CLAIMS

~~1. An electrosurgical instrument for delivering microwave energy into biological tissue, the electrosurgical instrument comprising:~~

~~a coaxial cable for conveying microwave energy, the coaxial cable having an inner conductor, an outer conductor, and a first dielectric material separating the inner conductor and outer conductor; and~~

~~a radiating tip portion disposed at a distal end of the coaxial cable to receive the microwave energy from the coaxial cable,~~

~~wherein the radiating tip portion comprises:~~

~~a dielectric tip formed from a second dielectric material that is different from the first dielectric material, and~~

~~a distal conductive portion of the inner conductor, which extends longitudinally into the dielectric tip, and~~

~~wherein the second dielectric material has a dielectric constant greater than the first dielectric material, whereby the radiating tip portion is arranged to radiate a localized microwave field for tissue ablation.~~

~~2. An electrosurgical instrument according to claim 1, wherein the outer diameter of the coaxial cable and radiating tip portion is equal to or less than 1.9 mm.~~

~~3. An electrosurgical instrument according to claim 1 or 2, wherein the microwave energy has a single stable frequency, and the dielectric constant of the second dielectric material is selected based on the frequency of the microwave energy such that the axial length of the dielectric tip corresponds to a non-negligible fraction of a wavelength of the microwave energy when propagating in the dielectric tip.~~

~~4. An electrosurgical instrument according to any preceding claim, wherein the dielectric constant of the second dielectric material is equal to or greater than 80.~~

~~5. An electrosurgical instrument according to any preceding claim, wherein the radiating tip portion further comprises an intermediate dielectric element surrounding a proximal part of the distal conductive portion and separating the first dielectric material from the dielectric tip, the intermediate dielectric element being formed from a third dielectric material that is different from the second dielectric material.~~

~~6. An electrosurgical instrument according to any preceding claim, wherein the radiating tip portion is arranged to act as a quarter wave impedance transformer to match an input impedance to a tissue load impedance.~~

~~7. An electrosurgical instrument according to any preceding claim comprising conductive material arranged on an outer surface of the dielectric tip to form a microstrip or coplanar transmission line for delivering the microwave energy into biological tissue.~~

~~8. An electrosurgical instrument according to any one of claims 1 to 6, wherein the radiating tip portion includes a field shaping element arranged to direct the microwave field to one side of the radiating tip portion.~~

~~9. An electrosurgical instrument according to claim 8, wherein the field shaping element is a conductive finger extending longitudinally along a side of an outer surface of the dielectric tip opposite to the side from which the microwave field is directed, the conductive finger being electrically connected to the outer conductor of the coaxial cable.~~

~~10. An electrosurgical instrument according to claim 9, wherein the radiating tip portion includes a dielectric cap disposed distally to the dielectric tip and distal conductive portion, the conductive finger extending along an outer surface of the dielectric cap, whereby the conductive finger extends further from the coaxial cable than the distal conductive portion.~~

~~11. An electrosurgical instrument according to claim 9 or 10, wherein the conductive finger is an extension of the outer conductor of the coaxial cable.~~

~~12. An electrosurgical instrument according to claim 9 or 10, wherein the conductive finger is a distal part of a conductive sleeve mounted on and electrically connected to the outer conductor of the coaxial cable, wherein the conductive sleeve is rotatable relative the dielectric tip to adjust the circumferential position of the conductive finger.~~

~~13. An electrosurgical instrument according to claim 8, wherein the field shaping element is a conductive sleeve formed over the dielectric tip, the conductive sleeve having a radiating slot formed therein on the side from which the microwave field is directed.~~

~~14. An electrosurgical instrument according to claim 13, wherein the conductive sleeve is rotatable relative the dielectric tip to adjust the circumferential position of the radiating slot.~~

~~15. An electrosurgical instrument according to claim 13, wherein the conductive sleeve has a pair of radiating slots on opposite sides of the dielectric tip, and wherein the radiating top portion comprises an actuator operable to selectively expose only one of the pair of radiating slots.~~

~~16. An electrosurgical instrument according to claim 15, wherein the actuator comprises a longitudinally slidable sleeve having opposed cut outs formed therein, wherein the actuator is movable between a first position in which a first cut out exposes a first one of the pair of radiating slots and a second position in which a second cut out exposes a second one of the pair of radiating slots.~~

~~17. An electrosurgical instrument according to any preceding claim including an imaging element for conveying an imaging signal to permit visualisation of a distal end of the instrument.~~

~~18. An electrosurgical instrument according to claim 17, wherein the imaging element includes a fibrescope comprising a bundle of optical fibres.~~

~~19. An electrosurgical instrument according to claim 18, wherein the inner conductor and distal conductive portion are hollow to define a channel for carrying the bundle of optical fibres.~~

~~20. An electrosurgical instrument according to claim 18, wherein the bundle of optical fibres extends through the first dielectric material and radiating tip portion and has a layer of conductive material over its outer surface to form the inner conductor of the coaxial cable and the distal conductive portion.~~

~~21. An electrosurgical instrument according to claim 17, wherein the imaging element comprises an image sensor mounted at the distal end of the radiating tip portion and a communication cable for conveying a signal from the image sensor to the proximal end of the instrument.~~

~~22. An electrosurgical instrument according to claim 21, wherein the inner conductor and distal conductive portion are hollow to define a channel for carrying the communication cable.~~

~~23. An electrosurgical instrument according to any preceding claim including a temperature sensor at the distal end thereof.~~

~~24. An electrosurgical instrument according to claim 23, wherein the temperature sensor is a thermocouple mounted on the outer conductor of the coaxial cable.~~

~~25. An electrosurgical instrument according to claim 24, wherein the thermocouple comprises a plurality of stubs arranged to filter out a signal having the same frequency as the microwave energy.~~

~~26. An electrosurgical instrument according to claim 23, wherein the temperature sensor includes a temperature sensitive micromechanical structure at the distal end of the end, and a means of optically monitoring the temperature sensitive micromechanical structure.~~

~~27. An electrosurgical instrument according to any preceding claim, wherein the coaxial cable is mounted in an outer sheath, and wherein the outer sheath is a multi lumen catheter arranged to convey any one or more of:~~

~~guide wires for controlling movement of the radiating tip section, and~~

~~fluid for cooling the distal end of the instrument.~~

~~28. An electrosurgical apparatus for delivering microwave energy into lung tissue, the electrosurgical apparatus comprising:~~

~~a generator for generating microwave energy;~~

~~a bronchoscope for non-percutaneous insertion into a patient's lungs, the bronchoscope having an instrument channel running along its length; and~~

~~an electrosurgical instrument according to any preceding claim mounted in the instrument channel of the bronchoscope,~~

~~wherein the coaxial cable is connected to receive microwave energy from the generator.~~

~~29. An electrosurgical apparatus according to claim 28, wherein the generator is arranged to deliver pulses of microwave energy in time with the breathing cycle of the patient.~~

~~30. A bronchoscope comprising:~~

~~a body; and~~

~~a flexible instrument cord for non-percutaneous insertion to a patient's lungs, the instrument cord extending from the body and having an longitudinally extending instrument channel formed therethrough,~~

~~wherein the body includes:~~

~~a power input port that is connectable to receive microwave energy, and~~

~~a optical port arranged to receive optical signals from a distal end of the instrument cord, and~~

~~wherein the instrument cord comprises a coaxial transmission line formed around the instrument channel, the coaxial transmission line being connected to the power input port to convey microwave energy to the distal end of the instrument cord.~~

~~31. A bronchoscope according to claim 30 having a radiator mounted at a distal end of the instrument channel, the radiator being electrically connected to the coaxial transmission line to receive microwave energy therefrom and emit a microwave field.~~

~~32. A bronchoscope according to claim 31, wherein the radiator is an electrosurgical instrument according to any one of claims 1 to 26.~~

~~33. A bronchoscope according to claim 32, wherein the outer diameter of the coaxial transmission line is greater than the outer diameter of the coaxial cable in the electrosurgical instrument.~~

~~34. A bronchoscope according to claim 31, wherein the radiator comprises any one of:~~

~~an expandable balloon,~~

~~a radially expanding tube,~~

~~a forceps structure, and~~

~~a paddle structure.~~

~~35. A bronchoscope according to any one of claims 30 to 34, wherein the body includes a fluid input port, the fluid input port being in communication with the instrument channel.~~

~~36. A bronchoscope according to any one of claims 31 to 35, wherein the body includes a control actuator connected to one or more guide wires, the guide wires extending through the instrument cord to the radiator, wherein the control actuator is operable to move the guide wires within the instrument cord to control movement of the radiator.~~

~~37. A bronchoscope according to any one of claims 30 to 36, wherein the body includes an illumination port, and wherein the instrument cord including one or more optical channels in optical communication with the illumination port for conveying an illumination signal to the distal end thereof to illuminate a treatment region.~~

~~38. A bronchoscope according to claim 37 including a light source mounted to the body to generate the illumination signal.~~

~~39. A bronchoscope according to any one of claims 30 to 38 including an imaging element for conveying an imaging signal to permit visualisation of a treatment region at the distal end of the instrument cord.~~

~~40. A bronchoscope according to claim 39, wherein the imaging element includes a fibrescope comprising a bundle of optical fibres.~~

~~41. A bronchoscope according to claim 39, wherein the imaging element comprises an image sensor mounted at the distal end of the instrument cord and a communication cable for conveying a signal from the image sensor to the proximal end of the instrument.~~

~~42. A bronchoscope according to any one of claims 30 to 41 including a temperature sensor at the distal end thereof.~~

~~43. An electrosurgical apparatus for delivering microwave energy into lung tissue, the electrosurgical apparatus comprising:~~

~~a generator for generating microwave energy; and~~

~~a bronchoscope according to any one of claims 30 to 42,~~

~~wherein the power input port is connected to the generator to convey the microwave energy to the coaxial transmission line.~~

~~44. An electrosurgical apparatus according to claim 43, wherein the generator is arranged to pulse the microwave energy with a duty cycle between 1% and 50%.~~

1. A bronchoscope (300) comprising:

a body (302); and

a flexible instrument cord (304) for non-percutaneous insertion to a patient's lungs, the instrument cord (304) extending from the body (302) and having a longitudinally extending hollow instrument channel (314) formed therethrough,

wherein the body (302) includes:

a power input port (305) that is connectable to receive microwave energy, and

an optical port arranged to receive optical signals from a distal end of the instrument cord (304), and

wherein the instrument cord (304) comprises a coaxial transmission line (316) formed around the instrument channel (314), the coaxial transmission line (316) being connected to the power input port (305) to convey microwave energy to the distal end of the instrument cord (304).

2. A bronchoscope (300) according to claim 1 having a radiator (306) mounted at a distal end of the instrument channel (314), the radiator (306) being electrically connected to the coaxial transmission line (316) to receive microwave energy therefrom and emit a microwave field.

3. A bronchoscope (300) according to claim 2, wherein the radiator (306) comprises any one of:

an expandable balloon (334),

a radially expanding tube (340),

a forceps structure (350), and

a paddle structure (364).

4. A bronchoscope (300) according to any one of claims 1 to 3, wherein the body (302) includes a fluid input port, the fluid input port being in communication with the instrument channel (314).

5. A bronchoscope (300) according to any one of claims 2 to 4, wherein the body (302) includes a control actuator (312) connected to one or more guide wires (332), the guide wires (332) extending through the instrument cord (304) to the radiator (306), wherein the control actuator (312) is operable to move the guide wires (332) within the instrument cord (304) to control movement of the radiator (306).

6. A bronchoscope (300) according to any one of claims 1 to 5, wherein the body (302) includes an illumination port (311), and wherein the instrument cord (304) including one or more optical channels (326) in optical communication with the illumination port for conveying an illumination signal to the distal end thereof to illuminate a treatment region.

7. A bronchoscope (300) according to claim 6 including a light source (310) mounted to the body (302) to generate the illumination signal.

8. A bronchoscope (300) according to any one of claims 1 to 7 including an imaging element for conveying an imaging signal to permit visualisation of a treatment region at the distal end of the instrument cord (304).

9. A bronchoscope (300) according to claim 8, wherein the imaging element includes a fibrescope comprising a bundle of optical fibres.

10. A bronchoscope (300) according to claim 8, wherein the imaging element comprises an image sensor mounted at the distal end of the instrument cord (304) and a communication cable for conveying a signal from the image sensor to the proximal end of the instrument.

11. A bronchoscope (300) according to any one of claims 1 to 10 including a temperature sensor (374) at the distal end thereof.

12. An electrosurgical apparatus for delivering microwave energy into lung tissue, the electrosurgical apparatus comprising:

a generator for generating microwave energy; and

a bronchoscope (300) according to any one of claims 1 to 11,

wherein the power input port (305) is connected to the generator to convey the microwave energy to the coaxial transmission line (316).

13. An electrosurgical apparatus according to claim 12, wherein the generator is arranged to pulse the microwave energy with a duty cycle between 1% and 50%.