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COATED FLAME HOLDER FOR JET ENGINES

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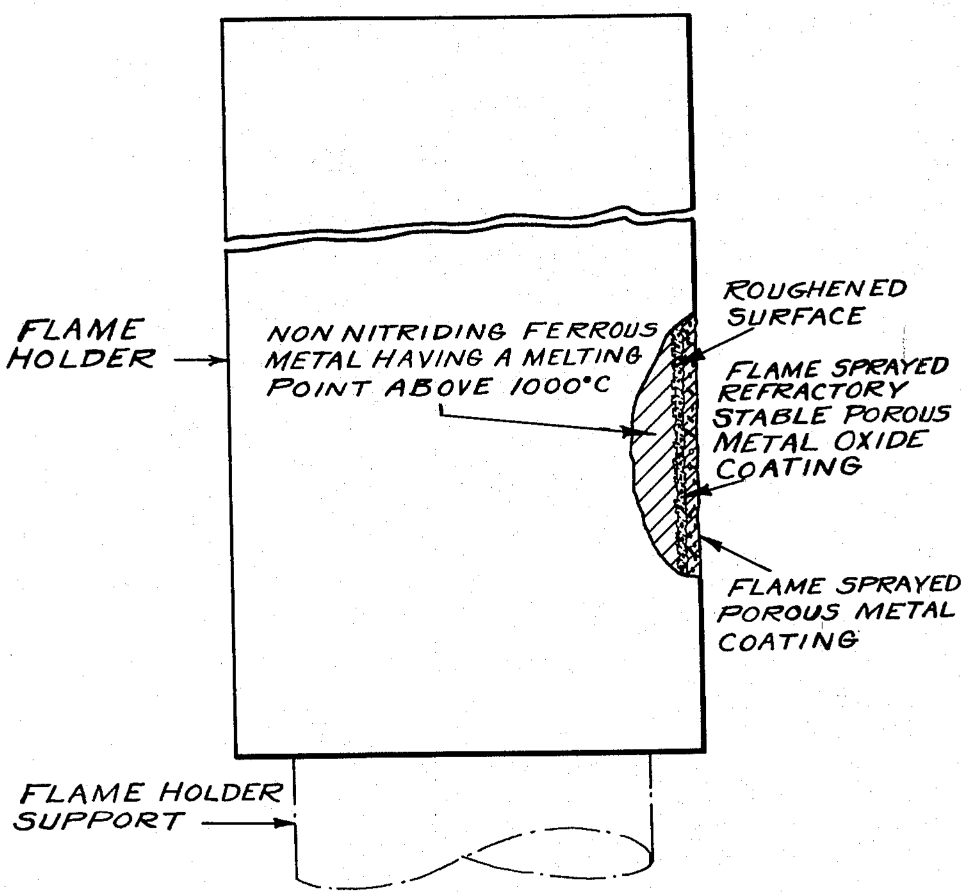

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1

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COATED FLAME HOLDER FOR JET ENGINES

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1 Claim. (Cl. 117—46)

The invention relates to flame holders for jet engines for use in the combustion chambers which hold the flame by catalytic action, relighting the flame if it dies and doing so in a very small fraction of a second. These are vital to jet engines which would frequently fail if not provided with flame holders. This application is based upon my British complete specification No. 39,045, filed December 16, 1957.

One object of the invention is to provide a more reliable flame holder, since jet engines still occassionally fail and present holders can be improved. Another object is to achieve the above object with economy so that the holders cost little more, or no more or even less than present holders which is a matter not yet fully determined.

Another object is to provide more reliable flame holders at a cost, for flame holders over a period of time for a given engine not much more or the same or even less than the cost of providing and replacing present flame holders. This also has not been fully determined yet, but naturally if a jet airplane is saved by the use of a superior flame holder, a considerable increase in the cost of flame holders can be easily tolerated especially as lives may also be saved.

Another object of the invention is to provide flame holders for use in the combustion chambers of jet engines and otherwise (herein flame holder includes flame reigniter) which resist the erosion of the jet producing flame in the combustion chambers better than other flame holders and which are satisfactory in other respects. Not only is the flame of combustion in a jet engine very hot but the gases are travelling at very high speeds.

Other objects will be in part obvious or in part pointed out hereinafter.

A typical structure embodying the invention is shown in the drawings.

As conducive to a better understanding of the present invention, a typical flame holder now in use will be described. It is a sleeve of platinum, two and one-half inches long, three-eighths of an inch in outside diameter, with a wall thickness of one-sixteenth of an inch and therefore with a bore of one-quarter of an inch. These flame holders are mounted upon steel studs in the combustion chambers of jet engines. Stainless steel studs are usually used.

For my flame holder, for brevity, I shall describe articles of the same geometry for the basic part made of metal. In compliance with the statute the following description represents the best mode of the invention now known to me. I provide a sleeve of the above shape and size but made of stainless steel, but it can be made of any other metal with a melting point above the combustion temperature of the fuel, which is about 1000° C.

The conditions in the combustion chamber are not oxidizing but they are nitriding so metals which readily nitride are excluded, such as Ti, Zr, Hf, V, Nb, Ta, Cr, Mo and W. This leaves all steels and irons. These can be called the ferrous metals with melting point of not less than 1000° C. Any iron alloy of those characteristics can be used but commercial stainless steel is the best one now known to me. This is 18% chromium and 8% nickel, the balance iron except for about .5% of carbon. This has a high specific heat which is desirable. Platinum family metal and also gold can be used, the

2

former would give added safety although expensive, and the latter might be used to avoid infringement if not covered. So the metal is any non-nitriding metal having a melting point above 1000° C. The above metals Ti, Zr, etc. are the only nitriding metals for this definition.

This sleeve is then sand blasted on the outside. Sand blasting is now better accomplished with fused aluminum oxide grain and a good grit size and the best one known to me for the job is 24 grit size of sharp grain configuration. 24 grit size is also called 24 mesh size. Sand blasting technique is well known and therefore need not be described. This leaves a roughened reentrant angle surface on the sleeve.

Now the sleeve is coated with refractory stable metal oxide in accordance with the teachings of the U.S. patent to Wheildon, No. 2,707,691, of May 3, 1955. Wheildon defines exactly what he means by refractory stable metal oxide in this patent and I can use any within the definition of the patent. The metal oxide is applied, according to the Wheildon patent, by fusing, atomizing and spraying it with a hot flame and a blast of compressed air using a flame spraying gun the genesis of which is found in U.S. patent to Erika Morf, No. 1,100,602, of June 16, 1914. As taught in the Wheildon patent a flame of acetylene burning in oxygen is preferred because it is very hot. This is frequently called an oxy-acetylene flame.

Specifically for the best embodiment of the invention, I use sintered fused alumina rods for the coating. These are simply alpha aluminum oxide, Al_2O_3, also called alumina, rods which produce a coating of gamma alumina when flame sprayed in accordance with the Wheildon patent. This coating of gamma alumina is stronger and less porous than the coating of zirconia flame sprayed in accordance with the Wheildon patent which is the second preferred coating.

In the best embodiment of the invention that I know, the coating of refractory stable metal oxide should be about .010″ thick but this is not critical at all and thinner and thicker coatings can be provided. While aluminum oxide has a higher specific heat than does steel, it has a lower specific gravity, and the sprayed coating described is also porous, so more thermal units can be included in a given volume of steel than in a given volume of aluminum oxide coating and the same is true for steel compared to other stable metal oxides. Therefore a thin coating which is however thick enough to provide anchorage to the stainless steel and to provide good anchorage for the platinum is the best embodiment.

I now flame spray the stable metal oxide coated steel sleeve with platinum family metal. This can be done by providing platinum wire for use in a flame spraying gun as described in the Morf patent. Most guns take ⅛″ diameter wire. There are many other patents on flame spraying guns and they can be procured on the open market. An oxy-acetylene flame is also the best one for spraying platinum. In the preferred embodiment of the invention for the best mode, commercial platinum is used because it is quite satisfactory. This has minor proportions of the other metals of the platinum family which are ruthenium, rhodium, palladium, osmium and iridium. These metals are highly catalytic for holding the flame in jet engine combustion chambers and any alloy of platinum family metal can be used, but there is no advantage in selecting rare ones and no advantage that I know of in using anything other than commercial platinum which has a minor proportion, less than 5%, of some or all of the other metals.

Enough experience has not yet been gained to say what is the best thickness for the coating of platinum family metal. It will depend upon many factors. Too little would burn out too soon and too much might be wasteful. The best estimate that I can make is that the coating should be about .07″ thick. It will be remembered that the wall thickness of the platinum sleeve replaced was .0625″ thick. As the coating is porous, an equivalent mass is roughly .07″ thick and this is therefore the preferred thickness. I am unable to give a minimum or a maximum thickness for this coating. However, as a practical matter .005″ would seem to be the minimum thickness and I cannot see why a coating of more than one-half inch thick would be wanted. However, in the future these flame holders may be much larger than they are now.

I also cannot give a range for the thickness of the metal oxide coating but it seems it should be at least .001″ thick and it would seem to be unnecessary to make it more than one quarter inch thick. The chief function of this coating is to provide an excellent anchorage for the platinum family metal.

There is no reason why the flame holder has to be a sleeve since it is not made of platinum. It could be a stud of ferrous metal, a bolt of ferrous metal, a screw of ferrous metal, or any irregular body of ferrous metal with provision for securing it in place in the combustion chamber.

The only way to describe the physical characteristics of the coatings is to say that they are flame sprayed in situ. They can be produced, each of them, by fusing, atomizing and spraying powder as well as by fusing, atomizing and spraying rods or wire. The platinum family metal coating can be produced by flame spraying molten platinum.

In bench tests of a jet engine a flame holder according to the invention was found to be superior to standard flame holders for reignition of the flame which was deliberately put out for testing. Indications were that flame holders according to the invention will resist erosion better than solid platinum flame holders. This is surprising because the platinum surface in the flame holder of the present invention is porous. However, apparently the reason for the superiority is that the flame sprayed platinum does not have insipient crystallization.

It will thus be seen that there has been provided by this invention a flame holder for jet engines in accordance with which the various objects hereinabove set forth together with many thoroughly practical advantages are successfully achieved. As many possible embodiments may be made of the above invention and as many changes might be made in the embodiment above set forth, it is to be understood that all matter hereinbefore set forth is to be interpreted as illustrative and not in a limiting sense.

I claim:

A flame holder for jet engines consisting of a body of non-nitriding ferrous metal having a melting point above 1000° C., said body having a roughened surface, a porous coating at least .001″ thick of refractory stable metal oxide flame sprayed in situ interlocked with said roughened surface, and integral with said body, said coating being selected from the group consisting of alumina and zirconia, a surface coating at least .005″ thick of platinum family metal flame sprayed in situ upon and interlocked with the surface of the coating of refractory stable metal oxide and integral with the said coating of refractory stable metal oxide, said platinum family metal coating being also porous, whereby the intermediate refractory metal oxide coating anchors the ferrous metal to the surface coating of platinum family metal.

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