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[45] **Apr. 3, 1973**

[54] **SEALED COMBUSTION FORCED AIR FURNACE**

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[21] Appl. No.: **133,632**

[52] **U.S. Cl.**.....**126/85 B,** 98/62, 126/116 B, 126/307 R

[51] **Int. Cl.**.....**F23j 11/00,** F24c 3/00, F24h 3/00

[58] **Field of Search**..126/85 B, 110 R, 110 B, 116 R, 126/116 B, 307 R; 98/62

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[57] **ABSTRACT**

A sealed combustion forced air furnace for use in a mobile home or the like comprising a rectangular casing having open interior and exterior ends communicating with the interior and exterior of the home respectively. A partition within the casing divides the casing into forward and rear compartments and includes a cut-out communicating the two compartments. An interior grill covers the open interior end of the casing and a motor-driven blower within the forward compartment draws room air through the interior grill into the forward compartment and discharges the air through the cut-out into the rear compartment. A pair of vertical side baffles and a top baffle in the rear compartment extending rearwardly from the cut-out define a central air heating tunnel. A rectangular burner box lies vertically below the tunnel and a pair of heat exchangers project upwardly therefrom within the air heating tunnel. A pair of burners are within the burner box below each heat exchanger. A vent pan encloses the open exterior end of the casing by means of an interior upright wall and an exterior grill covers the exterior end of the vent pan to define therewith a ventilation chamber. The burner box communicates with the ventilation chamber, and the heat exchangers have discharge outlets communicating with the ventilation chamber. A flue pan assembly within the ventilation chamber comprises a vertical deflector plate spaced rearwardly opposite the discharge outlets, and a pair of lateral exhaust openings between the upright vent pan wall and the deflector plate. The flue pan assembly further includes a pair of vertical side walls spaced laterally outwardly of and opposite the lateral exhaust openings. The upper portion of the exterior grill has a plurality of louvered openings and an imperforate lower portion in juxtaposition to the burner box. The uppermost louvered openings are at the same or higher elevation as the lateral exhaust openings. The combustion air circuit and the room air circuit are sealed from one another in the casing. In the combustion air circuit, outside combustion air is drawn by natural gravity draft through the lowermost louvered openings in the exterior grill to flow downwardly within the ventilation chamber. The air then enters the burner box where it is mixed with fuel in the burners and ignited to produce hot flue gases which rise upwardly within the heat exchangers to flow through the discharge outlets. The flue gases are deflected and divided by the deflector plate to flow in diverging streams laterally against the side walls of the flue pan assembly and then outwardly through the uppermost louvered openings in the exterior grill. In the room air circuit the blower draws room air through the interior grill and horizontally discharges the room air into the heating tunnel to sweep the outer surface of said heat exchangers to be heated. The heated room air upon exiting from the tunnel is deflected and divided by the upright wall of the vent pan to flow in two streams between each side baffle and the adjacent casing side wall to a plurality of discharge openings in the casing bottom and sides. The furnace controls are located within the forward compartment and are conveniently accessible from the interior of the home by removing the interior grill. The burner box and heat exchangers are rendered accessible for cleaning from the exterior of the home by removing the exterior grill.

34 Claims, 9 Drawing Figures

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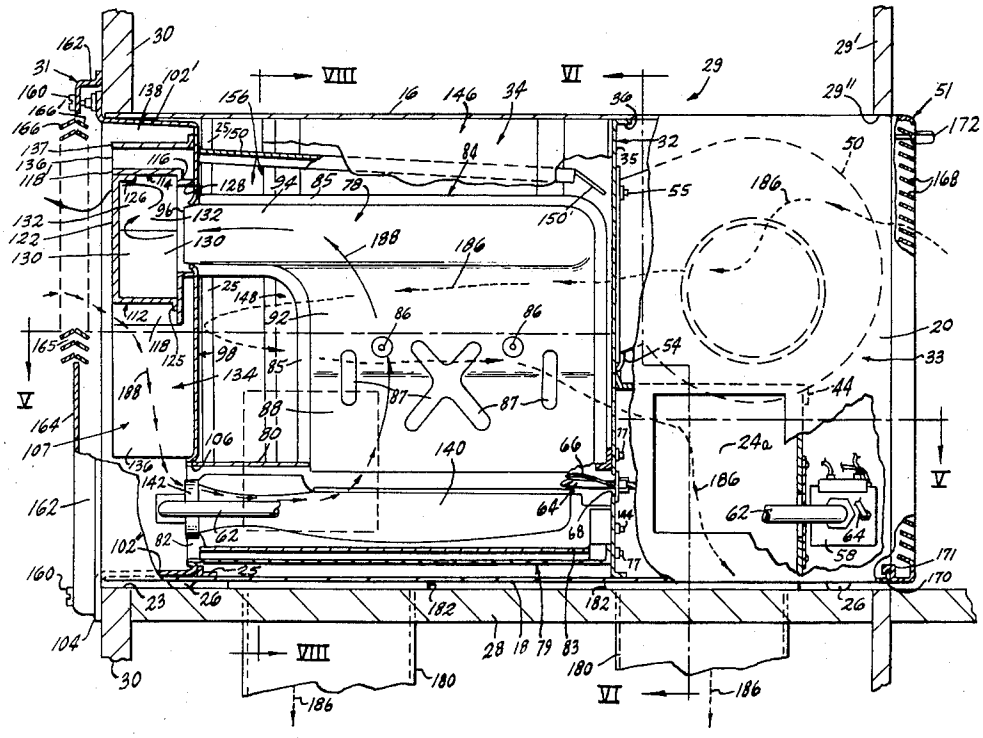

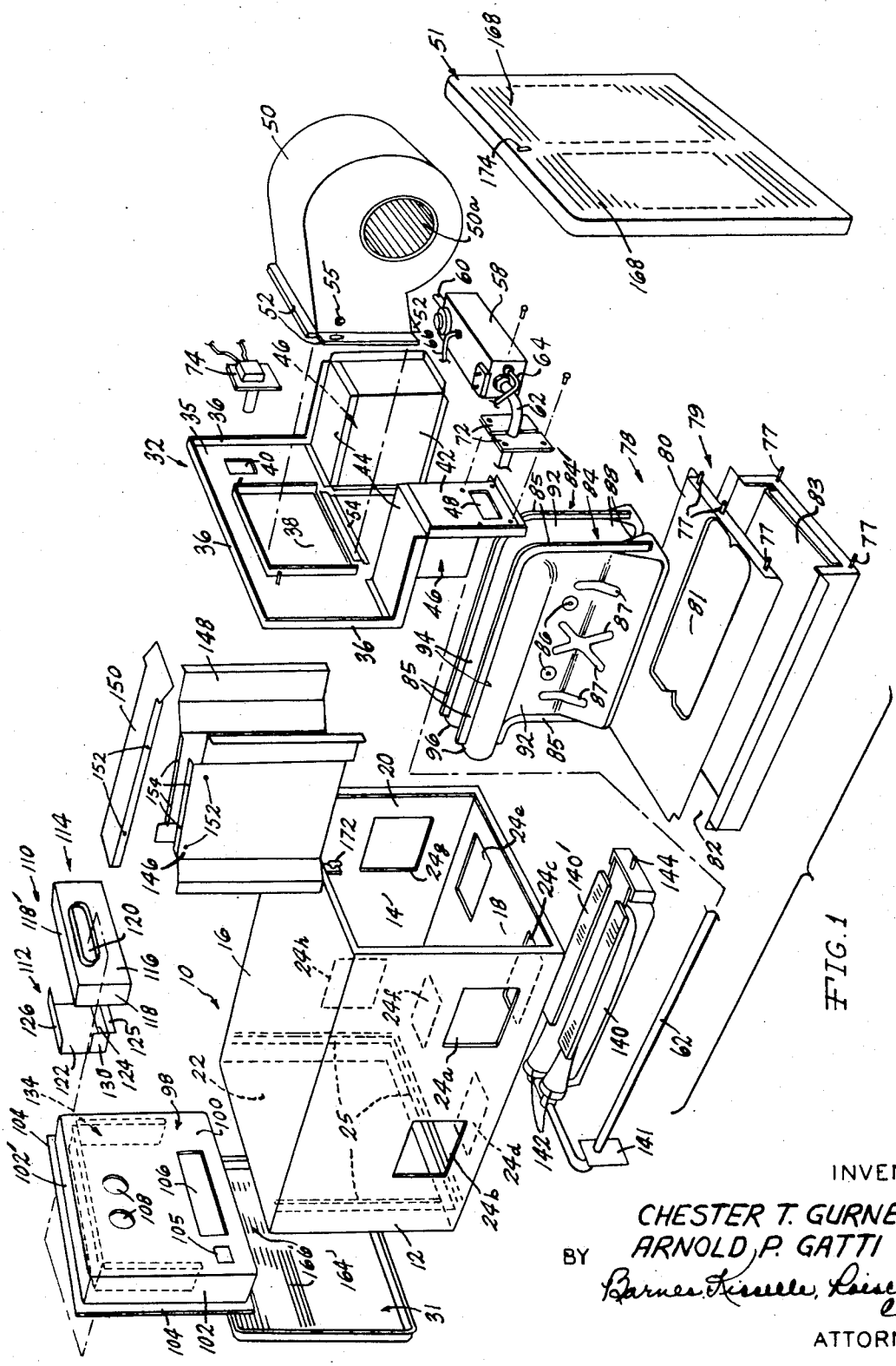

FIG. 1

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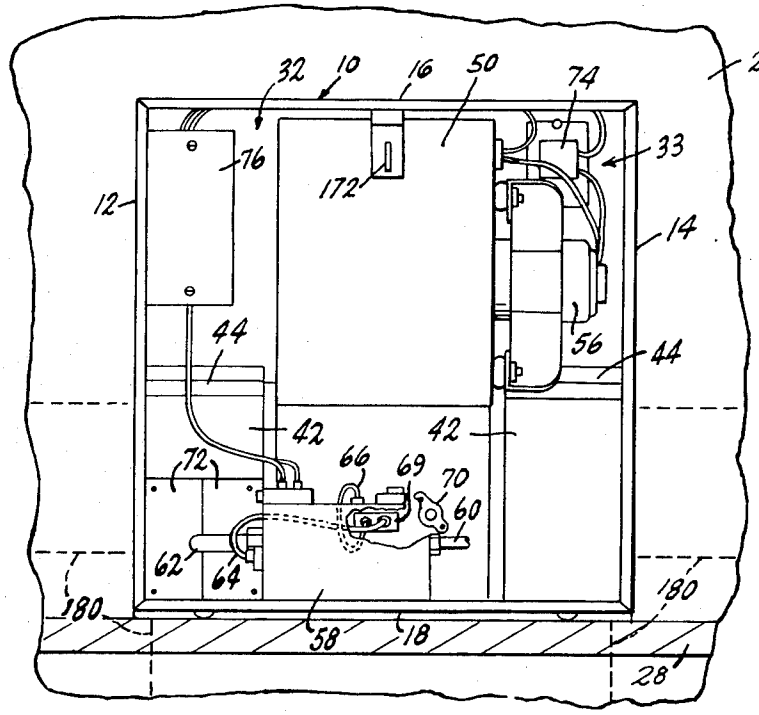

FIG. 2

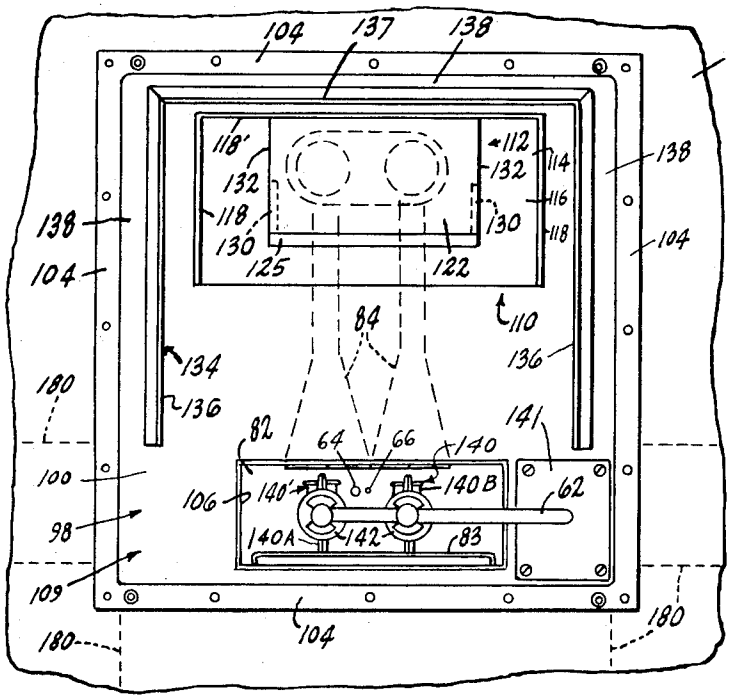

FIG. 3

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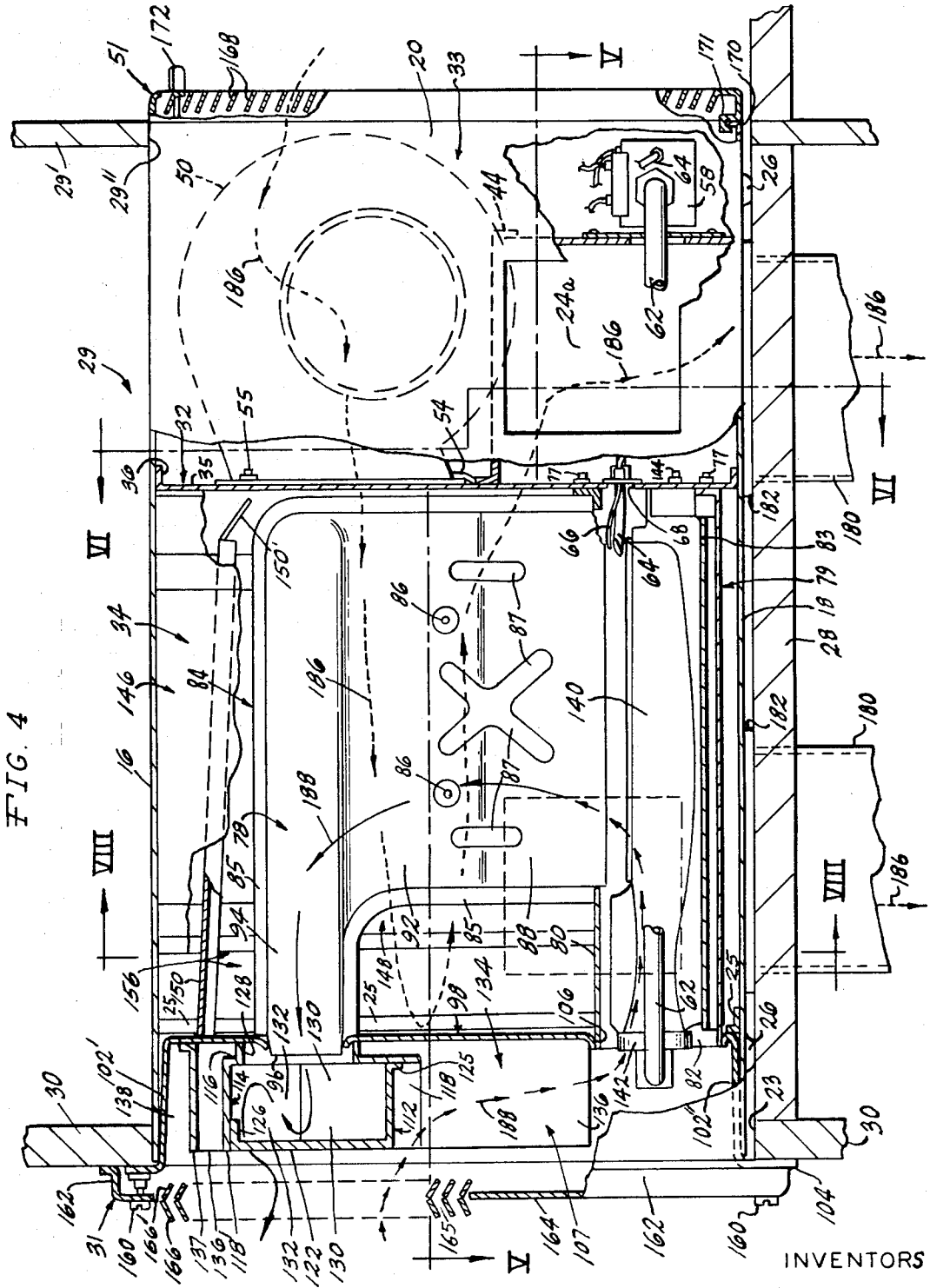

FIG. 4

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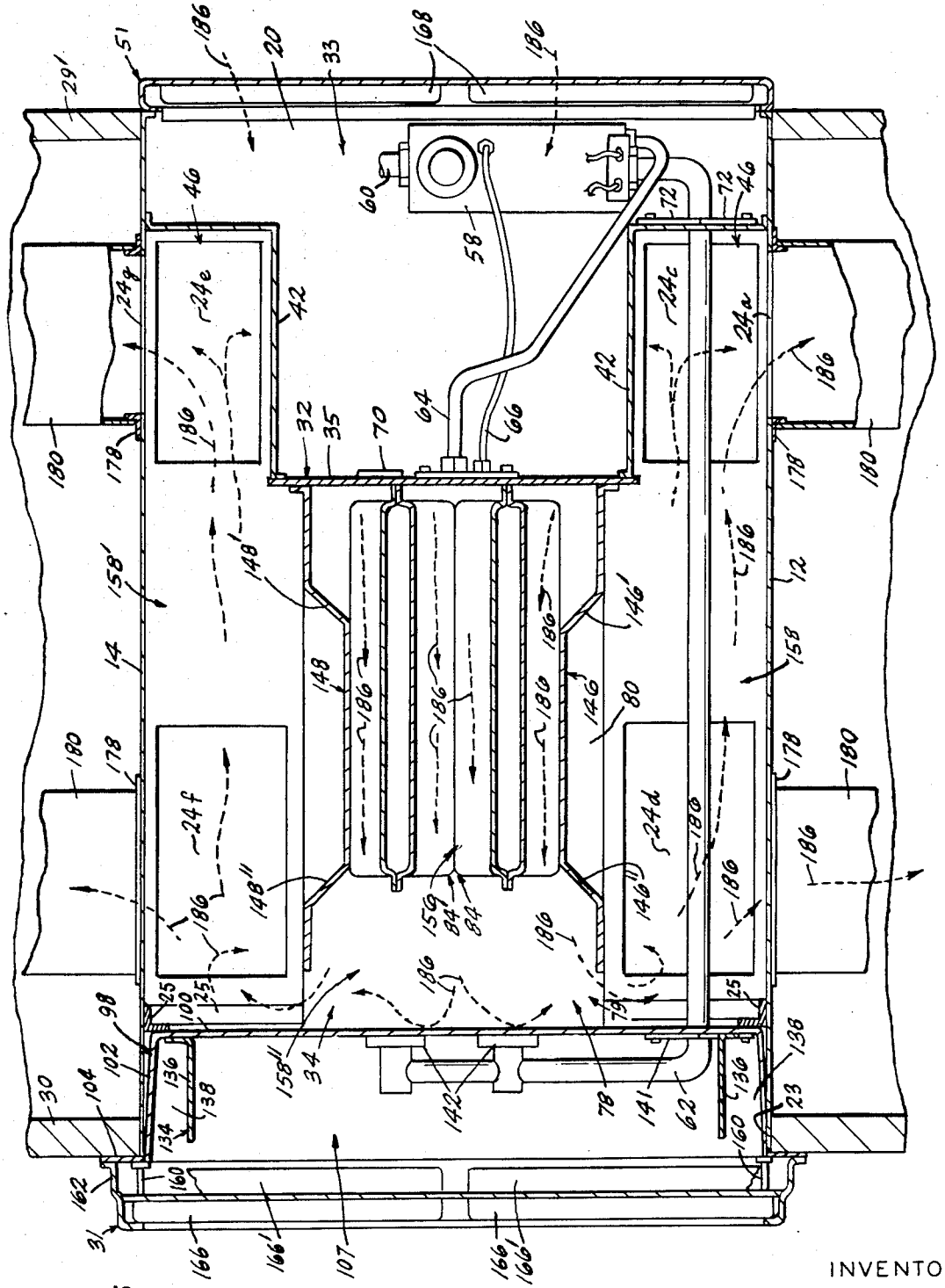

FIG. 5

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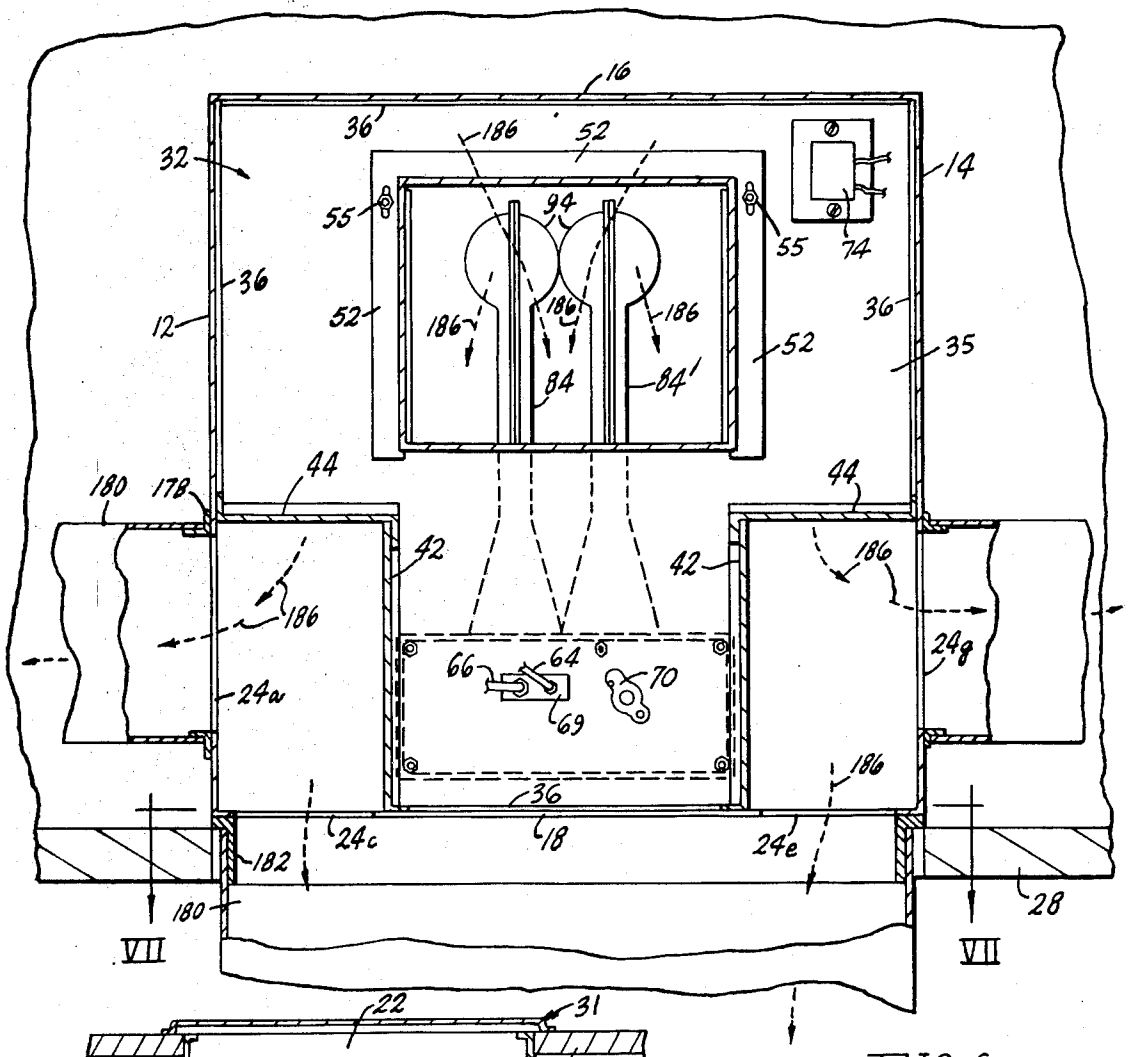

FIG. 6

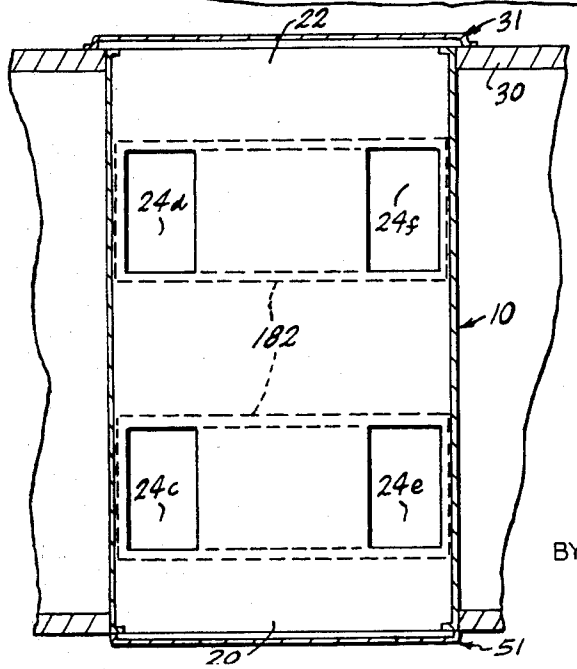

FIG. 7

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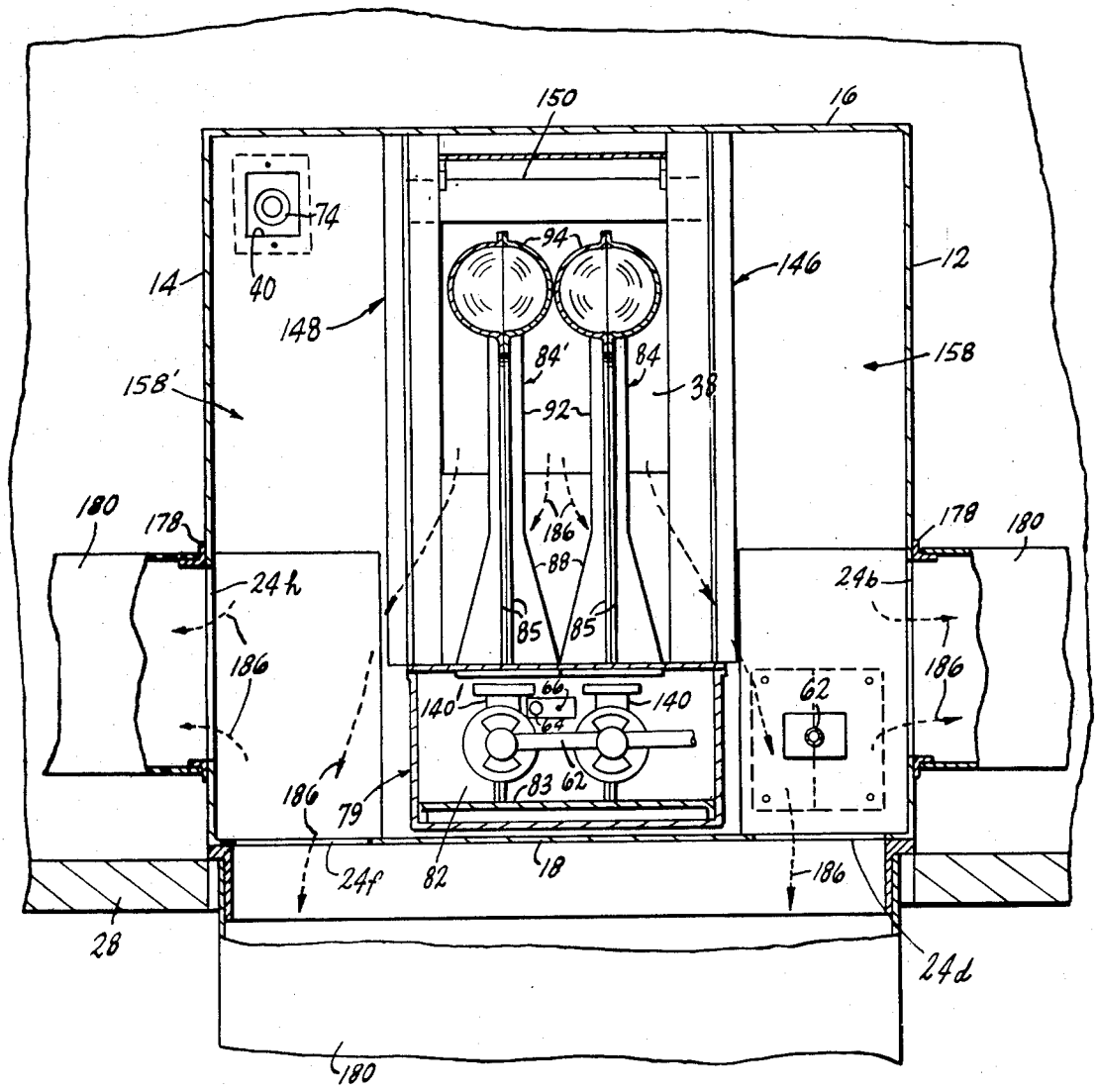

FIG. 8

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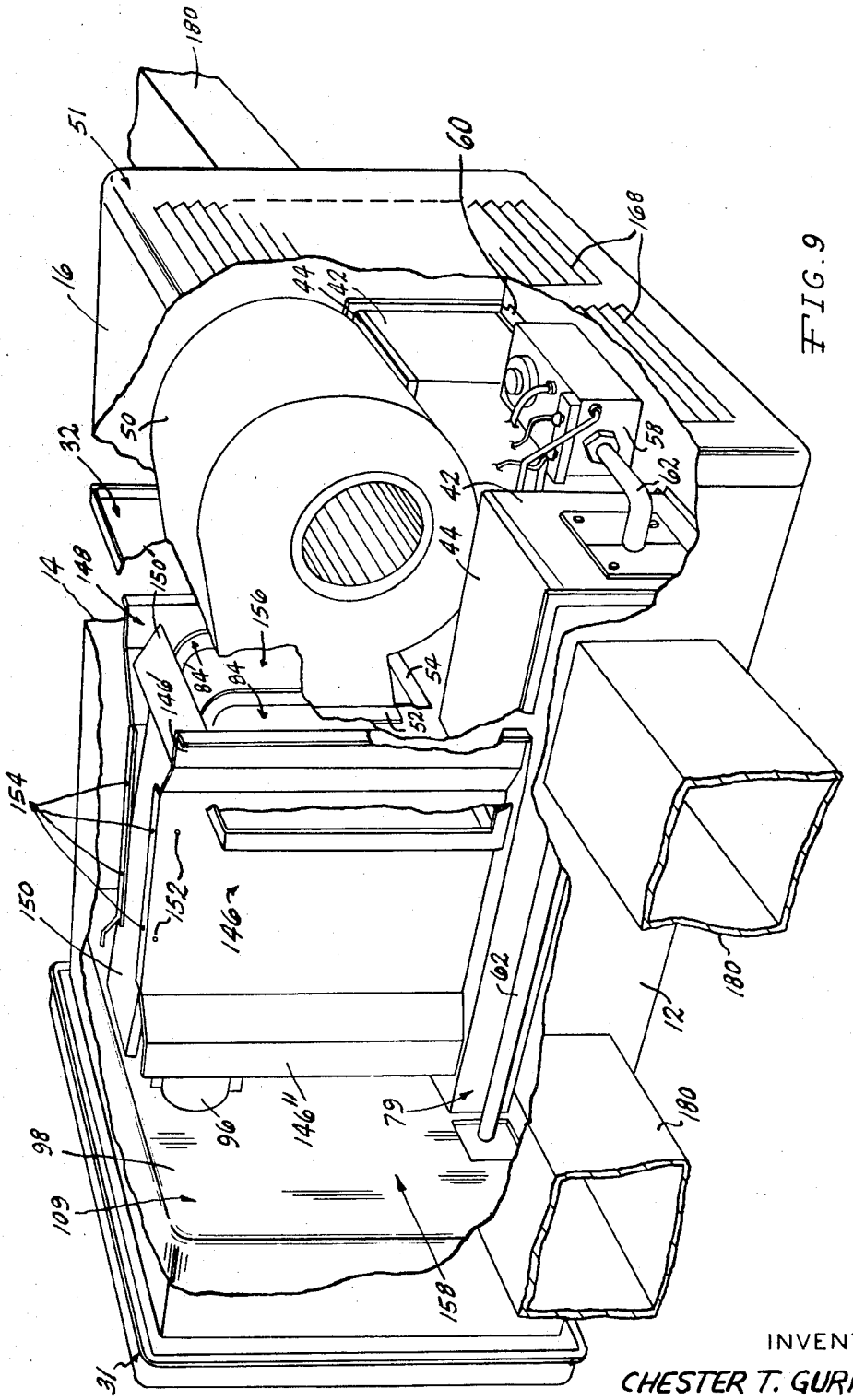

FIG. 9

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SEALED COMBUSTION FORCED AIR FURNACE

This invention relates to forced air furnaces of the sealed combustion type for use in applications where installation space is at a premium, such as in a motor home, mobile home, travel trailer or the like.

An object of this invention is the provision of an improved, sturdily constructed, forced air furnace of the sealed combustion type for a mobile home or the like which has a relatively large heating capacity and which occupies a relatively small amount of installation space, and in which the components are readily accessible for maintenance and replacement and the controls are conveniently located.

Another object of this invention is the provision of a furnace of the character described suitable for floor-mounted installation adjacent an exterior wall and which includes an improved sealed combustion system communicating through the exterior wall with the outside air.

A further object is to provide a furnace of the type described having an improved venting system for the combustion air intake and the flue exhaust.

Still another object is to provide an improved furnace of the aforementioned type having a natural draft, sealed combustion system and a forced room air system, which systems are readily accessible for cleaning and service from the exterior and the interior of the home respectively.

Yet another object of the invention is to provide a furnace of the character described in which a partition divides the furnace into a forward blower compartment containing the blower and controls and a rear air heating compartment containing the heat exchangers, and wherein return air is drawn into the forward compartment by the blower and horizontally discharged through an opening in the partition into the rear compartment where it is heated and made available for distribution.

Another object is to provide a furnace as described in the preceding object in which the partition defining the forward and rear compartments is advantageously constructed to use space within the furnace which would otherwise be wasted so that the overall size of the furnace may be reduced.

A further object of the invention is the provision of a furnace of the character described wherein many of the component parts are permanently assembled as individual units to facilitate removal for maintenance, thereby greatly reducing the number of separate attaching parts required.

Other objects, features and advantages of the present invention will become apparent in the following detailed description taken in conjunction with the accompanying drawings in which:

FIG. 1 is an exploded perspective view showing the component parts of an exemplary but preferred embodiment of a furnace constructed in accordance with the present invention.

FIG. 2 is a front elevational view of the furnace of the present invention with the interior grill removed and having a portion broken away.

FIG. 3 is a rear elevational view of the furnace of FIG. 2 with the exterior grill removed.

FIG. 4 is a side elevational view of the furnace, slightly enlarged over FIG. 2, having portions shown in vertical section and portions broken away.

FIG. 5 is a horizontal sectional view taken along line V—V in FIG. 4.

FIG. 6 is a vertical sectional view taken along line VI—VI in FIG. 4.

FIG. 7 is a horizontal sectional view taken along line VII—VII in FIG. 6.

FIG. 8 is a vertical sectional view taken along line VIII—VIII in FIG. 4.

FIG. 9 is a perspective view of the assembled furnace of the present invention and having portions broken away.

Referring now to the drawings and more particularly to FIG. 1, a generally rectangular sheet metal furnace casing 10 is defined by opposed vertical side walls 12 and 14 and opposed horizontal top and bottom walls 16 and 18 respectively. The forward, or interior, end 20 and the rear, or exterior, end 22 of casing 10 remain open for reasons which will become apparent. A plurality of eight rectangular knock-outs (not shown) are formed in walls 12, 14 and 18 and these may be removed to provide openings 24 through which heated air is distributed, as will be later described. The three stop brackets 25 are welded to the inside of casing 10 slightly forwardly or interiorly of rear end 22. Referring additionally to FIG. 4, a plurality of feet 26 are formed in bottom wall 18 so that casing 10 may be mounted on a horizontal floor 28 of a mobile home or the like, or to serve as spacers to provide air space between bottom wall 18 and horizontal floor 28. When the furnace is installed therein, rear end 22 lies within a corresponding opening 23 in an exterior wall 30 of the home and is covered by an exterior grill 31. The furnace is preferably located within a furnace compartment 29 having an interior wall 29′ and side walls (not shown). Front end 20 extends through a corresponding opening 29″ in wall 29′ and is covered by an interior grill 51.

Still referring to FIGS. 1 and 4 and also to FIG. 5, a partition 32 is situated within casing 10 to divide the casing into a forward blower compartment 33 and a rear air heating compartment 34. Partition 32 includes a generally flat panel 35 whose marginal edges 36 are turned inwardly for attachment to walls 12, 14, 16 and 18 (FIG. 6). A flanged rectangular cut-out 38 is located centrally of the width of panel 35 in the upper portion thereof and a smaller cut-out 40 lies adjacent cut-out 38 in the upper right-hand corner of panel 35 as viewed in FIG. 1. The two lower corners of panel 35 are cut away to provide openings to the spaces enclosed by side panels 42 and caps 44. Panels 42 and caps 44 cooperate with side walls 12 and 14 and bottom wall 18 to define two ducts 46 through which heated air is distributed to whichever one or more of the four forward openings 24 is created by the removal of a selected one or more of the four forward knock-outs, as will soon become apparent. The marginal edges of panels 42 and caps 44 are flanged and securely welded to each other and to casing 10. As best seen in FIG. 1, an opening 48 is provided in the front panel 42 of the left-hand duct 46.

Referring now to FIGS. 1 and 2, forward compartment 33 houses a centrifugal blower 50 which draws room air into the blower intake 50*a* through interior grill 51 and discharges the air through cut-out 38 into rear compartment 34. The retention and sealing of blower 50 to partition 32 is provided by peripheral flanges 52 at the blower discharge outlet. The lower

horizontal flange 52 is seated on a bracket 54 welded to partition 32 and the vertical side flanges 52 are secured to partition 32 by suitable detachable fastening means 55. Blower 50 is driven by an electric motor 56 which is mounted to one side thereof. A conventional electrically actuated gas valve 58 beneath blower 50 regulates the flow of fuel to the combustion chamber in accordance with the command of a remotely located thermostat (not shown). The fuel supply is directed to valve 58 through an inlet pipe 60, and valve 58 admits fuel to the combustion chamber through a manifold pipe 62 until the thermostat is satisfied. Manifold 62 extends through opening 48 which is in turn covered by two plates 72. A fuel pilot 64 and a thermocouple 66 are routed into rear compartment 34 through a small opening 68 (FIG. 4) in partition 32 which is in turn covered by a plate 69. Pilot 64 may be lighted through a small door 70 pivoted on partition 32. Thermocouple 66 senses the presence of a pilot flame and prevents actuation of valve 58 if the flame is extinguished, as is conventional.

The electrical control system is also conventional, and in addition to the remotely located thermostat (not shown) includes thermostatic means 74 extending through cut-out 40 to sense the temperature of the heated air leaving rear compartment 34 for controlling the operation of motor 56. The controls operate from a 12-volt DC source, but may be converted to use 120-volt AC power by a conventional AC-DC converter 76 which is shown only in FIG. 2.

Directing attention now to FIGS. 1, 3, 4 and 5, rear compartment 34 houses a combustion chamber 78 (FIGS. 4 and 5) which consists of a rectangular burner box 79 and two left and right heat exchangers 84 and 84'. Burner box 79 includes a top panel 80 having a cut-out 81 therein, an opening 82 at the rear end thereof and an elevated platform 83 on the bottom. Combustion chamber 78 is securely attached to partition 32 by means of five studs 77 on the forward end of burner box 79. Heat exchangers 84 and 84' are each formed from two symmetrically opposite panels which are welded together along marginal seams 85 and at weld buttons 86 to define a heat exchange compartment through which the combustion gases are circulated. The structure is reinforced by a plurality of integrally formed ribs 87. The adjacent lower edges of heat exchangers 84 and 84' are welded together and the two heat exchangers 84 are then inserted as a unit to fit closely within cut-out 81 in burner box 79. The lower edges of heat exchangers 84 are welded to the inwardly-turned edges of cut-out 81. The lower side portion 88 of each heat exchanger 84 and 84' inclines upwardly (FIG. 8) toward the opposite side portion to form a narrow restricted passage chamber 92, which in turn communicates at its open upper end with a tubular flue 94. The rear of each flue 94 terminates in a circular outlet duct 96 (FIGS. 1 and 4) having an open rearward end through which the combustion gases are discharged.

The rear end of casing 10 is closed by a vent pan 98 (FIGS. 1, 3, 4 and 5) which is dished inwardly to form an upright wall 100, two sides 102, top 102' and bottom 102'' with marginal edges 104 flanged outwardly. A rectangular cut-out 106 two flanged circular cut-outs 108 are formed in wall 100. A small opening 105 is also provided adjacent cut-out 106. With pan 98 positioned such that the outside of wall 100 lies in a vertical plane at the rear of combustion chamber 78, opening 82 of burner box 79 and ducts 96 of heat exchangers 84 are registered respectively with cut-outs 106 and 108 and welded thereto to form a vent pan and combustion chamber assembly 109. Rear end 22 of casing 10 is enclosed by inserting pan 98 until wall 100 abuts stops 25. In this position the marginal edges 104 abut the outside surface of exterior wall 30 and are attached thereto by fastening means (not shown). The space within vent pan 98 defines a ventilation chamber 107 for the intake of combustion air and the exhaust of combustion or flue gases. The various components assembled together to form vent pan and combustion chamber assembly 109 are securely welded to prevent the entrance of combustion gases into the room air.

A flue pan assembly 110 (FIGS. 1, 3 and 4), which is spot welded or detachably secured to pan 98 by fastening means (not shown), is formed by welding a deflector 112 to a flue pan 114. Flue pan 114 comprises a front wall 116, adapted to be positioned upright and spaced from the inside of wall 100, and three rearwardly projecting walls comprising two side walls 118 and a top wall 118'. With flue pan 114 positioned on vent pan 98, a flanged oval opening 120 in wall 116 registers with cut-outs 108. Deflector 112 comprises a vertical deflector plate 122 spaced rearwardly of and opposite opening 120 by means of a horizontal bottom wall 124 having a front lip 125 welded to wall 116. A top flange 126 on deflector 112 is welded to wall 118'. Wall 118' of pan 114 forms the top wall of flue pan assembly 110 and wall 116 has a flange 128 around opening 120 to abut wall 100, flue pan assembly 110 being attached by fasteners to wall 100. The two sides 130 of wall 124 are turned upright to define two lateral openings 132 in the opposite sides of deflector 112 through which the combustion gases are laterally exhausted from within deflector 112. A U-shaped heat shield 134 (FIG. 3) is also mounted within pan 98 to the inside of wall 100. Shield 134 comprises two vertical sides 136 and a horizontal top 137 extending parallel to and spaced inwardly of the adjacent sides 102 and top 102' of pan 98 to thus define three passages 138 therebetween.

A pair of burners 140 and 140' (FIGS. 1, 3, 4 and 8) are located within burner box 79 respectively aligned beneath heat exchangers 84 and 84'. Fuel is supplied to burners 140 and 140' through manifold 62 which extends through opening 105 in wall 100 which is in turn covered by a plate 141 (FIG. 3). Manifold 62 communicates with air mixing caps 142, one at the rear end of each burner 140, which are accessible via opening 82. Burners 140 rest on platform 83 in burner box 79 and are secured at their forward ends to partition 32 by a stud 144 on the forward end thereof (FIG. 4).

Burner 140 is constructed of two symmetrical opposite sheet metal stampings 140A and 140B, which are welded together along marginal seams to form the burner cavity. This serves to keep the burner 140 cool relative to conventional burners, so that manifold 62 can be extended substantially the length of the combustion chamber without any adverse effects. The perforated burner head 140' is constructed of sheet steel which is crimped over the outwardly flanged opening of

burner **140** and extending substantially the length of the combustion chamber.

Three air deflecting baffles **146**, **148** and **150** are assembled together as at **152** (see FIGS. **1** and **9**) and are mounted within rear compartment **34** by securing the flanged upper edges of the upright baffles **146** and **148** to top wall **16** by fasteners or spot welds at **154**. The side baffles **146** and **148** are spaced laterally inward of side walls **12** and **14** respectively (FIG. **5**), and the top baffle **150** is spaced vertically below top wall **16** and is inclined slightly downwardly and forwardly as best seen in FIG. **4**. The forward ends **146'** and **148'** of baffles **146** and **148** diverge from one another and abut partition **32**, and the further inclined forward end **150'** of baffle **150** is spaced a short distance from partition **32**. The rear ends **146''** and **148''** of baffles **146** and **148** also diverge from one another and terminate forwardly of vent pan **98** (FIG. **5**), as does baffle **150**. The space between baffles **146**, **148** and **150** defines an air heating region **156** in which air horizontally discharged from blower **50** is directed through the tunnel defined by the baffles over the external surfaces of heat exchangers **84** and **84'**. The remainder of rear compartment **34** defines a U-shaped plenum chamber made up of left and right chambers **158** and **158'** (as viewed from the forward end of casing **10**) and the space **158''** adjacent wall **100** rearwardly of exchangers **84**, **84'** and baffles **146** and **148** for dividing and distributing the heated air into two flow paths as it emerges from the heating tunnel. The U-shaped cross section of the plenum is apparent in FIG. **5** wherein the chambers **158** and **158'** defining the sides of the U are defined by the cooperation of side baffle **146** with side wall **12** and of baffle **148** with the adjacent side wall **14** respectively, and the space **158''** defining the bottom of the U is defined by wall **100** and an imaginary vertical plane passing through the rear ends of side baffles **146** and **148**. In the lower portion of casing **10**, plenum chambers **158** and **158'** are effectively forwardly elongated by ducts **46**. The inner surfaces of casing **10** within rear compartment **34** are preferably covered by a conventional foil faced corrugated asbestos lining material (not shown) which serves as both an insulator and radiant heat shield to keep the outer surfaces of the casing relatively cool.

The entire furnace is preferably installed from the outside of the mobile home by inserting the front end of the furnace through opening **23** in exterior wall **30** and bodily moving the furnace interiorly until flanges **104** abut the outside surface of wall **30** (FIG. **4** and **5**). After flanges **104** are fastened to wall **30**, grill **31** may be attached to flanges **104** by fasteners **160**. The edges **162** of grill **31** are turned inwardly to abut wall **30** so that ventilation chamber **107** is entirely covered from the outside. The lower half **164** of grill **31** is imperforate while the upper half has a large opening covered by two grill plates secured back-to-back and each having two registering vertical rows of louvered openings **165**. The outer louvers **166** are inclined outwardly and downwardly to shed rain water, while the inner louvers **166'** are inclined downwardly and inwardly to direct incoming combustion air downwardly in chamber **107**. The upper six or so louvers **166**, **166'** in each row at and above the elevation of openings **132** serve as exhaust openings, while the louvers therebelow serve as intake openings for chamber **107** due to their elevation being lower than the level of openings **132**.

The interior grill **51** (FIGS. **1**, **4** and **9**) includes two rows of inwardly turned louvers **168** which extend substantially the full height thereof. The attachment of grill **51** to casing **10** is accomplished by means of interlocking flanges **170** and **171** along their respective bottom edges and a rotary latch **172** on the top of casing **10** which engages a slot **174** in grill **51**. If desired, the mounting arrangement of grill **51** may be modified to include provision for a replaceable air filter (not shown).

With the furnace in place, the duct work for distributing heated air to various remote locations may now be attached to casing **10** as shown in FIGS. **4–9** inclusive. The appropriate knock-outs provided in the side and bottom walls of casing **10** are selected and removed to provide the proper arrangement and number of openings **24** as may be required for the particular installation. Thus, a total of eight openings **24*a***, **24*b***, **24*c*** , **24*d***, **24*e***, **24*f***, **24*g*** and **24*h*** are available, as numbered and best seen in FIG. **1**, for attaching distribution ducts. Collars **178** (FIG. **5**) are positioned and secured over openings **24** in side walls **12** and **14**, and up to four horizontally extending lateral air ducts **180** may then be slipped over and secured to collars **178** (FIG. **5** and **9**). Removal of the knock-outs in bottom wall **18** allows up to four additional vertical, downwardly extending ducts **180** to be connected to casing **10** by connectors **182**. As shown in FIGS. **6** and **7**, each of the two bottom connectors **182** extends the full width of casing **10** so that the front connector **182** communicates with openings **24*c*** and **24*e*** and rear connector **182** with openings **24*d*** and **24*f***.

The operation of the furnace is described with reference to the broken arrows **186** and the solid arrows **188** (FIG. **4**) in the drawings which respectively indicate the forced room air flow and the natural draft combustion air flow. Because grill **51** is positioned at a low level within the interior of the home, the coolest room air is drawn via grill **51** (and air filter) into forward compartment **33** by blower **50** and is horizontally discharged into the air heating tunnel region **156** of rear compartment **34**. The converging walls **146'** and **148'** of baffles **146** and **148** (FIG. **5**) deflect the air leaving the blower outlet in against the outer sides of heat exchangers **84** as well as into the central space therebetween, thus producing a sweeping action of the incoming air without unduly restricting its flow. As the room air travels rearwardly past heat exchangers **84**, the heat of the combustion gases within combustion chamber **78** is transferred to the room air. The heated air is allowed to expand by the diverging baffle rear walls **146''** and **148''**, and as it strikes wall **100** of vent pan **98**, it is laterally deflected and divided into two forward flow paths in plenum chambers **158** and **158'** for distributing the heated air from both sides and through the bottom of the casing via openings **24** into ducts **180**. Since side baffles **146** and **148** are heated radiantly as well as by convection, the air in plenum **158** continues to be heated by flow along these baffles as it passes toward openings **24**. It should be noted that there are no separate return air ducts shown in the drawings since the room space(s) being heated is intended to be relatively small and not too remote from

the furnace, although return ducts could be provided to communicate with forward compartment **33** if needed.

The convection flow of combustion air indicated by solid arrows **188** in FIG. **4** begins with the intake of outside air through the lower openings **165** in grill **31**. The combustion air is deflected downwardly by louvers **166'** and travels downwardly in chamber **107** by natural gravity draft toward rear opening **82** of burner box **79** where it enters the box to provide the supply of primary and secondary air for mixing burners **140**. The fuel and air mixture is then ignited by the flame of pilot **64** and the products of combustion or flue gases rise within heat exchangers **84** where heat is transferred to the room air. The flue gases are exhausted horizontally rearwardly through outlet ducts **96** of heat exchangers **84**. As these gases exit from ducts **96**, they strike deflector plate **122** of flue pan assembly **110** to be laterally divided and diverted so as to flow laterally out of flue pan assembly **110** through side openings **132**. As the gases leave openings **132**, they are directed rearwardly again by walls **118** and then flow upwardly and outwardly through the uppermost openings **165** in grill **31**.

It will now be better understood that one important feature of the present invention is the provision of the gas feeding and pilot controls at the front of the furnace whereas the burner venturies are located at the rear of the furnace. The air inlets to the burners are thus positioned to take combustion air in the coolest area of the furnace, i.e., at the end closest to the exterior of the mobile home and at the lowest elevation in the casing. This in turn makes a gravity draft, instead of a forced draft, possible for the combustion air system. Nevertheless, the controls remain located at the front of the furnace adjacent the room space for easy operator access and serviceability.

Another feature made possible by the foregoing arrangement is the provision of a single opening, i.e., the louvered upper half of exterior grill **31**, for both intake of combustion air and discharge of flue products. Despite the use of a single grill opening, the oppositely directed flows of combustion air and flue gases within ventilation chamber **107** are naturally segregated by the particular construction disclosed. Due to chamber **107** being relatively shallow horizontally compared to its vertical dimension, when combustion begins, the heavier cool air enters the lowermost openings **165** and once within chamber **107** falls downwardly to replace the air which has been drawn into rear intake opening **82** to support combustion within combustion chamber **78**. The hot combustion gases which are discharged through ducts **96** into flue pan assembly **110** are prevented from blasting directly out to the grill louvers by deflector **112**, which thus helps prevent such gases from mixing with the incoming combustion air. Since the only exit paths available for the combustion gases from flue pan assembly **110** are through the two lateral openings **132**, which are directed to the side, the gases must make two right angle turns before reaching grill **31**, thus slowing the velocity of the gases and allowing them to rise so that they are exhausted through the upper set of openings **165** in grill **31**. Hence, the cooler outside air will flow beneath the hot flue products into chamber **107** through the lower set of openings **165** to continue the combustion process. Due to burners **140** aspirating directly from the bottom of chamber **107**, where relatively cool air is available, gravity draft can be accomplished because of the relatively high pressure and temperature differences created between the incoming combustion air and outgoing flue gases, considering the relatively short distance in which they could co-mingle in chamber **107**. Of course the size of the total open area in grill **31** must be great enough to accommodate the required flow rates for both combustion air and flue gases. Additionally, at least some of the openings **165** preferably are spaced vertically below the flue openings **132**.

Flue pan assembly **110** also serves to reduce the effective outlet area of the heat exchangers **84** and **84'** so that the discharge area as defined by openings **132** is smaller than the intake area of opening **82** of the burner box. This provides the proper imbalance of pressure zones required to limit the maximum flow through the heat exchangers without requiring internal restrictors or baffles.

Another feature of the structure disclosed resides in the natural circulation of air through passages **138** to keep the adjacent outside portions of casing **10** relatively cool. As sides **118** of flue pan **110** and sides **136** of heat shield **134** effectively reflect the heat from the hot exhaust gases, they themselves are heated and in turn conduct this heat to the air within passages **138**. As this heated air rises within the side passages **138** to the upper passage **138**, the air in the upper passage **138** is forced outwardly through the upper set of openings **165** and cooler air is drawn upwardly within the side passages **138**. Thus, zero clearance is obtained relative to combustible materials adjacent the outside of casing **10**.

Deflector **112** also shields ducts **96** from direct wind gusts which could possibly create sufficient back drafts within combustion chamber **78** to extinguish the pilot flame. Likewise, the lower imperforate portion **164** of grill **31** blocks the direct entrance of wind gusts into opening **82** which otherwise might extinguish the burner main and/or pilot flames.

The advantages afforded by the furnace of the present invention relate both to improved servicing techniques and to improved operating efficiencies. With regard to the former, interior grill **51** is easily removable from inside the home to provide convenient access to the controls in forward compartment **33**. Because the electrical controls (with the exception of the remotely mounted thermostat) and connections are entirely within forward compartment **33**, electrical trouble shooting is greatly facilitated and replacement of parts is relatively easy. Similarly, blower **50** and motor **56** as well as valve **58** may be expeditiously removed for maintenance or replacement. The lighting of pilot **64** is also particularly convenient.

On the other hand, accessibility to rear compartment **34** is obtained from outside the home by removing grill **31**. Deposited combustion products such as soot may be directly removed from burner box **79** without contaminating the inside of the home. Removal of flue pan assembly **110** allows flues **94** to be cleaned in similar fashion. Burners **140** and manifold **62** are removable as a unit by detaching plates **72** and **141**, unfastening the end of manifold **62** which is connected to valve **58** and unfastening attaching stud **144** on the front of burners

140. Should vent pan and combustion chamber assembly 109 also have to be removed, studs 77 may be unfastened from partition 32 to allow the entire assembly to be bodily removed through rear end 22.

With respect to the advantageous operating features of this furnace, a relatively high thermal capacity is provided in a relatively small installation space by the advantageous use of space within casing 10. By way of example, a furnace constructed in accordance with the present invention whose overall dimensions are 24 3/4 inches from front to rear by 14 1/4 inches high by 14 inches wide provides a heat input of 19,000 Btu/hr. and a heat output of 15,200 Btu/hr. for an 80 percent efficiency factor.

Particularly important is the utilization of space within forward compartment 33 which would otherwise be wasted. The positioning of ducts 46 forwardly of panel 35 along the lower sides of compartment 33 exemplifies economy in the use of material while reducing the overall size of the furnace. Moreover, the vacant space between ducts 46 may be advantageously used if required. For one example, ducts 46 could be extended into this space to provide distribution through an opening (not shown) between the two forward openings 24 in bottom 18. As another example, an appropriate revision to grill 51 would permit a larger diameter blower 50 to be nested between ducts 46 to thus increase the capacity of the furnace. In this latter regard, the components in rear compartment 34 are also preferably modified to accommodate an additional heat exchanger 84 within casing 10. This is done by increasing the width of top baffle 150 to space side baffles 146 and 148 farther apart and thereby increase the size of air heating compartment 156. The now three heat exchangers 84 may be positioned over three burners 140 within burner box 79. The constructions of vent pan 98 and flue pan assembly 110 are also modified to accommodate three ducts 96. The slightly reduced size of plenum chambers 158 and 158' has an insignificant effect on the performance of this higher capacity furnace.

The efficient natural draft of the combustion air venting structure which contributes to the compact length of casing 10 eliminates the need of a forced combustion air system. Moreover, since the venting structure effectively seals the combustion air system from the room air system and circulates air along passages 138 to cool casing 10, the furnace can be operated with maximum safety for the home and the occupants thereof.

We claim:

1. In a furnace for use in a mobile home or the like comprising a casing shaped to form an enclosure having walls extending lengthwise from an open exterior end adapted to be located in alignment with an opening in an exterior wall of the home for communication with air outside the home and terminating in an interior end spaced interiorly of said external end, combustion means within said casing, a natural draft combustion air system for conducting combustion air from outside the home to the combustion means where the air is mixed with a combustible material and ignited to produce a heated combustion gas and for conducting said combustion gas away from said combustion means to outside the home, a forced draft room air system for conducting room air from the interior of the home into the casing and for distributing said room air from said casing to the interior of the home, means for sealing the combustion air system from the room air system whereby entrance of combustion gas into the room air system and vice-versa is prevented including heat exchange means for transferring heat from the combustion gas to the room air, the improvement wherein said combustion air system includes means defining a chamber aligned with the exterior end of said casing and the opening in said exterior wall and communicating with air outside the home, said chamber comprising an interior wall positioned to enclose the open exterior end of the casing and side walls extending exteriorly from the marginal edges of said interior wall and terminating at an open exterior end of said chamber, combustion air inlet means on said interior wall communicating with said combustion means for conducting air from outside the home through said chamber to said combustion means, combustion gas outlet means on said interior wall and spaced vertically above said combustion air inlet means communicating with said combustion means for conducting combustion gases away from said combustion means through said chamber to outside the home and closure means for enclosing the open exterior end of said chamber comprising an imperforate lower portion in juxtaposition to the combustion air inlet means and an upper perforate portion in juxtaposition to the combustion gas outlet means, said upper portion comprising vent means through which combustion air is taken into said chamber and through which combustion gas is discharged from said chamber.

2. The furnace defined in claim 1 wherein said combustion gas outlet means comprises a discharge opening in said interior chamber wall through which combustion gas is exhausted.

3. The furnace defined in claim 2 wherein said combustion gas outlet means further comprises deflector means positioned within said chamber between said discharge opening and said vent means for deflecting the combustion gas exhausted through said discharge opening.

4. The furnace defined in claim 3 wherein said deflector means comprises a first panel spaced vertically below said discharge opening and extending exteriorly from said interior chamber wall.

5. The furnace defined in claim 4 wherein said deflector means further comprises a second panel spaced exteriorly of said interior chamber wall and extending upwardly from said first panel in juxtaposition to said discharge opening.

6. The furnace defined in claim 3 wherein said deflector means has an exhaust opening horizontally spaced from said discharge opening in a direction perpendicular to the direction of discharge of flue gas from said discharge opening and includes means for conducting said combustion gas from said discharge opening to said exhaust opening, and wherein a portion of said exhaust opening is at a vertical elevation at least as great as the vertical elevation of said discharge opening.

7. The furnace defined in claim 3 wherein said deflector means comprises a box-like structure having an upright exterior panel spaced exteriorly of said in-

terior chamber wall in juxtaposition to said discharge opening and laterally juxtaposed exhaust openings leading to said chamber, said exhaust openings being correlated in size and location relative to one another and said discharge opening and said combustion air inlet means on said interior wall to restrict maximum flow through said combustion air system.

8. The furnace defined in claim 7 wherein said box-like structure has an upright interior panel larger than said exterior panel thereof with side walls disposed in planes parallel to the length of the furnace and juxtaposed to said exhaust openings for diverting flue gases discharged therefrom toward said vent means.

9. The furnace defined in claim 8 including a heat shield disposed at least partially in spaced encompassing relation to said deflector means in said chamber and having walls disposed in planes parallel to the length of said furnace.

10. The furnace defined in claim 1 including means in said chamber for shielding the heat of the hot combustion gas from the side walls of the chamber.

11. The furnace defined in claim 10 wherein said shielding means comprises a first U-shaped member having a horizontal top wall and two parallel upright side walls spaced respectively inwardly of the top and side walls of said chamber and extending exteriorly from said interior chamber wall, and a second U-shaped member spaced inwardly of said first member and forming the top and side walls of a flue pan enclosure having an inlet registering with said discharge opening and deflector means diverting flue gases toward the side walls of said second chamber.

12. The furnace defined in claim 1 wherein said combustion air inlet means comprises an inlet opening in said interior chamber wall.

13. The furnace defined in claim 12 wherein said combustion means is spaced interiorly of said interior chamber wall and wherein said combustion means comprises burner means having air and fuel inlet means adjacent said inlet opening.

14. The furnace defined in claim 13 wherein said closure means is removable and said burner means is insertable and removable through said inlet opening.

15. The furnace defined in claim 14 wherein said heat exchange means is spaced interiorly of said interior wall and positioned above said burner means such that hot combustion gases from said burner means travel upwardly through said heat exchange means toward said combustion outlet means.

16. The furnace defined in claim 15 wherein said heat exchange means includes a flue extending lengthwise of the furnace casing and communicating with said combustion gas outlet means.

17. The furnace defined in claim 1 wherein said chamber is defined by a pan dished inwardly to form said interior chamber wall and said side walls and wherein said pan is insertable and removable from the open exterior end of said casing.

18. The furnace defined in claim 17 wherein said combustion air inlet means and said combustion gas outlet means comprise inlet and outlet openings respectively in said interior chamber wall, and wherein said combustion means and said heat exchange means are positioned interiorly of said interior chamber wall, said heat exchange means being positioned vertically above said combustion means, said combustion means having an intake opening registered with said inlet opening and said heat exchange means having an exhaust opening registered with said outlet opening.

19. The furnace defined in claim 18 wherein said interior chamber wall, combustion means and heat exchange means are secured together to render the same insertable and removable from the open exterior end of said casing.

20. The furnace defined in claim 1 wherein said chamber has a vertical dimension in the order of about four to six times the horizontal dimension thereof in the direction of gas flow via said closure means.

21. The furnace defined in claim 20 wherein said closure means comprises a removable panel and wherein said upper portion of said closure means comprises a plurality of openings in said panel with the vertically lowest of said openings being spaced vertically below said combustion gas outlet means.

22. The furnace defined in claim 21 wherein said openings are defined by inner and outer sets of louvers arranged back-to-back with both sets inclined downwardly away from one another.

23. A compact furnace for use in a mobile home or the like comprising a casing defined by exterior walls arranged to form an enclosure, upright partition means within said casing separating the casing into forward and rear compartments, said partition means having means for communicating the forward compartment with the rear compartment, air moving means in the forward compartment for drawing air from the interior of the home into the forward compartment and moving said air through said opening and horizontally through said rear compartment, heating means in the rear compartment for heating said air including means forming a tunnel-like zone centrally of said rear compartment and means for reversing and distributing the heated air in split paths at the rear of said tunnel-like zone and thence to the interior of the home comprising duct means on opposite sides of said zone for conducting the heated air from said split paths in the rear compartment toward said forward compartment and at least two laterally spaced discharge openings in said casing walls for connecting said duct means with the interior of the home.

24. The furnace defined in claim 23 wherein said discharge openings are spaced rearwardly of said partition means and said duct means includes a second upright partition means extending transversely of said casing rearwardly of said zone.

25. The furnace defined in claim 24 wherein said casing comprises a top wall, a bottom wall and side walls connecting the top and the bottom walls and wherein said casing discharge openings are formed in said side walls.

26. The furnace defined in claim 25 wherein said air moving means is centered between said two discharge openings and the associated ductwork feeding heated air thereto.

27. The furnace defined in claim 25 further including control means for said heating means and said air moving means, said controls being located in the forward compartment.

28. The furnace defined in claim 27 wherein said control means comprises electrical control means for

operating said air moving means and fuel control means for regulating the flow of fuel to said heating means.

29. The furnace defined in claim 28 wherein said fuel control means comprises valve means positioned vertically below said air moving means.

30. The furnace defined in claim 29 including conduit means for conducting fuel from said valve means through said partition means rearwardly to said heating means.

31. The furnace defined in claim 30 wherein said conduit means is detachably attached to said valve means and removable through the rear end of said casing.

32. The furnace defined in claim 31 including means for covering the forward end of the casing comprising a panel having a plurality of openings through which room air is drawn into the forward compartment.

33. The furnace defined in claim 32 wherein said panel is detachably attached to said casing for permitting the removal of said controls through the forward end of the casing.

34. A sealed combustion forced air furnace for use in a mobile home or the like comprising a rectangular casing adapted to extend between interior and exterior walls of the mobile home, said casing having horizontal top and bottom walls, two vertical side walls and open interior and exterior ends, a partition within said casing between said two ends dividing the casing into forward and rear compartments respectively adjacent the interior and exterior ends of said casing, a cut-out in said partition communicating the two compartments, an interior grill covering the open interior end, a motor-driven blower within said forward compartment for drawing room air through said interior grill into said forward compartment and for discharging the room air through said cut-out into said rear compartment, a rectangular burner box vertically below and extending rearwardly from said cut-out, at least one heat exchanger communicating with said burner box and projecting upwardly therefrom within said rear compartment, a burner within said burner box below said heat exchanger, a vent pan enclosing the open exterior end of the casing having an interior upright wall and sides extending exteriorly from the marginal edges of said interior wall, an exterior grill covering the exterior end of said vent pan and defining therewith a ventilation chamber, said burner box communicating at its rear end with said ventilation chamber, said heat exchanger having a discharge outlet communicating with said ventilation chamber and spaced vertically above said burner box, a flue pan assembly within said ventilation chamber comprising a vertical deflector plate spaced rearwardly opposite said discharge outlet, a pair of lateral exhaust openings between said upright wall and said deflector plate and a pair of vertical side walls spaced laterally outwardly of and opposite said lateral exhaust openings, said exterior grill comprising an upper portion having a plurality of louvered openings and an imperforate lower portion in juxtaposition to said burner box, the uppermost louvered openings being at the same or higher elevation as said lateral openings, whereby a combustion air circuit and a room air circuit are provided sealed from one another in said casing such that in the combustion air circuit outside combustion air is drawn by natural gravity draft through the lowermost louvered openings to flow downwardly within said ventilation chamber to enter said burner box where the air is mixed with fuel in said burner and ignited to produce hot flue gases which rise upwardly within said heat exchanger and then flow through said discharge outlet and are deflected and divided by said deflector plate to flow in diverging streams laterally against said side walls of said flue pan assembly and then outwardly through the uppermost louvered openings in said exterior grill, and in the room air circuit said blower draws room air through said interior grill and horizontally discharges the room air into said rear compartment to sweep the outer surface of said heat exchanger to be heated by the hot flue gases therein, the heated room air being deflected and divided by the upright wall of said vent pan to flow in two streams to said discharge openings.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,724,442 Dated April 3, 1973

Inventor(s) Chester T. Gurney and Arnold P. Gatti

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 11, line 33 - "chamber" should be --member--

This certificate supersedes Certificate of Correction issued August 7, 1973.

Signed and sealed this 4th day of February 1975.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

UNITED STATES PATENT OFFICE

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Signed and sealed this 8th day of October 1974.

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