

July 8, 1952

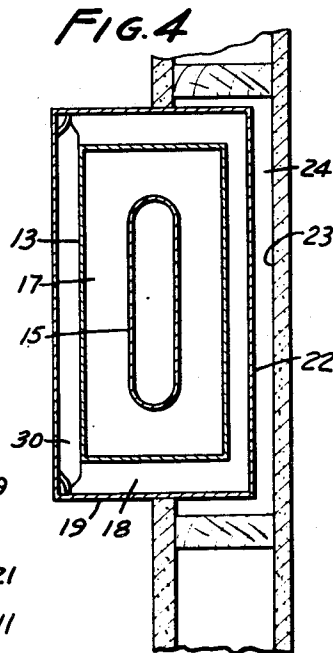
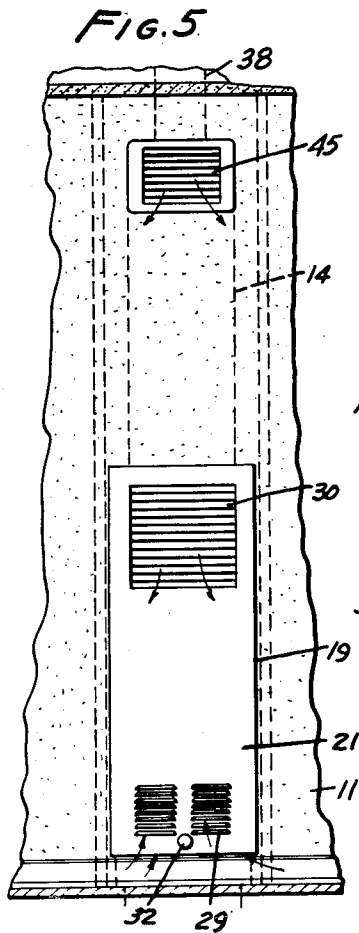
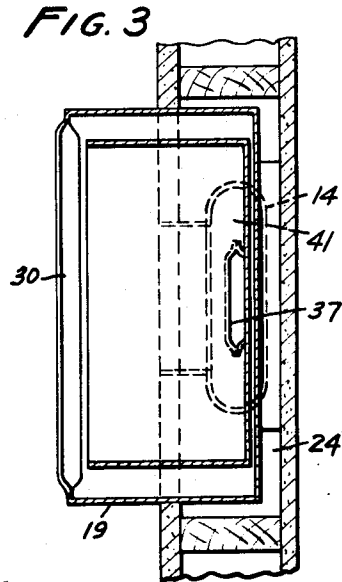
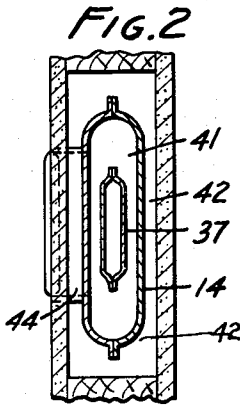
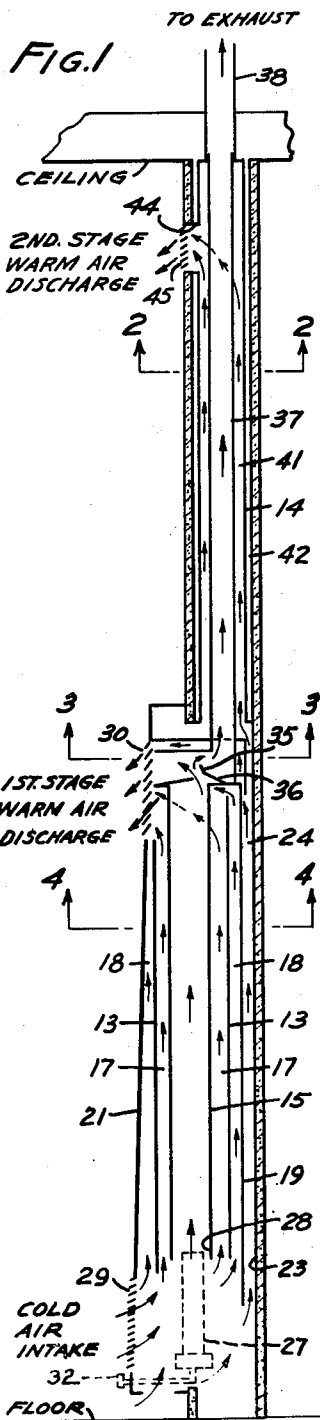
J. H. HOLLINGSWORTH ET AL

2,602,441

GAS-BURNING WALL HEATER

Filed April 23, 1951

2 SHEETS—SHEET 1



INVENTORS:
JOHN H. HOLLINGSWORTH,
KARL L. BEDELL,
BY
James O. Christie
ATTORNEY.

July 8, 1952

J. H. HOLLINGSWORTH ET AL

2,602,441

GAS-BURNING WALL HEATER

Filed April 23, 1951

2 SHEETS—SHEET 2

FIG. 6.

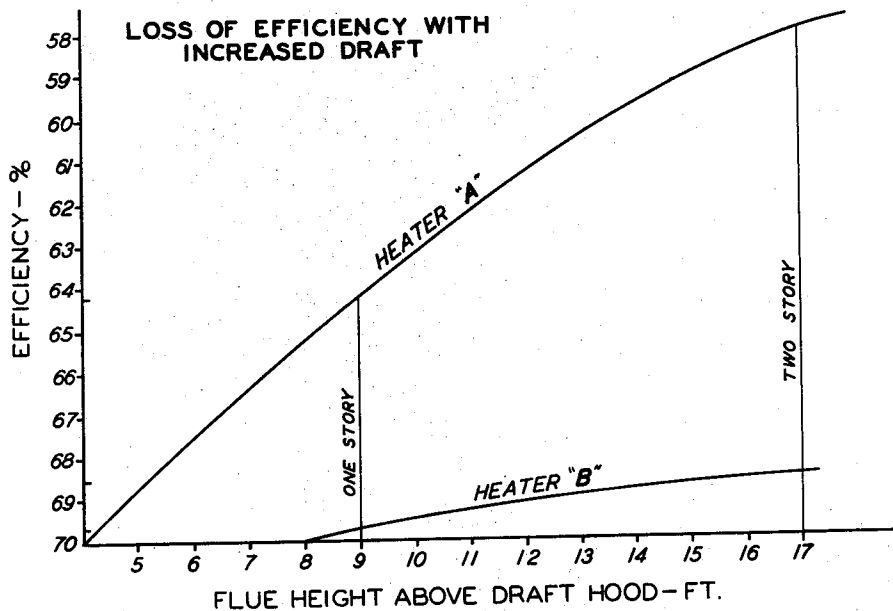
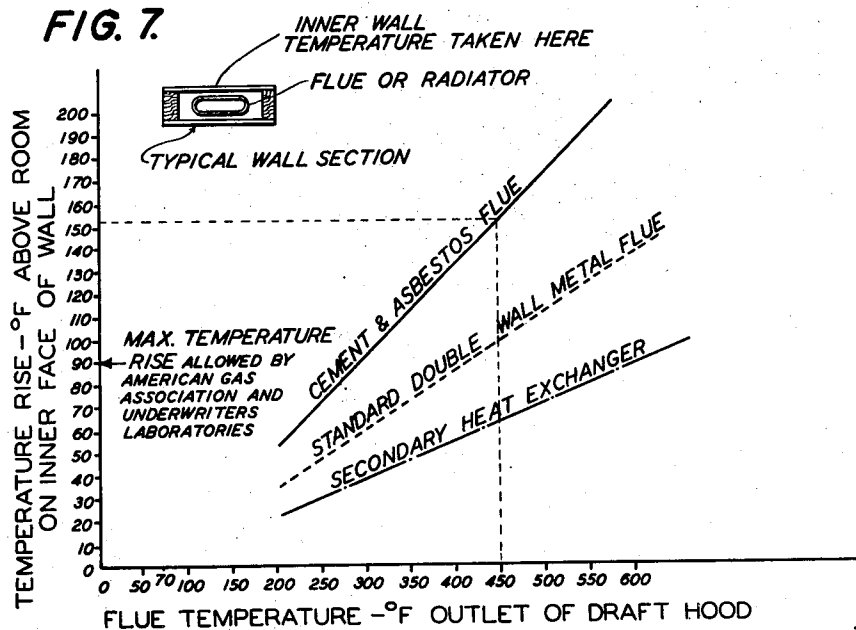


FIG. 7.



INVENTORS.
JOHN H. HOLLINGSWORTH
KARL L. BEDELL

BY

James B. Presdee

ATTORNEY

UNITED STATES PATENT OFFICE

2,602,441

GAS-BURNING WALL HEATER

John H. Hollingsworth, Altadena, and Karl L. Bedell, Pasadena, Calif., assignors to Holly Manufacturing Company, Pasadena, Calif., a corporation of California

Application April 23, 1951, Serial No. 222,500

5 Claims. (Cl. 126-116)

1

This invention is concerned with wall heaters fired with gaseous fuel and provides improvements therein to the end that thermal efficiency and air circulation are increased and undesirable heating of the wall is avoided.

This is a continuation-in-part of our co-pending application Serial No. 157,670, filed April 24, 1950, now abandoned.

Wall heaters are employed widely, especially in areas where gaseous fuel is cheap. They offer a number of advantages. They are relatively inexpensive to build and simple to install. If properly constructed, say in accordance with the standards of the American Gas Association, they are safe. They are relatively economical in operation and heat space quickly—an advantage in climates where the mornings or nights are cool but the days are relatively warm. But there are disadvantages. Conventional wall heaters tend to produce high wall temperatures above the heater and adjacent the flue, and this is so even when the installation meets the requirements of the Underwriters' Laboratories and presents no fire hazard. High wall temperatures, even in the absence of fire hazard in the wall, evidence a heat loss in the flue. Even when this loss is not excessive, the customer reaction is poor. If an effort is made to lower the wall temperature by bleeding air into the flue, the resulting heat loss, though apparently lower, may actually be increased.

A conventional wall heater comprises a tall shallow box set in a wall of a room to be heated. The box may be open at the front, but customarily is closed except for grills at top and bottom through which the air from the room to be heated circulates. A tall hollow radiator is set in the box and is fired inside with gaseous fuel. Air rising through the box is heated by the radiator and passes out into the room. Heat not transferred by the radiator remains in the gaseous products of combustion and is wasted up the flue connected to the top of the radiator.

A draft hood or diverter may be connected in the flue above the radiator. This has a relief outlet, usually into the room through the box in which the radiator is disposed, and serves several purposes. If the flue should become choked, the flame in the radiator will not be blown out and the gaseous combustion products will escape through the relief outlet. If a down draft should develop in the flue, the same results will follow. On the contrary, if an excessive up-draft should exist due to an excessively high chimney or flue, or should develop temporarily due to a high wind,

2

air from the room will be sucked into the flue from the relief outlet and the relief outlet will thus prevent the excessive draft from interfering with proper combustion in the radiator.

For safety's sake, a wall heater of the type described is so designed that, even with only the four foot flue employed in American Gas Association tests, a considerable volume of warm air will pass continuously into the flue through the relief outlet from the room. With the taller flues customarily used even in one story houses, this volume is increased. A two story flue still further increases the draft and the amount of warm air lost up the chimney or flue. The warm air sucked into the flue through the draft diverter thus represents a constant and substantial heat loss, which increases as draft is increased.

As indicated at the outset, the flue above the radiator tends to heat the wall in which it is enclosed. The more the fuel burned, the hotter the flue gas, the hotter the wall and the greater the loss of heat up the flue. In cold weather, the wall may become unpleasantly if not dangerously hot due to the large amount of fuel burned, and this hot wall condition is accompanied by increased loss of heat up the flue. If an attempt is made to reduce the wall temperature by bleeding in air from the draft diverter, a lower wall temperature is obtained but only at the expense of a still further decrease in heating efficiency.

As a result of our investigations we have developed a wall heater which

- (a) eliminates high wall temperature;
- (b) does so without decreasing heating efficiency and in fact with a substantial increase in heating efficiency;
- (c) increases air circulation in the room in which the heater is installed; and
- (d) can be installed with flues which normally would produce excessive draft, without deleterious effect upon heating efficiency, so that the heater is adaptable to a greater variety of draft conditions than conventional heaters while keeping heating efficiency high.

In accordance with our invention, a wall heater is constructed in two sections. The lower section comprises a gas-fired hollow radiator disposed in a box in the wall of a room immediately above floor level. The upper section is likewise a radiator disposed in a box in the wall and placed above the first radiator but mainly below the ceiling. The two radiators are connected in series. Gas is burned in air in the first radiator and the resulting flue gases rise through the

second radiator and are discharged into a flue connected to its top.

No damper or the like for constricting the flow of the flue gas through the two radiators is provided, and a draft diverter is connected between the two radiators, instead of at the flue, as is customary. This diverter has its relief opening into the room, preferably through the box in which the lower radiator is placed.

Air to be heated is admitted into the lower portion of the box from the room, rises along the lower radiator and is discharged into the room at the top of the box. Air from floor level in the room is passed upward through a separate conduit into the bottom of the upper box in which the second radiator is disposed. Preferably this separate conduit is disposed around the sides or back or both of the lower box. Air introduced by the conduit into the upper box rises along the second radiator and is discharged into the room through an outlet in the upper box near the ceiling.

The second radiator preferably is formed as a unit with its box, and spaced from the upwardly extending walls of the box. Box and enclosed radiator are thus installed together in the wall, preferably with an insulating space in the wall outside the box.

In the heater just described the horizontal cross section of the second radiator is considerably smaller than that of the first, and is designed so that a normal draft with a very short flue will barely cause air to be drawn into the system through the draft hood and so that increase in chimney effect does not increase dilution through the draft hood to a substantial degree.

The reasons for the structure just described and the results thereof are as follows:

Draft is what tends to make gas move upward through a flue and is the result of a pressure differential, i. e. the difference in the density of the column of gas in the flue and a like column of equal height outside. Hence theoretically available draft is a function of flue height and flue temperature. Although the theoretically available draft is a measure of static condition and is never fully obtained due to frictional losses in the flue, the actual draft at any flue temperature is still closely related to the flue height and any increase in that height will cause the flow of gas to increase until the total energy loss of the system equals the theoretically available draft.

The function of the draft hood or diverter in the device of the invention is to stabilize draft conditions existing within the lower radiator regardless of variations in draft conditions above it. This is accomplished by placing suitable baffles in the draft hood (so as to direct the flow of gas properly) and by the vent which provides a source of relief air. The draft hood does not control the draft action established within the flue but only its effect on the combustion zone in the lower radiator.

Draft in a flue may be controlled satisfactorily and safely in many instances by a damper. They have been used for many years in the flues of fireplaces. Adjustable dampers, however, are not satisfactory in the flue of a gas-burning device, because of the possibility of asphyxiation. Recognized testing agencies and governmental bodies condemn them, and they are forbidden in many places by building codes and ordinances.

Frictional resistance to laminar flow is essen-

tially proportional to the velocity of such flow. But under conditions of turbulent flow resistance to flow is more nearly proportional to the square of the velocity. Consequently, if the horizontal cross section of the upper radiator is constricted, preferably until turbulent flow conditions obtain, a large increase in draft, say due to a tall chimney or a high wind, will have a minimum effect at the draft hood below the radiator. Hence the suction at the relief opening of the draft diverter tends toward a constant value. If the system is designed so that it barely draws in air through the draft hood with a short flue (say one four feet high) it will pull only a slightly greater proportion if the flue height is increased. Loss of heat by leakage through the draft hood into the second radiator may thus be held at a low figure even if the wall heater is installed with a flue system that creates excessive draft, and heating efficiency is thereby improved.

In other words, the cross section of the second radiator is chosen so that as a conduit it will just handle the maximum products of combustion to be conducted in the first radiator, with scarcely any dilution through the draft hood. With such a design, a marked increase in draft will produce a minimum increase in draft at the base of the second radiator, and hence a minimum increase in dilution through the draft hood.

By drawing the cold air up around the sides or the back, or both, of the lower box, the neighboring wall surfaces are cooled and more fuel may be burned safely without attaining excessive lower wall temperatures. Hence, the heating capacity of the apparatus is increased. Moreover, the air for the upper heat exchange, because it is drawn from a low level has a lower temperature, so that the heat transfer from the upper radiator is increased. In this way the amount of heat imparted to the air passed through the upper box (i. e. in the conduit around the upper radiator) is increased, with a resulting improvement in over-all heating efficiency. Third, the use of cold or low level air as feed to the secondary heat exchanger makes it possible safely to encase this secondary heat exchanger in a combustible wall. Fourth, the structure of the invention is such that the hotter air is brought out into the room at an intermediate level while cooler but still warm air is introduced into the upper part of the room near the ceiling, thus reducing stratification and increasing air circulation in the room.

The over-all effect of the application of the invention is striking. In actual tests it raised thermal efficiency by more than 10%, increased the volume of warm air circulated in the room by approximately 25% and reduced upper wall temperature from about 150° F. above room temperature to about 90° F. above room temperature. At the same time, the cost of the secondary heat exchanger employed was but little more than that of the flue section which it replaced.

The foregoing and other aspects of our invention will be understood more thoroughly in the light of the following detailed description, taken in conjunction with the accompanying drawing in which:

Fig. 1 is a diagrammatic sectional elevation of a presently preferred embodiment of the wall heater of our invention;

Figs. 2, 3 and 4 are cross sections taken respectively along the lines 2-2, 3-3, and 4-4 of Fig. 1;

Fig. 5 is a front elevation of the wall heater of Fig. 1;

Fig. 6 is a graph of the results of tests conducted to determine the relative heating efficiency of conventional wall heaters and that of the invention for various chimney or flue heights, thermal input being the same in all cases; and

Fig. 7 is a plot of wall temperatures against flue temperatures obtained in testing wall heaters of the invention, as compared with similar plots for conventional heaters equipped in one case with an accepted composition flue (Portland cement-asbestos) and in the other with a standard double wall metal flue.

Figs. 1 and 5 show a wall heater set in a wall 11 of a room and having two separate chambers 13, 14, one disposed above and offset centrally of the other.

The lower chamber 13 is a tall shallow box or jacket, set upright in a recess of the wall. The box is rectangular in section both horizontally and vertically. A hollow radiator or heat exchanger 15 preferably made of a black surfaced metal and of considerably smaller horizontal cross section than the jacket, is disposed centrally of the jacket in an upright position. There is an inner annular air space 17 between the jacket and radiator, and a second outer annular air space 18 between the jacket and an encompassing heat conductive shell 19. The shell is box shaped and of greater cross sectional dimensions than the jacket which is disposed centrally within it. The shell has a front side 21 exposed to the room and an opposite rear side 22 spaced from the back wall 23 of the recess, leaving an air space or conduit 24 behind it.

Neither the jacket nor radiator extends to the bottom of the shell as shown in Fig. 1. However, the jacket could extend to the bottom if it were provided with a series of ports for circulation of air.

A gas burner 27 at the bottom of the shell is so placed that it projects flaming gases into the open bottom of the radiator.

The front of the shell is provided with two spaced sets of louvers 29, 30. Relatively cold air is drawn into the chamber through the lower louvers, near the floor, and discharged as heated air to the room through the upper set of louvers, adjacent the top of the shell and about midway up the wall. The air may rise through either the annular space 17 defined by the heat exchanger and jacket or between the jacket and the shell in the space 18 or between the shell and the wall in the space 24, with the combustion gases ascending through the interior of the hollow heat exchanger. The lower jacket or chamber does not extend to the top of the shell and hence hot air rising in the jacket may escape into the shell, and thence to the room through the upper set of louvers. The outer annular air space 24 serves primarily as an insulating chamber, protecting the rear wall of the recess and the sides of the shell from excessive heat. The gas burner is provided with a pilot light (not shown) and is controlled by manipulation of a knob 32 on the front of the shell.

The primary heat exchanger opens into the base of a draft hood 35 having a diverter 36. A second radiator 37 is connected to the top of the draft hood. The second radiator opens into a flue 38 through which the combustion gases are exhausted to the outside. The second radiator, like the first, is oblong in section and is

constructed of a dark surfaced heat radiating metal. Save for the lower end which extends into the recess, the second heat exchanger is completely enclosed in the upper wall in an upright position.

The second box or jacket 14 is completely enclosed in the upper wall and is centrally disposed around the second radiator to which it is attached. The second jacket extends from the top of the recess to the ceiling of the room, forming two annular air spaces, a first air space 41 (see Figs. 1 and 2) between the jacket and the radiator and a second air space 42 between the jacket and the interior surfaces of the wall. The air space 24 defined by the outer wall of the shell and the inner surface of the back wall of the recess opens into the air space 41 between the upper jacket and second radiator.

Air heated by the upper radiator and rising through the air space 41 is discharged into the room through a lateral duct 44 connecting the jacket to the louvers of a register 45 set flush in the wall near the ceiling of the room. The outer air space 42 between the jacket and the interior surfaces of the wall aids in preventing excessive heating of the wall.

As shown plainly in Fig. 2, the chamber and the radiator of the secondary heat exchanger are of flattened cross section, both being considerably shorter transverse to the wall than parallel to the wall. Conveniently, both radiator and shell or jacket are made of opposed sheet steel halves welded together along lapped flanges. The flattened section of the exchanger is useful in that it permits large heat exchange capacity to be installed in a relatively thin wall. The radiator is substantially smaller in cross section than the lower or primary radiator.

The operation of the apparatus described in conjunction with the drawings is as follows:

Gas is burned in the lower radiator. This gas may attain a temperature adjacent the burner as high as 2000° F. The hot gases of combustion rise through the radiator and the draft hood into the second radiator and thence are exhausted to atmosphere. The hot gases in rising through the lower radiator decrease in temperature to about 650° F. This temperature is reduced slightly in the draft hood. The temperature of the gases leaving the upper end of the second radiator is about 450° F. Air enters the space in the lower heat exchanger around the radiator at floor level and at a temperature of about say 70° F. In passing up through the jackets in the lower exchanger the temperature of this air is increased to about 375° F., at which temperature it is discharged into the room through the middle louver.

Cold air, say at about 70° F., passes up from the floor level to the box surrounding the second radiator through the wall and in passing to the upper louver (of the second heat exchanger) adjacent the ceiling attains a temperature of 165° F., at which temperature it is discharged.

Extensive tests have been made to determine quantitatively the effect of the heater of the invention on heating efficiency and wall temperature. These results are summarized in Figs. 6 and 7 and there compared with heating efficiency and wall temperatures observed with conventional wall heaters of high quality under like conditions.

Fig. 6 illustrates the effect of draft (chimney action) upon heating efficiency with conventional wall heaters and those of the invention. The

figure has a plot of heating efficiency against flue height for heater A, which represents the average values obtained in actual tests with a number of makes of heaters disposed in a wall, with a suitable draft hood at the top of the heater and about half-way up the wall in each case at which point it was connected to a standard flue section; the height of which was increased as shown in order to increase the draft stepwise. The line marked "Heater B" is a plot of actual efficiencies obtained with the heater illustrated in Figs. 1 to 5, as with the conventional flue section immediately above the draft hood of heater A replaced by a secondary heat exchanger. The radiator of this second exchanger was of uniform but small horizontal cross section so that with the shortest flue height, the draft hood barely drew air. Both heaters A. and B. burned fuel equivalent to 25,000 B. t. u./hr.

Fig. 6 shows plainly that the heater of the invention is superior to the conventional gas-fired wall heaters irrespective of flue height, and that as flue height and draft are increased the superiority of our heater becomes more marked. Stated in another way, the heater of the invention has a high thermal efficiency which decreases only slightly as draft increases, whereas the conventional heater has a lower efficiency to start with and this initial lower efficiency becomes sharply worse as flue height is increased.

Fig. 7 illustrates the decrease in wall temperature in the neighborhood of a wall heater brought about by the invention. In the figure, flue temperature is plotted against upper wall temperature for (1) a conventional wall heater extending about halfway up the wall of a room, with a draft hood at the top and a standard "composition" flue of cement and asbestos in the wall above it; (2) the same conventional heater with the same draft hood but employing a standard double wall metal flue in the wall; and (3) the heater of the invention, similar to the other two heaters except that the flue sections were replaced by a secondary heat exchanger in the wall fed with air from floor level and discharging at ceiling level, as illustrated in Figs. 1 to 5.

Irrespective of flue temperature, wall temperatures with the apparatus of the invention are consistently lower than those obtaining when conventional heaters with either of the usual flue types are used. This means that in times of very cold weather, when the demand is high, the heater of the invention may be called upon to burn a great fuel load safely, something that cannot be said of the other heaters. It also means that under normal conditions, no annoying "hot wall" conditions are obtained.

We claim:

1. In a wall heater for burning gas, the combination which comprises a first box adapted to

be mounted in a wall of a room to extend upward therein from a level near the floor of the room to a level part way to the ceiling; a first hollow radiator mounted in the box and spaced from the walls thereof, means for burning fuel in the first radiator; means connected to the lower portion of the first box for introducing air thereinto near the floor of the room; means connected to the upper portion of the first box for discharging air into the room from the box near its top; a second box adapted to be mounted in the wall above the first box to extend from a level just above the first box to a level near the ceiling; a second hollow radiator disposed in the second box and spaced from the walls thereof, the horizontal cross section of the second radiator being substantially smaller than that of the first radiator; means connected with the upper portion of the second box for discharging air from the second box into the room just below the ceiling; a draft hood provided with a relief opening into the room and connecting the top of the first radiator with the bottom of the second radiator; said second hollow box having an inlet opening adjacent the bottom thereof and adapted to receive air flowing upward outside the first box and inside the wall; and a flue connected to the top of the second radiator.

2. Apparatus according to claim 1 provided with a baffle disposed in the first box behind the first radiator and spaced from the radiator and also from the rear wall of the box.

3. Apparatus according to claim 1 provided with a baffle disposed in the first box behind the first radiator and spaced from the radiator and also from the rear wall of the box to provide a conduit between the rear wall of the box and the baffle, said conduit being open at the bottom and also at the top and in communication at the top with the interior of the first box.

4. Apparatus according to claim 1 in which the second radiator is composed of a shallow front member and a shallow rear member.

5. Apparatus according to claim 1 in which the second box is composed of a shallow front member and a shallow rear member.

JOHN H. HOLLINGSWORTH
KARL L. BEDELL

REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
1,361,389	McLeod	Dec. 7, 1920
1,698,775	Traut	Jan. 15, 1929
2,453,954	Wright	Nov. 16, 1948
2,484,457	Marble	Oct. 11, 1949
2,487,775	Cartter	Nov. 8, 1949