WE CLAIM:

1. A fuel injection valve (1) comprising:

a valve body (4) provided so as to open and close;

a valve seat member (7) having a valve seat (6) on which the valve body (4) is seated upon valve closure and an opening part (48) at a downstream of the valve seat member (7);

a nozzle plate (8) provided at a downstream side of the valve seat member (7);

a swirl providing chamber (46) formed into a recessed shape on the nozzle plate (8) at a valve seat member (7) side and providing a swirl force to fuel by swirling the fuel in the swirl providing chamber (46);

an injection orifice (44) formed on a bottom of the swirl providing chamber (46) and penetrating the swirl providing chamber (46) to an outside; and

a communication passage (45) formed into a recessed shape on the nozzle plate (8) at the valve seat member (7) side and connecting the swirl providing chamber (46) and the opening part (48) of the valve seat member (7), and

a corner portion (46c) between a bottom portion (46a) and a side surface portion (46b) of the swirl providing chamber (46), and a corner portion (45c) between a bottom portion (45a) and a side surface portion (45b) of the communication passage (45), being formed into a curved shape in a cross section, and

when radii of the cross sectional shape of the corner portion (46c) between the bottom portion (46a) and the side surface portion (46b) of the swirl providing chamber (46) and of the cross sectional shape of the corner portion (45c) between the bottom portion (45a) and the side surface portion (45b) of the communication passage (45) are r2, and also widths of the swirl providing chamber (46) and the communication passage (45) are W, the swirl providing chamber (46) and the communication passage (45) being formed so as to satisfy an expression of r2 < W/2.

2. The fuel injection valve (1) as claimed in claim 1, wherein:

when radii of a cross sectional shape of a corner portion (46d) between a side surface (8a), at the valve seat member (7) side, of the nozzle plate (8) and the side surface portion (46b) of the swirl providing chamber (46) and of a cross sectional shape of a corner portion (45d) between the side surface (8a), at the valve seat member (7) side, of the nozzle plate (8) and the side surface portion (45b) of the communication passage (45) are r1, and also the widths of the swirl providing chamber (46) and the communication passage (45) are W, the swirl providing chamber (46) and the communication passage (45) are formed so as to satisfy an expression of r1 < r2 < W/2.

3. The fuel injection valve (1) as claimed in claim 1, wherein:
the swirl providing chamber (46) and the communication passage (45) are formed by cutting, pressing or etching process.

4. The fuel injection valve (1) as claimed in claim 2, wherein:
the swirl providing chamber (46) and the communication passage (45) are formed by cutting, pressing or etching process.

5. The fuel injection valve (1) as claimed in claim 1, wherein:
two swirl providing chambers (46) are provided.

6. The fuel injection valve (1) as claimed in claim 1, wherein:
six swirl providing chambers (46) are provided.

7. The fuel injection valve (1) as claimed in claim 2, wherein:
two swirl providing chambers (46) are provided.

8. The fuel injection valve (1) as claimed in claim 2, wherein:
six swirl providing chambers (46) are provided.

9. A fuel injection valve (1) comprising:
a valve body (4) provided so as to open and close;

a valve seat member (7) having a valve seat (6) on which the valve body (4) is seated upon valve closure and an opening part (48) at a downstream of the valve seat member (7);

a nozzle plate (8) provided at a downstream side of the valve seat member (7);

a swirl providing chamber (46) formed into a recessed shape on the nozzle plate (8) at a valve seat member (7) side and providing a swirl force to fuel by swirling the fuel in the swirl providing chamber (46);

an injection orifice (44) formed on a bottom of the swirl providing chamber (46) and penetrating the swirl providing chamber (46) to an outside; and

a communication passage (45) formed into a recessed shape on the nozzle plate (8) at the valve seat member (7) side and connecting the swirl providing chamber (46) and the opening part (48) of the valve seat member (7), and

a corner portion (46c) between a bottom portion (46a) and a side surface portion (46b) of the swirl providing chamber (46), and a corner portion (45c) between a bottom portion (45a) and a side surface portion (45b) of the communication passage (45), being formed into a curved shape in a cross section, and

when radii of a cross sectional shape of a corner portion (46d) between a side surface (8a), at the valve seat member (7) side, of the nozzle plate (8) and the side surface portion (46b) of the swirl

providing chamber (46) and of a cross sectional shape of a corner portion (45d) between the side surface (8a), at the valve seat member (7) side, of the nozzle plate (8) and the side surface portion (45b) of the communication passage (45) are r1, and radii of the cross sectional shape of the corner portion (46c) between the bottom portion (46a) and the side surface portion (46b) of the swirl providing chamber (46) and of the cross sectional shape of the corner portion (45c) between the bottom portion (45a) and the side surface portion (45b) of the communication passage (45) are r2, and also depths of the swirl providing chamber (46) and the communication passage (45) are L, the swirl providing chamber (46) and the communication passage (45) being formed so as to satisfy an expression of r1 < r2 < L/2.

10. The fuel injection valve (1) as claimed in claim 9, wherein:
two swirl providing chambers (46) are provided.

11. The fuel injection valve (1) as claimed in claim 9, wherein:
six swirl providing chambers (46) are provided.

Dated this 25th day of February 2015

Of Anand and Anand Advocates
Agent for the Applicant