The present invention relates to low temperature heaters and has among its objects the provisions of simple construction and particularly economical utilization of the heat developed in the combustion chamber of such heaters.

The improvement essentially consists in arranging the flow of the combustion gases in such a manner that the same are first discharged from the combustion chamber into a primary heat exchanger, wherein they pass for reheating around the combustion chamber in a passage formed between the double walls thereof, and thereafter the gases pass through a secondary heat exchanger and are then expelled in cooled state to the outside, normally by suction of a suitable fan.

The novel features which I consider as characteristic for my invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

The figure presents a sectional view, in schematic, of one embodiment of my invention.

A low temperature heater is illustrated in the drawings, comprising a hollow heating element made of refractory material and having on its interior a combustion chamber $a$ surrounded by double walls and dimensioned and equipped in accordance with the type of fuel used, which may be of solid, liquid or gaseous substance.

A primary heat exchanger $b$ is located adjacent to the exterior of the combustion chamber $a$ and is made of a metal of high thermal conductivity and comprises tubes which are smooth on the inside and provided with fins on the outside; said tubes are arranged to communicate with one end with the interior of the combustion chamber $a$, and with the other end to communicate with a closed passage $c$ which is formed in the heating element between the double walls surrounding said combustion chamber $a$. The passage $c$ is adapted to conduct combustion gases and is disposed on the outside of the combustion chamber and separated therefrom by a heat conductive wall surrounding the chamber $a$ and is spaced from the exterior of the heating element.

A secondary heat exchanger $d$, similar to the primary heat exchanger $b$, is located near the same and comprises tubes having a smooth surface on the interior and integral fins on the exterior; said tubes are connected with one end to the conduit $c$ for providing continuous communication therewith and are connected with the other end to a waste gas collector $e$. A fan $f$ is provided adjacent to the waste gas collector $e$ and arranged to provide an induced draught for the entire path of fumes for removing the combustion gases from the collector into discharge into a chimney.

Furthermore, the device comprises a shaft $g$ housing the two heat exchangers $b$ and $d$ and adapted to direct over these exchangers a stream of cool air to be heated.

The operation of my device is as follows:

Owing to the reduced pressure provided by the action of the fan $f$, the gases are forced through the primary heat exchanger $b$ where their heat is given off, heating the cold air surrounding them. Thereafter, they arrive in a fairly cool state in the passage $c$, adjacent to the combustion chamber $a$, and by passing through the passage they absorb heat developed in the combustion chamber $a$. After being thus reheated, the gases flow through the tubes of the secondary heat exchanger $d$, therein giving off their heat, and are finally discharged through the chimney by fan action.

Cool air is directed into the device by the duct $g$ and is heated while passing over the exterior surface of the tubes of the two heat exchangers which are provided with fins, as already set forth above, for increasing the exterior surface area and thereby promoting the rate of heat transmission.

The heat exchange occurs under particular conditions specified below. Only a portion of the heat developed by combustion is taken along by the gases which transmit it by means of the primary heat exchanger $b$ to the air to be heated; the other portion of the heat is absorbed by the walls of the combustion chamber which transmit it to the gases directed through the passage $c$ therein, and is finally used to heat the air by means of the second heat exchanger $d$.

It is therefore possible to have a combustion chamber of high temperature, and to reduce ex-
cess air of combustion to a practically negligible value resulting in a high degree of efficiency of combustion. Since on the other hand, the heat of combustion is lost completely passed along to the cool air by the heat exchangers, the over-all efficiency of the heater is very high.

The rate of transfer of heat between the hot gases and the heat exchangers, as well as that between the exchangers and the cold air, is proportional to the product of the surface area of heat transmission and the difference of temperature levels.

Transfer of heat between the hot gases and the heat exchangers takes place along the relatively small inner smooth surface of the tube; hence the difference in temperature should be great. On the other hand, as the transfer of heat between the heat exchangers and the cold air takes place along the outer surface of the tube provided with fins and consequently relatively large, the difference in temperature may therefore be small.

In view of the high thermal conductivity coefficient of the metal from which the tubes are made, it is possible, for practical purposes, to disregard the difference of temperature between the inner and the outer surfaces of the tube, and to assume that the temperature difference between the heat exchangers and the hot gases is great, and that between the heat exchangers and the cold air is small.

This is highly important because in the industrial application of the device it is essential for the safety of the operation and the good quality of the heated air, that the heat exchanger should not be at a highly elevated temperature. At the same time, it is thus possible to build the heater at a low cost by using commercial metals which are inexpensive and easily available.

The heater may also be used without fan at a lower rate with natural draught action.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of improvements in low temperature heaters, differing from the types described above.

While I have illustrated and described the invention as embodied in low temperature heaters, I do not intend to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of my invention.

Without further analysis, the foregoing will so fully reveal the gist of my invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention, and, therefore such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What I claim as new and desire to secure by Letters Patent is:

1. In a low temperature heater, a heating element having on the interior a chamber for fuel combustion and a passage around the same separated therefrom by a heat conductive wall surrounding said chamber; and a plurality of exposed heat exchangers each arranged so as to conduct gases through its interior and each surrounded by the cool air to be heated; one of said heat exchangers connected to one end of said passage for receiving combustion gases developed in said chamber and emanating therefrom at elevated temperatures and for conducting them to said passage, and another of said heat exchangers connected to the other end of said passage for conducting gases therefrom, said passage thus connecting said heat exchangers and adapted to conduct gases therebetween and adjacent to said heat conductive wall surrounding said chamber for causing the gases to be reheated.

2. In a low temperature heater for heating air, a heating element having on the interior a chamber for fuel combustion and a passage around the same separated therefrom by a heat conductive wall surrounding said chamber, a plurality of heat exchangers, each composed of tubes having smooth interior surfaces and carrying integral fins on the exterior surfaces for providing large surface areas and each arranged to conduct gases through its interior and each surrounded by the cool air to be heated; one of said heat exchangers connected with one end to said chamber and with its other end to one end of said passage for receiving combustion gases developed in said chamber and emanating therefrom at elevated temperatures and for conducting them to said passage, another of said heat exchangers connected to the other end of said passage for conducting gases therefrom, said passage thus connecting said heat exchangers and adapted to conduct gases therebetween and adjacent to said heat conductive wall surrounding said chamber for causing the gases to be reheated, and means arranged to admit the cool air to be heated and to direct the same towards the exterior surface of said heat exchangers.

3. In a low temperature heater for heating air, a heating element having on the interior a chamber for fuel combustion and a passage around the same separated therefrom by a heat conductive wall surrounding said chamber; and a plurality of exposed heat exchangers each arranged so as to conduct gases through its interior and so as to be surrounded by the cool air to be heated and to heat the same, one of said heat exchangers connected with one end to said chamber and with its other end to one end of said passage for receiving combustion gases developed in said chamber and emanating therefrom at elevated temperatures and for conducting them to said passage, and another of said heat exchangers connected to the other end of said passage for conducting gases therefrom, said passage thus connecting said heat exchangers and adapted to conduct gases therebetween and adjacent to said heat conductive wall surrounding said chamber for causing the gases to be reheated.

4. In a low temperature heater for heating air, a heating element having on the interior a chamber for fuel combustion and a passage around the same separated therefrom by a heat conductive wall surrounding said chamber; and a plurality of exposed heat exchangers each including a tube having a smooth interior surface and carrying fins on the exterior surface for providing a large surface area, and each arranged so as to conduct gases through its interior and so as to be surrounded by the cool air to be heated and to heat the same, one of said heat exchangers connected with one end to said chamber and with its other end to one end of said passage for receiving combustion gases developed in said chamber and emanating therefrom at elevated temperatures and for conducting them to said passage, another of said heat exchangers connected to the other end of said passage for
conducting gases therefrom, said passage thus connecting said heat exchangers and adapted to conduct gases therebetween and adjacent to said heat conductive wall surrounding said chamber for causing the gases to be reheated; and means arranged to admit the cold air to be heated and to direct the same towards the exterior surface of said heat exchangers.

PIERRE GEORGES VICARD.

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