1. A plasma torch comprising:

- a plasma generator comprising:

- a cathode extending along an axis X and an anode, the cathode and the anode being placed so as to be able to generate, in a chamber, an electric arc between the anode and the cathode under the effect of a voltage; and

- a device for injecting a plasmagen gas comprising an injection duct opening, along an injection axis (I_i), via an injection orifice, into the chamber;

- means for injecting a material to be sprayed into a plasma flux generated by said plasma generator,

the plasma torch being characterized in that

- the ratio R" between:

- the radial distance (y_i) of said injection orifice, defined as the minimum distance between the axis X and a center of said injection orifice; and

- the largest transverse dimension (D_c) of the cathode in a region of the chamber downstream of the position p_{AC}, p_{AC} denoting the axial position of minimum radial distance between the anode and cathode,

is smaller than 2.5, and

- the projection of the injection axis (I_i) in a transverse plane passing through the center of the injection orifice of said injection duct defines an angle β larger than 5° and smaller than 45° with a radius lying in said transverse plane and passing through the axis X and through the center of said injection orifice.

2. The plasma torch according to the preceding claim, in which the projection of the injection axis (I_i) in a radial plane passing through the center of the injection orifice of said injection duct makes an angle α, with the axis X, larger than 10° and smaller than 70°.

3. The plasma torch according to any of the preceding claims, in which:

- the angle α is larger than 20 ° and smaller than 60 °; and/or
- the angle β is smaller than 30 °.

4. The plasma torch according to any of the preceding claims, in which, among the set of injection orifices of said injection device, said injection orifice is that or one of those having the furthest downstream axial position (p_i).

5. The plasma torch according to any of the preceding claims, in which the radial distance (y_i) of said injection orifice is shorter than 27 mm and longer than 6 mm.

6. The plasma torch according to any of the preceding claims, in which the injection device is placed upstream of the position p_{AC} of minimum radial distance between the anode and cathode.

7. The plasma torch according to any one of the preceding claims, in which the cathode comprises a frustoconical portion and in which said injection orifice is placed in a transverse plane (P) cutting said frustoconical portion.

8. The plasma torch according to any of the preceding claims, in which the cathode comprises a frustoconical portion and all of the injection orifices are placed in one or more transverse planes (P) cutting said frustoconical portion.

9. The plasma torch according to any of the two immediately preceding claims, in which said transverse plane or planes are placed at a distance from the base of said frustoconical portion lying between 30% and 90% of the length of said frustoconical portion.

10. The plasma torch according any of the preceding claims, in which the axial distance x" separating the axial position p_{AC} from an axial position (P_A) of the furthest downstream point of the anode is longer than 30 mm.

11. The plasma torch according to the preceding claim, in which the axial distance x" separating the axial position p_{AC} from the axial position (p_A) of the furthest downstream point of the anode is shorter than 60 mm.

12. The plasma torch according to any of the preceding claims, in which the ratio R between:

- the axial distance x between the axial position p_{AC} of minimum radial distance between the anode and cathode and an axial position (p_i) of said injection orifice; and

- the largest transverse dimension (D_C) of the cathode in the region of the chamber downstream of the axial position p_{AC},

is smaller than 3.2.

13. The plasma torch according to the preceding claim, in which the axial distance x is longer than 5 mm and shorter than 25 mm.

14. The plasma torch according to any of the preceding claim, in which the ratio R' between:

- the axial distance x' separating the axial position p_C of the downstream end of the cathode and the axial position (p_i) of said injection orifice; and

- the largest transverse dimension (D_C) of the cathode in the region of the chamber downstream of the axial position p_{AC} of minimum radial distance between the anode and cathode,

is smaller than 3.5.

15. The plasma torch according to the preceding claim, in which the axial distance x' is longer than 9 mm and shorter than 30 mm.

16. The plasma torch according to any of the preceding claims, in which the ratio R''' between the minimum radial distance y_{AC} between the anode and the cathode in the position p_{AC} and the largest transverse dimension (D_C) of the cathode in the region of the chamber downstream of the position p_{AC} of minimum radial distance between the anode and cathode is smaller than 1.25.

17. The plasma torch according to any of the preceding claims, in which the injection device comprises a plurality of injection orifices, at least one of the conditions on the ratios R, R', and R'', and on distances x, x', x'' and y_i, being true whichever injection orifice is considered.

18. The plasma torch according to any of the preceding claims, comprising a single cathode and/or a single anode.

19. The plasma torch according to any of the preceding claims, in which the cathode, in the form of a rod of axis X, comprises in succession, coaxially, from upstream to downstream, a frustoconical portion of decreasing diameter, a cylindrical portion of circular cross section and a conical portion having a rounded apex.

The invention claimed is:

1. A plasma torch comprising:
a plasma generator having:
a cathode extending along an axis X,
an anode, and
a chamber, the cathode and the anode being placed so as to be able to generate an electric arc in the chamber when voltage is applied between the anode and the cathode; and
an injection device for injecting a plasmagen gas, the injection device comprising an injection duct opening, along an injection axis (I_i), via an injection orifice, into the chamber;
means for injecting a material to be sprayed into a plasma flux generated by said plasma generator; wherein,
a ratio R" between:
a radial distance (y_i) of said injection orifice, defined as a minimum distance between the axis X and a center of said injection orifice; and
a largest transverse dimension (D_C) of the cathode in a region of the chamber downstream of an axial position p_{AC}, p_{AC} denoting the axial position of minimum radial distance between the anode and cathode,
is smaller than 2.5, and
a projection of the injection axis (I_i) in a transverse plane passing through the center of the injection orifice of said injection duct defines an angle β smaller than 45° with a radius lying in said transverse plane and passing through the axis X and through the center of said injection orifice.

2. The plasma torch according to claim 1, in which the projection of the injection axis (I_i) in a radial plane passing through the center of the injection orifice of said injection duct makes an angle α, with the axis X, larger than 10 ° and smaller than 70 °.

3. The plasma torch according to claim 1, in which said angle β is larger than 5 °.

4. The plasma torch according to claim 1, in which:
the angle α is larger than 20 ° and smaller than 60 °; and/or
the angle β is smaller than 30 °.

5. The plasma torch according to claim 1, in which, among a set of injection orifices of said injection device, said injection orifice is that or one of those having a furthest downstream axial position (p_i).

6. The plasma torch according to claim 1, in which a radial distance (y_i) of said injection orifice is shorter than 27 mm and longer than 6 mm.

7. The plasma torch according to claim 1, in which the injection device is placed upstream of the position p_{AC} of minimum radial distance between the anode and cathode.

8. The plasma torch according to claim 1, in which the cathode comprises a frustoconical portion and in which said injection orifice is placed in a transverse plane cutting said frustoconical portion.

9. The plasma torch according to claim 5, in which the cathode comprises a frustoconical portion and all of the injection orifices are placed in one or more transverse planes cutting said frustoconical portion.

10. The plasma torch according to claim 8, in which said transverse plane or planes are placed at a distance from a base of said frustoconical portion lying between 30% and 90% of the length of said frustoconical portion.

11. The plasma torch according to claim 1, in which an axial distance x" separating the axial position p_{AC} from an axial position (P_A) of the furthest downstream point of the anode is longer than 30 mm.

12. The plasma torch according to claim 11, in which the axial distance x" separating the axial position p_{AC} from the axial position (p_A) of the furthest downstream point of the anode is shorter than 60 mm.

13. The plasma torch according to claim 1, in which the ratio R between: an axial distance x between the axial position p_{AC} of minimum radial distance between the anode and cathode and an axial position (p_i) of said injection orifice; and

a largest transverse dimension (D_C) of the cathode in a region of the chamber downstream of the axial position p_{AC}, is smaller than 3.2.

14. The plasma torch according to claim 13, in which the axial distance x is longer than 5 mm and shorter than 25 mm.

15. The plasma torch according to claim 1 claims, in which a ratio R' between:
an axial distance x' separating an axial position p_C of a downstream end of the cathode and an axial position (p_i) of said injection orifice; and
the largest transverse dimension (D_C) of the cathode in the region of the chamber downstream of the axial position p_{AC} of minimum radial distance between the anode and cathode, is smaller than 3.5.

16. The plasma torch according to claim 15, in which the axial distance x' is longer than 9 mm and shorter than 30 mm.

17. The plasma torch according to claim 1, in which a ratio R''' between a minimum radial distance y_{AC} between the anode and the cathode in the axial position p_{AC} and the largest transverse dimension (D_C) of the cathode in the region of the chamber downstream of the axial position p_{AC} of minimum radial distance between the anode and cathode is smaller than 1.25.

18. The plasma torch according to claim 1, in which the injection device comprises a plurality of injection orifices, at least one of conditions on ratios R, R', and R'', and on distances x, x', x'' and y_i, being true whichever injection orifice is considered.

19. The plasma torch according to claim 1, comprising a single cathode and/or a single anode.

20. The plasma torch according to claim 1, in which the cathode, in the form of a rod of axis X, comprises in succession, coaxially, from upstream to downstream, a frustoconical portion of decreasing diameter, a cylindrical portion of circular cross section and a conical portion having a rounded apex.