United States Patent [19]

Schlosser

[11] **3,832,991**

[45] **Sept. 3, 1974**

[54] **RADIANT SPACE HEATER**

[76] Inventor: **Irvin L. Schlosser,** 29 E. Broad St., Hatfield, Pa. 19440

[22] Filed: **June 21, 1973**

[21] Appl. No.: **372,076**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 281,743, Aug. 18, 1972, abandoned.

[52] **U.S. Cl.**..... **126/91 A,** 248/68 CB, 285/137 R, 285/189, 285/424

[51] **Int. Cl.** **F24c 3/06**

[58] **Field of Search** ..... 126/110 R, 110 B, 116 R, 126/91 R, 91 A; 237/70; 285/424, 137 R, 189; 248/68 CB; 165/144, 175

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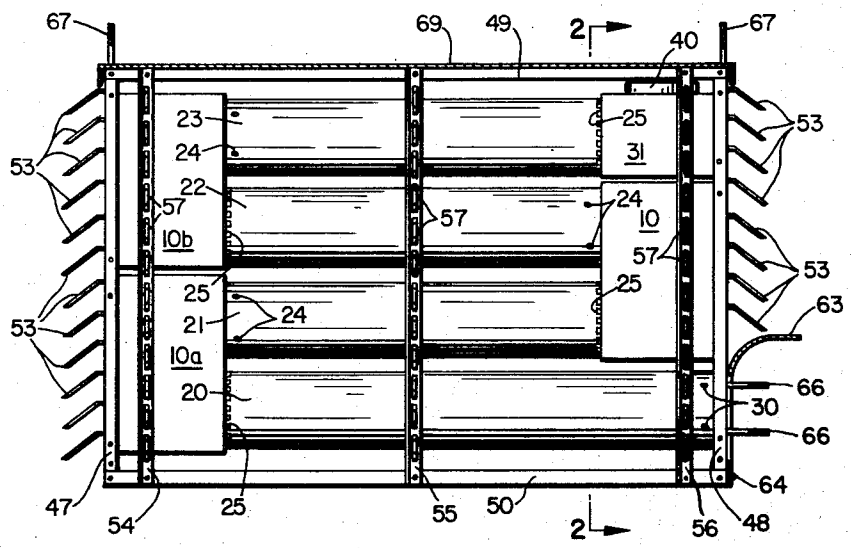
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Assistant Examiner—William E. Tapolcai, Jr.

[57] **ABSTRACT**

A radiant space heater includes separate and functionally distinct module units for (a) supporting a burner, (b) reversing the flow of combustion gases, and (c) supporting a tube end for discharge into a chimney, combustion tubes connecting them in serial order and two side frames which support the module units and which are themselves held in spaced relationship by the module units.

12 Claims, 15 Drawing Figures



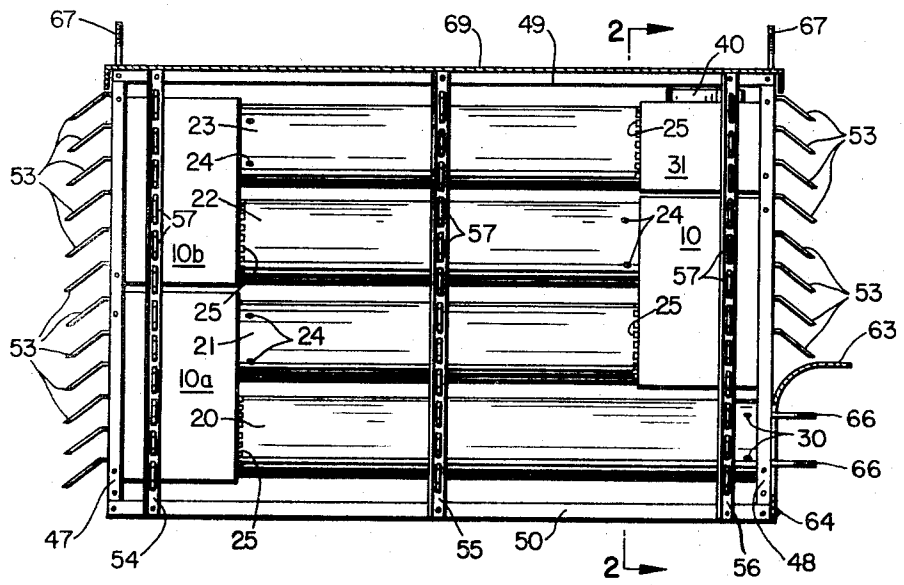


FIG. 1

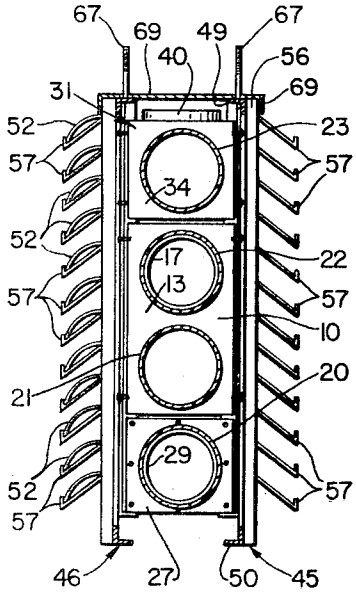


FIG. 2

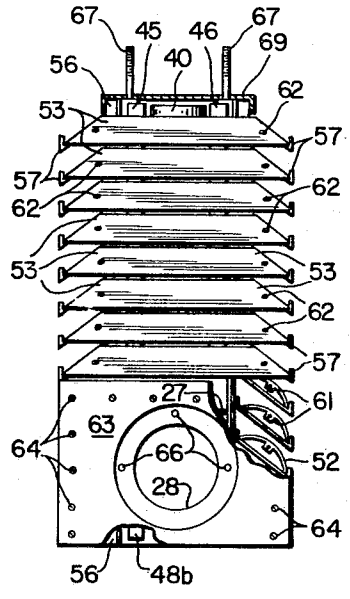


FIG. 3

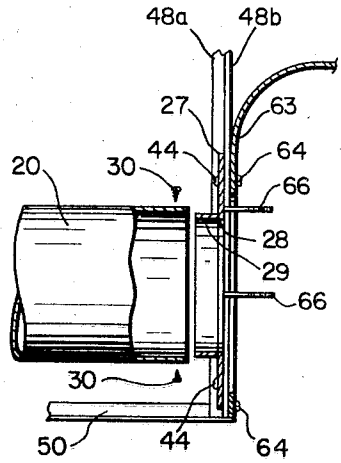


FIG. 4

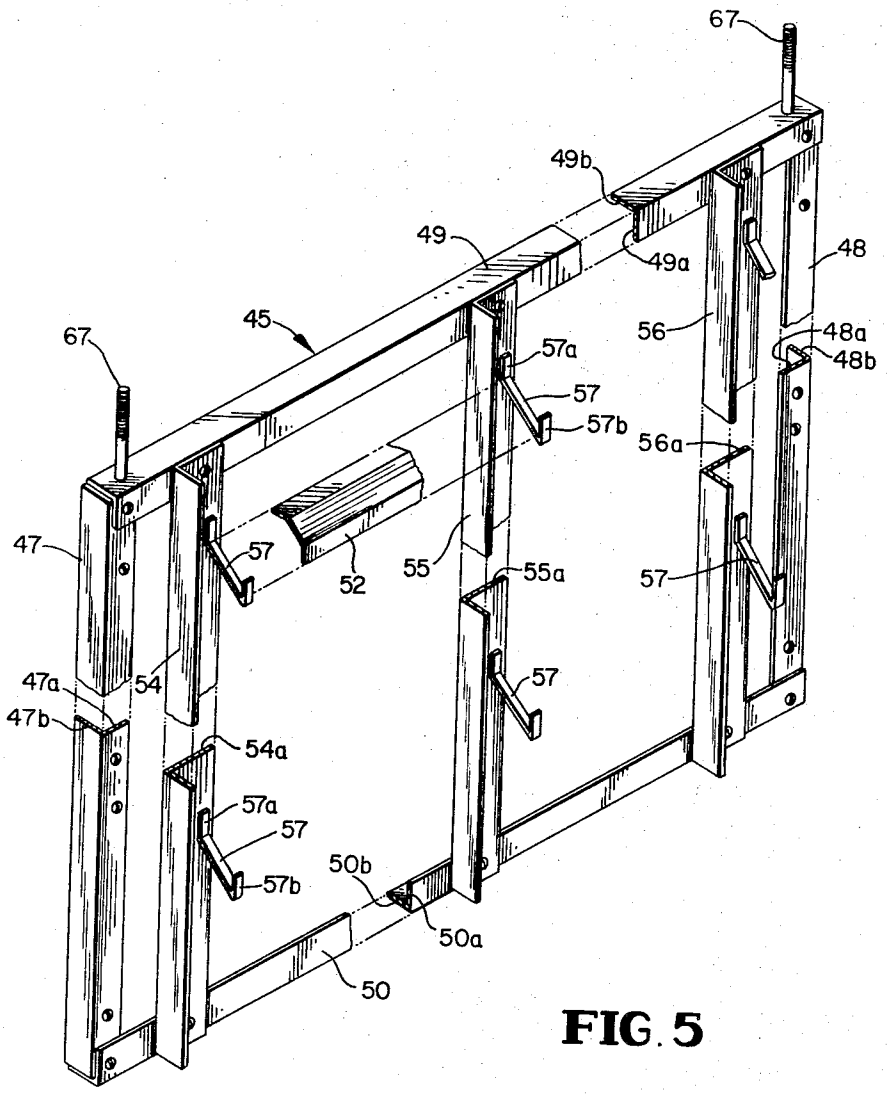

67
49b
49
49a
48
45
56
48a
48b
67
57a
57
57b
56a
47
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52
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47b
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50b
57b
50a
50

FIG. 5

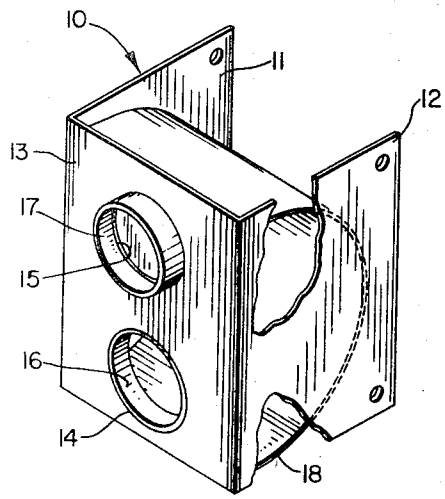


FIG. 6

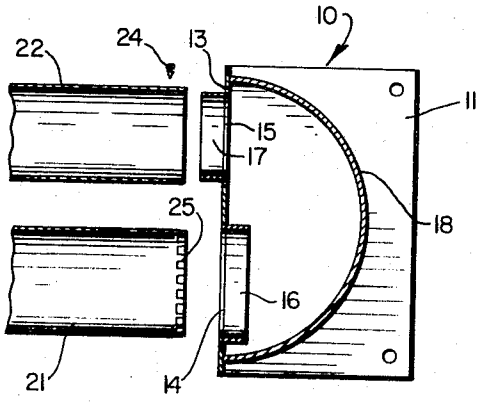


FIG. 7

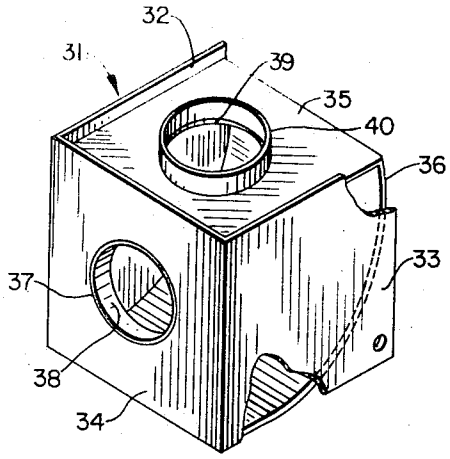


FIG. 8

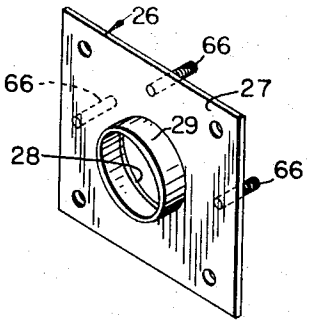


FIG. 9

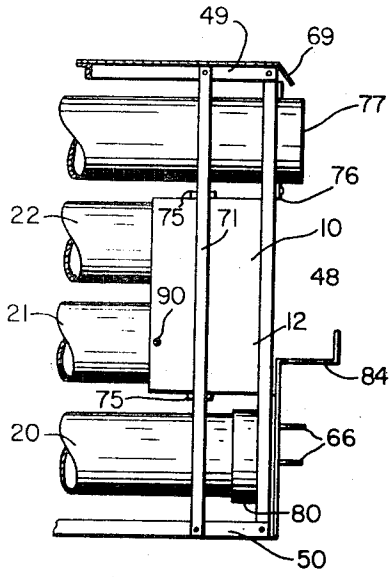


FIG. 10

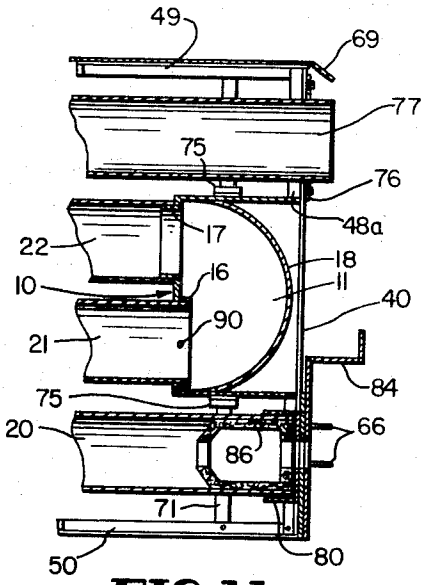


FIG. 11

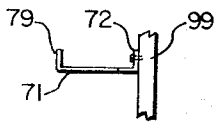


FIG. 15

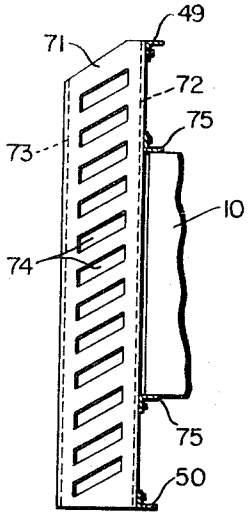


FIG. 14

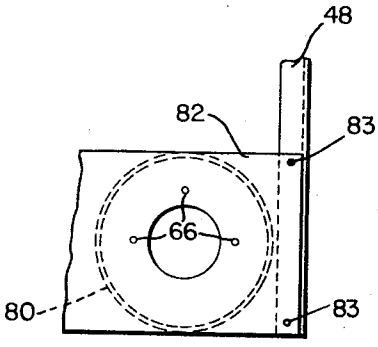


FIG. 13

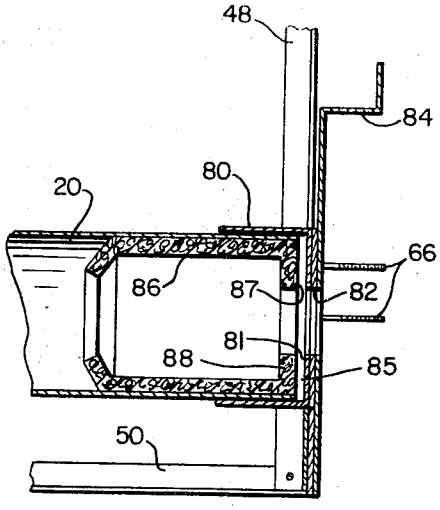


FIG. 12

RADIANT SPACE HEATER

This application is a continuation-in-part of my parent application filed on Aug. 18, 1972 having U.S. Pat. Ser. No. 281,743, now abandoned.

This invention relates to space heaters and particularly to a self-fired heater which dissipates a major portion of the heat by radiation. Space heaters of this type are generally supported well above head level and include radiator fins or reflector vanes to direct radiant heat downwardly.

Although those prior, self-contained burner and radiating tube heaters serve to adequately deliver heat to the ambient space, they all have complicated structures. This not only makes it difficult and time consuming to assemble them initially, but even more time is required to take them apart to replace a damaged part. As the entire heater is subjected to an extremely high temperature due to the direct contact of the flame and hot combustion gases with the major structural parts, these parts are subject to unusual erosion and may burn through. The replacement of such damaged parts in the prior art space heaters has been quite difficult. In some instances, an entire complex casing structure would have to be replaced if only a small portion of its wall had become burned through.

In accordance with the present invention, the completed structure is made up of individual units which are each of fairly simple structure and which are readily assembled to form the composite heater. These advantages are achieved by making use of modular elements or units which have individualized functions. For instance, a key modular unit serves to reverse the flow of the hot combustion gases and direct it from one tube into the tube next above. These key, reverse flow modules are retained in assembled relation in a simplified manner, as will be explained and they possess the important feature that they can individually be replaced when the need arises. This facility of replacement is true of the other structural units of the complete heater, as will be made clear by the following description and drawings.

In the drawings:

FIG. **1** is a side elevational view of the heater with the forward reflectors removed to show the structure behind them,

FIG. **2** is a sectional view on the line **2—2** of FIG. **1**,

FIG. **3** is an elevational view of the right hand end of FIG. **1**, a portion of the shield plate being broken away to show the structure behind it,

FIG. **4** is an enlarged, fragmentary, sectional view of the burner receiving module with the associated combustion tube displaced,

FIG. **5** is a perspective view of one of the two side frames, portions being broken away to show the structure on an enlarged scale,

FIG. **6** is a perspective view of one of the reverse-flow module units, portions of the side plate being broken away, on an enlarged scale,

FIG. **7** is a vertical, transverse section through FIG. **6** with the associated combustion tubes displaced,

FIG. **8** is a perspective view of the discharge module unit, on an enlarged scale, portions of the side plate being broken away,

FIG. **9** is a perspective view of the burner receiving module, on an enlarged scale,

FIG. **10** is a front elevational view similar to FIG. **1** but showing modifications of the right hand end of FIG. **1**, the reflector vanes being omitted,

FIG. **11** is a vertical sectional view through the axes of the combustion tubes of FIG. **10**,

FIG. **12** is an enlarged view of the lower right hand portion of FIG. **11** to show the details,

FIG. **13** is a side elevational view of FIG. **12** with the heat shield omitted,

FIG. **14** is a front elevational view of the apertured plate of FIG. **10** for holding the reflectors,

FIG. **15** is a top end view of FIG. **14**.

As the reverse-flow module unit **10**, shown in detail in FIGS. **6** and **7**, is a key element of the structure, it will be described first. It includes two parallel, laterally spaced side plates **11** and **12** and a connecting face plate **13**. As shown, these plates are portions of a single sheet of metal which is bent to this U-shaped configuration. However, the plates **11, 12,** and **13** can be individual plates which are welded or otherwise held together to form this shape and for convenience they will be referred to as plates. It will be noted that the face plate **13** is oblong and that the side plates **11** and **12** are on its long sides.

This face plate **13** has two holes therein, spaced along its length. At hole **14** and concentric therewith is an internal cylindrical ring **16** and at hole **15** and concentric therewith is an external cylindrical ring **17**. Fitting between the side plates **11** and **12** and also abutting the front plate **13**, is a curved, deflecting plate **18**. This deflecting plate preferably is hemi-cylindrical in curvature but as it serves to reverse the flow of the combustion gases, it is apparent that it may have any suitable, general curvature.

The curved deflecting plate **18** is welded at all its edges to plates **11, 12,** and **13** or is otherwise affixed to them so that a leak proof seal is established. The rings **16** and **17** are welded around their peripheries to the face plate **13**. Welding is preferably utilized as the several plates are intended to be of heavy guage thickness, but it is apparent that any mechanical attachment means may be utilized. For instance, if a light duty heater is being made, the several plates and the rings may be held together by flanging the plates and rings and holding them together by rivets, sheet metal screws, or bolts and nuts. Or, the rings **16** and **17** may simply be pressed out from the face plate **13**.

The internally located ring **16** has an internal diameter such that it will snugly receive therein a combustion tube **21**. The externally located ring **17** has an external diameter such that a combustion tube **22** will firmly fit thereover and to retain it in place, sheet metal screws **24**, or alternative attachment may be applied. The tube **21** is free to move slightly back or forth within ring **16** to allow for heat expansion and contraction and, to avoid binding, it is preferable that this end of the tube have longitudinal crimps or flutings, shown at **25**.

In the illustrated heater, there are four vertically spaced tubes, **20, 21, 22,** and **23**, but there may be fewer or more of them. A large capacity burner may make it desirable to use five or even six tubes to extract most of the heat before it escapes to the flue. Or, a small capacity burner may make two or three tubes sufficient to obtain an efficient utilization of the heat from the burner.

In FIGS. **1** to **9**, tubes **21, 22,** and **23** are identical and the reverse-flow module units **10, 10*a***, and **10*b*** are of

identical construction. This duplication is an important feature as the initial assembly of the heater requires a minimum number of stock parts and for replacement purposes the same stock module **10** will fit in either of the three places.

The lowermost tube **20** slidably fits at one end in the reverse-flow module unit **10***a* and its other end is attached to a burner receiving module unit **26** best shown in FIG. **9.** This unit consists of a plate **27** having a central opening **28** therethrough and a ring **29** affixed thereto as by welding, pressing outwardly of the plate material, etc. The ring **29** is of a size to tightly receive the adjacent end of tube **20** and to hold it in place the sheet metal screws **30,** or alternative attachment means, are utilized. It will be observed that the tube **20** is longer than tubes **21, 22,** and **23** by an amount equal to the depth of the reverse-flow module units **10.** This plate **27** and its attached ring **29** is approximately half of end plate **13** to which ring **17** is affixed.

The topmost tube **23** is attached at one end to the upper flow module unit **10**b and its other end slidably fits within the discharge module unit **31** best shown in FIG. **8.** This unit **31** is comparable to half of the reverse-flow units **10** in the sense that it causes a one-fourth turn in the flow of the combustion gases so as to direct them upwardly into a chimney (not shown). The discharge module unit **31** is made up of parallel, laterally spaced side plates **32** and **33** which are approximately square. A front face plate **34** is affixed to corresponding edges of side plates **32** and **33** as by welding or by being an integral, bent portion of them. A top plate **35** is affixed to their adjacent edges preferably by welding. A curved plate **36** is attached along its curved edges to the side plates **32** and **33** and its curve is preferably a 90° arc. The straight edges of curved plate **36** are respectively attached to the face plate **34** and the top plate **35.** All of these places of attachment are preferably gas tight.

The face plate **34** has a central hole **37** therein and it is surrounded by an internally directed, attached ring **38.** The top plate **35** likewise has a central hole **39** therein and it is surrounded by an externally directed, attached ring **40.** The top tube **23** lies within the face plate **34** and slidably fits the ring **38.** A chimney or flue pipe (not shown) fits over the ring **40** of top plate **35.** This discharge module unit **31,** therefore, serves to direct incoming combustion gases from tube **23,** upwardly into a chimney or flue. The tube **23** is a duplicate of tubes **21** and **22** since the discharge module unit **31** has the same depth as that of the reverse-flow module units **10.**

Each one of the modules **10, 10***a*, **10***b*, **26,** and **31** is of an independent, unitary, firm, self-supporting construction such that it will withstand the stresses imposed by severe temperature changes, shipment, and storage when stacked on top of each other. Each one of them may be replaced by a duplicate without the need to discard either one of the other two types. The sheet metal screws **24** and **30** which attach the one end of the combustion tubes to its abutting module, are easily removed and replaced in the repaired assembly.

To hold the module units **10, 26,** and **31** in their special relationship, two independent side frames **45** and **46** are provided. A description of the one will suffice for both of them as they are mirror images of each other. Referring to side frame **45** in FIG. **5,** it is made up of so-called angle iron in that a cross section of it is a right angle. The frame **45** is made up of two spaced apart vertical bars **47** and **48** and two spaced apart horizontal bars **49** and **50.** They are connected together at their meeting ends by rivets, bolts and nuts, sheet metal screws, by welding or any mechanical means so that a rigid, open oblong frame is formed. The angle bar members are so related to each other that their faces **47***a*, **48***a*, **49***a*, and **50***a* are flatwise and their faces **47***b*, **48***b*, **49***b*, and **50***b* all extend outwardly in the same direction to form a box-like, shallow, open, construction.

The reverse flow modules **10, 10***a*, and **10***b* and the discharge module **31** are attached to the faces **47***a* and **48***a* so that the modules are vertically spaced in proper position relative to one another. This attachment is preferably by sheet metal screws **51,** bolts and nuts, or other means in anticipation of replacement needs. The side plates **12** and **33** of the modules are fastened to the faces **47***a* and **48***a*, while the side plates **11** and **32** of the modules are fastened to the corresponding faces (not numbered) of the other frame **46.**

The burner receiving or attachment plate **27** is fastened by sheet metal screws **44** or other means to the face **48***b* of frame **45** and to the corresponding face (not numbered) of the other frame **46.** This serves to direct the ring **29** inwardly of the heater structure so that it will receive combustion tube **20** thereover.

As the modules **10** and **31** and the burner module **26** are all of rigid, strong construction even though they are separate units, they serve to hold and support the frames **45** and **46** in spaced relation. There is no need, therefore, for any angle irons to tie the two frames **45** and **46** together as this is done by the module units themselves. As there is no complete, box-like frame, the two side frames **45** and **46** would be movable relative to each other if the modules were not present between and fastened to them.

The frames **45** and **46** also serve as a framework to support the side reflectors **52** and the end reflectors **53.** This support is provided by the angle irons **54, 55,** and **56** which are attached at their ends to the faces **49***a* and **50***a;* this attachment may be by means of any mechanical means mentioned above. The faces **54***a*, **55***a*, and **56***a* fit flatwise against the faces **49***a* and **50***a* so that the other faces (not numbered) of the angle irons extend away from the frame **45,** opposite from the faces **49***b* and **50***b*. There are three vertical angle irons **54, 55,** and **56** shown, but there could be more or fewer, depending on the strength of the reflectors **52** and on the overall length of the heater.

Attached to the angle irons, preferably by welding, are the supporting arms **57.** Their ends **57***a* and **57***b* are bent in the same direction away from the middle portion, the end **57***a* being at an obtuse angle and the end **57***b* being at an acute angle. The end **57***a* is attached to the angle irons so that the acutely disposed end **57***b* projects upwardly so as to form a corner for the side reflectors **52** to abut against. The reflectors **52** remain in their assembled position by gravity alone and are easily removable to enable access to the tubes and module units.

The end reflectors **53** are attached to and are carried by the side reflectors **52.** To accomplish this, each side reflector is provided at both ends with a tab **61** which is fastened by sheet metal screws **62** or alternative means to the adjoining ends of the end reflectors. This arrangement could be reversed by providing similar

tabs on the end reflectors. The tab **61** is disposed at an angle to the side reflector so that the end reflector fits flatwise against it.

Some of the lower end reflectors at the burner end of the heater have been omitted as they would be in the way of the burner itself. In the arrangement of FIGS. **1–9,** there are twelve vertically spaced reflectors except at the burner end where the lowermost four have been eliminated, but it is to be understood that there may be more or fewer reflectors as this is generally determined by their widths and desired spacing. The burner (not shown) is attached in place by bolts **66** fastened to plate **27** of the burner module unit and to shield the burner from the intense heat radiated from the adjacent combustion tubes and module unit **10,** a shield plate **63** is provided where the end reflectors are not present. This shield plate **63** is vertically disposed but its upper portion is curved (see FIG. **4**) so as to partially overlie the burner and afford it better heat protection.

The shield plate **63** can be attached by screws **64** to the outer face **48***b* of frame **45** and the corresponding face of frame **46.** It must have a central opening large enough so that the burner can pass through it and fit firmly against the plate **27.** The four lowermost side reflectors are made slightly shorter than the upper eight so that they terminate at the rear of the shield plate **63.** These four lowermost side reflectors are formed with the same tabs **61,** but they are bent at an angle so that they may be attached flatwise against the shield plate **63** by the same sheet metal screws **62** or alternative means.

To suspend the assembled heater from the ceiling or other superstructure, hanger bolts **67** will generally be used. They may be welded to opposite ends of the top face **49***b* of frame **45** and to the corresponding top face of the other frame member **46.** Or, these hanger bolts **67** may pass through holes in these top frame members and be held in place by bolt heads or nuts on the undersides of the top frame members.

To prevent heat loss at the top of the heater a cover **69** is provided. It has a peripheral, descending flange to abut against the topmost side and end reflectors so as to hold the heat in. It may or may not, as desired, be screwed down against the topmost face **49***b*.

The assembly of the heater is facilitated by the use of the modular units of the invention and almost any order of securing the parts in place may be followed, having in mind that the tubes cannot be inserted if both of its end modules are fixed in place. One easy mode of assembly is to first attach the plate **27** of the burner module unit **26** to the face **48**b of the vertical frame member **48** and to the corresponding vertical frame member of the other frame. This assembly will include the lower tube **20** which is held on ring **29** by screws **30** or alternative means. Next, the lowermost return flow module unit **10***a* is passed over the free end of tube **20** and this module unit is fastened in place. Then, the tube **21** is secured to this same return flow module unit **10***a* and the opposite free end of tube **21** is located in its return flow module unit, after which this latter module unit **10** is secured in place. This procedure is repeated until the discharge module unit **31** is fastened in position. Finally, the reflectors **52** and **53** are located in place, shield **63** is attached, and cover **69** is applied.

If tube **21** becomes burned out, for instance, it is merely necessary to remove the reverse-flow module unit **10** to which it is attached, without having to replace any other tube or module unit. Replacement of the tube **21** is then readily accomplished and all the original parts are retained. In similar manner, if the module unit **10a** becomes burned out, it alone needs to be replaced without requiring replacement of module unit **10, 10***b*, or **31.**

The feature of the invention, therefore, is the provision of the separately functional modular units; i.e., the burner receiving module, the reverse-flow module, and the discharge module which are not themselves connected together but which are supported in a series-flow disposition by independent attachment to two side frames which otherwise are not connected together. It is this novel arrangement which facilitates the assembly of the completed heater and which makes it easy to replace only the damaged functional module without having to discard any other functional module. This also makes it possible to sell as a distinct, separate product, each of the module units and to stockpile each kind apart from the others.

The modification of FIGS. **10** to **15** shows several variations or improved features over the structure of FIGS. **1** to **9** inclusive. A structure made according to FIGS. **10** to **15** would have the same construction (except possibly for the reflector vane supports) at its left end, as the left end of the heater of FIGS. **1** to **9.** Or, stated differently, one or more or all of the features of FIGS. **10** to **15** may be incorporated in the heater of FIGS. **1** to **9.**

One possible change from FIGS. **1** to **9** is the replacement of the reflector supporting angle irons or vertical bars **54, 55,** and **56,** with the reflector supporting plates **71,** best shown in FIGS. **14** and **15.** These plates **71** are preferably made of sheet metal and are bent at their long edges to form right angle flanges **72** and **73.** The flange **72** is used to attach, as by sheet metal screws, the plates **71** to the top and bottom horizontal bars **49** and **50** of the two side frames **45** and **46.** The flange **72** also serves to strengthen the plate **71** and the outer flange **73** provides additional strengthening.

Each plate **71** is perforated with the oblong, slanting cutouts or openings **74** to receive and support the side reflector vanes **52.** These plates **71** may be made rapidly by a forming and stamping operation, and they have the feature of eliminating the many bent, supporting arms **57** and their individual attachment to the vertical bars **54, 55,** and **56.** The sheet plates **71** may replace one, several, or all of the bars **54, 55,** and **56.**

Another feature which is incorporated in FIGS. **10** to **15** is the floating support of the reverse-flow module **10** so that it can move back and forth relative to the other modules **10***a* and **10***b*. Thus, the module **10** can move away from modules **10***a* and **10***b* to accommodate the lengthwise expansion of tubes **21** and **22** under the influence of the combustion heat. When the tubes **21** and **22** cool off and contract in length, the module **10** can move back to its position for cooled conditions.

This is accomplished by eliminating the direct attachment of module **10** to the vertical end bar members **48** of the two side frames **45** and **46.** To hold the module **10** in position, against an up and down movement, it fits between angular guide plates **75** which are attached to the sheet plates **71.** These guide plates **75** are fastened to the flange **72** of each vertical plate **71** and project inwardly so that the module **10** loosely fits between them as is best shown in FIG. **14.**

If the vertical bars **56** of FIG. **5** are present instead of the plates **71** of FIG. **14**, the angular guide plates **75** would be attached to the bars **56.** Movement of the module **10** sidewise out of the frame is prevented by the faces **48**a (see FIGS. **5** and **11**) as the module **10** loosely fits between them. As is stated above, the module **10** is not firmly fixed in position but is supported in a floating manner so that it can move back and forth within the up and down restraints of guides **75** and the sidewise restraints of faces **48***a*.

To simplify the construction, the discharge module unit **31** may be replaced by discharge module unit **76** which is simply a plate with a hole in it for the upper tube **77** to pass through. The tube **77** is longer than tube **23** which it replaces, as the exhaust module **31** is not present and the tube **77** must be long enough to pass through the exhaust module unit **76.** A straight exhaust flue pipe can be engaged over the projecting end of tube **77** to carry the exhaust gases to and through a side wall of a building. Or, a flue pipe elbow can be engaged over the projecting end of tube **77** so that the exhaust gases can be conducted up and out of the roof.

The plate **76** constitutes a module unit in the sense that it is used here as it is fastened to the vertical end bar members **48** of both side frames **45** and **46** to support them in spaced relationship, and the plate **76** also serves to support the adjacent end of tube **77.** The module unit **76** therefore serves a dual function such as is served by the module unit **31** which it replaces.

If the long tube **77** is utilized, the upper three or four of the end reflector vanes **53,** shown at the right hand end of FIG. **1,** must be eliminated. The side reflector vanes **52** which would have been connected to these removed end vanes **53** will be connected to the plate **76** and the plate **76** should be long enough to permit this.

In FIG. **4** the lower tube **20** fits over or around the outside of the cylindrical ring **29** of the burner receiving module unit **26,** whereas in FIGS. **10** to **13** the lower tube **20** fits within a larger cylindrical ring or collar **80.** The tube **20** can move back and forth therein when the tube expands and contracts during its heating and cooling. The collar **80** has a flat base **81** welded or integral therewith so that the collar **80** and base **81** are cup shaped. The burner attachment bolts **66** are welded to the flat base **81.** The base **81** has a central hole therein for the burner flame to pass through.

The bolts **66** pass through holes in a supporting plate **82** and this plate is attached as by sheet metal screws **83** to the end vertical bar members **48** of the side frames **45** and **46.** This holds the cup shaped member **80–81** in fixed position, and the elements **82, 80,** and **81** thereby constitute a burner supporting module which serves the function of module **26** in FIG. **9.** The heat shield **84** (similar to **63**) has holes therein for the bolts **66** to pass through and this supports the shield **84.** When a burner is attached to the bolts **66,** the cup shaped member **80–81,** the supporting plate **82,** and the heat shield are all clamped together and the central holes in them should all align up.

When tube **20** is cool or at room temperature, it should be short enough so that its end is spaced from the base plate **81** as is shown by the space at **85.** This space or gap should be so large that when tube **20** is hot because of the flame being projected into it, the expansion of the tube **20** will just about close this gap. The end of tube **20** should not press forcibly against the base plate **81** as this could press the frames out of shape or cause other permanent distortion.

In FIG. **12** is shown a burner gasket **86** of a heat resistant substance of conventional construction and material. Its end outside face at **87** should be flush with the end of tube **20** as shown in FIG. **12.** This gasket **86** should forcibly fit in tube **20** so that it moves with the tube and cannot be dislodged except by manual pressure. When the tube **20** expands, the end face **87** should snugly press against the face of base plate **81** so that a substantially gas tight seal is formed.

To assemble the structure of FIGS. **10** to **15,** substantially the same order is followed which has been explained for the heater of FIGS. **1** to **9** inclusive, however, with the slip fit between the lower tube **20** and the collar **80,** this lower tube should be attached to the module unit **10***a*. In like manner, tube **21** is attached to the module **10** by a long self tapping screw **90** which passes through the side plate **12** of this module, through its ring **16** and through the end of the tube **21.** A similar long self tapping screw passes through plate **11** of module **10** and through the diametrically opposite side of ring **16** and tube **21.** This same attachment is provided between the tube **22** and the module **10***b*.

In the heater of FIG. **10,** therefor, the end of tube **20** within collar **80** can move back and forth therein, the end of tube **77** within plate **76** can move back and forth therein, and the other ends of the tubes are attached to the return-flow modules **10, 10***a* and **10***b*. The structural details, and the back and forth movability of module **10,** accommodates the expansion due to heat.

FIG. **12** shows the preferred structure in which the collar **80** is integral with the base **81** but if desired the collar can be a separate cylinder which is attached as by welding to the base plate **81.** Or, if the collar is a separate cylinder it can be welded to the plate **82** which is attached to the flanges **48***b* of the two vertical bars at the same end of the heater. This plate **82,** like plate **76,** serves to fixedly space the frames at this end of the heater.

FIG. **14** shows the guides **75** attached to the slotted vertical plates **71** and it shows the plates **71** about midway of the width of the module **10** so that the module is balanced on the guides. This is preferred but the guides **75** could be attached to the vertical frame bars **48.**

The gasket **86** is shown as a lining within the end of tube **20** and it preferably has integral therewith the disc portion **88** which is centrally apertured for the combustion flame to pass through. The increased surface provided by this apertured disc portion **88,** to bear against the plate **81,** serves to establish a better gasket seal when the expansion of the tube brings them into contact. This apertured disc portion **88** can lie partially beyond the end of tube **20** as it is supported by the lining portion **86.**

The lining **86** protects the tube against the intense heat of the burner flame and it is made of asbestos or asbestos like material. It is sold as a corbel unit and as a pyrolite combustion chamber.

As has been stated above, various combinations of the structural details of FIGS. **1** to **9** inclusive may be combined or interchanged with the structural details of FIGS. **10** to **15** inclusive. For instance, the top tube **77** and module unit **76** may be substituted for the top tube **23** and module unit **31.** Or, the structural details of

FIG. 12 can replace the structural details of FIG. 4. In like manner, the return-flow module in FIG. 1 can be supported in a floating manner as is shown in FIG. 11.

What is claimed is:

1. A space heater which delivers radiant heat downwardly which comprises a separately functional burner receiving module unit, a series of separately functional reverse-flow module units, a separately functional discharge module unit, two side frames each made up of two horizontal bar members and two vertical bar members connected at their meeting ends to form an open frame, and combustion tubes disposed parallel to said side frames and arranged to direct combustion gases from the burner receiving module unit, through the reverse flow module units and finally through the discharge module unit, said combustion tubes being connected to and supported by said module units, and several of said module units being attached to said vertical bar members to thereby hold and support said two side frames in their spaced relationship.

2. The space heater according to claim 1 in which all of the module units are connected to said vertical bar members.

3. The space heater according to claim 1 in which the burner receiving module and the discharge module units are connected to the same end vertical bar members and the reverse-flow module unit between these latter module units is supported for free endwise movement.

4. The space heater according to claim 1 in which the discharge module unit is a plate which is attached to vertical bar members at the same end of the heater and it has a hole therethrough to receive and support a combustion tube.

5. The space heater according to claim 1 in which the discharge module unit includes two spaced side plates which are connected respectively to the two vertical bar members at the same end of the heater and also includes a curved plate which is attached to said two spaced side plates and serves to direct the gases through a guarter turn.

6. The space heater according to claim 1 in which the reverse-flow module units each include two spaced side plates and a curved plate attached to them and serving to direct the gases through a half turn, the side plates of at least one of the reverse-flow module units being connected respectively to the two vertical bar members at the same end of the heater.

7. The space heater according to claim 1 in which the burner receiving module unit includes a plate and a collar projecting therefrom inwardly of the heater, the end of the associated combustion tube having a sliding fit within said collar, and a heat resistant material lines the interior of said tube end and serves as a gasket by contact with said plate upon lengthwise heat expansion of the tube.

8. The space heater according to claim 7 in which said heat resistant material includes an apertured disc portion which provides an increased gasket surface to contact said plate and form a seal.

9. The space heater according to claim 1 in which the burner receiving module unit includes a plate which is attached to vertical bar members at the same end of the heater and it has a hole therethrough for the passage of a combustion flame.

10. The space heater according to claim 1 in which slotted vertical plates extend between and are attached to the horizontal bars of each frame and horizontal reflector vanes are carried in the slots.

11. A space heater which delivers radiant heat downwardly which comprises a separately functional burner receiving module unit, a series of separately functional reverse-flow module units, a separately functional discharge module unit, two side frames each made up of two horizontal bar members and two vertical bar members connected at their meeting ends to form an open frame, and combustion tubes disposed parallel to said side frames and arranged to direct combustion gases from the burner receiving module unit, through the reverse-flow module units and finally through the discharge module unit, said module units being connected to the combustion tubes and being attached to said vertical bar members so that the module units serve the dual functions of supporting the combustion tubes in said relationship and also holding and supporting said two side frames in their spaced relationship.

12. The space heater of claim 11 in which at least one of said reverse-flow module units includes two spaced side plates which are attached respectively to said side frames.

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