Preferred embodiments of the present invention seek to overcome the above described disadvantages of the prior art.

According to an first aspect of the present invention, there is provided a nozzle for a HVOF thermal spray gun, the nozzle comprising:-

at least one combustion chamber having at least one fuel inlet for receiving at least one fuel, at least one combustion zone within which combustion of said at least one fuel takes place to produce a stream of combustion gases and at least one exhaust for exhausting said stream of combustion gases; and

diverging means, located at least partially within said combustion chamber, for creating a divergence in said stream of combustion gases thereby creating a plurality of streams or an annular stream before converging to a single stream wherein said diverging means further comprises at least one coating material inlet for introducing at least one coating material into said stream of said combustion gases at a most downstream point of said diverging means in said stream characterised in that said diverging means extends at least partially outside said combustion chamber through said exhaust.

Also disclosed is a nozzle for a thermal spray gun, the nozzle comprising:-

at least one combustion chamber having at least one fuel inlet for receiving at least one fuel, at least one combustion zone within which combustion of said at least one fuel takes place to produce a stream of combustion gases and at least one exhaust for exhausting said stream of combustion gases; and

diverging means, located at least partially within said combustion chamber, for creating a divergence in said stream of combustion gases thereby creating a plurality of streams or an annular stream before converging to a single stream.

By creating a divergence in the stream of combustion gases, which then recombine into a single stream, a number of advantages are provided. Firstly, the nozzle of the present invention generates a more stable supersonic jet which reaches a higher axial velocity (around 2 mach) and is maintained for longer than in devices of the prior art under the same conditions of oxygen/fuel mixture and mass flow rate. The device of the present invention also reduces the trailing shock waves (diamond shock waves seen in the prior art jet) thereby reducing the loss of energy/temperature of the powder particles. This results in a single expansion of the flow, just after the tip of the diverging means, reducing the loss of energy. As a result, of the increased stability of the jet, the barrel portion of the nozzle is not necessary and can be eliminated. The overall length of the nozzle is therefore reduced allowing spraying of previously inaccessible surfaces, for example, internal surfaces of components.

Furthermore, because a divergence is created in the combustion gas stream, either producing two or more linear gas streams with the diverging means between them or an annular stream with the diverging means at the centre, the coating material can be introduced within the gap or divergence created in the stream by the divergence means. As a result, the coating material is never in contact with the fuel and oxygen mixture and is only in contact with the combusted gases once combustion is complete. As a result, the risk of oxidation of the coating material is reduced. This risk of oxidation is further

In another preferred embodiment, the exhaust comprises a plurality of substantially linear apertures extending between said combustion chamber and said diverging means.

In a further preferred embodiment, the diverging means extends at least partially outside said combustion chamber through said exhaust.

According to a~~nother~~ second aspect of the present invention, there is provided an HVOF thermal spray gun comprising:-

at least one nozzle substantially as set out according to the first aspect of the present invention~~above~~;

fuel supply means for supplying fuel to at least one said fuel inlet; and

coating material supply means for supplying coating material to said coating material inlet.

In a preferred embodiment, the spray gun is a high velocity oxygen fuel spray gun.

According to a ~~further~~third aspect of the present invention, there is provided a HVOF method of applying a coating material on an object, comprising the steps of:-

introducing at least one fuel into a combustion chamber of a nozzle of a thermal spray gun and combusting said fuel to produce combustion gases that form a stream of gases within said combustion chamber towards an exhaust;

diverging said stream around at least one diverging device thereby creating a plurality of streams into a plurality of streams or an annular stream before converging said streams to a single stream;

introducing at least one coating material into said stream through at least one coating material inlet at a most downstream point of said diverging device and spraying said material onto an object characterised in that at least one said diverging device extends at least partially outside said combustion chamber through said exhaust.

Also disclosed is a method of applying a coating material on an object, comprising the steps of:-

introducing at least one fuel into a combustion chamber of a nozzle of a thermal spray gun and combusting said fuel to produce combustion gases that form a stream of gases within said combustion chamber towards an exhaust;

diverging said stream around at least one diverging device thereby creating a plurality of streams into a plurality of streams or an annular stream before converging said streams to a single stream;

introducing at least one coating material into said stream and spraying said material onto an object.

In a preferred embodiment, the at least one coating material is introduced into said streams in the space between a plurality of diverged streams or in the centre of the annular stream.

Claims

1. A nozzle for a thermal spray gun, the nozzle comprising:-

at least one combustion chamber having at least one fuel inlet for receiving at least one fuel, at least one combustion zone within which combustion of said at least one fuel takes place to produce a stream of combustion gases and at least one exhaust for exhausting said stream of combustion gases; and

diverging means, located at least partially within said combustion chamber, for creating a divergence in said stream of combustion gases thereby creating a plurality of streams or an annular stream before converging to a single stream.

2. A nozzle according to claim 1, wherein said diverging means further comprises at least one coating material inlet for introducing at least one coating material into said stream of said combustion gases.

3. A nozzle according to claim 2, wherein said coating material inlet comprises at least one aperture in said diverging means at a most downstream point of said diverging means in said stream.

4. A nozzle according to any one of claims 1 to 3, wherein said exhaust comprises a substantially annular aperture

extending between said combustion chamber and said diverging means.

5. A nozzle according to any one of claims 1 to 3, wherein said exhaust comprises a plurality of substantially linear apertures extending between said combustion chamber and said diverging means.

6. A nozzle according to anyone of the preceding claims wherein said diverging means extends at least partially outside said combustion chamber through said exhaust.

7. A nozzle for a thermal spray gun substantially as hereinbefore described with reference to Figures 2 to 14 of the accompanying drawings.

8. A thermal spray gun comprising:-

at least one nozzle according to any one of claims 1 to 7;

fuel supply means for supplying fuel to at least one said fuel inlet; and

coating material supply means for supplying coating material to said coating material inlet.

9. A spray gun according to claim 8, wherein said spray gun is a high velocity oxygen fuel spray gun.

10. A thermal spray gun substantially as hereinbefore described with reference to Figures 2 to 14 of the accompanying drawings.

11. A method of applying a coating material on an object, comprising the steps of:-

introducing at least one fuel into a combustion chamber of a nozzle of a thermal spray gun and combusting said fuel to produce combustion gases that form a stream of gases within said combustion chamber towards an exhaust;

diverging said stream around at least one diverging device thereby creating a plurality of streams into a plurality of streams or an annular stream before converging said streams to a single stream;

introducing at least one coating material into said stream and spraying said material onto an object.

12. A method according to claim 11, wherein said at least one coating material is introduced into said streams in the space between a plurality of diverged streams or in the centre of the annular stream.

13. A method according to claim 10 or 11, wherein said fuel is oxygen and at least one fluid fuel.

14. A method of applying a coating material on an object substantially as hereinbefore described with reference to Figures 2 to 14 of the accompanying drawings.

15. A nozzle for a spray gun, the nozzle comprising:-

at least one chamber having at least one inlet for receiving a stream of at least one carrier gas and at least one exhaust for exhausting said stream of gas; and

diverging means, located at least partially within said chamber, for creating a divergence in said stream of gas thereby creating a plurality of streams or an annular stream before converging to a single stream.

16. A nozzle for a spray gun, the nozzle comprising at least one chamber having at least one inlet for receiving at least one carrier gas and at least one exhaust for exhausting said gas, wherein said exhaust further comprises at least one aerospike.

Claims

1. A nozzle for a HVOF thermal spray gun, the nozzle comprising:-

at least one combustion chamber having at least one fuel inlet for receiving at least one fuel, at least one combustion zone within which combustion of said at least one fuel takes place to produce a stream of combustion gases and at least one exhaust for exhausting said stream of combustion gases; and

diverging means, located at least partially within said combustion chamber, for creating a divergence in said stream of combustion gases thereby creating a plurality of streams or an annular stream before converging to a single stream wherein said diverging means further comprises at least one coating material inlet for introducing at least one coating material into said stream of said combustion gases at a most downstream point of said diverging means in said stream characterised in that said diverging means extends at least partially outside said combustion chamber through said exhaust.

2. A nozzle according to claim 1, wherein said exhaust comprises a substantially annular aperture extending between said combustion chamber and said diverging means.

3. A nozzle according to claim 1, wherein said exhaust comprises a plurality of substantially linear apertures extending between said combustion chamber and said diverging means.

4. An HVOF thermal spray gun comprising:-
at least one nozzle according to any one of claims 1 to 3;
fuel supply means for supplying fuel to at least one said fuel inlet; and
coating material supply means for supplying coating material to said coating material inlet.

5. A HVOF method of applying a coating material on an object, comprising the steps of:-

introducing at least one fuel into a combustion chamber of a nozzle of a thermal spray gun and combusting said fuel to produce combustion gases that form a stream of gases within said combustion chamber towards an exhaust;

diverging said stream around at least one diverging device thereby creating a plurality of streams into a plurality of streams or an annular stream before converging said streams to a single stream;

introducing at least one coating material into said stream through at least one coating material inlet at a most downstream point of said diverging device and spraying said material onto an object characterised in that at least one said diverging device extends at least partially outside said combustion chamber through said exhaust.

6. A method according to claim 5, wherein said at least one coating material is introduced into said streams in the space between a plurality of diverged streams or in the centre of the annular stream.