CLAIMS

1. A pulsed cathodic arc propulsion system for use in a spacecraft comprising:

a cathode, wherein said cathode is solid and is conductive or semi-conductive;

an anode having a potential difference relative to said cathode, said potential difference creating an electric field between said anode and said cathode; and

an insulated electrical trigger comprising a trigger pin and an insulator between said trigger pin and said cathode, said insulated electrical trigger adapted to trigger an arc discharge from a point on an outer surface of said cathode when said insulated electrical trigger and said cathode are in a vacuum or a near vacuum space environment, said insulated electrical trigger being bounded within the cathode so that the point at which the arc discharge is triggered is located on the outer surface of said cathode, said anode and said cathode being arranged so that the arc discharge propels the spacecraft,

wherein the insulated electrical trigger comprises a trigger power supply configured to operate in the vacuum or the near vacuum space environment and to apply a charging voltage in the range of 50V to 500V between the cathode and the anode and to generate a trigger pulse of 1.2 kV or less with a first duration of 3 μs or less to create a high current surface flashover across said insulator between the trigger pin and the outer surface of the cathode to create a plasma, and the trigger power supply is further configured to maintain the production of the plasma by applying a burning voltage of between 30V and 100V between the cathode and the anode for a second duration of between 20 μs to 500 μs after the trigger pulse.

2. The pulsed cathodic arc propulsion system according to claim 1, wherein the cathode is selected from the group consisting of: magnesium, titanium, carbon, aluminium, calcium, carbon, vanadium, molybdenum, tungsten, tantalum, tin, bismuth, nickel, iron and chromium.

3. The pulsed cathodic arc propulsion system according to claim 1, wherein the cathode is an alloy or composite comprising at least one of magnesium, titanium, carbon, aluminium, calcium, carbon, vanadium, molybdenum, tungsten, tantalum, tin, bismuth, nickel, iron or chromium.

4. The pulsed cathodic arc propulsion system according to any one of the preceding claims, wherein the insulated electrical trigger is a wire which protrudes from the cathode at a trigger point on the outer surface of the cathode, and further wherein the insulated electrical trigger is internal to the cathode.

5. The pulsed cathodic arc propulsion system according to any one of the preceding claims 1 to 3, wherein the insulated electrical trigger is located at a trigger point on the outer surface of the cathode, said trigger point being within a perimeter of said outer surface.

6. The pulsed cathodic arc propulsion system according to claim 5, wherein said trigger point is located at or adjacent to a centre of the outer face of the cathode.

7. The pulsed cathodic arc propulsion system according to claim 6, wherein said trigger point is located on or proximal to an edge of a centre-bored hole of said cathode, wherein at least part of said insulated electrical trigger is located within said centre-bored hole.

8. The pulsed cathodic arc propulsion system according to claim 5, wherein the trigger point is located less than one half of a distance from a centre of the outer surface of the cathode to a circumference of the outer surface of the cathode.

9. The pulsed cathodic arc propulsion system according to claim 8, wherein the trigger point is located less than one quarter of the distance from the centre of the outer surface of the cathode to the circumference of the outer surface of the cathode.

10. The pulsed cathodic arc propulsion system according to any one of the preceding claims, wherein said trigger pin comprises a refractory metal.

11. The pulsed cathodic arc propulsion system according to claim 10, wherein said refractory metal is tungsten.

12. The pulsed cathodic arc propulsion system according to any one of the preceding claims, wherein said plasma forms a plasma plume normal to the outer surface of the cathode.

13. The pulsed cathodic arc propulsion system according to any one of the preceding claims, further comprising:

a feed mechanism to control movement of said cathode relative to said insulated electrical trigger.

14. The pulsed cathodic arc propulsion system according to claim 13, wherein said feed mechanism includes a worm drive, said worm drive including a worm wheel adapted to engage a worm screw forming part of said cathode, said worm wheel being driven by a motor.

15. The pulsed cathodic arc propulsion system according to claim 13 or claim 14, wherein said feed mechanism includes a spring biased to advance the cathode, relative to said insulated electrical trigger, as said cathode wears from said arc discharge.

16. The pulsed cathodic arc propulsion system according to claim 12, further comprising a magnetic nozzle for directing said plasma plume.

17. The pulsed cathodic arc propulsion system according to claim 16, wherein said magnetic nozzle includes at least one permanent magnet.

18. The pulsed cathodic arc propulsion system according to any one of the preceding claims, further comprising:

a magnetic guide adapted to steer the point of the arc discharge on the outer surface of said cathode.

19. The pulsed cathodic arc propulsion system according to claim 18, wherein said magnetic guide includes at least one of a magnetic coil or a permanent magnet.

20. The pulsed cathodic arc propulsion system according to any one of the preceding claims, further comprising a main capacitor bank (C_m) configured to dissipate stored energy through the cathode to maintain production of the plasma after triggering.

21. The pulsed cathodic arc propulsion system according to claim 20, wherein the insulated electrical trigger further comprises a pulse control and termination system which

controls grounding of the main capacitor bank to terminate the trigger pulse a predetermined time period after triggering.

22. The pulsed cathodic arc propulsion system according to claim 21, wherein the pulse control and termination system uses pulse shaping to change a magnitude of a current of the arc discharge to control an erosion profile of the cathode.

23. The pulsed cathodic arc propulsion system according to claim 22, further comprising a steering device to steer cathode spots across the upper surface of the cathode, the steering device comprising the main capacitor bank C_m in series with an inductor L_m and a switch S_m, wherein the main capacitor bank is in parallel with a set of sub-banks of capacitors where each capacitor of the set of sub-banks of capacitors is in series with a respective inductor and a respective switch, and the pulse control and termination system controls operations of each switch.

24. A spacecraft propulsion system comprising the pulsed cathodic arc propulsion system of any one of the preceding claims.

25. A spacecraft comprising the spacecraft propulsion system according to any one of claims 1 to 23, wherein the spacecraft is selected from the group consisting of: rockets, space shuttles, satellites, and space stations.