June 21, 1960 D. B. SPALDING 2,941,361

COMBUSTION APPARATUS HAVING A FLAME STABILIZING BAFFLE

Filed Oct. 12, 1953

3 Sheets-Sheet 1

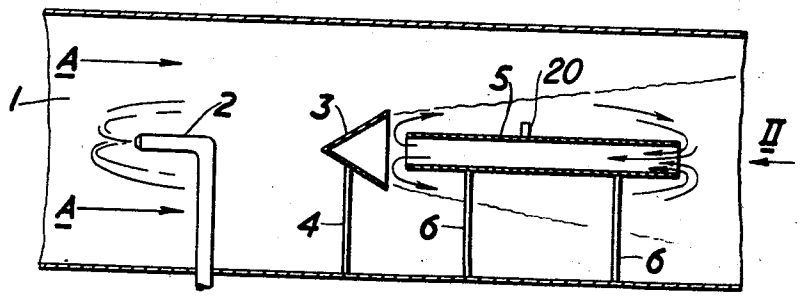


FIG. 1.

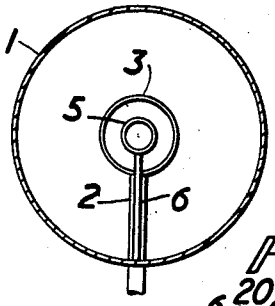


FIG. 2.

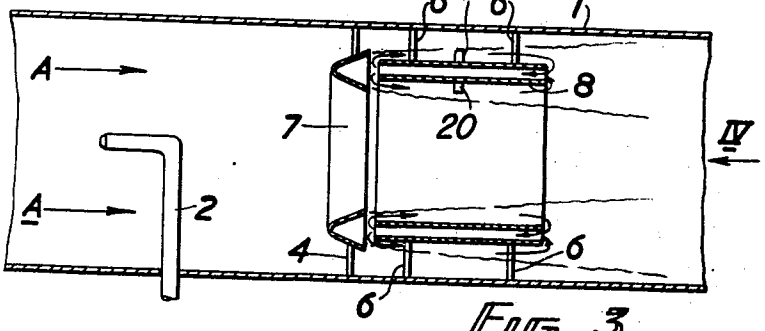


FIG. 3.

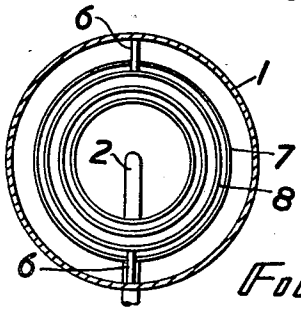


FIG. 4.

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3 Sheets-Sheet 2

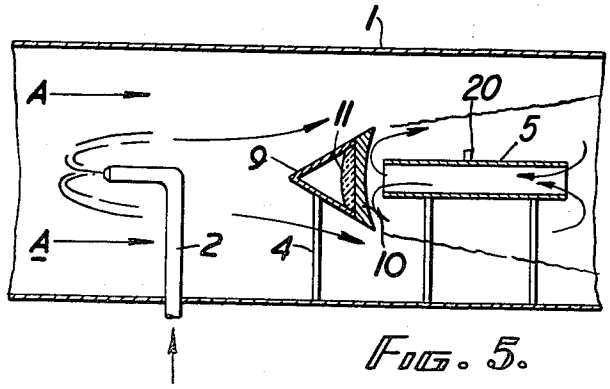


FIG. 5.

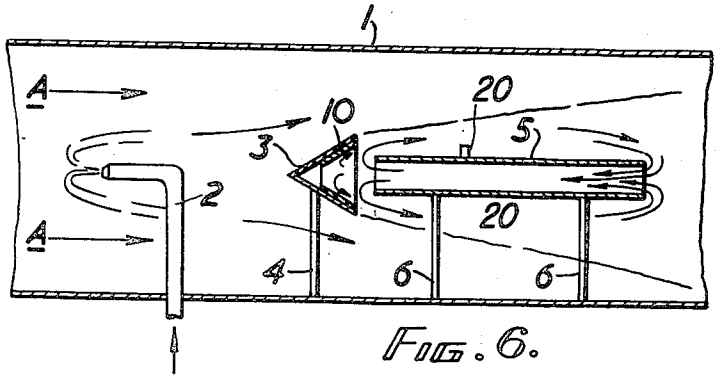


FIG. 6.

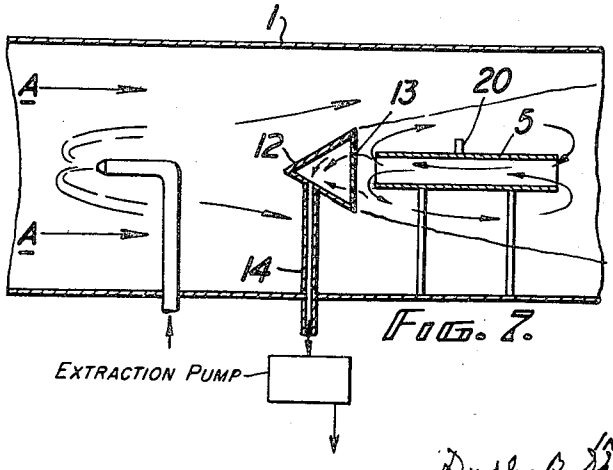


FIG. 7.

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June 21, 1960 D. B. SPALDING 2,941,361

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3 Sheets-Sheet 3

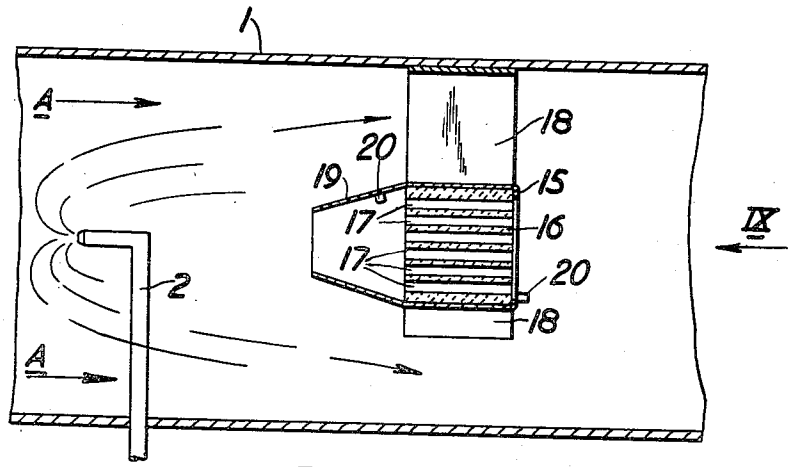


FIG. 8.

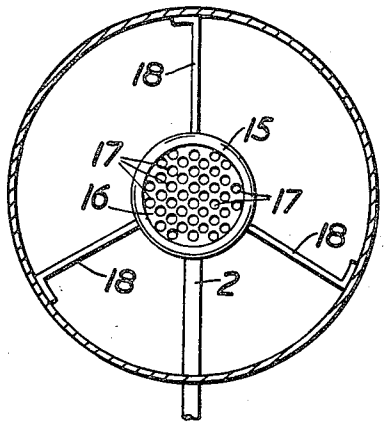


FIG. 9.

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COMBUSTION APPARATUS HAVING A FLAME STABILIZING BAFFLE

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3 Claims. (Cl. 60—39.72)

The invention relates to equipment for burning vaporific fuel in a ducted stream of combustion-supporting gas and is particularly applicable in circumstances where the velocity of the gas stream is high, as in the case of continuous combution gas turbine plant for example.

In combustion systems for such plants it has been previously proposed to place a baffle in the stream in the wake of which the gases have a recirculating motion. Fuel is burnt in the wake of the baffle and the flame there is stabilized because the recirculation draws hot burnt gases upstream to mix with and ignite the unburnt fuel and air flowing around the baffle edge. If the recirculating gases are insufficiently hot to cause sufficient fresh reaction for the supply of such recirculating gases to be maintained, then the flame would be extinguished. Extinction is aided by a high velocity gas stream, by small baffle dimensions and by unduly low temperatures and pressures. An object of the present invention is to arrange the combustion system in such manner that flames are less easily extinguished than heretofore.

Broadly stated, the present invention provides a combustion system for burning vaporific fuel in a ducted stream of fast moving combustion-supporting gas comprising a duct defining a path for the said gas stream, a flame-stabilizing baffle positioned in the duct, means for introducing fuel into the duct for combustion in the gas stream, and means for encouraging the complete combustion, in a sheltered region afforded by the baffle, of some of the said gas before that gas comes into contact with unburnt gas which has flowed past the baffle.

According to one aspect of the invention the baffle is so shaped and positioned in the duct that some of the gas flowing past the baffle is recirculated in the wake thereof to form the aforesaid sheltered region. The aforesaid means for encouraging complete combustion may be constituted by an open-ended tube extending lengthwise in the wake of the baffle and so positioned that burnt gas is recirculated through the tube from a downstream part of the combustion zone to an upstream part near the baffle. This tube discourages the recirculation of incompletely burnt gases by virtue of the position of its downstream end and therefore tends to ensure that only burnt gas comes into contact with unburnt gas which has flowed past the baffle. Alternatively or additionally to the inclusion of the aforesaid tube, the downstream surface of the baffle may be catalytic, the catalyst causing partly burnt recirculated gas to complete its combustion at the said surface before the partly burnt gas comes into contact with unburnt gas which has flowed past the baffle. Following the recirculation of the burnt gas and its mixing with unburnt gas which has flowed past the baffle, it is desirable that ignition should occur; but it is possible that the baffle may have chilled the recirculated burnt gas, thereby preventing ignition. According to an embodiment of the invention, therefore, means are provided for extracting from the system the surface layer of burnt gas contacting the downstream surface of the baffle. The baffle may be hollow and the downstream surface thereof porous or

apertured and means may be provided for extracting by suction recirculated gas in contact with the said surface through the pores or apertures therein.

According to another aspect of the invention the baffle comprises an open-ended tube extending lengthwise of the duct, the inside thereof constituting the aforesaid sheltered region and an insert of refractory material contained within the tube, the insert presenting a large surface area to gas flowing through the tube for encouraging the complete combustion of the said gas, the burnt products passing from the downstream end of the tube and there mixing with and igniting the unburnt gas which has passed around the outside of the tube. The refractory insert may be impregnated with a catalyst such as platinum or palladium and may be a single body of a porous nature or having a plurality of lengthwise extending throughways.

By way of example, several embodiments of the invention will now be described with reference to the accompanying drawings in which:

Figure 1 is a longitudinal sectional view of the duct showing one embodiment of the invention.

Figure 2 is a sectional view of Figure 1 in the direction of arrow II,

Figure 3 is a view similar to Figure 1 showing a modification of the embodiment,

Figure 4 is a sectional view of Figure 3 in the direction of arrow IV,

Figure 5 is a longitudinal sectional view of the duct showing another embodiment of the invention,

Figure 6 is a longitudinal sectional view of the duct showing a combination of the embodiments shown in Figures 1 and 5,

Figure 7 is a longitudinal sectional view of the duct showing another embodiment of the invention,

Figure 8 is a longitudinal sectional view of the duct showing yet another embodiment of the invention, and

Figure 9 is a sectional view of Figure 8 in the direction of arrow IX.

Considering firstly the embodiment shown in Figures 1 and 2, **1** denotes the duct through which a fast moving stream of combustion-supporting gas e.g. air is passing, the direction of flow being in the direction of arrows A. Fuel is injected into the air stream in an upstream direction by means of fuel nozzle **2**. The fuel is carried by the gas stream in droplet form into the region of combustion immediately downstream of a baffle **3**. The baffle **3** is of conical form and has its apex pointing upstream and is hollow. **4** denotes a support for the baffle. The baffle is so shaped that air flowing over the surface of the baffle is little disturbed and a relatively stable and sheltered region in which recirculation of the air occurs is produced in the wake of the baffle, where it is ignited by igintion means **20**, combustion occurring in this region. An open-ended tube **5** is mounted axially of the duct **1** on support members **6** with its upstream end in the vicinity of the baffle **3**. The tube **5** is of such a length that the downstream end is in a part of the combustion region in which combustion is substantially complete. In the arrangement shown in Figures 1 and 2 the tube **5** is so positioned that the recirculated gas is encouraged to flow through the tube **5**, the gas entering at the downstream end of tubes **5** and re-emerging at the upstream end of the tube where it mixes with unburnt air/fuel mixture which has flowed around the outside of baffle **3**. By positioning the tube **5** so that the downstream end is in the region where the combustion is substantially complete only burnt gas is recirculated through the tube. This embodiment including the baffle and the tube therefore tends to ensure that only substantially completely burnt gases mix with the fresh unburnt air/fuel mixture.

In the modification shown in Figures 3 and 4 the baffle is of annular form instead of conical form and similarly

the tube is also annular. In Figures 3 and 5, reference numeral 7 denotes the baffle and 8 denotes the tube. The other reference numerals used are the same as those used in Figures 1 and 2. The arrangement of baffle 7 and tube 8 in the duct 1 and the operation of this system are similar to those described in Figures 1 and 2.

Figure 5 shows another embodiment of the invention. In this embodiment 9 represents another conical-shaped baffle causing recirculation of the air stream thereby forming a combustion region in its wake. The baffle is positioned with its apex directed upstream and is supported on a support 4. The downstream surface 10 of the baffle, that is that surface in contact with the recirculated gases, is catalytic. The catalyst employed is a refractory material impregnated with, for example, platinum or palladium. The catalyst is not placed in immediate contact with the baffle but is separated therefrom by a thermally insulating layer 11. Any partially burnt gases which are recirculated by the baffle 9 are encouraged to become completely burnt during their passage over the catalytic surface 10, so that the recirculated gases are substantially completely burnt by the time they come into contact with fresh unburnt air/fuel mixture which has flowed around the outer surface of the baffle.

The embodiment of the invention shown in Figure 6 is a combination of the arrangements of Figures 1 and 5, the conical baffle 3 of Figure 1 having a catalytic surface 10 on its downstream face. The catalyst may cover the whole of the downstream surface or, as shown in Figure 6, only that part of the surface which is likely to be swept by gases recirculated from tube 5. The catalyst should be separated from the baffle by a thermally insulated layer as in Figure 5; but for the sake of simplicity this layer has not been shown in Figure 6. The arrangement of Figure 6 ensures that should any partially burnt gases be recirculated through tube 5, the catalytic surface 10 will encourage the complete combustion of those gases before they come into contact with fresh unburnt air/fuel mixture flowing around the baffle 3.

In the embodiment shown in Figure 7 the baffle 12 is of a hollow conical form, the apex of the cone being directed in the upstream direction. The baffle is closed on its downstream side by a perforated or porous wall 13. A pipe 14 connects the inside of the baffle to an extraction pump mounted outside the duct 1. As shown, this pipe 14 also constitutes the support for the baffle. By this arrangement the layer of recirculated gases adjacent the downstream wall 13 of the baffle may be sucked away through the wall 13 and the hollow baffle and the pipe 14. This is done because this layer may have been cooled by the baffle, thereby reducing the capability of igniting the unburnt gas. The hollow baffle arrangement shown in Figure 7 may be employed with the tube 5.

In the embodiments shown in Figures 5 and 7 an annular baffle may be employed.

In the embodiments shown in Figures 8 and 9 a baffle producing recirculation of the type previously described is not employed. Instead, a different form is shown in which the baffle comprises an open-ended tube 15 through which part of the air/fuel mixture flows, the remainder flowing around the outside of the tube. Within the tube there in an insert made of a refractory material impregnated with a catalyst, for example, platinum or palladium; the insert 16 has a large number of longitudinally extending throughways 17 for the passage of the air/fuel mixture. These throughways constitute a sheltered region in which complete combustion of the gas flowing through the tube 15 is encouraged by the catalyst. The tube 15 is supported by legs 18 and has an extension 19 in the upstream direction, this extension being tapered inwardly to increase the shelter afforded by the baffle. This embodiment tends to ensure that gases which flow through the tube 15 are completely burnt by the time they re-emerge and mix with the air/fuel flow around the outside of the baffle. The hot gases emerging from the tube 15 ignite the fresh air/fuel stream which has flowed past the baffle. The refractory insert radiates heat to the walls of the tube thereby providing a means for preheating the fresh air/fuel mixture passing over the outside of the baffle.

Instead of having throughways 17, the insert may be in the form of a porous refractory mass the gas flow occurring through the pores. Alternatively, the tube may be filled with refractory granules or with a bundle of small diameter tubes of this material. Although the insert described is constructed from a refractory material impregnated with a catalytic substance, it may be constructed from a refractory material that has not been impregnated with a catalyst; provided, of course, that conditions are such that the insert alone encourages complete combustion.

What I claim is:

1. A combustion apparatus for burning vaporific fuel in a stream of fast-moving combustion-supporting gas comprising a duct defining a path for the said stream, a flame-stabilizing baffle or conical shape positioned in the said duct with the apex of the cone directed upstream, a combustion region immediately downstream of the said baffle, the said baffle producing turbulence of the said stream in the said combustion region, fuel supply means in the said duct for supplying fuel to the said combustion region, ignition means in the said combustion region and a cylindrical, continuous gas recirculating tube positioned within the duct longitudinally thereof, the said tube being open at each end, of diameter smaller than that of the downstream end of the said baffle and of length at least substantially the length of the combustion region, the upstream end of the said tube being just downstream of the baffle.

2. A combustion apparatus for burning vaporific fuel in a stream of fast-moving combustion-supporting gas comprising a duct defining a path for the said stream, a flame-stabilizing baffle positioned in the said duct, a combustion region immediately downstream of the said baffle, the said baffle producing turbulence of the said stream in the said combustion region, means for extracting from the duct a layer of gas immediately adjacent the downstream surface of the baffle, fuel supply means in the said duct for supplying fuel to the said combustion region, ignition means in the said combustion region and a continuous tube positioned within the duct longitudinally thereof, the said tube being open at each end and of length at least substantially the length of the combustion region, the upstream end of the said tube being just downstream of the baffle and wholly within the wake thereof.

3. A combustion apparatus for burning vaporific fuel in a stream of fast-moving combustion-supporting gas comprising a duct defining a path for the said stream, a flame-stabilizing baffle of open conical shape positioned in the said duct with the apex of the cone directed upstream, a combustion region immediately downstream of the said baffle, the said baffle producing turbulence of the said stream in the said combustion region, a permeable plate closing the otherwise open downstream end of the said baffle, pipe means connecting the interior of the baffle to a region externally of the duct, means connected to the said pipe means for extracting from the duct gas which has passed through the said permeable plate from the said combustion region, fuel supply means in the said duct for supplying fuel to the said combustion region, ignition means in the said combustion region and a cylindrical tube positioned within the duct longitudinally thereof, the said tube being open at each end, of diameter smaller than that of the downstream end of the said baffle and of length at least substantially

the length of the combustion region, the upstream end of the said tube being just downstream of the baffle.

References Cited in the file of this patent

UNITED STATES PATENTS

421,477	Beckfeld et al.	Feb. 18, 1890
1,047,152	Benedict	Dec. 17, 1912
1,839,880	Hyatt	Jan. 5, 1932
2,546,432	Darling	Mar. 27, 1951
2,548,087	Williams	Apr. 10, 1951
2,592,110	Berggren et al.	Apr. 8, 1952
2,622,396	Clarke et al.	Dec. 23, 1952
2,657,532	Reid et al.	Nov. 3, 1953
2,679,137	Probert	May 25, 1954
2,734,560	Harris et al.	Feb. 14, 1956

FOREIGN PATENTS

483,784	Canada	June 3, 1952