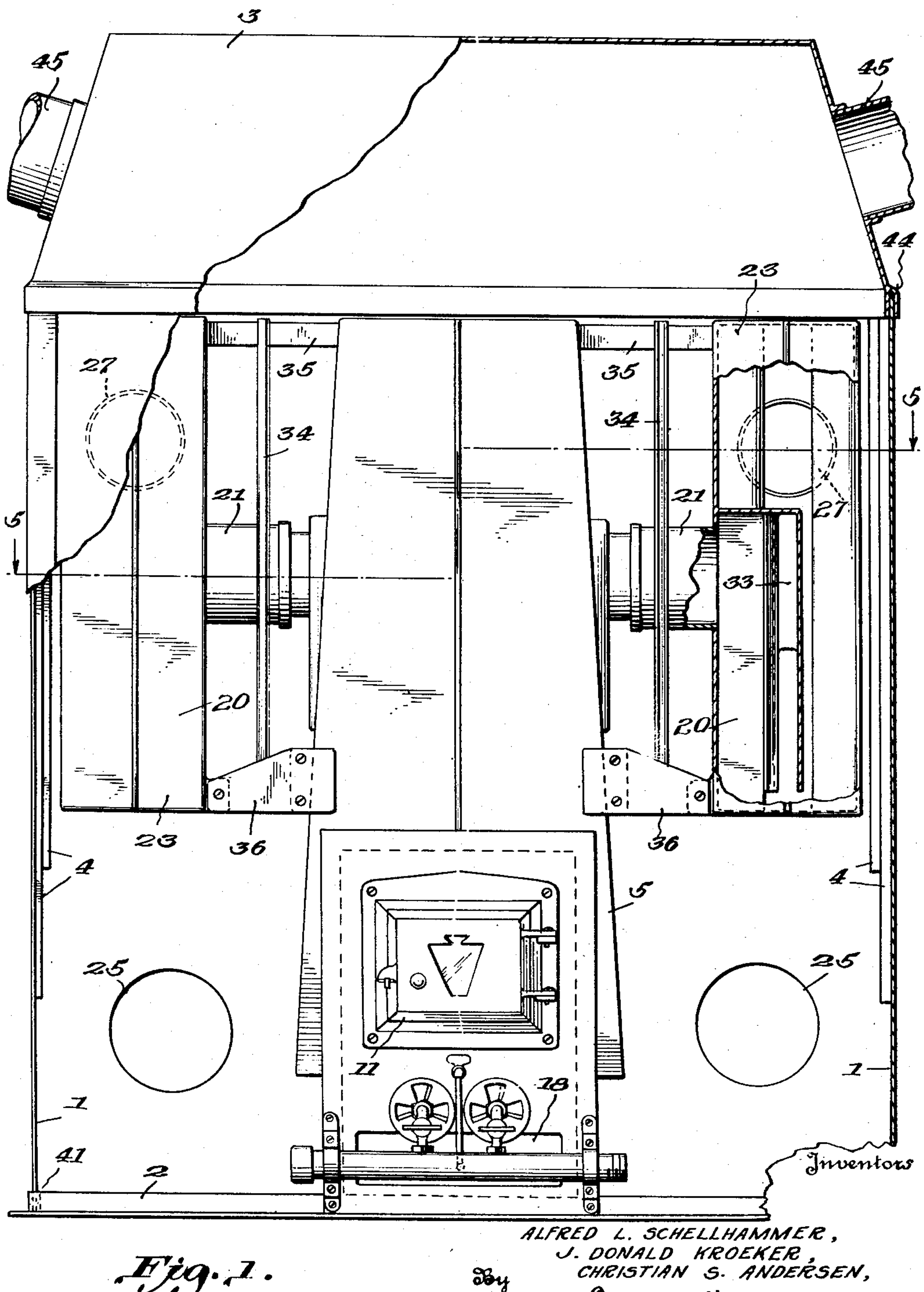

Fig. 1.

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FURNACE

Filed Oct. 28, 1931 5 Sheets-Sheet 2

Fig. 2.

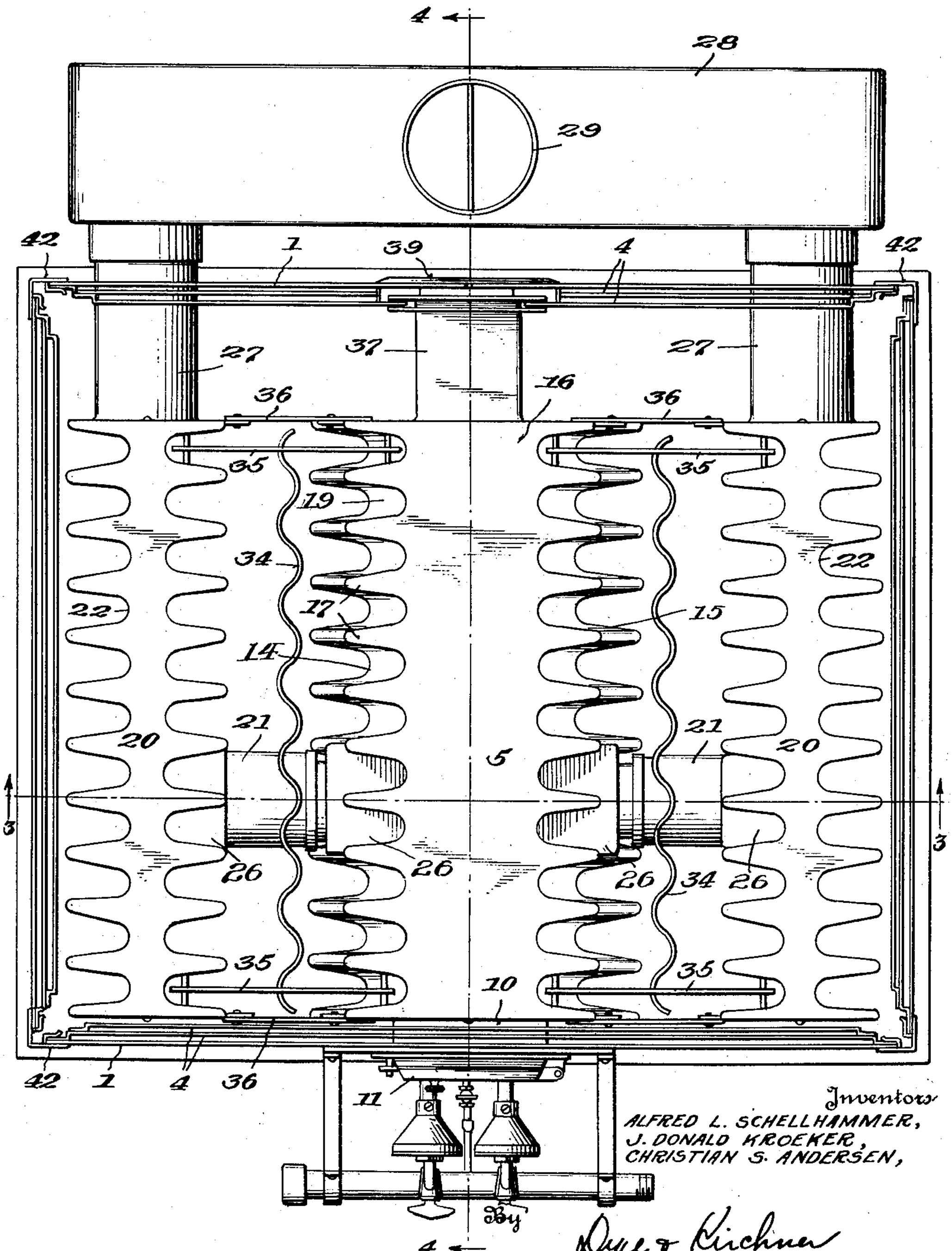

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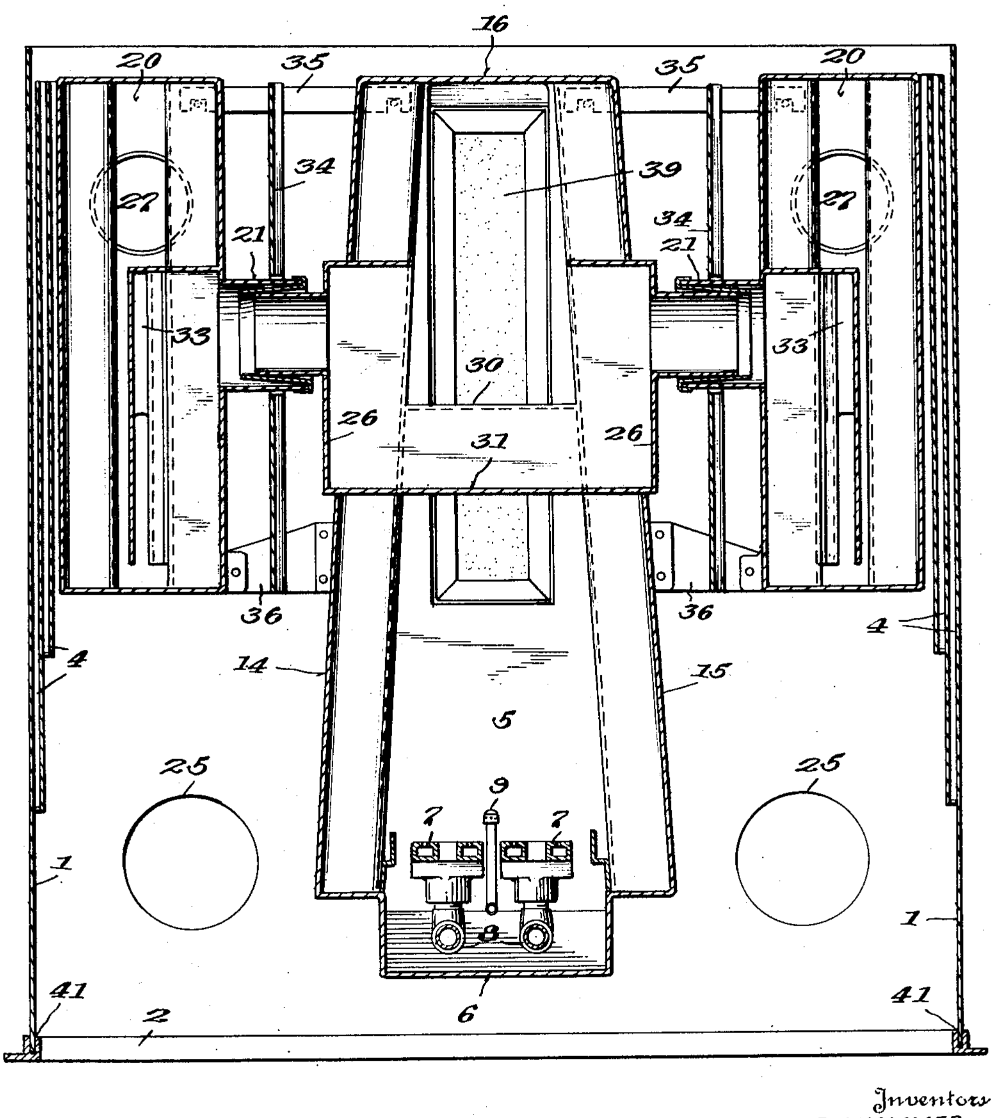
Fig. 3.



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Filed Oct. 28, 1931　　5 Sheets-Sheet 4

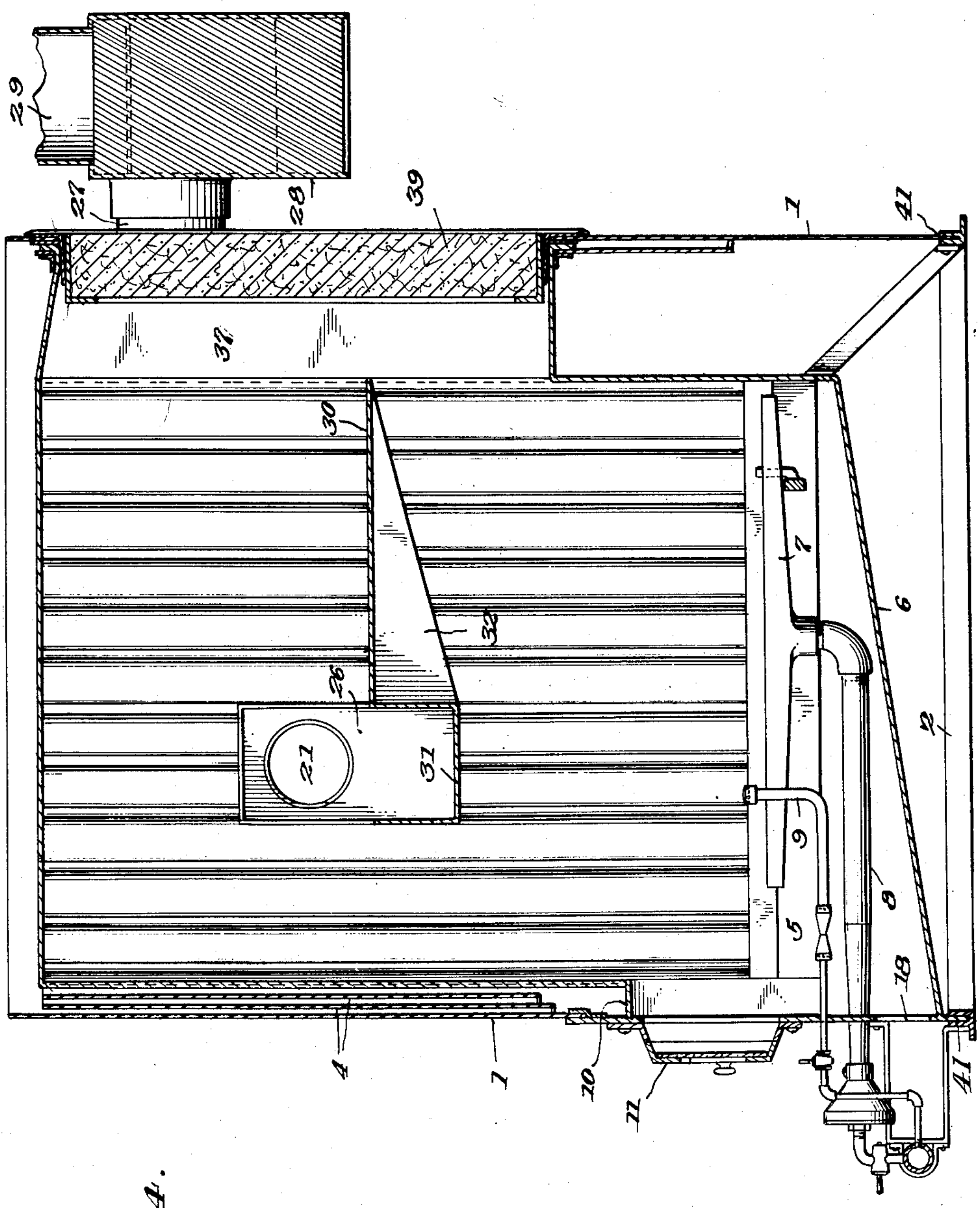

Fig. 4.

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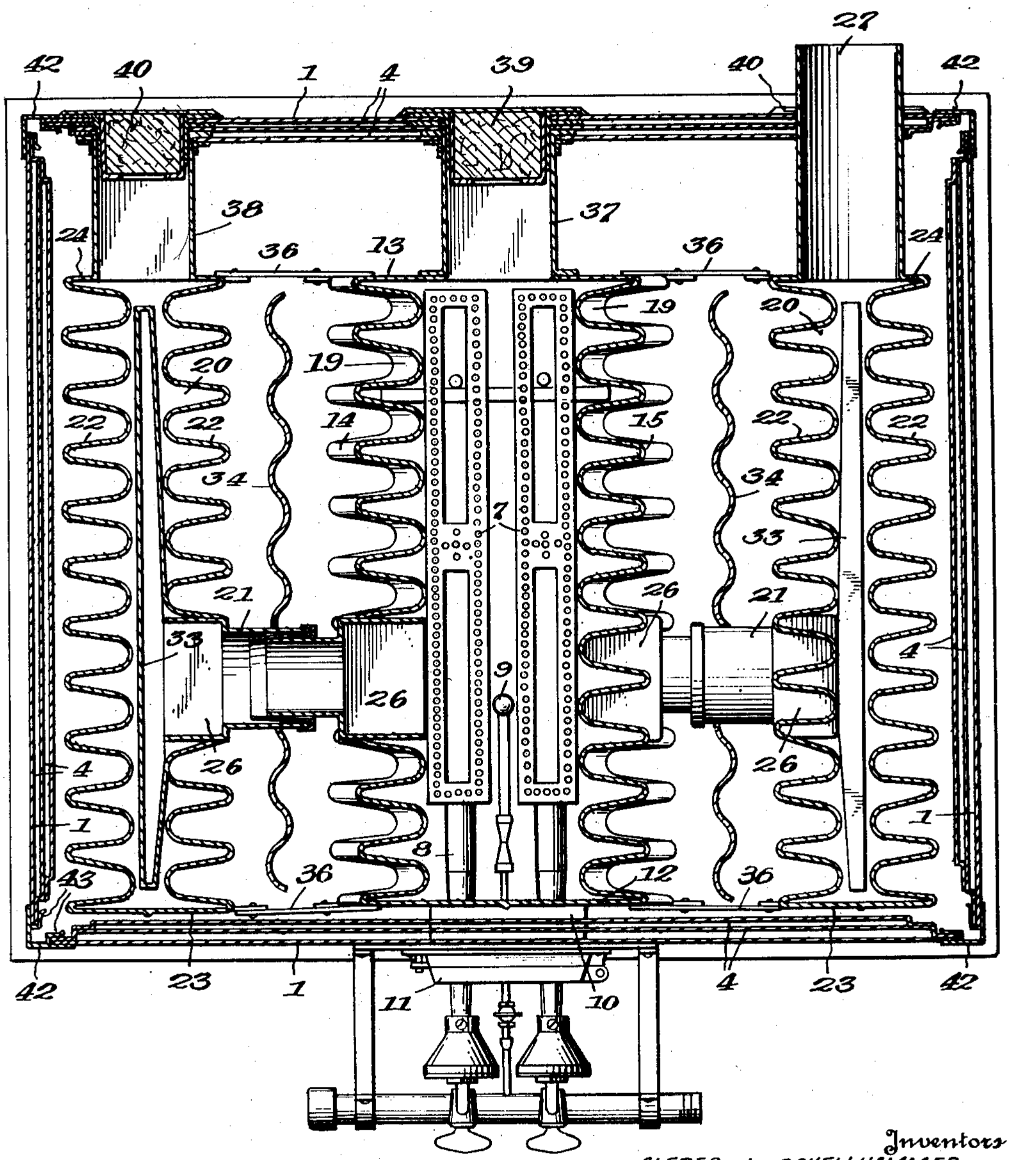
Filed Oct. 28, 1931 5 Sheets-Sheet 5

Fig. 5.



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FURNACE

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Application October 28, 1931, Serial No. 571,616

8 Claims. (Cl. 126—116)

Our invention relates to furnaces, and particularly to hot air furnaces burning a fluid fuel such as gas.

A primary object of the invention is to provide a furnace of superior heating efficiency.

Another object is to provide a furnace which will be substantially silent in operation, being free from the objectionable "creeping" noises developed in furnaces of the prior art during expansion and contraction of the metal parts when the furnace is heating or cooling.

A further important object of the invention is to provide an efficient and silently operable furnace structure which will be unusually durable and which may be manufactured at low cost.

Various detailed objects of the invention include the provision of: a fire box having side walls provided with a novel type of fluting adapted to present a maximum of surface to the air to be heated and to offer a minimum of resistance to the passage of the air through the furnace and to the rapid and uniform heating thereof; a novel relationship of surfaces cooperating to define a heating chamber adapted to accommodate expansion of the air being heated and to facilitate its passage through the furnace; a novel series of members adapted to conduct the products of combustion from the burner to the outlet flue and provide ample opportunity for such products to give up a large part of their heat content during their passage through the members; means to insure the progressive and continuous cooling of the products during their passage through the furnace; a novel disposition of the various parts of the structure to accommodate expansion and contraction movements and prevent the usual noises incident thereto, which disposition includes the use of expansible and contractible flue pipe connections; novel means incorporated in the combustion chamber and/or its tributary members for relieving sudden destructive pressures generated by explosions; and other features and combinations of parts the nature and advantages of which will more fully appear from the following description of a preferred embodiment of the invention; and it is to be understood that our invention includes severally and collectively the various parts and combinations of parts which we provide to accomplish the objects of the invention herein set forth, so far as the various means are novel over the prior art.

The invention is shown, in one preferred form of embodiment, on the accompanying drawings which constitute part of this application for Letters Patent, is described in the following specification, and more particularly pointed out in the appended claims.

In the accompanying drawings wherein each reference character designates the same part in the several views,

Figure 1 is a front elevational view of a furnace structure embodying our invention, with the front of the casing partially broken away to show to advantage the interior structure of the furnace;

Fig. 2 is a top plan view with the casing dome or cover removed;

Fig. 3 is a vertical cross sectional view taken on the line 3—3 of Fig. 2;

Fig. 4 is a central vertical sectional view taken at right angles to the view of Fig. 3, along the line 4—4 of Fig. 2; and

Fig. 5 is a horizontal cross sectional view taken along the line 5—5 of Fig. 1.

Referring now to the drawings, the furnace includes a surrounding casing 1, conveniently rectangularly formed of sheet metal, resting on a channeled iron base strip 2 and surmounted by a dome cover 3. For the purpose of insulating the furnace, a plurality of spaced apart metal plates 4 may be secured to the interior surface of the casing walls, especially the upper portions thereof. It will be evident however that any convenient insulating medium may be provided, and that the casing may be formed of any suitable material and in any desired shape.

A fire box designated generally 5 is mounted in the casing, and in the embodiment of the invention shown in the drawings this fire box occupies the central portion of the casing extending from the front wall thereof nearly to the rear wall. The fire box 5 is a box-like member having a closed bottom 6 inclined upwardly from its front to its rear disposed immediately below burners 7 and fuel feed pipes 8. In the drawings we have shown more or less conventional gas burners 7, provided with a pilot burner 9, but it is to be understood that the invention is not limited to a structure including burners for any specific kind of fuel.

The fire box 5 is provided at its front, just above the burner supply pipes 8, with an extension 10 communicating with the exterior of the casing where a fire door 11 is provided. The front wall 12 and rear wall 13 of the fire box may be substantially plane but the side walls 14, 15 are preferably fluted. The top 16 of the fire box may be plane, being provided with marginal tongues 17 receiving in a welded seam or other tight seal the upper edges of the fluted side walls.

The fire box 5 thus forms a primary chamber for the combustion of fuel admitted through the burners 7 supported by air entering through a secondary air opening 18 formed in the front wall of the casing below the burners.

The function of the fluted form of the sides 14, 15 of the fire box is two-fold: to increase the heat radiating area of the sides, and to accommodate expansion and contraction of the sides consequent upon temperature changes in the furnace. We are aware that corrugated or otherwise irregularly surfaced walls are not broadly new in heat exchange apparatus, but we believe that the specific type of fluted wall disclosed in this application is new with us. Our novel type of wall is characterized by a marked disparity between the volumetric capacities of the interior and exterior flutes, it being understood that the interior flutes contain the products of combustion and the exterior flutes are rubbed by the air which is being heated. Specifically we have found that the highest degree of heat exchange efficiency is attained by forming the exterior flutes approximately three times the volumetric size of the interior flutes, and we have discovered that even a relatively small departure from this relationship of dimensions entails a relatively large lowering of efficiency.

We have found also that the specific form of the flutes, as distinguished from their relative dimensions, is of importance. It has been ascertained that heated air normally tends to rise in a spiral or helical path along the surfaces from which it is deriving heat. To take advantage of this tendency the base of each of our exterior flutes is formed substantially as a parti-cylindrical surface 19, in distinction from the angularly channeled contours of certain prior art corrugated walls. Our flute bases closely conform to a large portion of the surface of an upwardly spiraling column of air, and thus present a maximum of heating area to the column, offer to it a minimum of mechanical resistance, induce no efficiency-decreasing cross eddies, and prevent the formation of pocketed bodies of highly heated air. It will be noted that each flute is continuous and unobstructed from the bottom to the top of the side wall in which it is formed.

As has already been made apparent, the side walls 14, 15, of the fire box 5 constitute one surface of the air heating chamber. This chamber comprises in a general way the entire interior of the casing 1, less only the connected series of members through which the products of combustion pass to the stack. The surfaces of these members serve to define the limits of the heating chamber and function as heat radiating surfaces.

The principal element of this series of members is a radiator. We prefer to provide each fire box with a pair of radiators mounted in the casing, one radiator on each side of the fire box and connected thereto by a flue pipe branching from the side of the fire box. In the drawings the radiators are designated generally 20, while the connecting flue pipes are shown at 21.

Each radiator is in general similar in form and construction to the fire box 5, being provided with similarly fluted side walls 22, 22, and plane front and rear walls 23 and 24 respectively. The dimensions and proportions of the fluting of the radiator side walls 22, 22, may be identical with those of the fire box side walls, but each radiator as an entirety may be and preferably is considerably narrower, i. e., thinner from side wall to side wall, than the fire box, thus serving to bring into more intimate contact with its side walls the hot products of combustion generated in the large interior of the fire box.

A further important dimensional difference exists between the fire box 5 and the radiators 20. It will be noted upon reference to the drawings that the fire box extends from just below the dome 3 almost to the base strip 2, while the radiators extend from about the level of the top 16 of the fire box to about the horizontal mid-portion of the fire box, where the radiators are provided with a closed and preferably horizontal bottom. This construction provides below each radiator, and between the opposing surfaces of the casing 1 and the side walls 14 or 15 of the fire box, a chamber into which the air to be heated is admitted through a cold air inlet port 25 formed in any convenient portion of the lower zone of the casing 1.

We prefer to form each air heating chamber bounded by the opposing radiator side walls 22 and fire box side walls 14 or 15 wider in its upper portion than in its lower portion, in order to accommodate the increased volume of the ascending heated air. To this end one of the side walls 22, 14 or 15 is inclined away from the wall which cooperates with it to define the chamber. We prefer to incline the side walls 14 and 15 of the fire box, and this construction is illustrated in the drawings.

Communication between the fire box and each radiator is effected by means of a flue connection 21, which is conveniently a large, circular, sheet iron pipe. We have found it desirable to provide a special type of connection 21, consisting of a pair of telescoping pipe sections, one section being fixed in the fire box and the other in the radiator, which may move relatively to each other to accommodate expansion and contraction movements of the fire box and radiator walls. Our specific form of slip joint connection forms the subject of a copending application Serial No. 572,843, filed by one of us November 3, 1931.

In order to facilitate passage of the products of combustion into and out of the flue pipes 21, and to prevent the products in the pipes assuming the form of a vena contracta, we have found it desirable to provide an enlarged box-like port 26 in each wall surrounding the pipe opening and welded or otherwise secured in gas-tight relation to the wall.

While the pipes 21 may be located at any of a wide variety of points with relation to the fire box and radiator walls, we have found that one particular location effects the highest operating efficiency of the furnace. As shown in the drawings, we prefer to dispose each pipe 21 horizontally between its radiator and the fire box with its center approximately on the horizontal center line of the radiator and on a vertical line which is about three-eighths of the distance from the front wall of the radiator to its rear wall. Such disposition of the pipes provides the utmost efficiency in the heat exchange properties of the furnace, by causing the temperature of the products of combustion to fall continuously and progressively during their passage through the system.

The spent products of combustion pass out of the radiators through outlet flues 27 which penetrate the rear casing wall and deliver into a draft hood 28 in which is provided a stack connection 29.

In order to require the products of combustion to take a circuitous path through the system beginning with the burners 7 and ending with the stack connection 29, we provide baffle means in the several members. Thus the fire box 5 contains a horizontal partition 30 extending approximately through its rear midportion rearwardly from the enlarged port 26 in the fire box wall. The forward edge of the partition 30 is conveniently welded to an open horizontal trough 31 connecting with opposite ports 26 of the fire box, and tapered side aprons 32 depend from the partition 30.

Inside of each radiator we provide a narrow box-like hood 33 closed at its top and sides but open in the lower half of its front and rear end walls and having an open bottom just above the closed bottom of the radiator. It will be evident that products of combustion discharged into each radiator through its port 26 are delivered downwardly and pass thence upwardly in the interior flutes of the radiator en route to the radiator outlet flue 27. An important feature of this portion of the furnace is the relatively narrow opening in the bottom of each hood 33 through which the very hot products of combustion are constrained to pass. This construction produces during operation of the furnace a constant current of hot gas across the floors of the radiators, heating the radiator bottoms substantially to the high temperature of the products of combustion at this portion of their travel. Since these temperatures are well in excess of the dew point or condensation temperature of the water vapor content of the flue gas, condensation of water on the radiator floors and consequent corrosion of the metal thereof are prevented.

As will readily be appreciated, the temperature of the products of combustion in the upper part of the fire box 5 is higher than in the upper part of the radiators. In order to prevent radiation between the facing side walls 14 or 15 and 22 operating to reheat the products of combustion in the upper portion of the radiators 20, we provide, in each of the heating chambers defined by these walls, a radiation shield 34, preferably extending the whole vertical height of the radiator wall 22 and parallel therewith. The shields may be fluted to accommodate expansion movements and may be supported in position from cross members 35 hung from the front and rear top portions of the radiators and the fire box. A slot may be formed in each shield to permit the shield to be fitted down over the pipe 21, and we have found it desirable to make the slot large enough to keep the shield and pipe out of contact, thereby eliminating undesirable "creeping" noises normally incident to rubbing of the metal parts during expansion and contraction. The presence of these shields serves to intercept radiation from the fire box. In operation the shields become heated by radiation and their heat is given up to the air passing in contact with them upwardly through the heating chambers.

The various purely structural details of the furnace embodiment shown in the drawings form no part of the broad invention which is pointed out in the appended claims, but certain of these structural details serve to promote the efficiency of the furnace as a whole and will therefore be briefly described in this application. Among these novel structural features may be mentioned the following:

Each radiator is conveniently secured to the fire box by means of two relatively small tie plates 36 disposed in a vertical plane to offer a minimum of resistance to the passage of air through the heating chambers.

In order to prevent demolition of the furnace should for any reason an explosion occur in any of the members through which the products of combustion pass, we form in the rear wall 13 of the fire box an extension 37, and in the rear wall 24 of each radiator an extension 38, each communicating with an opening in the rear wall of the casing 1. These openings are normally closed by frictionally fitted explosion doors 39 and 40 respectively which blow out to relieve high pressures generated by an explosion, thus saving the furnace from destruction.

While the casing may be formed in any suitable and convenient manner, we have devised a novel combination of separate wall, base and dome parts which may be assembled quickly, without bolts, welding or the like, and without the use of tools. To this end, the base strip 2 is channeled, as shown at 41. Into the channeled base are received four angled corner posts 42 each of which has a pair of vertical side channels 43 which receive the vertical edges of the casing walls. The peripheral lower edge 44 of the dome 3 is channeled similarly to the base strip 2, and when the channeled lower edge 44 of the dome is received down over the interfitted casing wall plates and corner posts, disengagement of the parts is effectually prevented. We have found it unnecessary to fasten the dome in position over the casing walls and corner posts, the weight of the dome and the rigidity of the assembled structure of any given installation provided by the fixed hot air leader pipes 45 being sufficient.

The invention has been shown and described in this application embodied in a gas fired furnace. It is to be understood that the essence of the invention is not limited to such embodiment, the various structural elements of the furnace being capable of modification and alteration, wherever necessary, without departure from the principles of the invention, to provide a furnace adapted to the burning of oil, coal or other fuel. All such modifications, and any others which may be deemed desirable to meet varying conditions of manufacture and use or the preference of designers, to the extent that they embody the principles of the invenion as pointed out in the appended claims, are to be deemed within the scope and purview thereof.

Having thus described our present invention what we claim and desire to secure by Letters Patent is:

1. A hot air furnace including an outer casing, a fire box mounted in the casing a radiator spaced opposite each side of the fire box and having an outlet in its upper portion, a pipe connecting the fire box with each radiator, substantially midway its height, and means for directing toward the lower portion of each radiator gases entering through said pipe, the side walls of the fire box and the opposite side walls of each radiator defining a pair of air heating chambers, and each side wall of the fire box being progressively inclined from the bottom to top away from the opposite side wall of the adjacent radiator whereby each air heating chamber is regularly tapered in vertical section, being wider at its top than at its bottom.

2. A hot air furnace including a casing having

an air inlet opening in its bottom, a central fire box in the casing, a fuel burner positioned in the lower part of the fire box, a radiator having a closed bottom positioned on each side of the fire box in spaced relation thereto and having in the upper part of its rear wall an outlet for the products of combustion, a single horizontal pipe connecting each of the radiators with the fire box, each of said pipes being secured at one end to a radiator at a point substantially midway the height thereof and substantially nearer the front than the rear thereof, and a baffle in each radiator for directing the products of combustion from the pipe to the bottom of the radiator before passing through the radiator outlet.

3. A hot air furnace including a central fire box, a fuel burner positioned in the lower part thereof, a radiator positioned on each side of the fire box in spaced relation thereto having in the upper part of its rear wall an outlet for the products of combustion, a single horizontal pipe connecting each of the radiators with the fire box, each of said pipes being secured at one end to a radiator at a point substantially midway the height thereof and substantially nearer the front than the rear thereof, and means in each radiator for directing gases entering through the pipe downwardly toward the bottom of the radiator.

4. A hot air furnace structure as claimed in claim 3 in which the walls of the radiators and the fire box are fluted and the pipes are provided with enlarged end portions in the walls of each radiator and each wall of the fire box to facilitate passage of gases through the pipes.

5. A hot air furnace including a casing, a fire box and a radiator spaced apart inside the casing, means for conducting hot gases from the fire box to the lower part of the radiator, an outlet in the upper part of the radiator for discharging said gases, the casing being provided with an inlet for admitting air into the space between the fire box and the radiator and an outlet for said air, and a shield positioned in the space between the fire box and the radiator to prevent loss of heat by radiation from the fire box to the radiator.

6. A hot air furnace including a casing, a fire box and a radiator spaced apart inside the casing, a connection between the fire box and the lower part of the radiator and an outlet in the upper part of the radiator, the casing being provided with an inlet for admitting air into the space between the fire box and the radiator and an outlet for said air, and a shield positioned in the upper part of the space between the fire box and the radiator to prevent loss of heat by radiation from the relatively hot upper zone of the fire box to the horizontally opposite wall of the relatively cold radiator.

7. A hot air furnace as claimed in claim 5, a single fire box, a pair of radiators, one on each opposite side of the fire box, a separate flue pipe connecting each radiator with the fire box, and a radiation shield positioned in the space between each radiator and the fire box.

8. A hot air furnace comprising a fire box and a radiator, a heating chamber defined by the opposed walls of the fire box and radiator, a flue pipe connecting the fire box and radiator, means in the radiator for conducting the products of combustion from the fire box first to the lower part of the radiator and thence to the upper part thereof, whereby the upper part of the radiator is normally cooler than the opposite upper part of the fire box, and a shield positioned in the heating chamber for preventing radiation from the upper part of the fire box to the upper part of the radiator.

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