

Jan. 23, 1940.

W. M. HEPBURN

2,188,133

HEATING APPARATUS

Filed Nov. 11, 1937

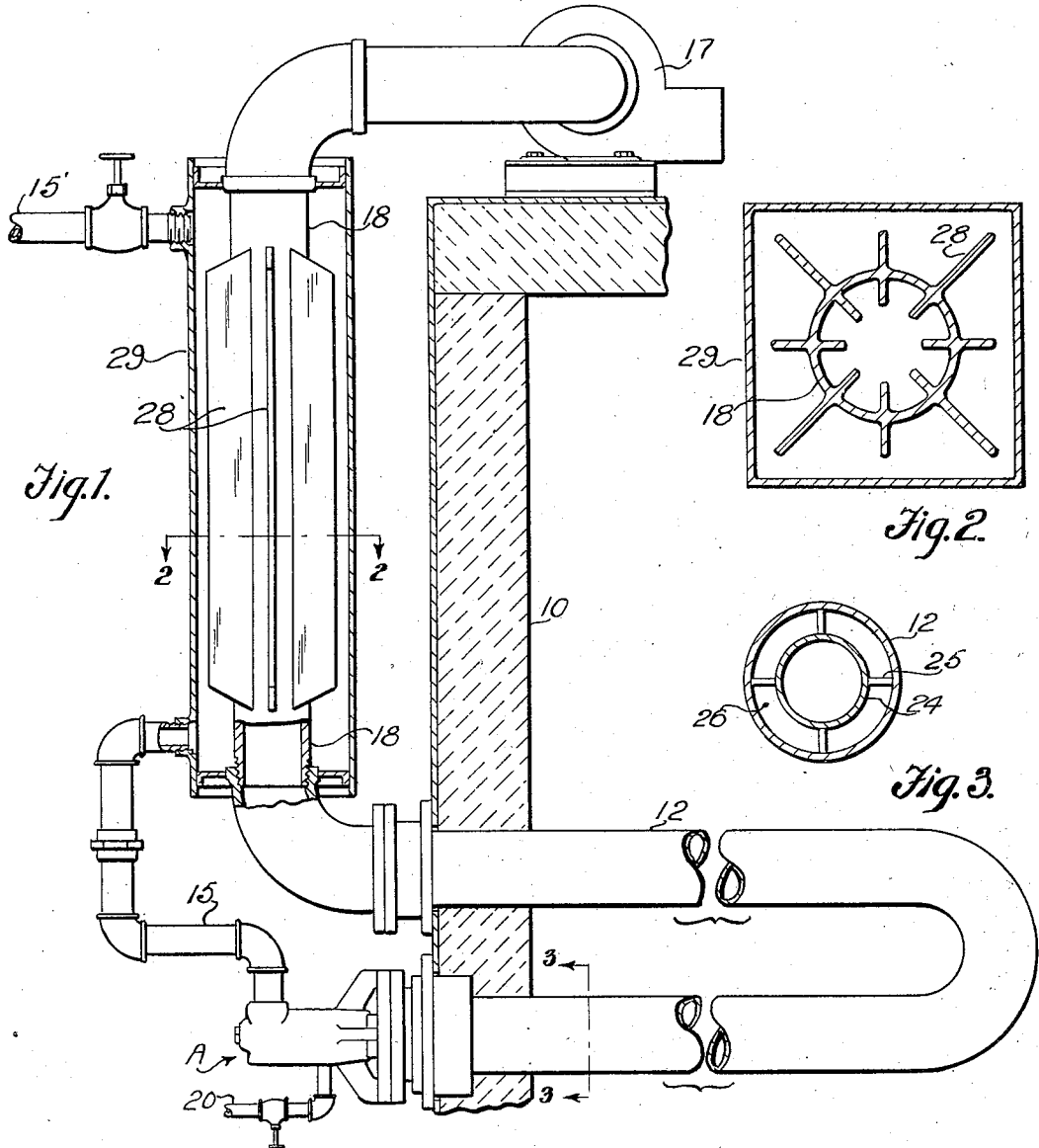


Fig. 1.

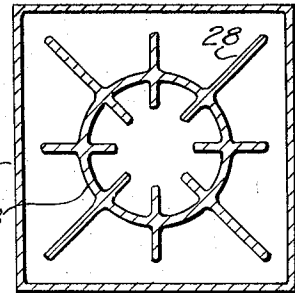


Fig. 2.

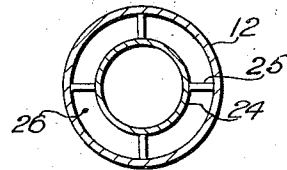


Fig. 3.

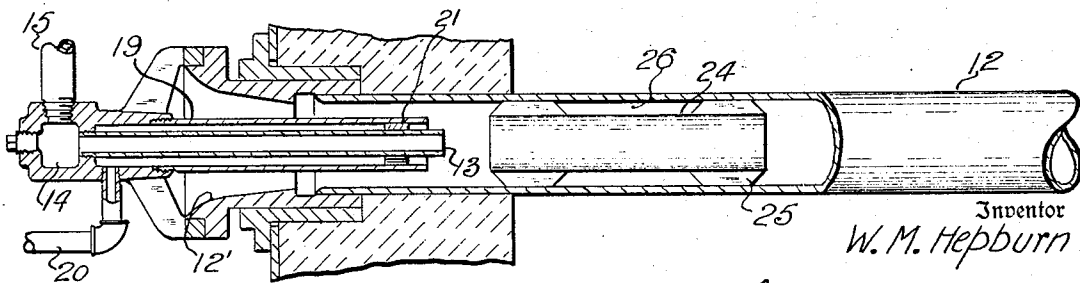


Fig. 4.

Inventor
W. M. Hepburn

By

Charles A. Lind
Attorney

UNITED STATES PATENT OFFICE

2,188,133

HEATING APPARATUS

William M. Hepburn, Ottawa Hills, Ohio, assignor
to Surface Combustion Corporation, Toledo,
Ohio, a corporation of New York

Application November 11, 1937, Serial No. 174,087

4 Claims. (Cl. 126—91)

This invention relates to heating apparatus comprising a fuel-fired radiator tube for producing radiant heat in a furnace chamber and an exhaust fan for the double purpose of withdrawing gases of combustion from the tube and for drawing combustion-supporting air into the intake end of the tube; and the object of the invention is to increase the utility of such apparatus by the improvements hereinafter described.

In the drawing wherein the preferred form of the invention is shown:

Fig. 1 is a side elevation of the improved heating apparatus with parts in section;

Fig. 2 is a sectional view on line 2—2 of Fig. 1;

Fig. 3 is a sectional view on line 3—3 of Fig. 1, and

Fig. 4 is a sectional view of the burner associated with the radiator tube.

Referring to Fig. 1, 10 indicates a wall of a furnace chamber wherein is positioned a fuel-fired radiator tube 12 which, for convenience of illustration, is shown as of the hairpin type with its free ends projecting out of said chamber through the wall 10.

The tube 12 is fired by a burner generally indicated at A, the same comprising a fuel tube 13 which leads from a chamber 14 to which fuel gas is supplied by a gas pipe 15, it being noted that the tube 13 extends a substantial distance into the radiator tube 12 beyond the mouth 12' of the latter. The air for supporting combustion of the fuel flowing from the fuel tube 13 enters the radiator tube 12 at its mouth 12', the air being drawn into said mouth by a suction fan 17 coupled to the exhaust end of the radiator tube 12 by means including an exhaust pipe 18. In order to insure ignition of the fuel gas discharged from the fuel tube 13, a stream of premixed air and gas is caused to burn around the discharge end of said tube, said mixture being delivered to said end by means including a pipe 19 to which the mixture is delivered by a supply pipe 20, it being noted that the pipe 19 surrounds the fuel tube in spaced relation and terminates short of the discharge end of the latter. To prevent said mixture from backfiring there is provided between the two tubes a ring 21 provided with restricted discharge passages. The burner A thus briefly described forms, per se, no part of the present invention.

Positioned in the radiator tube 12 in front of the fuel tube 13 is a sleeve 24 which is held spaced from the walls of the radiator tube by spacer fingers 25, thus providing a flow space 26 between

the sleeve 24 and the radiator tube. The purpose of the sleeve 24 will be presently explained.

The exhaust pipe 18 is internally and externally provided with heat conducting fins 27 and 28 respectively, and is surrounded by a casing 29 into whose upper end fuel gas is discharged by a supply 15' and from whose lower end the fuel gas flows into the pipe 15 leading to the burner A, it being understood that by heat exchange between the fuel gas and the exhaust gases, the latter become cooled and the fuel gas becomes heated.

Let us now briefly consider some of the advantages resulting from effecting heat exchange between the outgoing exhaust gas and the incoming fuel gas.

It is a characteristic of fan performance that the static suction is directly proportional to the density and therefore inversely proportional to the absolute temperature of the gases entering the fan. This is expressed by the equations $S=KD$ and

$$S = \frac{K}{T}$$

where S =static suction; D =density of the gas; T =absolute temperature of the gas, and K =a constant. Thus with every temperature change of gases entering the fan, the static suction of the fan will always change. Likewise when the static suction of the fan changes the quantity of the gases by weight handled by the fan will also change.

Now let us consider what takes place when a fan is utilized for the dual purpose of expelling combustion gases from an internally fired radiator tube and for drawing combustion supporting air into the tube. In the first place let us assume that fuel gas is being supplied to the intake end of the tube at a constant rate by weight and that the static suction of the fan when the combustion gases at the fan are at some predetermined temperature, say 1000° F., is just enough to cause the required amount of combustion supporting air to enter the radiator. As the temperature of the exhaust gases increases the rate of air by weight drawn into the tube by the fan decreases with the result that the amount of oxygen delivered to the fuel for supporting its combustion is decreased. This is the same thing as saying that the air to gas ratio decreases as the static suction of the fan decreases or as the temperature of the exhaust gases pulled out of the tube by the fan increases.

In the operation of a furnace wherein the tem-

perature variation is small after the normal operating temperature has been reached and therefore where the exhaust gas temperatures are substantially constant, the variation in air to fuel weight ratio is exceedingly slight and the problem of controlling this ratio is not necessarily of great importance. However, the temperature of the exhaust gases varies considerably during the warming-up period, but as this period is relatively short, the inefficiency due to the changing air to fuel weight ratio is negligible.

However, in furnaces wherein the operating temperature variation is appreciable, such as furnaces which are used for two or more heating operations requiring more than one operating temperature, the maintenance of proper air to fuel weight ratio without readjusting the burner equipment for each temperature change is of considerable importance.

By the present invention the air to fuel weight ratio remains substantially constant at all rates of firing because of the exchange of heat between the incoming fuel gas and the outgoing exhaust gases. Cooling of the exhaust gases increases the static suction of the exhaust fan, thereby permitting more air to enter the radiator tube than would be the case if the exhaust were not cooled. Heating of the fuel gas expands the same and thus compensates for the reduced volume of air that is drawn into the radiator tube, because of the decrease in static suction of the exhaust fan. Moreover since the degree to which the fuel gas is heated and therefore expanded is directly proportional to the temperature of the exhaust gases, it will be appreciated that the degree of expansion of the fuel gas is automatically controlled.

The conduit or sleeve 24 serves to provide a constricted combustion zone in which the fuel discharged therein will only partially burn due to the insufficiency of air drawn into the sleeve, the major portion of the air for combustion being drawn around the sleeve in the passage 26. As the unburned fuel leaves the sleeve 24, it slowly diffuses with the air flowing through the annular passage 26, thereby lengthening the zone of combustion. This results in an elongated and more uniform flame which provides improved

temperature distribution throughout the radiator tube.

From the foregoing it will be seen that the present invention substantially increases the heating efficiency of heating apparatus comprising a fuel fired radiator tube, also permits use of lean producer gases and blast furnace gas for higher temperature application than could normally be attained.

What I claim is:

1. In combination, a fuel-fired radiator tube, a burner firing into the intake end of said tube, a fan at the discharge end of said tube for producing a suction therethrough, and means for maintaining a substantially constant air to fuel weight ratio at the intake end of said tube comprising means for cooling the exhaust gases entering said fan whereby the static suction of said fan will remain substantially constant and simultaneously proportionally heating the fuel being supplied to said burner.

2. In combination, a fuel-fired radiator tube, a burner firing into the intake end of said tube, a fan at the discharge end of said tube for withdrawing gases of combustion therefrom and for inducing a flow of air into the intake end thereof, and means for cooling the exhaust gases before they enter said fan comprising means for heating the fuel before the same is discharged into the tube.

3. In combination, a fuel-fired radiator tube, a burner firing into the intake end of said tube, a fan at the discharge end of said tube for producing a suction therethrough, and means for maintaining a substantially constant air to fuel weight ratio at the intake end of said tube comprising means for heating the fuel proportional to the temperature of the gases of combustion discharged from said tube.

4. In combination, a furnace chamber, an internally fired tube within said chamber for producing radiant heat therein, a suction fan for withdrawing gases of combustion from said tube, means outside of said chamber for absorbing heat from said gases before they reach said fan, means for transferring the absorbed heat to a gaseous medium, and means for transferring said medium to the intake end of said tube.

WILLIAM M. HEPBURN.