Sept. 2, 1941. R. H. NELSON 2,254,383

HEAT EXCHANGER

Original Filed Aug. 10, 1936 4 Sheets-Sheet 1

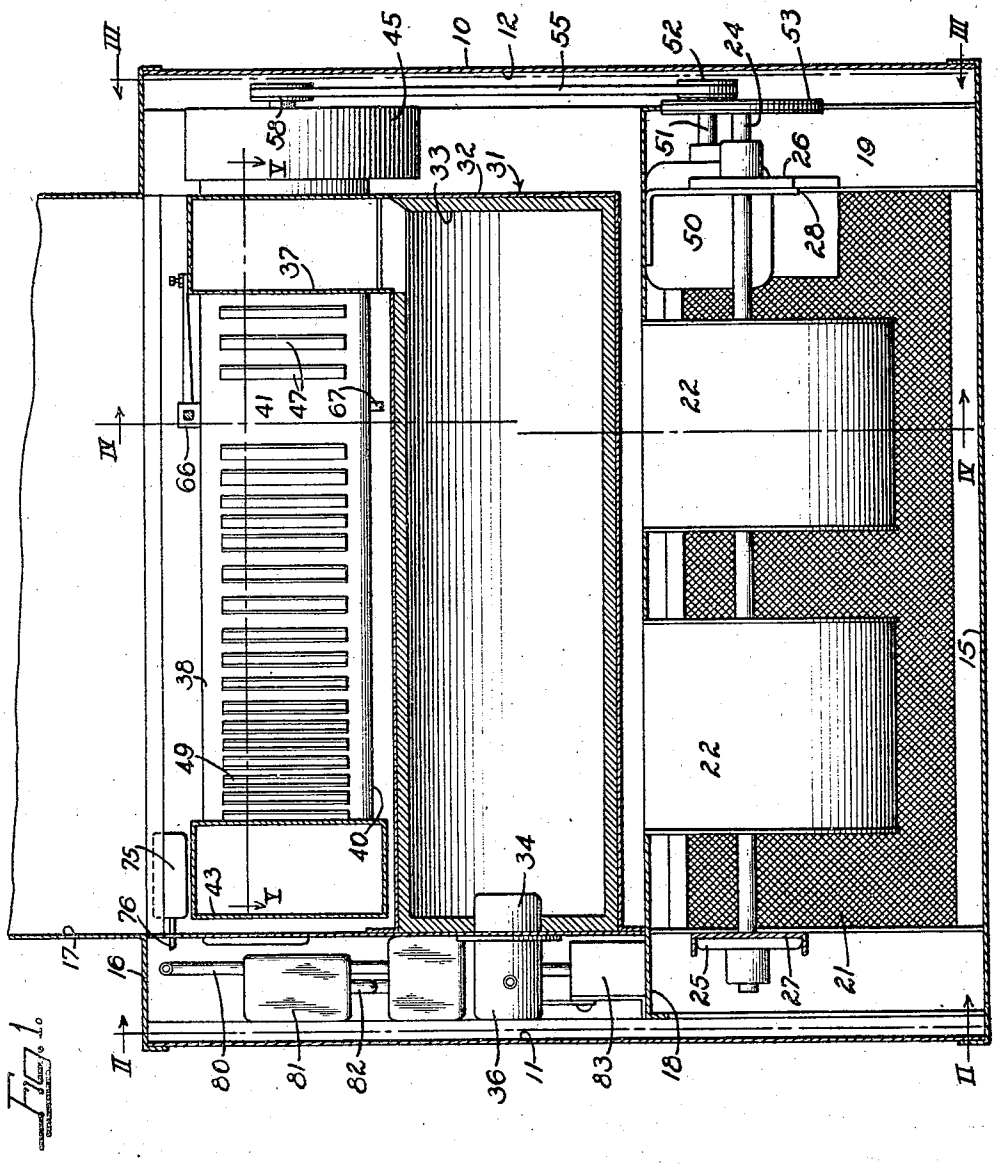


Fig. 1.

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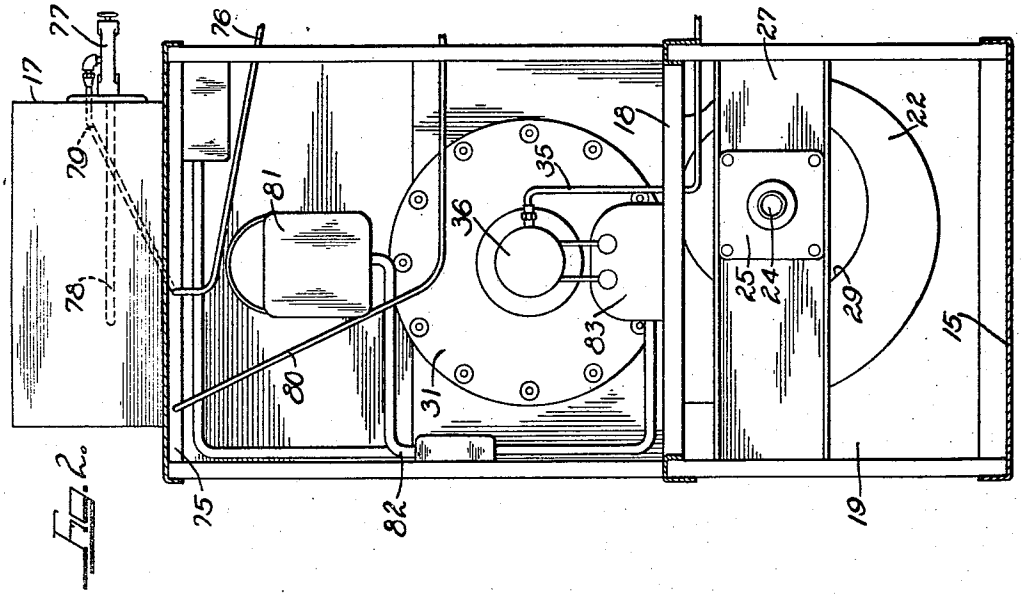


Fig. 2.

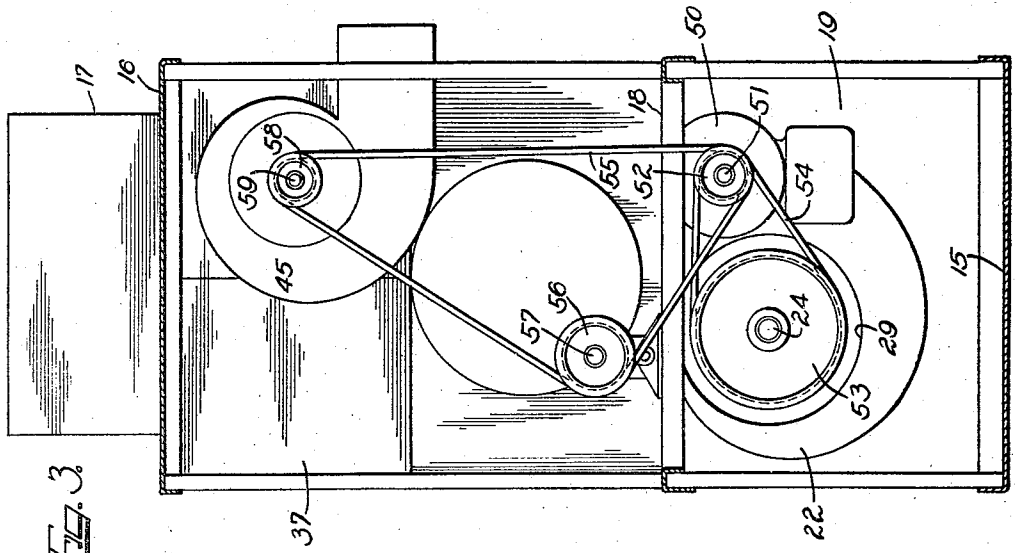


Fig. 3.

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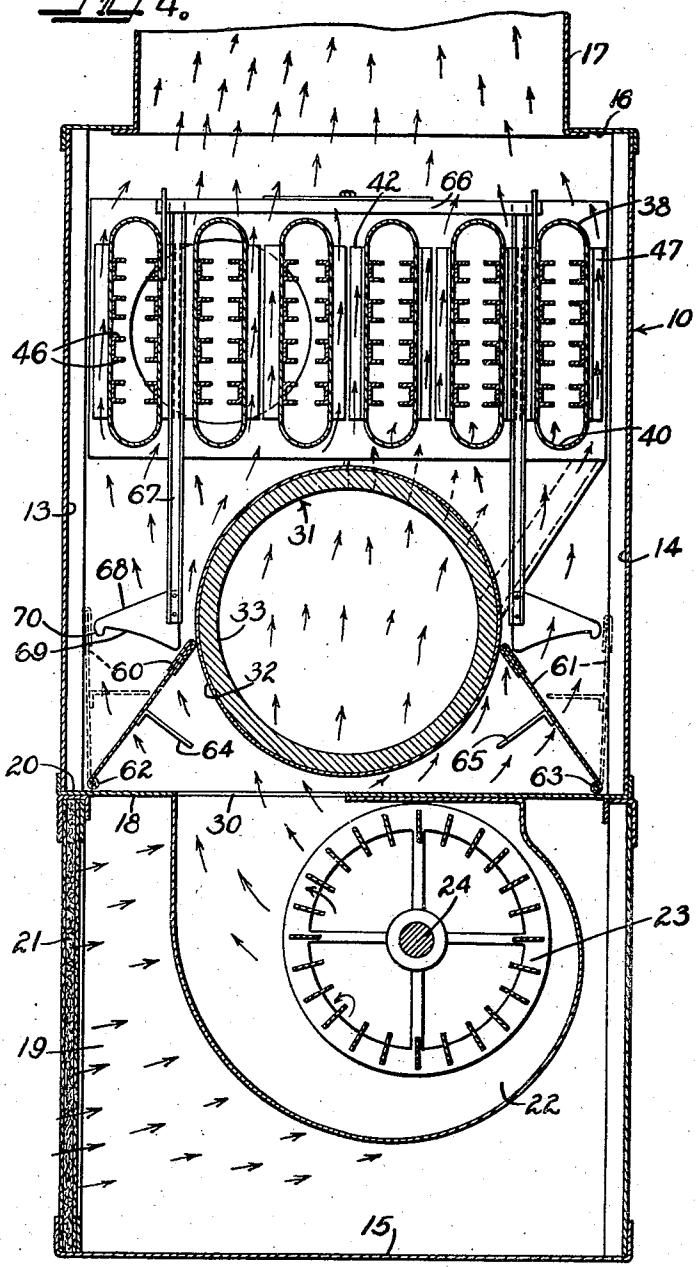
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Fig. 4.



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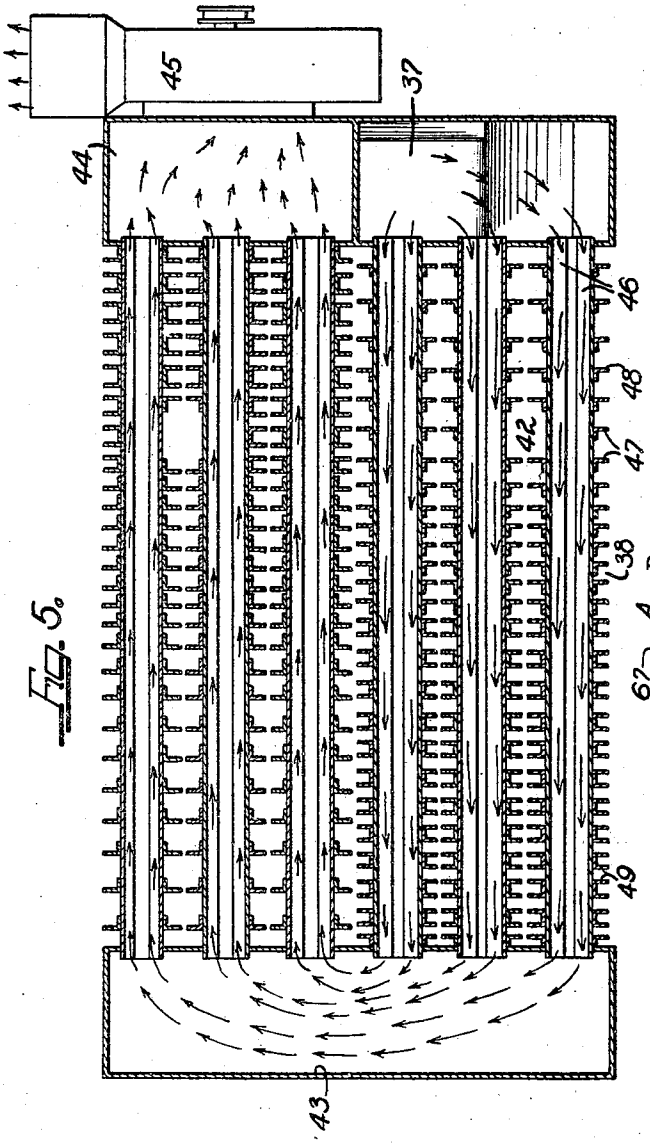


Fig. 5.

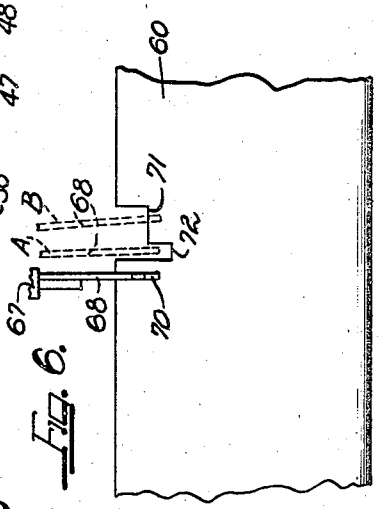


Fig. 6.

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Patented Sept. 2, 1941 2,254,383

UNITED STATES PATENT OFFICE

2,254,383

HEAT EXCHANGER

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Original application August 10, 1936, Serial No. 95,141. Divided and this application May 25, 1939, Serial No. 275,587

7 Claims. (Cl. 126—118)

The present invention relates in general to heat exchangers especially adapted for use in apparatus for the conditioning of air for circulation to rooms and the like, and while the heat exchanger may be utilized in either cooling or heating apparatus, it will be described herein in connection with a furnace.

The present application constitutes a division of my United States Letters Patent No. 2,172,667.

The illustrated furnace with which the present invention is utilized embodies a compact unit, preferably employing oil as the combustion fuel and provided with an induction blower to create a stack draft and reduce the tendency of the gases of combustion to seep into the air flow passages surrounding the combustion chamber and flues or ducts. Broadly, my heat exchanger as embodied in the furnace preferably utilizes flues or ducts for the combustion gases which are provided with fins or ribs both inside and outside for the better transfer of heat from the combustion gases to the air flowing past the flues or ducts, and with the ribs or fins spaced more closely where the temperature difference between the gases and air is lower so as to equalize the amount of heat transferred along the length of such ducts or flues.

It is therefore an important object of the present invention to provide a heat exchanger which is efficient in operation and economical to construct; and which is provided with a plurality of tubes so arranged that, when it is mounted in an air conditioning chamber, it will condition the air temperature uniformly in a direction longitudinally of the tubes.

Other and further important objects of this invention will be apparent from the disclosures in the specification and the accompanying drawings.

This invention (in a preferred form) is illustrated in the drawings and hereinafter more fully described.

On the drawings:

Figure 1 is a longitudinal sectional view with parts in elevation, of a furnace embodying my invention.

Figure 2 is a sectional view taken substantially along the line II—II of Fig. 1.

Figure 3 is a sectional view taken substantially along the line III—III of Fig. 1.

Figure 4 is a sectional view taken substantially along the line IV—IV of Fig. 1.

Figure 5 is a sectional view taken substantially along the broken line V—V of Fig. 1.

Figure 6 is an enlarged detail view of the damper and control arrangement.

As shown on the drawings:

The reference numeral 10 indicates generally an outer casing or housing formed of a suitable gauge of sheet metal and enclosing the various operative elements of a furnace embodying the features of my invention. Said housing 10 comprises end walls 11 and 12, side walls 13 and 14, a bottom wall 15 and a top wall 16 from which latter wall extends a stack 17 for conducting the heated air to the branch ducts and thence to the registers used in heating the room, building, or the like.

The interior of said housing 10 is divided by a horizontal plate 18 into a lower air intake and mixing space 19. The lower portion of the side wall 13 terminates at the horizontal plate 18, as at 20 (Fig. 4), and a foraminous screen and air filter 21 is positioned therebeneath to permit the flow of air into the chamber 19. One or more blower or fan units 22 are mounted within said chamber 19 supported from the horizontal plate 18. Each of said blower units includes a blower proper 23 mounted upon a horizontal axis 24, the ends of which extend through bearing plates 25 and 26 secured to supporting members 27 and 28, respectively. The casings of said blower units 22 are opened at their ends, as at 29, to permit air to be drawn thereinto, and the horizontal plate 18 is apertured as at 30 (Fig. 4), to permit the upward flow of air into the space thereabove.

In the space above the plate 18, there is mounted a combustion chamber, indicated generally by the reference numeral 31 and comprising an elongated cylindrical fire box having an outer shell 32 of metal and an inner refractory lining 33. At one end of said combustion chamber 31 oil burner equipment is mounted upon the plate 18, including a draft casing 34, which extends through an opening in said end of the combustion chamber. An oil supply pipe 35 leads to the oil burner, indicated generally by the reference numeral 36.

The other end of the combustion chamber 31 has a conduit 37 leading upwardly to a plurality of longitudinally extending ducts 38 arranged in two sets or banks of three ducts each. Said ducts are flattened to present their narrow rounded lower portions 40 to the upwardly ascending air currents and their flattened faces 41 are arranged in closely spaced parallel relation to provide passages 42 therebetween. At the further end from the intake duct 37, a header box 43 (Fig. 5) extends across all of the horizontal ducts

38 to direct the flue gases issuing from the first set of ducts into the second set of ducts. From the second set of ducts, the flue gases pass through a header box 44 into the housing of an induction blower 45 and thence are delivered to a stack (not shown).

Each of the ducts 38 is provided internally with longitudinally extending fins or ribs 46, which may suitably take the form of channel strips riveted or otherwise secured to the inner flat vertical surfaces of the ducts. These fins or ribs 46 serve to absorb and transfer the heat from the flue gases to the metal walls of the ducts for radiation into the air passing around and outside of the ducts. Fins or ribs 47 are also secured to the outside flat walls of said ducts 38, said fins or ribs taking the form of angle irons 48 or channel irons 49, depending upon their position along the length of said ducts.

I have found that more efficient heat transfer can be effected if the outer fins or ribs 47 have substantially a logarithmic spacing, the ribs or fins 47 being spaced more closely along the length of the ducts 38 where the temperature of the flue gases passing through said ducts is lower. The channel members 49 are therefore positioned along the ducts 38 toward the discharge ends thereof, while the angle irons 48 are positioned at the intake ends of said ducts. Thus, the amount of heat radiated by said fins or ribs 47 is largely equalized throughout the length of said ducts by virtue of the greater radiating surface area where the temperature of the flue gases passing through the ducts is lower.

The driving mechanism (Figs. 1 and 3) comprises a motor 50, suitably mounted within the lower compartment 19 at one end thereof, and having a shaft 51 to which are keyed a pair of pulleys 52. One of said pulleys 52 drives a pulley 53 on the shaft 24 through a belt 54. A second belt 55 is trained around a pulley 56 secured on a pump shaft 57 and around a pulley 58 secured on the induction blower shaft 59. Said second belt 55 is driven by the other of the pulleys 52 on the motor shaft 51. I have thus provided a common driving means for all of the moving parts in the furnace assembly.

An arrangement of dampers for the flow of air past the combustion chamber 31 is provided comprising a pair of plate dampers 60 and 61 (Fig. 4) hinged at their lower edges, as at 62 and 63, respectively, from adjacent the side walls 13 and 14. Said dampers 60 and 61 extend substantially the full length of the combustion chamber 31 and in their closed position rest with their upper edges against the outer wall of said combustion chamber. In their open position, shown in dotted lines in Fig. 4, said dampers 60 and 61 are substantially vertical and parallel to the side walls 13 and 14. The dampers are of relatively light sheet metal construction and are provided with angle irons 64 and 65 which serve as counterweights to cause the dampers to fall into closed position when there is no air flow from the blowers 23. The flow of air, when the blowers 23 are operating, is sufficient to open the dampers 60 and 61 in the absence of any means for regulating their position.

Means are provided, however, for regulating and controlling the dampers 60 and 61 so that these dampers will remain closed until after the furnace has been brought up to a predetermined temperature, and also for keeping the dampers open after the motor 50 has been shut off until the temperature of the furnace has dropped below a predetermined point. Such means comprise a horizontally extending frame portion 66 (Fig. 4) having depending from each end thereof a bimetal rod 67 carrying at its free end a cam shaped plate 68. Said plates 68 are provided with a lower arcuate shaped surface 69 terminating at one end in a hooked portion 70.

The bimetal rods 67 are so constructed that upon being heated they bend in a plane parallel to the side walls 13 and 14, as best illustrated in dotted lines Fig. 6. The upper edges of the dampers 60 and 61 are provided with stepped recesses 71 and 72 of less and greater depth, respectively. Normally, with the furnace cold as at the starting up of the furnace, the bimetal rods 67 are in vertical position and out of alignment with the recesses 72 and 71, so that the cam plates 68 resist the opening of the dampers 60 and 61. The dampers therefore remain shut even after the motor 50 has been started up and the blowers 23 set in operation. However, as the furnace heats up, due to the combustion of fuel within the combustion chamber 31, the bimetal rods 67 bend until they assume the position indicated by the letter A, (Fig. 6). In this position, the cam plates 68 are in alignment with the deeper recesses 72 and the dampers 60 and 61 are thus free to move upwardly under the force of the draft of air from the fans or blowers 23. The dampers thereupon assume the substantially vertical position shown in dotted lines in Fig. 4 and continue to remain open so long as the furnace is in operation.

Upon the shutting off of the motor 50, and consequently of the burner and other operating elements of the furnace, but before the furnace has cooled down substantially, the bimetal rods 67 are in their extreme bent position indicated by the letter B (Fig. 6). In this position, the ends of the cam plates 68 overlie the edges of the recessed portions 71 of said dampers 60 and 61 to prevent the dampers from falling shut. As the furnace continues to cool down, the bimetal rods 67 come to assume the position indicated by the letter A (Fig. 6), where the cam plates 68 are in alignment with the deeper recesses 72 and the dampers 60 and 61 are free to fall closed by reason of the counterweights 64 and 65. During this interval while the furnace is cooling off and the dampers are open, a natural convection of air through the furnace and the air ducts is permitted, so that the remaining sensible heat of the furnace parts is utilized in the heating of the air.

In order to provide for humidification and conditioning of the air heated by the furnace, an evaporating pan 75 (Fig. 1) may be mounted above the header 43. Said evaporating pan 75 is provided with a supply of hot water through a pipe 76 (Fig. 2) that is a part of the domestic hot water circulating system. The flow of hot water from the pipe 76 into the evaporating pan 75 is controlled by means of a thermostatic humidity control valve 77 which has a part 78 extending into the outlet ducts 17 from the furnace. A humidifier feed line 79 leads from said valve 77 to control the flow of hot water from said pipe 76 into the evaporating pan 75. An overflow line 80 conducts the excess of water from said evaporating pan 75 to waste.

The electrical circuit for energizing the motor 50 includes a control box 81 (Fig. 2) from which a conduit 82 leads to the motor 50 and to a transformer primary within a housing 83.

I am aware that many changes may be made and numerous details of construction may be varied through a wide range without departing from the principles of this invention, and I, therefore, do not purpose limiting the patent granted hereon otherwise than necessitated by the scope of the appended claims.

I claim as my invention:

1. In a furnace, a plurality of waste flue ducts disposed in a horizontal plane and each having longitudinally extending heat absorbing ribs on the inside and vertically extending heat radiating fins on the outside thereof, said outside fins being spaced more closely together along the lengths of said ducts the lower the temperature gradient between the inside and outside of said ducts.

2. In heat exchange apparatus, an air conditioning chamber having an inlet and outlet opening, and a plurality of horizontally disposed ducts extending across said chamber for conducting a fluid for changing the temperature of air passing through said chamber, fluid flow in said ducts being in the same direction, and each of said ducts having heat exchange surfaces of increasing area per unit length of duct in the direction of the flow of said fluid.

3. In a device of the character described, a casing having an inlet and outlet for a fluid medium to be passed therethrough and be heated, a duct for the passage of a heating medium, said duct forming a single pass for the heating medium across the interior of the casing between its inlet and outlet and having laterally projecting external fins progressively spaced along said duct at intervals decreasing from one side of the casing to the other in the direction of the flow of the heating medium in the ducts, whereby the medium in the casing engaging said duct and fins will be uniformly heated from one end to the other of the duct.

4. In a device of the character described, a casing having an inlet and outlet for a fluid medium to be passed therethrough and heated, a plurality of subtsantially parallel ducts defining a single pass through the casing for the passage of a heating medium in the same direction of flow, said ducts longitudinally extending through the interior of the casing and horizontally disposed between the inlet and outlet thereof, and external fins progressively spaced along said ducts at intervals decreasing in the direction of the fluid flow therethrough, whereby the medium passing through the casing will be uniformly heated along said ducts.

5. In a furnace of the character described having a combustion chamber and a separate surrounding casing in spaced relation thereto, said casing having an inlet for the admission of air and an outlet for the delivery and distribution of heated air, tubes for conducting the hot gases away from said combustion chamber, said tubes traversing the space within the casing in a horizontal plane between said inlet and outlet and being provided with fins for transferring the heat from the hot gases to the air flowing past the tubes, said fins being spaced at intervals which progressively decrease in the direction in which the gases travel and cool, so as to more uniformly heat the air passing through said casing from one end to the other of each duct.

6. In heat exchange apparatus, a first duct for the passage of a fluid to be conditioned as to its temperature, said duct having a fluid inlet and a fluid outlet, a second duct for the passage of a fluid conditioning medium, said second duct consisting of a plurality of tubes traversing said first duct in a plane extending thereacross between its ends and defining a plurality of series connected passes in the first duct for the conditioning medium, and fins carried by said tubes, the fins on each tube of the passes being progressively spaced along the tube at intervals decreasing in the direction of flow of the conditioning medium therethrough, whereby the fluid at the respective passes of the conditioning medium will be uniformly conditioned as to its temperature along said tubes.

7. In heat exchange apparatus, a first duct for the passage of a fluid to be conditioned as to its temperature, said duct having a fluid inlet and a fluid outlet, a second duct for the passage of a fluid conditioning medium, said second duct consisting of a plurality of tubes traversing the first duct in a plane extending thereacross between its ends and defining a plurality of series connected passes in the first duct, the tubes of each of said passes constituting parallel flow paths for said medium, and fins carried by said tubes, the fins of each tube of the passes being progressively spaced along the tube at intervals decreasing in the direction of flow of the conditioning medium therethrough, whereby the fluid at the respective passes of the conditioning medium will be uniformly conditioned as to its temperature along said tubes.

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