This invention relates to an electric, explosion-proof heater.

One of the objects of the invention is to provide an electric explosion-proof heater which is simple, practical and thoroughly durable. Another object is to provide a heater of the above character which is efficient in operation. Another object is to provide a heater of the above character which can be inexpensively manufactured. Another object of this invention is to provide a heater of the above character which can be operated safely in explosive areas, such as atmospheres containing gasoline, petroleum, naphtha, acetone, benzol, lacquer, solvent vapors and natural gas. Another object is to provide a heater of the above character, none of the exposed parts of which ever become excessively hot even when operating under a full load. A further object is to provide a construction of the above character in which the material is so disposed as to attain a high degree of strength without heavy construction. Still another object is to provide a heater of the above character which is not affected by extreme temperature changes. Other objects will be in part obvious and in part pointed out hereinafter.

The invention accordingly consists in the features of construction, combinations of elements, and arrangements of parts, all as will be illustratively described herein and the scope of the application which will be indicated in the following claims.

In the accompanying drawings, in which is shown one of the various possible embodiments of this invention,

Figure 1 is a perspective view of a pair of heaters connected in series;
Figure 2 is an exploded perspective view of the heater;
Figure 3 is a vertical section on an enlarged scale taken on the line 3-3 of Figure 1;
Figure 4 is a vertical section taken on the line 4-4 of Figure 3;
Figure 5 is a horizontal section taken on the line 5-5 of Figure 4; and
Figure 6 is a view on an enlarged scale of one of the heating elements partly in section.

Similar reference characters refer to similar parts throughout the several views of the drawings.

Referring now to the drawings, in general, the heater includes an explosion-proof connection box, generally indicated at 24 (Figure 2), on which are mounted a series of grid members, generally indicated at 18a, 18b, 18c and 18d.

Each grid member has a heating element, generally indicated at 19 in Figures 4 and 6, cast therein, the terminals 7 and 15 (Figures 3 and 4) on the lower ends of each heating element 10 extending into connection box 24. Each grid member is provided with fins which form vertical passageways, so that when the grid member 18 and the connection box 24 are mounted in a housing, generally indicated at 13 (Figure 1), the air enters opening 16b, flows upwardly through the grid member passageways and passes out of the heater through opening 16a. A baffle, generally indicated at 11 (Figures 2 and 3), is positioned rearwardly of the grid members and spaced from the rear plate 31 of the housing to provide a passageway for secondary air circulation between the baffle and rear plate. Each heater may be used individually or as one unit in a series of heaters, such as shown in Figure 1.

As all of the grid members are substantially similar in construction, specific description of the grid members will be limited to grid member 18a. Grid member 18a is cast from aluminum or other metal having a high thermal conductivity and includes a backbone portion 20 (Figures 2, 4 and 5) having a plurality of fins 19a and 19b formed therein and a heating element 10 cast therein. As is best shown in Figure 6, heating element 10 is U-shaped and includes a resistance wire 11, the ends of which are connected to conductors 8 and 12. The resistance 11 and conductors 8 and 12 are centrally positioned within a tubular steel or copper sheath 13. The space intermediate resistance 11 and conductors 8 and 12 and the sheath 13 is filled by an oxide powder 14 which is a highly efficient electrical insulator and at the same time a good conductor of heat. Conductors 8 and 12 are connected to terminals 7 and 15, which in turn are connected to wires leading to an external power source (not shown).

Terminals 7 and 15 have collar portions 41 and 16 (Figure 6) which support insulators 42 and 17 mounted on the lower ends of conductors 8 and 12. Insulators 17 and 42 insulate conductors 8 and 12 from sheath 13, insulate sheath 13 from terminals 7 and 15, and also serve to hold the oxide powder 14 within sheath 13. When grid member 18a is cast, it is cast around and shrunk upon heating element 10 so that heating element 10 is centrally located within the backbone portion 20 of grid member 18a, as is best shown in Figures 4 and 5.

As pointed out hereinafore, the fins on grid member 18a form passageways through which air...
flows as it is heated. The fins 18a and 18b (Figures 4 and 5) extend outwardly from each side of the backbone portion 20 in pairs which are aligned with respect to each other. The central portions of each pair of fins branch outwardly from sides of backbone portion 20 of grid member 18a at uniformly spaced intervals in a direction taken from the front to the back of grid member 18a. The fins, with the exception of front fins 22 (Figure 3), are curved at their bottom and top extremities to facilitate the entrance of air into and exit of air from the passageways 21 and have a constant curvature at the bottom but a decreasing curvature relative to one another at the top so that the cross sectional area of the upper portion of each passageway constantly increases as it is followed upwardly. This permits the air to expand as it is heated while traveling upwardly thru the grid member passageway 21. Fins 22 are flat, extend outwardly from the sides of the backbone portion 20 adjacent the front edges thereof and their upper and lower ends are spaced from the upper and lower fins and positioned immediately rearwardly thereafter.

As is best shown in Figures 3 and 4, grid member 18a is cast with a base portion 23 integral with backbone portion 20 and the lower ends of the rear fins. Thus, a rugged, essentially one piece grid member has been described which is highly efficient in converting electrical energy into heat energy. The total radiating area of each of the grid members is many times the sheath area of each heating element. Thus, each grid member increases the convection surface of each heating element to a maximum and this results in each grid member having a high B. t. u. output at a low operating temperature for safety and long life.

As pointed out hereinafore, the grid members 18a, 18b, 18c and 18d are mounted on connection box 24. The body of connection box 24 is cast and includes four integral substantially vertical side walls and a top. The exterior surface of the top is flat and is machined to .002" feeler gage to permit a close fit with the bottom surface of each of the grid members which are also machined to the same tolerances. The top is provided with a pair of holes for each grid member, such as holes 43 and 44 (Figure 3), thru which the lower ends of the heating element of each grid member pass into the interior of the connection box when the grid members are mounted therein. The base of each grid member is secured to the top of the connection box by a pair of screws such as screws 25 (Figure 4).

The lower edges of the four walls of connection box 24 are also machined to close tolerances as well as the top of a cover 27 so that cover 27 fits the bottom of box 24 very closely. Cover 27 is secured to the walls of the connection box by means of screws 28. Thus, all openings through the top and bottom of the connection box are closed in such a manner that tight flame paths are provided, thus preventing any flame from reaching externally of connection box 24 should an explosion occur therein. Connection box 24 is of very heavy construction and is designed to withstand an internal explosion pressure of 85 pounds per square inch and a hydrostatic pressure of 350 pounds per square inch plus an appropriate safety factor.

To permit electrical connections to be made to the terminals of the heating elements within the connection box, a threaded hole is provided in each of the end walls of connection box 24. Conduits, such as conduit 26, are threaded into these holes and hold the power lines or wires which connect the terminals to the power source of power. The input wires are housed within conduit 26 so as to insulate the wires from any exposure to dangerous atmospheres, to reduce to a minimum the possibility of access of dangerous atmospheres to the interior of the connection box, and to prevent any flame from any explosion occurring within the connection box from reaching externally thereof. The conduit 26 also may be used to join two or more heaters in series if more than one heater is to be used. If a heater is used alone, one of the holes in one of the ends of connection box 24 is plugged. Thus, the relatively small portion of the terminals and power lines which are in any way exposed are protected from contact with any dangerous atmospheres in the vicinity of the heater by being safely housed within box 24 and conduit 26 and also allow for an explosion occur within the box, it will be contained therein.

The assembly consisting of the grid members 18a, 18b, 18c and 18d and connection box 24 is mounted within housing 9 (Figure 2), which includes a rear plate 30, a baffle 31 attached to plate 30, and a streamlined front cover 32 which is bolted to plate 30. Plate 33 essentially comprises a sheet of steel of rectangular shape, the upper and side edges of which are flanged forwardly. To connect the grid members on housing 9, the rear surface of connection box 24 (Figure 3) is provided with a pair of bosses, such as box 48. A pair of screws, such as screws 29, pass through rear plate 30 and thread into each box and firmly secure the grid members and connection box 24, plate 30, and thus housing 9. Baffle 31 includes side walls 31a and 31b and a rear plate 31c, the lower portion of which is flat and which is curved at the top to conform substantially to the shape of the rear fins of the grid members. Baffle 31 is attached by brackets 50 and 51 to rear plate 30 so that its rear surface is spaced from plate 30, thereby permitting a secondary circulation of air in this space, as indicated by the arrows 48. The air passes upwardly along the back plate between connection box bosses 49, and thus keeps rear plate 30 cool. A uniform separation is provided between plate 31c and the rear grid member fins to permit upward circulation of air between the baffle and the rearmost fins.

The housing cover 32 has a front, a top, and two sides, but is open at the back and bottom. It is fastened to the flanges on rear plate 30 by means of bolts, such as bolt 33 (Figure 3). Openings 8a and 8b (Figure 1) are provided in the front portion of cover 32 corresponding in position to the entrances into and the exits from the passageways 21 between adjacent fins, so that air may circulate through the heater. Openings are also provided at the bottom of the sides to permit the connection of conduits, such as conduit 26. To permit the heater to be connected to a wall, mounting brackets 34 are attached to the rear surface of the rear plate 30.

In operation, electrical energy is converted into heat energy in the heating elements 10, which is transmitted through the grid members to the radiating surfaces of their fins. Cool air from the area to be heated enters opening 8a (Figure 1), is heated as it flows upwardly through the passageways 21 (Figure 3) and passes out of opening 9b (Figure 1). After leaving the heater,
the warm air circulates through the room. At the same time, cool air flows upwardly between box 24 and baffle 31 and rear plate 33. This air flows out of the housing between the upper edges of baffle 31 (Figure 3) and opening 36. This secondary air circulation keeps rear plate 33 cool.

There are many distinct advantages which the heater offers. The relatively small radiating surface area of each heating element is multiplied to a maximum when it is compared to the large radiating surface of the grid member it heats. This ensures maximum efficiency in transferring heat energy from the heating elements to the air being heated. Because of the manner in which the grid members are constructed, any heat energy generated by the flow of current through the heating elements is quickly conducted to the surface of the fins where it is circulated by convection through the area to be heated. Even though a complete heater weighing only about 85 pounds may draw as much as 2000 watts, the maximum grid temperature will be less than 500°F, and the maximum temperature will be only about 150°F on the wall to which the heater is fastened, the ambient temperature in the above test being as high as 104°F.

Also, it should be noted that the heating elements which receive electrical energy and convert it into heat energy are completely covered throughout most of their length by grid members which serve to transmit the heat evenly to their entire radiating surface. In the small areas where the grid members do not cover the heating elements and where electrical connections are made to the heating elements, the electrical connections and heating elements are completely enclosed in an explosion-proof box which is so constructed that should an explosion occur therein, it will be completely contained within the box. The heater is composed of a minimum number of parts which may be assembled easily and quickly and which provide a highly efficient, safe, explosion-proof electric heater when once assembled. These advantages, in addition to the low operating temperatures of the grid members combined with their high B. t. u. output make it readily apparent that the heater has wide application where safety is paramount, such as in pipe line pump houses, refinery meter houses, gasoline bulk stations, propane bulk stations and similar properties. It will thus be seen that a practical and efficient explosion-proof heater has been described in which the several objects hereinabove mentioned as well as many others, have been successfully accomplished.

Since many possible embodiments of the above invention may be provided, and since many changes may be made in the embodiment above set forth, it is understood that the description hereinabove set forth or shown in the accompanying drawing is to be interpreted as illustrative and not in a limiting sense.

I claim:

1. In a heater, in combination, a grid member including a backbone portion having a plurality of fins thereon, said backbone portion including a base portion, an electric heating element cast within the backbone portion of said grid member and having its terminals extending from said base portion, a connection box including four walls and an integral top, said terminals extending through said top into the interior of said connection box, means connecting said base portion tightly to the top of said connection box, and a cover closing the bottom of said connection box, means connecting said cover tightly to said box, the engaging surfaces of all portions of said connection box, said base portion and said cover being smooth to fit closely to thereby provide tight flame paths from the interior of said connection box to the exterior thereof whereby the flame resulting from any explosion in the interior of said connection box will be completely dissipated in said flame paths before reaching the exterior of said connection box.

2. In a heater, in combination, a housing, said housing including a front wall, two side walls, a rear plate and a top, a plurality of grid members, each of said grid members including a backbone portion and a plurality of fins extending outwardly therefrom, the front portion of said housing including spaced openings positioned one above the other, said fins and said grid members being shaped to form passageways connecting said upper and lower openings in said front wall, a heating element cast within the backbone portions of each of said grid members, a connection box, the terminals on said heating elements extending into said connection box, said connection box being completely enclosing said terminals and all electrical connections thereto, all exits from the interior of said connection box to the exterior thereof being tightly closed, said connection box being connected to but spaced from said rear plate, and a baffle spaced from but conforming to the shape of the rear surfaces of the rearmost fins of said grid members, the upper end of said baffle being positioned beneath the lower edge of the upper opening in said housing, said baffle also being spaced from said rear plate whereby air flows upwardly between said fins and baffle and said baffle and rear plate and thence flows out of said housing through the uppermost opening therein, said air absorbing the heat radiated by the rearmost fins and thus preventing excessive heating of said rear plate.

3. In an electric space heater, in combination, a grid element comprising a vertical elongated backbone member, an electric heating element associated with said backbone member, and a plurality of fins projecting horizontally from each side of said backbone member, said fins having vertical middle portions and ends curving toward the front of said backbone member thereby forming passageways to guide air being heated from the bottom of said grid element to the top, the top ends of said fins being spaced further apart than the bottom ends thereof to increase the size of said passageways at the top and thereby increase the free flow of air as it is expanded on heating.

4. In an electric space heater, in combination, a grid element comprising a backbone member having a plurality of fins for heating and guiding air and a flat base portion integral with said backbone member, an electric heating element in said backbone member and having its terminals extending from said base portion, a connection box connected to said base portion of said grid element, said terminals extending through holes in the adjacent side of said connection box, the engaging surfaces of said element and box being machined flat, and a conduit fitted to said connection box for shielding a power line to said terminals, said connection box having a machined lower peripheral edge and a bottom cover which fits to said edge, the bottom cover and base portions being machined to fit said connection box and provide tight flame paths from the interior of said connection box to the exterior thereof.

5. In an electric space heater, in combination,
a heating element having a machined base portion with terminals extending therefrom, a connection box having a machined top for receiving said base portion, holes for said terminals and a machined lower peripheral edge, a bottom cover machined to fit said edge, and means for connecting said base portion and said cover firmly to said connection box to provide light flame paths from the interior of said connection box, said connection box and said cover being heavily constructed to withstand an internal explosion pressure of at least eighty-five pounds per square inch and a hydrostatic pressure of at least three-hundred and fifty pounds per square inch whereby the flame resulting from any explosion occurring in the interior of said connection box will be completely dissipated in said flame paths before reaching the exterior of said box.

6. In combination, an electric heater, a connection box therefore, a cover for said connection box, the edges of said box and adjacent surfaces of said cover being machined to form flat smooth surfaces, and means for fastening said cover to said box to form a tight fit therewith, the edges of said box being sufficiently thick so that said surfaces between said cover and said box form a flame path sufficient to dissipate all heat to a non-combustible temperature before it escapes to the atmosphere.

7. In a space heater, in combination, a grid member comprising a vertical backbone element, heating means associated with said backbone element, and a plurality of fins projecting horizontally from said backbone element thereby forming passageways to guide air being heated from the bottom of said grid member to the top, said fins comprising vertical portions curved at their bottom and top extremities to facilitate entrance of air into and exit of air from said passageways and having a constant curvature at the bottom but a decreasing curvature relative to one another at the top so that the cross sectional area of the upper portion of each passageway constantly increases as it is followed upwardly, thereby permitting air to expand as it is heated while rising through said passageways.

8. In a space heater, in combination, a heating element and a housing enclosing said heating element, said housing having a vertical wall with a pair of spaced openings positioned one above the other, and said heating element comprising a vertical backbone member, heating means associated with said backbone member, and a plurality of fins projecting horizontally from said backbone member, said fins being spaced from each other and having vertical portions curved at their vertical spaced respective extremities toward said housing openings, to form passageways for guiding air being heated from the bottom opening up through said housing and out the top opening.

9. In a space heater, in combination, a heating element and a housing enclosing said heating element, said housing having a vertical wall with a pair of spaced openings positioned one above the other, and said heating element comprising a backbone portion, a plurality of fins extending outwardly thereof, and heating means associated with said backbone portion, said fins being shaped to form passageways to connect said openings and to increase the cross sectional area of the upper portion of each said passageway, whereby directed air admitted in the lower of said openings through said passageways and out the upper of said openings and thereby permitting said air to expand freely as it is heated.

10. An explosion proof terminal connection box comprising, in combination, a box member one side of which is open, a conduit fitted to said box member for shielding a power line leading to the interior of said box, said box member having openings in one of its walls for receiving electrical terminals and having a machined flat surface adjacent said terminal openings, the marginal surface adjacent the open side of said box being machined flat, electrical apparatus with terminals extending through said openings and having a machined surface which is tightly secured to said wall of said box to cover said terminal openings and to provide tight flame paths leading therebetween said box and said electrical apparatus, a cover for said box member to fit tight upon the marginal surface adjacent the open side of the box, and means to secure said cover tightly to said box to provide tight flame paths leading from the interior thereof whereby tight flame paths are provided from all points in the interior of said box member to dissipate completely all flame resulting from an explosion in the interior of said box to a non-combustible temperature before it reaches the atmosphere.

LOWELL R. MAST.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

<table>
<thead>
<tr>
<th>Number</th>
<th>Name</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,556,617</td>
<td>Jaffe</td>
<td>May 1, 1934</td>
</tr>
<tr>
<td>2,109,279</td>
<td>Soverhill</td>
<td>Feb. 22, 1933</td>
</tr>
<tr>
<td>2,158,477</td>
<td>Olley</td>
<td>May 16, 1939</td>
</tr>
<tr>
<td>2,240,922</td>
<td>Bissell</td>
<td>May 6, 1941</td>
</tr>
<tr>
<td>2,312,786</td>
<td>Van Daam</td>
<td>Mar. 16, 1943</td>
</tr>
<tr>
<td>2,317,426</td>
<td>Wilson</td>
<td>Apr. 27, 1943</td>
</tr>
<tr>
<td>2,335,283</td>
<td>Bush</td>
<td>Nov. 30, 1943</td>
</tr>
<tr>
<td>2,453,875</td>
<td>Shannon</td>
<td>Nov. 2, 1948</td>
</tr>
<tr>
<td>2,455,859</td>
<td>Walton</td>
<td>Dec. 7, 1948</td>
</tr>
</tbody>
</table>