Surgical forceps or a similar instrument to be employed in HF surgery for coagulating tissue by means of HF currents in which at least the terminal parts of the jaws of the instrument which are adapted to clamp the tissue are designed so as to prevent them from overheating the tissue when an HF current is conducted to said instrument.

9 Claims, 3 Drawing Figures
SURGICAL INSTRUMENT FOR HIGH-FREQUENCY SURGERY

The present invention relates to a surgical instrument, especially in the form of surgical forceps, which is to be employed in surgical operations by means of high-frequency currents and comprises a pair of jaws for clamping the tissue which is to be coagulated.

When employing surgical instruments in high-frequency or HF surgery, and especially when using surgical forceps in carrying out a bipolar coagulation, it often occurs that one of the jaws of the instrument will continue to adhere or stick to the coagulated tissue. This sticking of the tissue to the jaws of the forceps is especially dangerous in neuro-microsurgical operations. When coagulating, for example, an aneurysm, such sticking of the tissue to the jaws of the forceps may cause the coagulated place to be torn so that a brain hemorrhage might result which cannot be stopped and might even lead to the death of the patient.

It is the object of the present invention to provide a surgical instrument for high-frequency surgery, especially in the form of surgical forceps, which avoids such sticking of the jaws of the instrument to the coagulated tissue as much as possible.

Although all of the causes of such sticking of the jaws of the instrument to the coagulated tissue have not as yet been definitely determined, the present inventors have found that such sticking is due to a local overheating of the parts of the clamped tissue which are clamped by these jaws. Consequently, for attaining the above mentioned object, the inventors undertook to eliminate the cause for such local overheating adjacent to the jaws of the surgical forceps or similar instrument.

For carrying out this invention, each of two different measures may be undertaken either alone or in conjunction with each other. One of these measures consists according to the invention in rounding off the edges of the terminal surfaces of the jaws of the instrument which are to come in contact with the tissue so that, when the tissue is being clamped between the jaws, the surface pressure of the jaws upon the tissue will not substantially increase but rather decrease toward these edges. The second measure which may be undertaken either alone or in conjunction with the first measure consists in making at least the surfaces of the jaws which are to come in contact with the tissue to be coagulated of a material which has a higher thermal and electric conductivity than steel.

By rounding off the edges of the terminal surfaces of the forceps or similar instrument which are to engage with the tissue to be coagulated, the entire surface of this tissue which is in direct engagement with the jaw surfaces will be subjected to a substantially uniform surface pressure which has the result that the electric contact resistance which is then produced will also be uniform along these surfaces. Therefore, the invention prevents the high current density which occurs on the usual relatively sharp edges of the jaws of the conventional surgical forceps or similar instruments and it thus prevents the local overheating of the tissue parts at and directly adjacent to these edges.

The second feature of the invention that at least the jaws of the surgical instrument consist of a material which has a better thermal and electric conductivity than steel has the result that the heat which is produced for the coagulation will be dissipated from the tissue immediately after the coagulation by the highly heat-conductive jaws. By making the jaws of the instrument also of a material which has a better electric conductivity than steel, the further advantage is attained that these jaws will be heated considerably less by the electric current and therefore have a lower temperature which, in turn, means that the heat will also be quickly dissipated from the points of contact between the jaws and the tissue.

Since by making at least the contact surfaces of the jaws of the surgical instrument which are to engage with the tissue to be coagulated of a material which has a higher thermal and electric conductivity than steel, the heat will also be better dissipated from the edges of the jaws, it will be of advantage to apply this feature of the invention also to surgical forceps or similar instruments the jaws of which have the conventional sharp edges.

The features and advantages of the present invention will become more clearly apparent from the following detailed description thereof, which is to be read with reference to the accompanying drawings, in which FIG. 1 shows, partly broken away, a side view of a pair of surgical forceps for high-frequency surgery; while FIG. 2 and 3 show cross sections which are taken along the lines II — II and III — III of FIG. 1, respectively.

The surgical forceps as illustrated in the drawings which are intended for use in high-frequency surgery comprise a pair of arms 1 and 2 which are electrically insulated from each other and connected to each other near their rear ends by an insulator 3. The two arms 1 and 2 of the forceps consist of a high-grade steel and may be connected in a conventional manner to the output electrodes of a high-frequency generator, not shown.

By means of rivets 6, a pair of jaws 4 and 5 are secured to the front ends of the two arms 1 and 2. These jaws 4 and 5 consist of a material which has a higher thermal and electric conductivity than steel. A material which is suitable for this purpose may be, for example, silver or an alloy of silver, for example, with gold, copper, palladium, cadmium, cadmium oxide or nickel.

As illustrated in FIG. 3, the longitudinal edges 7 of the jaws 4 and 5 are rounded so as to have a radius of curvature R which preferably amounts to at least one tenth of the width b of the jaws at a point which is spaced at a distance d of 3 mm from the tips 10 of the jaws.

By making the jaws 4 and 5 of a thermally and electrically highly conductive material, the present invention attains the advantage that the heat which is produced in the tissue when being coagulated by a high-frequency current will be immediately dissipated by the heat-conductive jaws 4 and 5 as soon as the coagulation has been effected. The high conductivity of the jaws 4 and 5 has the further advantage that these jaws will be heated very little, if at all, by the electric high-frequency current which is required for the coagulation and that during the coagulation the jaws 4 and 5 themselves have a low temperature and therefore serve for the additional purpose of quickly dissipating the heat from the coagulated tissue.
Since the longitudinal edges 7 of the jaws 4 and 5 are rounded, the edges of the terminal surfaces 8 of the jaws which are provided for coming in contact with the tissue are likewise rounded, as may be clearly seen in FIG. 3. This has the result that at the position where the tissue, for example, the blood vessel 9, is to be coagulated, the surface of the latter will be subjected by the entire surface 8 of jaws 4 and 5 which comes in contact with the tissue to a substantially uniform surface pressure the strength of which decreases rather than increases in the direction toward the outer edges of the surface 8. This, in turn, has the result that an electric contact resistance will be produced which is uniform at all points of contact between the entire surface 8 of the jaws 4 and 5 and the tissue to be coagulated, for example, the blood vessel 9. Due to the fact that the edges 7 of the jaw surfaces 8 of the forceps as illustrated are rounded, the current density will therefore be substantially equal at all of these points so that no overheating of the tissue will occur at any point and the tissue cannot stick to either of the jaws 4 or 5 and be torn when the forceps are opened and withdrawn.

If both of the features of the invention as previously described, that is, the construction of the jaws 4 and 5 of the surgical forceps or similar instrument of a material of a high thermal and electric conductivity and the rounding of the edges of the jaw surfaces 8, are applied together, an overheating of the coagulated tissue may be avoided with great certainty.

While the jaws 4 and 5 of the forceps as illustrated in the drawings are made entirely of the same thermally and electrically highly conductive material, the good conductivity of the parts of a surgical instrument which form the surfaces with which this instrument comes in contact with the tissue to be coagulated may also be attained by merely applying a thermally and electrically highly conductive coating upon the outer surface of the instrument which otherwise consists of a material of a lower conductivity. This may be attained, for example, by making each of the two arms 1 and 2 and the associated jaw 4 or 5 of the forceps or other surgical instrument internally of one piece of material which is provided with a coating of a thermally and electrically highly conductive material. Thus, for example, the arms of the forceps may consist of steel which is coated with a layer of silver or an alloy of silver with gold, copper, palladium, cadmium, cadmium oxide or nickel. Instead of employing steel as the basic material of the instrument, it is, of course, also possible to employ any other suitable material, for example, one which has a better thermal and electric conductivity.

If the costs of the instrument are of no importance, it is most advisable to make the entire instrument of a material which has a good thermal and electric conductivity, while the other properties of this material are as equal as possible to those of a high-grade steel. Such a material may be, for example, beryllium bronze or phosphor bronze.

Although our invention has been illustrated and described with reference to the preferred embodiments thereof, we wish to have it understood that it is in no way limited to the details of such embodiments but is capable of numerous modifications within the scope of the appended claims.

Having thus fully disclosed our invention, what we claim:

1. A surgical instrument adapted to be used in high-frequency surgery, said instrument having a pair of electrically conductive elongated jaw members with spaced terminals for clamping tissue to be coagulated, said jaw members being connected remote from the terminals to an insulating member, means to connect the jaw members to the output of a high-frequency generator, the improvement which comprises as a means for preventing said tissue from being overheated by said terminals when high-frequency current is conducted to said terminals, said surfaces of said terminals have rounded edges so that, when the tissue is clamped by said terminals at said rounded edges, a high current density is prevented.

2. A surgical instrument as defined in claim 1, in which at least the surfaces of said terminals which are adapted to engage with the tissue to be coagulated consist of a material having a higher thermal and electric conductivity than steel.

3. A surgical instrument as defined in claim 2, in which said material consists of a mixture of silver and cadmium oxide.

4. A surgical instrument as defined in claim 1, in which at least said surfaces of said terminals consist of a material having a higher thermal and electric conductivity than steel.

5. A surgical instrument as defined in claim 1, in which said edges have a radius of curvature amounting to at least one-tenth of the width of said terminals at points spaced substantially 3 mm from the tips of said terminals.

6. A surgical instrument as defined in claim 2, in which said material consists of silver.

7. A surgical instrument as defined in claim 2, in which said material consists of an alloy of silver with at least one material of the group consisting of gold, copper, palladium, cadmium, and nickel.

8. A surgical instrument as defined in claim 2, in which all of the thermally and electrically conductive parts of said instrument including said surfaces consist of at least one material having a higher thermal and electric conductivity than steel.

9. A surgical instrument as defined in claim 8, in which all of said thermally and electrically conductive parts of said instrument consist of bronze.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,685,518 Dated August 22, 1972

Inventor(s) HERBERT BEUERLE ET AL

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

On the cover sheet insert:

-- [30] FOREIGN APPLICATION PRIORITY DATA

February 11, 1970 Germany . . . . P 20 06 126.1 --.

Signed and sealed this 15th day of May 1973.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR. ROBERT GOTTSCHALK
Attesting Officer Commissioner of Patents