Nov. 2, 1948. H. J. DE N. McCOLLUM 2,452,780

NONPULSATING INTERNAL-COMBUSTION HEATER

Filed March 6, 1943 3 Sheets-Sheet 1

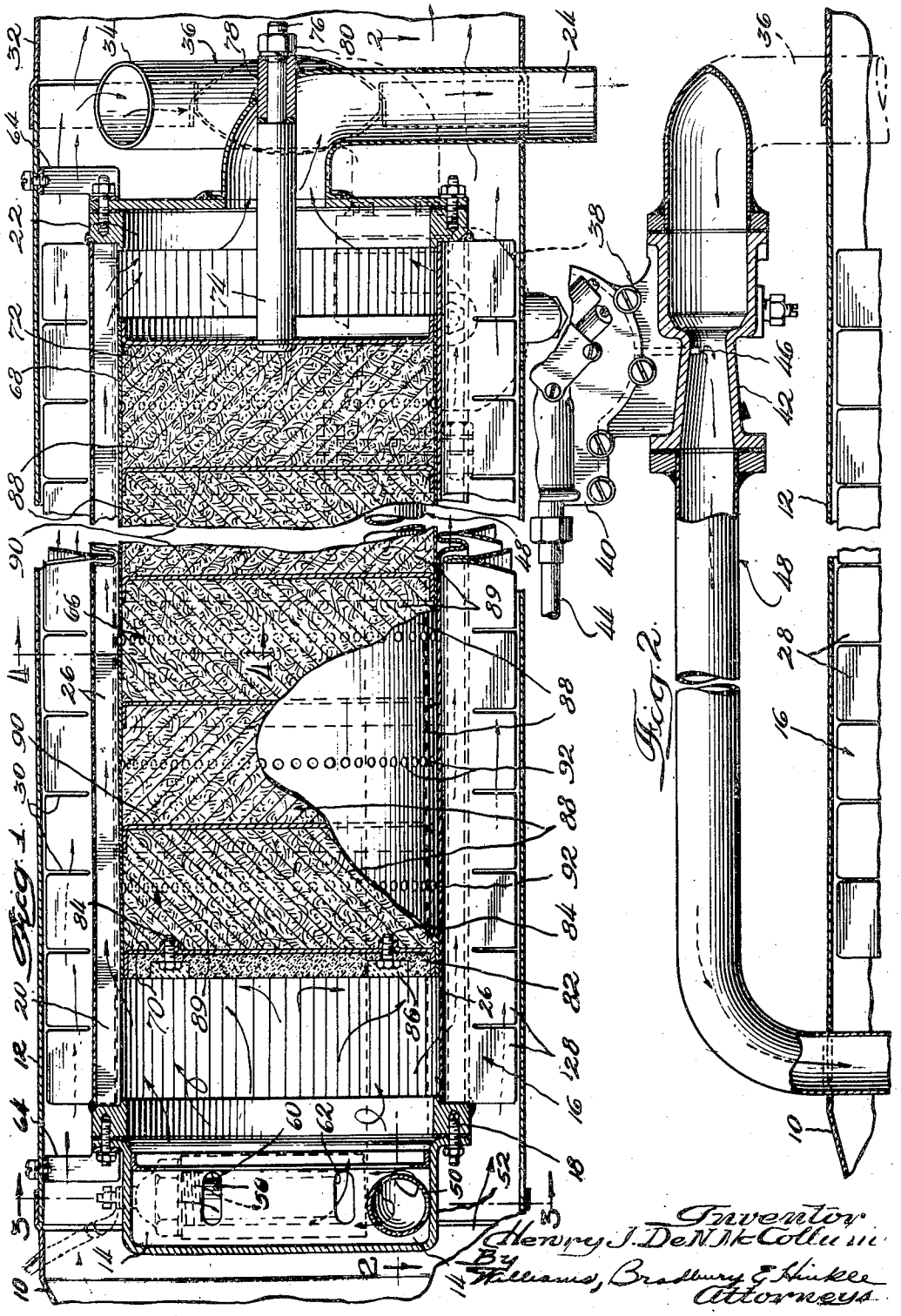


Fig. 1.

Fig. 2.

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Fig. 3.

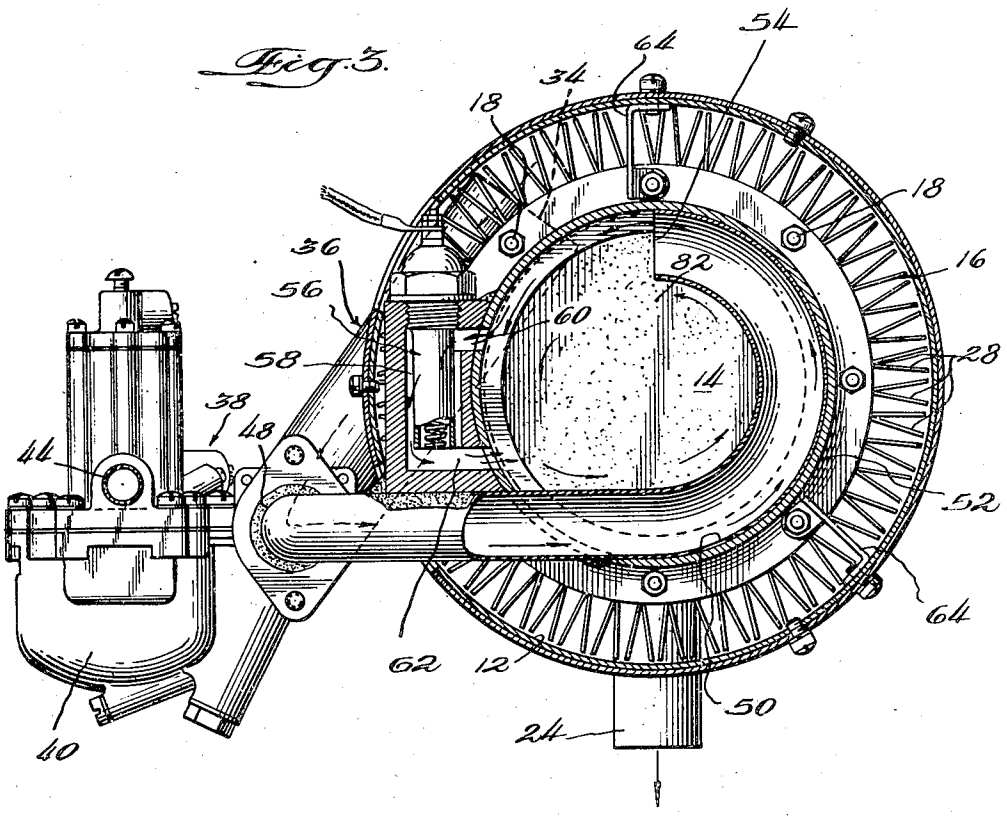
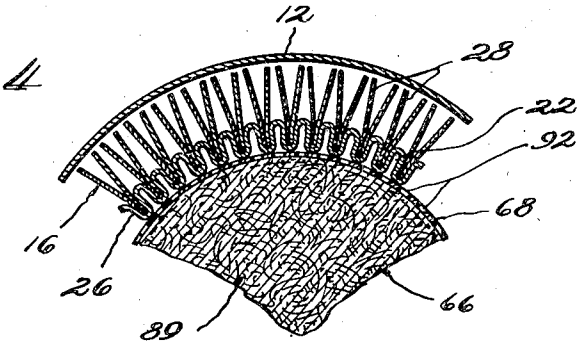


Fig. 4



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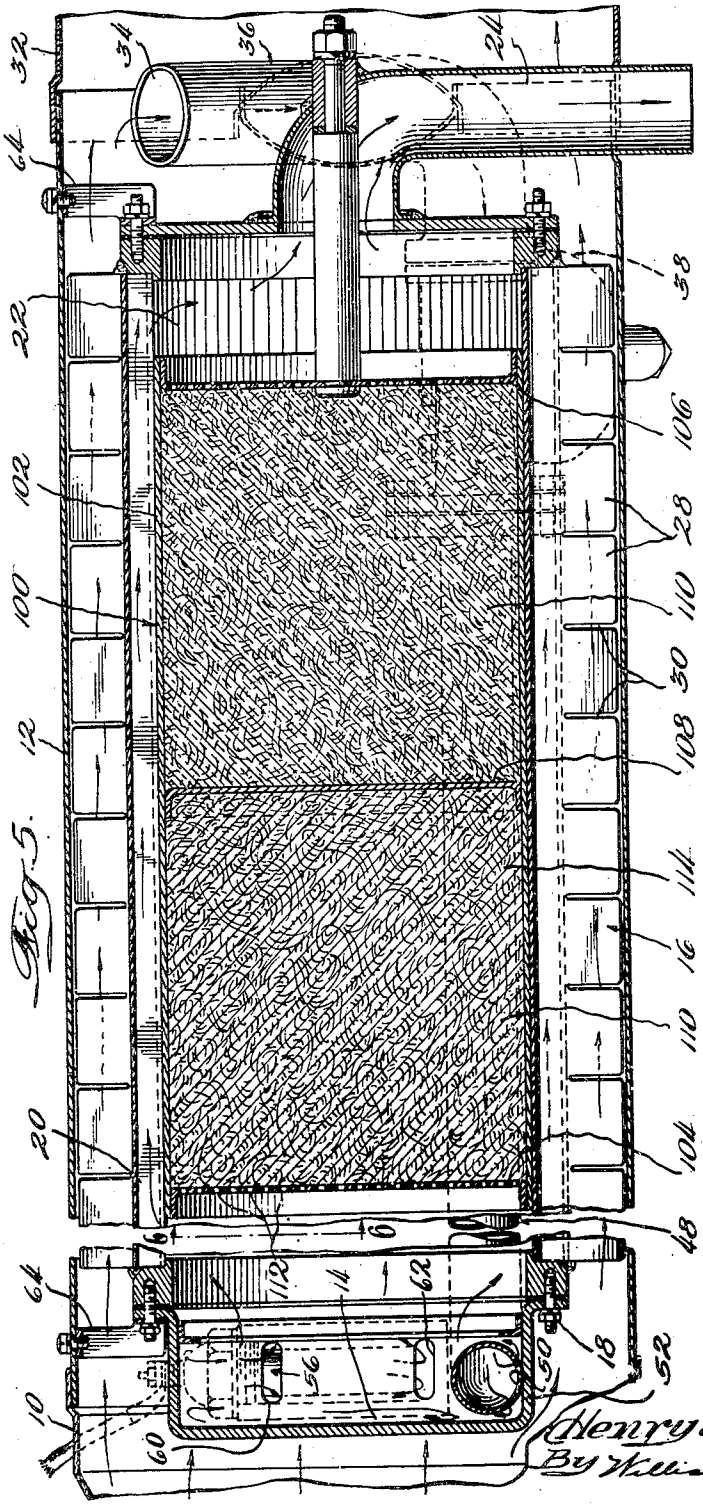


Fig. 5.

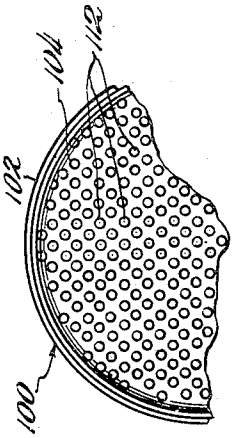


Fig. 6.

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UNITED STATES PATENT OFFICE

2,452,780

NONPULSATING INTERNAL-COMBUSTION HEATER

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Application March 6, 1943, Serial No. 478,259

11 Claims. (Cl. 126—116)

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My invention pertains to heaters and more particularly to heaters of the internal combustion type especially adapted for, but not limited to, use in aircraft.

In internal combustion heaters, it has been common practice to provide a muffler for silencing or reducing the noise of operation of the heater. Such muffler ordinarily consists of a metal shell containing glass wool or stainless steel wool which is in communication with gases issuing from the combustion chamber by way of a multiplicity of openings in the muffler shell whereby sound can enter the interior of the shells through these openings and be absorbed by the glass wool or stainless steel wool therein. In such heaters the sound absorbing material in the muffler shell deteriorates rapidly and an object of my invention is to provide a heater in which such rapid deterioration is avoided.

Another object of my invention is to provide a heater which minimizes such explosions as may occur when the heater is first started and which result from the presence of combustible mixture in the gas passages of the heater and in exhaust pipes connected thereto.

Another object of my invention is to provide a new and improved muffler which has a longer life than the mufflers heretofore in use.

Another object of my invention is to provide a heater having a new and improved muffler mounting whereby the muffler may be readily removed and replaced.

Another object of my invention is to provide a new and improved muffler particularly designed to absorb explosions occurring in the heater.

Other objects and advantages will become apparent as the description proceeds.

In the drawings:

Fig. 1 is a longitudinal, sectional view of a heater embodying a preferred form of my invention;

Fig. 2 is a partial, longitudinal, sectional view taken on the line 2—2 of Fig. 1;

Fig. 3 is a transverse, sectional view taken on the line 3—3 of Fig. 1;

Fig. 4 is a partial, transverse, sectional view taken on the line 4—4 of Fig. 1;

Fig. 5 is a longitudinal, sectional view of a heater embodying a modified form of my invention; and

Fig. 6 is a partial, transverse, sectional view taken on the line 6—6 of Fig. 5.

The heater shown in Figs. 1 to 4, inclusive, has an air inlet 10 connected to a ram, blower or any other suitable means which supplies all of the ventilating and combustion air required by the

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heater. The inlet 10 is connected to one end of a cylindrical casing 12 enclosing a combustion chamber 14 discharging products of combustion into one end of a cylindrical heat exchanger 16 to which the combustion chamber is attached as by studs 18. The hot gases issuing from the combustion chamber flow into the lefthand ends of gas passages 20 provided by the heat exchanger and are discharged from the righthand ends of these passages into an outlet chamber 22 from which the current gases flow through an exhaust pipe 24 leading to atmosphere. In conventional aircraft practice, the exhaust pipe discharges outside of the fuselage of the aircraft and the outlet end of this pipe is so arranged that suction is created thereat by the normal operation of the aircraft.

Referring more particularly to Figs. 3 and 4, it will be seen that the heat exchanger 16 comprises a corrugated sheet metal tube 26 supporting longitudinally extending fins 28 whose outer edges are divided into fingers by slots 30 best shown in Fig. 1. The air entering the lefthand end of the casing 12 absorbs heat from the fins 28 and most of this heated air flows from the righthand end of the casing 12 into a duct 32 leading to the aircraft cabin or one or more other spaces to be heated.

A portion of the heated air is used for combustion purposes and enters the inlet 34 of a combustion air pipe 36 leading to a carburetor 38, comprising the usual float bowl 40 and Venturi tube 42. A pipe 44 connects the float bowl 40 with any suitable source of fuel and fuel from the float bowl is delivered to the throat of the Venturi tube 42 by a jet 46 to form a mixture of fuel and air which passes into an induction tube 48 attached to the outlet end of the Venturi tube 42. The induction tube 48 is preferably of uniform diameter and has a smooth interior free from obstructions or interruptions and conducts the fuel and air mixture to the combustion chamber 14.

This induction tube has a preheating portion 50 located in and curved about the axis of the circular wall 52 of the combustion chamber and terminating in an outlet 54 which discharges a combustible mixture tangentially of the wall 52 whereby the combustible mixture whirls about the axis of the combustion chamber. This mixture is ignited by an electrical igniter 56 located in a cylindrical pocket 58 at one side of the combustion chamber and connected to this chamber by way of an inlet 60 and an outlet 62.

The heat exchanger and combustion chamber are shown as being supported in the casing 12 by

brackets 64 which constitute a suitable arrangement for attaching these parts together, although any other suitable attaching means may be substituted therefor. The heater, as thus far described, is identical with that disclosed in my copending application, Serial No. 478,258, filed March 6, 1943, which has become Patent No. 2,417,604 granted March 18, 1947, and is claimed in that application or the earlier applications referred to therein.

A muffler 66 is located in the heat exchanger 16 and is illustrated as comprising a sheet metal, cylindrical shell 68 of suitable size to slide into this heat exchanger. The ends of the muffler shell are closed by sheet metal cups 70 and 72 which are welded or otherwise secured to the shell 68 in such manner as to prevent any gas from seeping between these discs and the shell 68. The disc 72 is provided with a pin 74 having a reduced threaded end 76 extending through a sleeve 78 welded or otherwise secured in a wall of the exhaust pipe 24. A nut 80 is attached to the threaded end 76 of the pin 74 and serves to hold the muffler in assembled position in the heat exchanger 16.

The lefthand end of the muffler is exposed to the heat created in the combustion chamber 14 and to the hot gases issuing therefrom. I have found that the intense heat to which this end of the muffler is exposed causes rapid deterioration of glass wool and a somewhat slower deterioration of stainless steel wool and in order to reduce or eliminate completely such deterioration I provide this end of the muffler with an insulating plate 82 of fire clay, or other suitable material. This fire clay, or other heat insulating material, is molded or otherwise formed into a plate of just the right size and shape to be received in the cup 70 to which the plate is secured by screws 84, or in any other suitable manner. Inserts 86 of fire clay, or other suitable material, protect the heads of the screws 84 against the heat of the combustion chamber and the hot gases issuing therefrom.

I have found that where the interior of the muffler shell forms a large compartment and this compartment communicates with the gas passages through a multiplicity of holes, a certain amount of gas enters this compartment and flows through the glass or steel wool contained therein and produces rapid deterioration of this sound absorbing material. A feature of my present invention lies in the provision of means for preventing such flow of gas through the sound absorbing material of the muffler.

The muffler 66 is divided into a plurality of compartments 88 by partitions 90 which are welded or otherwise secured to the shell 68 in such manner that seepage can not occur between the edges of the partitions 90 and this shell. Each of the compartments 88 is filled with glass wool or stainless steel wool, or other suitable sound absorbing material 89, which communicates with the gas passages through a single circumferential row of openings 92, illustrated as being located centrally of the compartments 88. In the heater shown in Figs. 1 to 4, inclusive, deterioration of the sound absorbing material 89 is exceedingly slow and the heater is capable of giving long and trouble-free service without muffler replacement. When and if it is desirable to replace the muffler, the muffler may be readily slipped out of either end of the heat exchanger after the heater has been disassembled sufficiently to permit such removal.

In Figs. 5 and 6, I have shown a heater embodying a modified form of my invention which is particularly adapted to cushion such explosions as may occur in the heater when it is first started and which are due to the presence of combustible mixture in the gas spaces of the heater and exhaust pipe attached thereto. Cushioning of these explosions reduces noise and the possibility of injury to the heater and permits the heater to be made of lighter material and thus reduces the total weight of the heater.

The heater of Figs. 5 and 6 is identical with the heater of Figs. 1 to 4, inclusive, except as to the construction of the muffler. The heater of Figs. 5 and 6 has a muffler 100 comprising a cylindrical sheet metal shell 102 having discs 104 and 106 welded or otherwise secured to the ends thereof. A central partition 108 divides the muffler into a pair of compartments 110 which are shown as being of equal size, but, if desired, the partition 108 may be placed nearer either end of the muffler so that the acoustic properties of the compartments 110 will vary and will absorb different sounds associated with the inlet and outlet ends of the heaters respectively.

The discs 104 and 106 are provided with perforations 112 for admitting sound to the compartments 110. The partition 108, however, is imperforate and forms a gastight seal with the shell 102 to prevent any flow or seepage of gas from one compartment to the other. The compartments 110 are filled with stainless steel wool or glass wool, or other suitable sound absorbing material indicated at 114.

Since each compartment 110 has only a single set of perforations connecting this compartment with a gas passage, there is no tendency for gas to flow into or through these compartments. Little, if any, gas enters these compartments and the sound absorbing material located therein is protected against deterioration by contact with hot products of combustion. The lefthand end of the muffler, however, is exposed directly to the heat in the combustion chamber 14 and to the heat of the gases issuing therefrom and it is preferable to fill at least the lefthand end of the lefthand compartment 110 with stainless steel wool instead of glass wool, since stainless steel wool has the higher melting point and is less affected by intense heat.

The lefthand compartment 110 has restricted communication with the combustion chamber 14 and the gas passages adjacent thereto. If, upon starting the heater, or at any other time, an explosion should occur in this chamber or the adjacent gas passages, the explosive force would be partially absorbed and minimized by flow through perforations 112 into the lefthand compartment 110. Since this compartment would contain practically no combustible mixture, no explosion would occur in this compartment and at the time of the explosion the compartment would be at normal operating pressure, that is, slightly below atmospheric pressure and would constitute a cushion for the exploding gases.

The righthand compartment 110 has similar restrictive communication with the outlet chamber 22 and exhaust pipe 24 and would serve as a means for cushioning the effect of any explosion occurring therein. In addition to cushioning or minimizing the force of explosions in the heater, the compartments 110 and sound absorbing material contained therein reduce the noise occasioned by the explosion and prevent the occu-

pants of the aircraft from becoming unduly alarmed.

In each of the two heaters illustrated in the drawings, provision is made for preventing gas flow through the sound absorbing material of the muffler and for thereby increasing the useful life of this material. The particular number, size and arrangement and other details of the muffler compartments can, of course, be varied to suit particular conditions. Likewise my novel muffler is not limited to use in the particular design of heater shown in the drawing, but may be used in other heaters of the internal combustion type or which utilize gases capable of destroying the sound absorbing material if permitted to flow therethrough. It is to be understood that my invention is not limited to the details shown and described, but may assume numerous other forms and that the scope of my invention is defined in the following claims.

I claim:

1. A heater of the class described comprising a cylindrical heat exchanger which includes conduit means for hot gases extending from end to end and opening laterally toward the axis of the heat exchanger, means forming a combustion chamber at one end thereof for supplying hot gases to said conduit means of the heat exchanger, a casing enclosing said heat exchanger, means for supplying air to said casing to be heated by passing over said heat exchanger, means for supplying a combustible mixture to said combustion chamber, a muffler located in said heat exchanger and comprising a cylindrical shell shorter than the heat exchanger and fitting snugly therein to form an inner wall thereof spaced from both ends of the heat exchanger to provide access for hot gases thereto and therefrom and having one end adjacent said combustion chamber, a plurality of imperforate discs dividing said shell into a plurality of sound absorbing compartments, sound absorbing material located in said compartments, a single row of openings in said shell for each compartment providing acoustic coupling with the conduit means, and means to anchor said muffler against endwise movement in said heat exchanger.

2. A heater of the class described comprising a tubular heat exchanger, means forming a combustion chamber removably attached to one end thereof, an exhaust pipe removably attached to the opposite end of said heat exchanger, a muffler located in said heat exchanger and slidable lengthwise thereof, said muffler comprising a cylindrical shell closely fitting in said heat exchanger and supported thereby, said shell containing sound absorbing material acoustically coupled to said combustion chamber by openings in said shell, a pin projecting from one end of said muffler, and means for detachably connecting said pin to said exhaust pipe to prevent sliding movement of said muffler relative to said heat exchanger.

3. A heater of the class described, comprising a cylindrical heat exchanger, means forming a combustion chamber for supplying hot gases to one end of said heat exchanger, a gas exhaust pipe connected to the other end of said heat exchanger, and a muffler located in said heat exchanger, means dividing said muffler into separate explosion cushioning and sound absorbing compartments, restricted openings disposed in a single diametrical plane transverse to the muffler and providing communication between one of said compartments and the said combustion chamber,

restricted openings disposed in a single diametrical plane transverse to the muffler and providing communication between another of said compartments and said exhaust pipe and a sound absorbing material in said compartments.

4. A heater of the class described, comprising a cylindrical heat exchanger, means for supplying hot gases to one end of said heat exchanger, an exhaust pipe communicating with the other end of said heat exchanger, a muffler interposed between said means and said exhaust pipe, said muffler comprising a plurality of compartments, a perforated end for said muffler affording limited communication between said means and one of said compartments, a second perforated end for said muffler affording limited communication between said exhaust pipe and another of said compartments, sound absorbing material in said compartments, and means for directing air over said heat exchanger.

5. A heater of the class described comprising a tubular heat exchanger, means forming a combustion chamber for supplying hot gases to one end of said heat exchanger, an exhaust pipe for receiving said gases from the other end of said heat exchanger, and a muffler located in said heat exchanger, said muffler comprising a shell, a gas-proof partition dividing said shell into two compartments, a perforated end for said shell adjacent said combustion chamber and providing restricted communication between said chamber and one of said compartments, a second perforated end for said shell adjacent said exhaust pipe and providing restricted communications between said exhaust pipe and the other of said compartments, and sound absorbing material in said compartments.

6. A heater of the class described comprising a tubular heat exchanger having a corrugated wall forming inwardly open channels extending longitudinally thereof, means including a combustion chamber at one end of said heat exchanger for supplying hot gases to one end of said channels, a muffler located in said heat exchanger and having a cylindrical shell shorter than the corrugated wall, said shell being fitted snugly within said corrugated wall and spaced from both ends thereof to provide access to and from the said channels, gastight means dividing said shell into compartments arranged in end-to-end relation lengthwise of the muffler shell, each of said compartments having a series of openings acoustically coupling said channels with the interior of the shell, the openings in any compartment lying in a substantially common plane diametrically disposed with respect to the shell, and a sound absorbing material in said compartments.

7. A heater of the class described comprising a tubular heat exchanger having a corrugated wall forming inwardly open channels extending longitudinally thereof, means including a combustion chamber at one end of said heat exchanger for supplying hot gases to one end of said channels, a muffler located in said heat exchanger and having a cylindrical shell extending adjacent the open sides of the channels and directing said hot gases along said channels, said muffler shell having closed ends, gas-tight partition means dividing said shell into a plurality of compartments, each of said compartments having a series of openings through the shell acoustically coupling the compartments to said channels, the openings in any one compartment being positioned at points subject to a pressure variable from time to time but of the same magnitude at each of

said openings at any given time when the heater is operating and a sound absorbing material contained in each of said compartments.

8. A heater of the class described comprising a tubular heat exchanger having inwardly open gas channels extending longitudinally thereof, means including a combustion chamber in direct communication with said heat exchanger for supplying hot gases to one end of said channels, a muffler located in said heat exchanger and directing said hot gases along said channels, said muffler comprising a sheet metal shell having closed ends, one or more gas-tight partitions dividing said shell into a plurality of compartments, and a sound absorbing material in each of said compartments, each compartment having a series of openings in the shell acoustically coupling said compartments with said gas channels, the openings in any one compartment being positioned at points on the shell subject to a pressure variable from time to time but of the same magnitude at each of said openings at any given time when the heater is operating.

9. A heater of the class described comprising a heat exchanger having inwardly open longitudinally extending gas channels on the inner periphery thereof, means forming a combustion chamber in direct communication with one end of said heat exchanger for supplying hot gases of combustion to said channels, means directly communicating with the opposite end of said heat exchanger and forming an outlet for exhausting said gases, a muffler concentrically disposed in said heat exchanger and confining to said channels the flow of hot gases from said combustion chamber to said exhaust outlet, means forming a plurality of compartments arranged in end to end relation lengthwise of said muffler, each compartment being sealed against direct communication with an adjacent compartment and having a series of openings providing acoustic coupling between each compartment and the hot gases, the openings in any one compartment being positioned at points in the wall thereof subject to a pressure variable from time to time but of the same magnitude at each of said openings at any given time when the heater is operating, a sound absorbing material contained in said compartments, and means for directing ventilating air over said heat exchanger.

10. A heater of the class described comprising a heat exchanger, means forming a combustion chamber in direct communication with one end of said heat exchanger for supplying hot gases of combustion thereto, means directly communicating with the opposite end of said heat exchanger and forming an outlet for exhausting said gases, a muffler concentrically disposed in said heat exchanger, means forming a series of gas passages between said heat exchanger and

muffler connecting said combustion chamber and outlet, means forming a plurality of separate noncommunicating compartments arranged in end to end relation lengthwise of said heat exchanger, means for protecting one end of said muffler from the heat of said combustion chamber, means for attaching the other end of said muffler to said heat exchanger, means providing acoustic coupling between each of said compartments and said hot gas passages, the acoustic coupling means for any one compartment being positioned at points in the wall thereof subject to a pressure variable from time to time but of the same magnitude at any given time when said heater is operating, a sound absorbing material in each of said compartments and means for directing air over said heat exchanger.

11. A heater of the class described comprising a heat exchanger, means forming a combustion chamber in direct communication with one end of said heat exchanger for supplying hot gases of combustion thereto, means directly communicating with the opposite end of said heat exchanger and forming an outlet for exhausting said gases, a muffler concentrically disposed in said heat exchanger to form gas passages connecting said combustion chamber and outlet, means forming a plurality of noncommunicating compartments in said muffler disposed in end to end relation lengthwise of the muffler, each of said compartments having a circumferentially arranged series of openings in the walls thereof coupling the compartments acoustically to said hot gas passages, the openings in any one compartment being positioned at points in the walls thereof subject to a pressure variable from time to time but of the same magnitude at each of said openings at any given time when the heater is operating, sound-absorbing material in said compartments, and means at the end of said muffler adjacent said combustion chamber for protecting said sound-absorbing material from the hot gases formed in the combustion chamber.

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