parts, one of said sets of end portions extending in a direction generally transverse to the general direction of the other of said set of end portions.

4. Heating apparatus, comprising: at least two electric heating elements for use in a stream of fluid, each element having an elongated body portion and fin means for dissipating heat from said body portion, each said body portion including a metallic sheath and a resistor disposed in and insulated from said sheath, and said fin means including fin parts spaced longitudinally of said body portions respectively and extending transversely of said body portions respectively; said heating elements being disposed in general alinement with the fluid stream in respective general planes transverse to the fluid stream; and the fin means, of alined heating elements, each having a corresponding set of end portions extending transversely of the respective said fin parts, one of said sets of end portions extending in its respective said general plane in a direction generally transverse to the general direction of the other of said set of end portions in its respective said general plane.

5. Heating apparatus, comprising: at least two electric heating elements for use in a stream of fluid, each element having an elongated body portion and fin means for dissipating heat from said body portion, each said body portion including a metallic sheath and a resistor disposed in and insulated from said sheath, and said fin means including fin parts spaced longitudinally of said body portions respectively and extending transversely of said body portions respectively; said heating elements being disposed in general alinement with the fluid stream and so disposed that said respective fin parts are in staggered relation; and the fin means, of alined heating elements, each having a corresponding set of end portions extending transversely of the respective said fin parts.

6. Heating apparatus, comprising: at least two electric heating elements for use in a stream of fluid, each element having an elongated body portion and fin means for dissipating heat from said body portion, each said body portion including a metallic sheath and a resistor disposed in and insulated from said sheath, and said fin means including fin parts spaced longitudinally of said body portions respectively and extending transversely of said body portions respectively; said heating elements being disposed in general alinement with the fluid stream in respective general planes transverse to the fluid stream and so disposed that said respective fin parts are in staggered relation; and the fin means, of alined heating elements, each having a corresponding set of end portions extending transversely of the respective said fin parts, one of said sets of end portions extending in its respective said general plane in a direction generally transverse to the general direction of the other of said set of end portions in its respective said general plane.

7. An electrical heating element, comprising: an elongated body portion, and fin means for dissipating heat from said body portion; said body portion including a metallic sheath, a resistor disposed in and insulated from said sheath; said fin means including a plurality of fins extending transversely with respect to said body portion and spaced longitudinally of said body portion solely by collars telescoped over said sheath, said collars being integral with said fins respectively, and said fins being so bent as to intercept heat radiated laterally from said collars.

8. An electrical heating element, comprising: an elongated body portion, and fin means for dissipating heat from said body portion; said body portion including a metallic sheath, a resistor disposed in and insulated from said sheath; said fin means including parts spaced longitudinally of said body portion, at said body portion, and extending transversely with respect to said body portion to free end portions to provide free spaces extending laterally outwardly between said parts from said body portion to said free end portions respectively, adjacent free end portions being spaced from each other and so constructed and arranged as to intercept heat radiated laterally outwardly in said spaces from said body portion.

9. An electrical heating element, comprising: an elongated body portion, and fin means for dissipating heat from said body portion; said body portion including a metallic sheath, a resistor disposed in and insulated from said sheath; said fin means including parts spaced longitudinally of said body portion, at said body portion, and extending transversely with respect to said body portion to free end portions at opposite sides of said body portion to provide free spaces extending laterally outwardly between said parts from opposite sides of said body portion to said free end portions respectively, adjacent free end portions being spaced from each other and so con-

structed and arranged as to intercept heat radiated laterally outwardly in said spaces from the respective side of said body portion.

10. An electrical heating element, comprising: an elongated body portion, and fin means for dissipating heat from said body portion; said portion including a metallic sheath, a resistor disposed in and insulated from said sheath; said fin means including sheet metal parts spaced longitudinally of said body portion, at said body portion, and extending transversely with respect to said body portion to free end portions at opposite sides of said body portion to provide free spaces extending laterally outwardly between said parts from opposite sides of said body portion to said end portions respective, adjacent free end portions being so bent relative to the respective said parts as to intercept heat radiated laterally outwardly in said spaces from the respective side of said body portion.

11. An electrical heating element, comprising: an elongated body portion, and fin means for dissipating heat from said body portion; said body portion including a metallic sheath, a resistor disposed in and insulated from said sheath; said fin means including sheet metal parts spaced longitudinally of said body portion, at said body portion, and extending transversely with respect to said body portion to free end portions to provide free spaces extending laterally outwardly between said parts from said body portion to said end portions respectively, adjacent free end portions being so bent relative to the respective said parts as to substantially close off respective said spaces, to intercept heat radiated from said body portion, while leaving a space between a given free end portion and that one of said parts toward which said given end portion is bent.

12. Heating apparatus, comprising: at least two electric heating elements each having an elongated body portion including a metallic sheath and a resistor disposed in and insulated from said sheath, said heating elements being disposed in side-by-side spaced relation in a general plane; and metallic means constructed and arranged to receive heat only from at least one of said electric heating elements, said means being interposed between said heating elements and constructed and arranged to intercept heat radiated from one of said body portions toward the adjacent body portion.

13. Heating apparatus, comprising: at least two electric heating elements each having an elongated body portion and fin means for dissipating heat from said body portion, each said body portion including a metallic sheath and a resistor disposed in and insulated from said sheath; and each said fin means including parts spaced longitudinally of the respective body portion and extending transversely of the respective body portion; each of said heating elements constituting a separate finned heating element, and said heating elements being disposed in selected side-by-side relation in a general plane; and said fin means being so constructed and arranged as to intercept heat radiated from one of said body portions outwardly from said body portion between said parts.

14. Heating apparatus, comprising: at least two electric heating elements, each having an elongated body portion and fin means for dissipating heat from said body portion, each said body portion including a metallic sheath and a resistor disposed in and insulated from said sheath, and said fin means including fin parts spaced longitudinally of said body portions respectively and extending transversely of said body portions respectively; each of said heating elements constituting a separate finned heating element, said heating elements being disposed in selected side-by-side relation in a general plane; and adjacent fin means of adjacent heating elements having end portions extending transversely of said fin parts.

15. Heating apparatus, comprising: at least two electric heating elements, each having an elongated body portion and fin means for dissipating heat from said body portion, each said body portion including a metallic sheath and a resistor disposed in and insulated from said sheath, and said fin means including fin parts spaced longitudinally of said body portions respectively and extending transversely of said body portions respectively; each of said heating elements constituting a separate finned heating element, said heating elements being disposed in selected side-by-side relation in a general plane; and adjacent fin means, of adjacent heating elements, each having a set of end portions extending transversely of the respective said fin parts, said sets of end portions extending toward each other.

16. An electrical heating element, comprising: an elongated body portion, and fin means for dissipating heat from said body portion; said body portion including a metallic sheath, a resistor disposed in and insulated from said sheath; said fin means including a plurality of sheet metal fins extending transversely with respect to said body portion and spaced longitudinally of said body portion by collars telescoped over said sheath, said collars being integral with said fins respectively, and said fins having free end portions so bent as to intercept heat radiated laterally from said collars, adjacent bent end portions having opposed collateral spaced surfaces.

17. Heating apparatus, comprising: a housing providing a passage through which a stream of fluid is adapted to be directed; at least two electric heating elements, each having an elongated body portion including a metallic sheath and a resistor disposed in and insulated from said sheath, said heating elements being disposed in side-by-side spaced relation in a general plane transverse to said passage; and metallic means constructed and arranged to receive heat only from at least one of said electrical heating elements, said means being interposed between said heating elements and constructed and arranged to intercept heat radiated normally outwardly from one of said body portions toward the adjacent body portion.

18. Heating apparatus, comprising: a housing providing a passage through which a stream of fluid is adapted to be directed; at least two electric heating elements, each having an elongated body portion including a metallic sheath and a resistor disposed in and insulated from said sheath, said heating elements being disposed in side-by-side spaced relation in a general plane transverse to said passage; and at least one sheet metal part interposed between said heating elements and disposed edgewise with respect to the stream of air so that the stream is adapted to abstract heat from opposite surfaces of said part, said part being constructed and arranged to intercept heat radiated normally outwardly from one of said body portions toward the adjacent body portion.

19. Heating apparatus, comprising: a housing providing a passage through which a stream of

fluid is adapted to be directed; at least two electric heating elements, each having an elongated body portion and fin means for dissipating heat from said body portion, each said body portion including a metallic sheath and a resistor disposed in and insulated from said sheath; and each said fin means including parts spaced longitudinally of the respective body portion and extending transversely of the respective body portion; each of said heating elements constituting a separate finned heating element, said heating elements being disposed in selected side-by-side relation and in a general plane transverse to said passage; the fin means of at least one of said heating elements having a set of free end portions disposed between said body portions and edgewise of the stream of fluid so that the stream is adapted to abstract heat from opposite surfaces of said free end portions, said free end portions being so constructed and arranged as to intercept heat radiated from said at least one of said body portions outwardly from said body portion between said parts.

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