July 14, 1936. W. M. HEPBURN ET AL 2,047,471

GAS-FIRED RADIATOR TUBE

Original Filed March 26, 1934

Fig. 1.

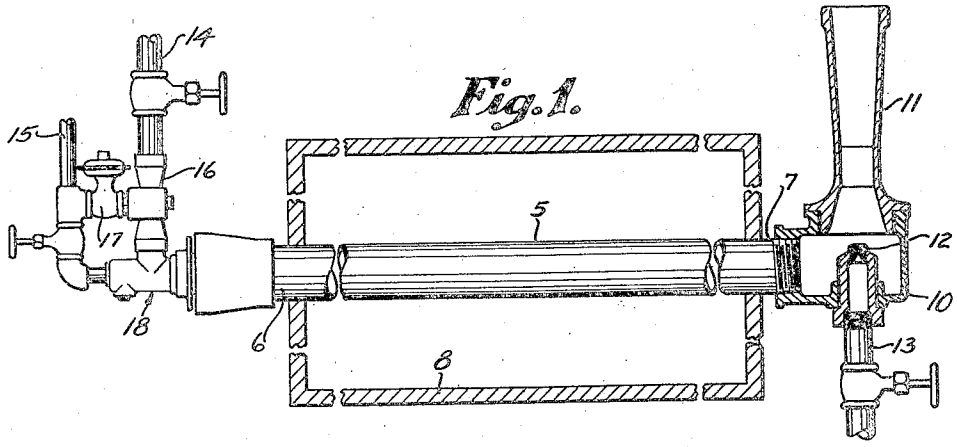


Fig. 2.

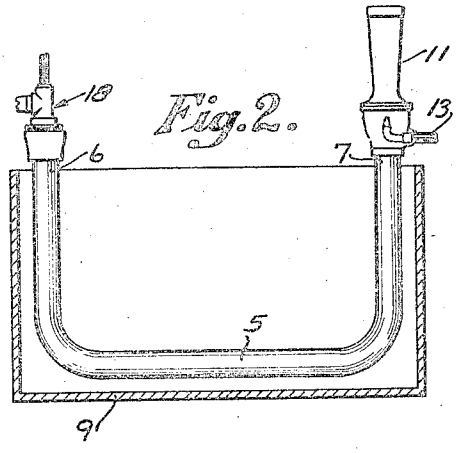


Fig. 3.

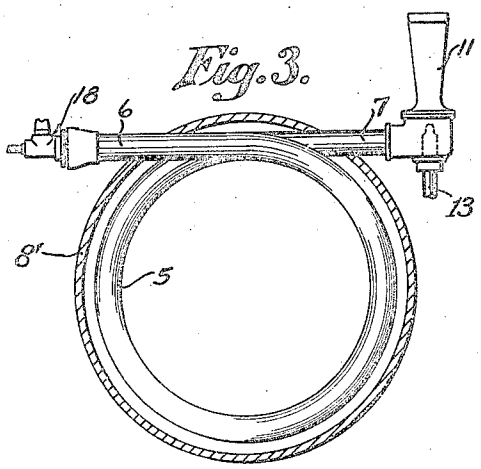
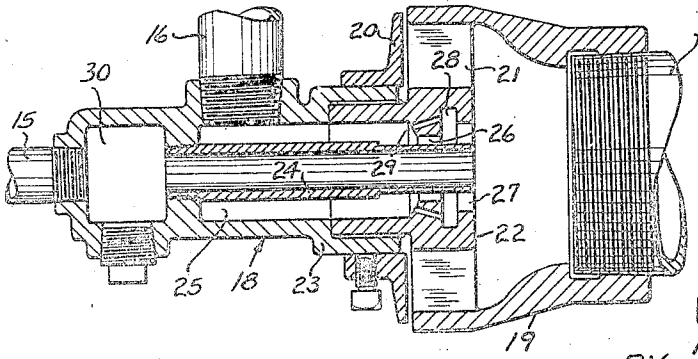


Fig. 4.



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GAS-FIRED RADIATOR TUBE

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Application March 26, 1934, Serial No. 717,460
Renewed April 8, 1936

11 Claims. (Cl. 126—91)

The present invention has for its object to provide improvements in ways and means for burning relatively large quantities of fuel in a relatively restricted combustion chamber such as a relatively long tube or conduit and in a manner to obtain uniform heating and high temperatures throughout a relatively great distance from the point where the fuel initially begins to burn.

In accordance with the present invention the fuel to be burned and its combustion-supporting air are separately flowed into one and the same end of the combustion tube; a power-operated suction-producing device is provided at the exhaust end of the tube for pulling the combustion-supporting air into the tube, and means are provided for constantly insuring ignition of the air and fuel where they initially intermix in combustible proportions.

The important advantages attained by firing the tube in the manner thus briefly indicated may be briefly stated as follows: By delivering the fuel and air to the combustion tube in separate streams combustion proceeds relatively slowly as compared with combustion of a preformed mixture of air and gas; by drawing or pulling the air into the tube both the air and the gas tend to flow in parallel streams with less turbulence than would be the case if the air were pushed or forced into the tube; by constantly insuring ignition of the air and fuel where they initially intermix in combustible proportions the rate of flow of the air and gas as a factor bearing on the problem of keeping the air and gas ignited is automatically eliminated, it being understood that in the absence of means for constantly insuring ignition the rate of flow would necessarily have to be low enough to prevent the flame from being pulled away from the discharge end of the fuel supply tube; and by utilizing a power-operated suction-producing device for pulling the air into the tube, the rate of flow of the air can be readily varied and maintained constant at any particular rate and the amount of fuel that can be burned is greatly in excess of what could be burned if ordinary stack draft were relied on to pull the combustion-supporting air into the tube.

For a more complete understanding of the invention, reference is made to the following description taken in connection with the accompanying drawing wherein the preferred form of the invention is shown.

In the drawing,—

Fig. 1 shows the radiator tube as straight throughout its length and how it may be utilized for heating a closed chamber 8, the tube being broken at two points in its length to indicate that it is of relatively great length, the mechanism at the exhaust end of the tube being in section;

Figs. 2 and 3 show how the invention may be utilized for heating a tank 9 and a circular chamber 8' respectively, and—

Fig. 4 is a sectional view of the apparatus associated with the fuel intake end of the tube.

The radiator tube is indicated at 5 and its intake and exhaust ends at 6 and 7, respectively. At the outset, it may be stated that it is quite immaterial to the present invention whether the radiator tube be straight throughout its length; but if it is not straight throughout its length, it should be straight for a substantial distance from the fuel intake end thereof in order that intermixing of the air and fuel shall not be unduly accelerated in the first portion of the tube.

Coupled to the exhaust end 7 of the radiator tube is a power-operated suction-producing device shown as comprising a chambered fitting 10, an eductor tube 11 supported by and extending from the fitting, and a jet orifice nozzle 12 positioned to discharge into the mouth of the eductor tube, air or other fluid under pressure being delivered to the nozzle 12 by a pipe 13 provided with a flow controlling valve. The means for delivering fuel to the radiator tube is generally indicated at 18 and will now be described.

Coupled to the intake end 6 of the tube 5 is a tubular fitting 19 which constitutes in effect an extension of the tube. The fuel to be burned is discharged straightforwardly into the radiator tube by a tube or conduit 24 of relatively large cross sectional area whereby relatively large volumes of fuel under moderate pressure can be discharged into the radiator tube with minimum turbulence. The fuel tube 24 is shown as leading from the chamber 30 to which fuel is supplied by a fuel supply pipe 15. The air for supporting combustion of the fuel discharged from the tube 24 enters the tubular fitting 19 through an annular passage 21 at the front end thereof, the air being drawn or pulled in by the operation of the power-operated, suction-producing device at the exhaust end of the radiator tube. In view of the fact that the air and fuel are separately introduced into the radiator tube, and in further view of the fact that the air is pulled into the tube and in further view of the fact that the cross sectional area of the radiator tube is relatively restricted where the fuel and air initially intermix in combustible proportions, it is essential to

the successful operation of the apparatus that means be provided for constantly insuring ignition of the air and fuel where they initially intermix in combustible proportions.

In accordance with the present invention, ignition of the air and fuel, where they initially intermix in combustible proportions, is effected by discharging between the air and fuel a burning stream of combustible mixture, the mixture being discharged from an annular passage 26 around the fuel tube 24 inwardly of the discharge end of the latter; and ignition of the combustible mixture is constantly insured by maintaining a ring of flame in an annular combustion groove 28 at the discharge side of the passage 26, this ring of flame being produced by discharging combustible mixture from a plurality of discharge orifices 29 which deliver into the combustion groove 28, a mixture supply chamber being indicated at 25. The outlet from the combustion groove 28 is an annular passage 27 around the discharge end of the fuel tube 24. The combustion groove 28 and orifices 29 are preferably formed in a hub 22 which is integral with the tubular fitting 18. The hub is extended outwardly in the form of a sleeve and detachably mounted on this sleeve is a body 23 which cooperates with the sleeve to form the mixture supply chamber 25. Mounted on the body 23 is an air shutter 20 which is adjustable to control the effective inlet area of the air passage 21.

The means for delivering combustible mixture to the chamber 25 may be of any preferred form and as shown in Fig. 1 comprises a mixing device 16 to which air is delivered by a pipe 14 and to which gas is delivered by a pressure regulator 17 shown as connected at its inlet end to the fuel supply pipe 15. Mixing apparatus of this type is well known in the art and, therefore, need not be further described.

A radiator tube fired in accordance with the present invention has wide utility in industrial heating operations and marks an important improvement in the art of burning fluid fuel.

What is claimed is:

1. The combination of a heat-radiating tube, and means for internally firing the tube comprising: means for flowing a stream of fuel gas as a core into one end of the tube, means for flowing a burning stream of combustible mixture into the same end of the tube as a sheath around said stream of fuel gas, and power-operated suction producing means for drawing combustion supporting air into the tube as a sheath around the burning combustible mixture.

2. The combination of a heat-radiating tube, and means for internally firing the tube comprising: means for flowing a stream of fuel gas as a core into one end of the tube, means for flowing a stream of burning combustible mixture into the same end of the tube as a sheath around said stream of fuel gas, and means including entraining apparatus at the other end of the tube for drawing combustion supporting air into the fuel intake end of the tube as a sheath around the burning combustible mixture.

3. In apparatus of the class described, the combination of a relatively long tubular conduit open at both ends to the open air, means including a tube having its outlet inside of one end of said conduit for delivering to the conduit a stream of fluid fuel in greater volume than could be burned with natural draft through the conduit, a power-operated suction-producing device forming part of the discharge end of said conduit for positively pulling into the fuel intake end of the conduit the required amount of air for supporting proper combustion of the fuel, and means surrounding said tube for constantly insuring ignition of the fuel and induced air where they initially intermix in combustible proportions.

4. In apparatus of the class described, the combination of a relatively long tubular conduit open at both ends to the open air, means including a tube having its outlet inside of one end of said conduit for delivering to the conduit a stream of fluid fuel in greater volume than could be burned with natural draft through the conduit, a power-operated suction-producing device forming part of the discharge end of said conduit for positively pulling into the fuel intake end of the conduit the required amount of air for supporting proper combustion of the fuel, and means at the fuel intake end of the conduit for discharging flaming gases between the respective air and fuel streams to constantly insure ignition thereof where they initially intermix in combustible proportions.

5. In apparatus of the class described, the combination of a relatively long tubular conduit open at both ends to the open air, means including a tube for delivering to the conduit a stream of fluid fuel in greater volume than could be burned with natural draft through the conduit, a power-operated suction-producing device forming part of the discharge end of said conduit for positively pulling into the fuel intake end of the conduit the required amount of air for supporting proper combustion of the fuel, and means surrounding said tube for constantly insuring ignition of the fuel and induced air where they initially intermix in combustible proportions.

6. In apparatus of the class described, the combination of a relatively long conduit; means for effecting the entrance into said conduit at the intake end thereof of substantially non-turbulent streams of combustion supporting air and gas whereby combustion is substantially dependent upon the inter-diffusion of said streams; and means effective between said streams, operable independently of said streams, and arranged to continuously create a zone of ignition extending therebetween.

7. In combination, a radiator tube, and means for burning a greater volume of fuel therein than could be burned with natural draft through the tube comprising: suction-producing means coupled to the exhaust end of the tube for inducing combustion supporting air to enter the intake end of the tube, means at the intake end of the tube for discharging the fuel thereinto in the form of a stream which tends to maintain its integrity for a substantial distance from its point of discharge from said means, and igniting means continuously operable independently of said fuel and air to create a zone of ignition extending lengthwise from adjacent the inlet end of said tube, thereby constantly insuring ignition of the fuel and induced air as and when they initially intermix in combustible proportions.

8. In combination, a radiator tube, and means for burning a greater volume of fuel therein than could be burned with natural draft through the tube comprising: suction-producing means coupled to the exhaust end of the tube for inducing combustion supporting air to enter the intake end of the tube, means at the intake end of the tube for discharging the fuel thereinto in the form of a stream which tends to maintain its

integrity for a substantial distance from its point of discharge from said means, and igniting means continuously operable independently of said fuel and air to create a zone of ignition extending lengthwise from adjacent the inlet end of said tube, thereby constantly insuring ignition of the fuel and induced air as and when they initially intermix in combustion proportions, said igniting means including a recess in which flame is maintained, and an outlet for said recess from which flaming gases are drawn forwardly to form the zone of ignition.

9. The combination with a radiator tube whose length is many times greater than its diameter and whose diameter is small enough to permit the tube to be utilized either as a straight or bent heating element in a heating chamber, of means for internally firing the tube in a manner to produce delayed combustion therein comprising means for releasing unignited gaseous fuel adjacent the intake end of the tube as a stream which tends to maintain its stream integrity for a substantial distance from its point of release in the tube, regulable means for producing a negative pressure at the discharge end of the tube to cause air at atmospheric pressure at the intake end of the tube to flow thereinto and to flow along with the fuel to support combustion thereof, and a continuously operable igniter adjacent the intake end of the tube for continuously igniting the incoming fuel as it intermixes with the incoming air.

10. The combination with a radiator tube whose length is many times greater than its diameter and whose diameter is small enough to permit the tube to be utilized either as a straight or bent heating element in a heating chamber, of means for internally firing the tube in a manner to produce delayed combustion therein comprising means for releasing unignited gaseous fuel adjacent the intake end of the tube as a stream which tends to maintain its stream integrity for a substantial distance from its point of release in the tube, regulable means for producing a negative pressure at the discharge end of the tube to cause air at atmospheric pressure at the intake end of the tube to flow thereinto and to flow along with the fuel to support combustion thereof, and a continuously operable igniter adjacent the intake end of the tube for continuously igniting the incoming fuel as it intermixes with the incoming air, said igniter comprising means for burning an explosive mixture of fuel and air.

11. The combination with a radiator tube whose length is many times greater than its diameter and whose diameter is small enough to permit the tube to be utilized either as a straight or bent heating element in a heating chamber, of means for internally firing the tube in a manner to produce delayed combustion therein comprising means for releasing unignited gaseous fuel adjacent the intake end of the tube as a stream which tends to maintain its stream integrity for a substantial distance from its point of release in the tube, regulable means for producing a negative pressure at the discharge end of the tube to cause air at atmospheric pressure at the intake end of the tube to flow thereinto and to flow along with the fuel to support combustion thereof, and a continuously operable igniter adjacent the intake end of the tube for continuously igniting the incoming fuel as it intermixes with the incoming air, said igniter comprising means for discharging explosive mixture in the same direction of flow as said fuel.

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