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(54) **DEVICE FOR CUTTING MATERIAL.**

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Description

The invention refers to a device for cutting materials, the device comprising a cutting means which can be mounted on a plotter or a similar device controlling the position of the cutting means, the cutting means comprising a cutting element with a holding part and a substantially cylindrical cutting part at its free end, and means to electrically heat the cutting element to a temperature suitable for cutting the material, a control circuit being provided for controlling the heating means in dependence of the temperature of the cutting element.

Background of the invention

At surgical operations on organic tissue, various types of heating treatments are used to transform the surface of the wound and thereby reduce the blood flow. Types similar to "soldering irons" and glowing blades of knifes are used. These are often bulky and lumbering in their design. For finer operations, more and more, laser heat is used as a knife which demands a relatively expensive equipment.

When cutting signs, letters etc. in cellular plastics of the "frigolit"-type, a so called hot wire saw is usually used. It consists of a resistance wire, which is clamped between the shanks of a bow. The bow shall keep the wire stretched enough. Both ends of the wire are connected to an electric current source. Because of the resistance of the wire, it is heated. By adjusting the current, a temperature is set which is above the melting point of the cellular plastics. By guiding the plastic disc against the hot wire, various figures may be cut out.

This technique is very hard to automate, very much depending on certain figures being provided with internal holes, which requires that one of the connections of the wire has to be released and the wire has to be pushed through the material which is going to be cut out. After the cutting, the wire has to be released once again in order to loosen the detail.

It is also difficult to automatically cut e.g. in a thin web "on line" which depends on that a fixedly mounted heating wire requires that the material moves, or the reverse. In that case it might be difficult to keep the material oriented in the "free air".

Through the Swedish patent no. 461 752 it is previously known to use an electrode in the form of a glow pen, as an automatic cutting means to an X/Y-table, e.g. a usual plotter. The invention shows different embodiments of this electrode, and methods to maintain the temperature constant during varying loads.

Through the British patent GB-2163092 and the European patent EP- 0116415, devices are also known to cut in plastic material by means of heated cutting devices. In both inventions the heating of the cutting tip is carried out by first heating a heat generating means by means of resistance heating, and then transferring the heat to the cutting tip. The drawback of these methods is that a part of the heat is lost during the heat transmission, that is from the heat generating means to the cutting tip, and the possibility to control heating of the cutting tip in relation to the cutting velocity is thereby detoriated.

The object of the invention

The object of the invention is to provide the market with an "easy to move" glow pen with possibility to use very thin cutting electrodes (down to some tenths of a millimetre), and depending on which patterns and forms are going to be cut out and the resolution, the cutting velocity and the heat generation have to be adapted to each other, e.g. a straight line which is cut at a high velocity demands a higher temperature in order to get the material to melt faster, and a curve which requires more careful cutting, has to be cut slower and demands less heat. In forms which contain both straight lines and curved lines the heat has to be controlled rapidly and effectively and requires that the temperature of the cutting electrode can be controlled in relation to the cutting velocity.

The invention is based on the external pin being mainly directly heated and that the electrode is either contact free or single ended connected. This implies that the invention can be used e.g. in surgery, as an easily movable pen, which serves as a "scalpel handle".

In a cutting device according to the preamble of claim 1, the above mentioned objects are achieved by the cutting element being constituted by a cutting electrode which is heated by electric induction and/or resistance heating, the heating means being suitable to generate an electrical current in the cutting electrode, the cutting part of the cutting electrode having a considerably smaller cross-sectional area than the holding part , so that the heat production is substantially localized in the cutting part of the cutting electrode.

Description of the drawings

Fig. 1 shows a device in perspective view with the glow pen in elevated position.

Fig. 2 shows a device in section with tube electrode.

Fig. 3 shows a section of the tube electrode according to Fig. 2.
Fig. 4 shows a device with a cable strain-relief and cooling means.
Fig. 5 shows a device in section with U-electrode.
Fig. 6 shows a section of a U-electrode according to Fig. 5 with an isolating surface layer.
Fig. 7 shows a section of a U-electrode according to Fig. 5 with an isolating layer in between.
Fig. 8 shows a device in section with an integrated temperature sensor.
Fig. 9 shows a device where the cutting electrode is heated contact free by way of an underlying field of force.
Fig. 10 shows a device where the cutting electrode is heated contact free by way of an overlying field of force.
Fig. 11 shows a device with a cutting electrode in section, with a plated surface layer and cable connections.
Fig. 12 shows a device with a cutting electrode in section, with tubular design and cable connections.
Fig. 13 shows a device with exchangeable cable and a plotter pen holder.
Fig. 14 shows an electric wiring diagram for maintaining constant temperature.
Fig. 15 shows a diagram over the supply current and power of the cutting electrode as a function of the velocity.
Fig. 16 shows a diagram of the resistance of the cutting electrode as a function of the supply current.

Description of embodiments

In the drawings, which show embodiments of devices according to the invention, the reference designations indicate:

1 A plotter pen holder
2 A cutting electrode
3 A connection for current supply
4 A cut out groove
5 A segment of a material disc
6 An external tubular electrode
7 An internal electrode
7a A thinner portion of an U-electrode
7b A thicker portion of an U-electrode
8 A welded contact point
9 A heat resistant electrically insulating layer
10 A flexible electric cable
11 An electric conductor
12 A cable connection
13 An attachment flange for a plotter pen holder
14 A cooling flange
15 A cable strain-relief
16 A temperature sensor
17 A connection cable for the temperature sensor
18 A cross section of a high frequency magnetic coil
19 A field line of so called "Foucault currents"
20 A heat resistant plotter table
21 A galvanic contact point
22 A tube for increasing the electric interconnection diameter
23 A connection terminal
24 An adapter for universal fitting in different plotter pen holders
25 A positive current feedback circuit
30 A cutting part
31 A holding part

One way in which the invention can be used makes various principles for the design and the function of the device possible. By using an X/Y-table, e.g. a flatbed plotter and that the glow pen is designed as a plotter pen, a cutting of figures can be carried out according to given computer instructions in a suitable web material. The pen function down/up may control start and stop of the cutting cycle. A general view without plotter table is shown in Fig. 1, where the cutting electrode 2 is brought to a temperature which lies above the melting point of the web material, by means of a current being applied on the terminal 3. By bringing down the plotter pen holder and move it in X/Y-direction by way of a plotter interface from a computer, the cutting electrode 2 cuts a section 4, in the web material 5. Since only the external part of the electrode is going to be heated, this cutting part is designed with a smaller cross-section or made of a material having a higher resistivity than the holding part. Within the scope of the invention, this can be designed in various ways which is shown in the figures: 2,3,5,6,7,8,11, and 12. By forming the external electrode 6 as a tube in Fig. 2, a thin cutting electrode is obtained with possibility of single ended connection 12 of the cable 10 by way of the cables 11. In order to prevent electrical short-circuiting between the external and the internal electrode an insulating layer is applied between them, e.g. by oxidation of the surface of the internal electrode. The electric circuit is closed by joining the external 6 and the internal 7 electrodes, e.g. by TIG-welding. The electrodes 6 and 7 can be connected 12 to the conductors 11 either by direct joining, e.g. spot-welding, or by providing the electrodes with a cable connecting device, e.g. a contact shrinking sleeve as in Fig. 11 and 12. In order

to prevent heat from spreading from the cutting electrode 2 to the plotter pen holder 1 as in Fig. 4 one can provide the part most adjacent to the electrode with a cooling flange 14. It is also possible to make the plotter pen holder completely in metal to obtain cooling, but a heat proof/insulating material also would work, such as e.g. a ceramic. Since the electrode is moving very much over the cutting surface, the device according to the invention can be provided with a cable strain-relief 15 to increase the length of life of the cable 10.

In Fig. 5 a U-electrode is used, where the external cutting electrode 7a is delimited to the cooler connection wire 7b by a difference in the electrical resistance. This can be achieved by the wire 7a being of smaller cross-sectional area. If a round wire is used to bend a U-electrode, its cross section will not be circular. Thus two different widths could be obtained of the groove 4 cut out, depending on the cutting direction. This can be compensated by continuously controlling the position of the electrode and turn it in the cutting direction. Another way is to form the U-electrode 7a with halfed cross-sectional area (section B-B). In order not to make electric contact between both shanks of the U, an isolating layer can be provided on the surface of the resistance wire as in Fig. 6 before the bending, e.g. by oxidation. In Fig. 7 the insulation problem has been solved by inserting/applying a foil or a layer between both shanks.

The cutting electrodes are formed as a substantially cylindrical pin, that is the said electrodes 2 have the same cross-sectional area in the longitudinal direction, but this cross-sectional area may vary at the point where the electrodes 2 are connected to each other.

The cutting electrode has a certain power (watts) at a given supply voltage (volts). This results in a temperature which depends on the external cooling, e.g. at different cutting speeds. Since the electric resistance is changed at different temperatures, according to the invention we may obtain a constant cutter electrode temperature independently of external cooling.

With reference to Fig. 14 a control circuit is shown for maintaining the cutter electrode temperature constant in a glow pin according to the present invention.

The function of the control circuit is the following:

The basic principle is that the temperature dependence of the resistance of the cutting electrode is used, which in the present case is increased resistance at elevated temperature.

In the circuit, deviations from nominal resistance is measured, whereby the power supplied is increased if the resistance drops and is reduced if the resistance increases.

A resistance R_1 with a known (low) value is connected in series with the cutting electrode R_2. An operational amplifier Op1 is coupled as a differential amplifier with the series resistance R_1 and the cutting electrode R_2 on the non-inverting input of Op1 and a potentiometer P1 with the resistance R_3 and a resistance on the inverting input of said amplifier.

The voltage U1 at the output of OP1 is, if we assume the current I through the series combination:

$$U1 = I R_2 - I R_1 \cdot R_4/R_3 = I(R_2 - R_1 \cdot R_4/R_3)$$

For U1 = 0 the following is valid:

$$R_2/R_1 = R_4/R_3$$

If R_2 increases, U1 increases to a positive value.

The output from the operational amplifier Op1 via a resistance R_5 connected to the inverting input of an operational amplifier Op2, which is contained in a PI regulator the output voltage of which takes a constantly increasing value as long as the input is negative and a constantly decreasing value for positive input voltages.

The potentiometer P1 is set for desired cutting electrode resistance.

If the cutting electrode is cooled, the resistance R_2 is reduced and the output voltage from Op1 will be negative. Thus Op2 will increase the value of its output voltage. The output of Op2 controls the current I to the cutting electrode via the transistor Tr1. The current to the cutting electrode and thereby the power will increase until the resistance R_2 has taken the correct value.

The resistance R_6 in parallel with the transistor Tr1 feeds a sufficient current I in order to make Op1 able to sense if the cutting electrode is intact or not. At interruption the output of Op1 takes the supply voltage + U which leads to a rapidly falling voltage on the output of Op2 and thereby to a break-through of the zener diode ZD. Thus the transistor Tr2 will be conducting and the alarm relay Re will be activated. At increased cutting speed, the supplied power has to be increased proportionally to the speed. In order to be able to melt more plastic per time unit, it is required that the temperature of the cutting electrode is increased with the speed. Through a positive current feedback 25 in the control circuit via a non-linear element (R7, D1), a control with a transition from curve 2 to curve 3 (fig. 16) can be achieved.

The graph 1 illustrated in Fig. 16 shows the resistance of the cutting electrode as a function of the supply current at still air. The graph 2 in the same figure shows the resistance of the cutting electrode as a function of the supply current at constant-

controlled resistance depending on the cutting speed. The graph 3 in the same figure shows optimal resistance depending on varied cutting velocity. The figure shows graph 4 which shows the change of the set value for the cutting electrode resistance as function of the current.

In Fig. 14, OP3, OP4, D_1 and R_7 compose the current feedback, whereby a low pass filtering (C, R_9) results in a more stable control. Op3 measures the current I and adds an offset. Op4 removes all negative voltages from the output of Op3. D_1 and R_7 change the gain in Op4 over a current I_2 and D_2 and D_3 remove all positive voltages from the output of Op4.

Fig. 15 shows a graph where the supply current **I** and the power **P** of the cutting electrode are shown as a function of the cutting speed *v*.

Another way to measure the temperature can be accomplished by inserting an external temperature sensor 16 between the shanks of the U, as in Fig. 8.

In Fig. 9 and 10, the cutting electrode is heated by means of an external field of force 19 (so called "Foucault currents"). In Fig. 9, the induction coil 18 is placed under the plotter table 20 and, in Fig. 10, it is placed above, in relation to the cutting electrode 2. By applying a high frequency AC current to the coil 18, an alternating magnetic field 19 is created which induces a contactless current in the cutting electrode 2. The resistance of the pin metal causes heating of the latter.

An alternative method to manufacture a tube electrode compared to that in Fig. 2, is shown in Fig. 11. Here the internal electrode 7, first oxidized with an insulating layer on all surfaces except for the ends, thereafter a metallic layer has been galvanically plated, vaporized or sprayed thereon. This layer then constitutes the external electrode with a predetermined electric resistance. When a voltage is applied on the terminals 12, the current passes through the external and the internal electrode via the galvanic connection point 21. Since the internal electrode core 7 is formed with different diameters automatically a larger conduction area is obtained on the thicker part, which results in that only the thinner part will be heated.

Instead of manufacturing an internal electrode with different diameters as in Fig. 2, in fig. 12, it has been shown that the same function can be obtained by using a resistance wire 7, with even cross sectional area, and to provide it with an external tube. Here a variant of a cable connection 12 is also shown, in which the electric conductors 11 can be connected by a shrink sleeve. As a further alternative a so called flat pin connector can be used.

Since there are a large number of different plotters and models in the market, with as many holders (13) for plotter pens, as in Fig. 13, a universal electrode adapter 24 is used, which fits in the holders 1 which are already available for plotter pens. The same figure also shows a design where the cable 10 has been provided with a separable connector 23.

Claims

1. Device for cutting materials, the device comprising a cutting means which can be mounted on a plotter or a similar device controlling the position of the cutting means, the cutting means comprising a cutting element with a holding part (31) and a substantially cylindrical cutting part (30) at its free end, and means to electrically heat the cutting element to a temperature suitable for cutting the material, a control circuit being provided for controlling the heating means in dependence of the temperature of the cutting element,
characterized therein,
that the cutting element is constituted by a cutting electrode which is heated by electric induction and/or resistance heating, the heating means being suitable to generate an electrical current in the cutting electrode, the cutting part (30) of the cutting electrode having a considerably smaller cross-sectional area than the holding part (31), so that the heat production is substantially localized in the cutting part of the cutting electrode.

2. Device according to claim 1,
characterized therein,
that the cutting part (30) of the cutting electrode is made of a material which has a higher resistivity than the material of the holding part (31).

3. Device according to claim 1,
characterized therein,
that the cutting part (30) consists of a cylindrical internal electrode (7), which is electrically insulated from a coaxially provided external electrode (6), by means of a heat resistant insulating layer (9) and that the internal electrode (7) at one of the free ends by a connection (8) is electrically joined to a circuit with the external electrode (6).

4. Device according to claim 3,
characterized therein,
that said heat resistant, insulating layer (9) consists of on either of the electrodes applied oxide layer and that the external electrode consists of a galvanically plated vapored or sprayed metallic layer, which has been elec-

trically connected with the internal electrode (7) through a galvanic connection (21) at the outer end of the electrodes.

5. Device according to claim 1,
characterized therein,
that the cutting part (30) is U-formed and consists of a wire (7a) with substantially semicircular cross section, which is bent in U-form so that an essentially circular cross section is formed.

6. Device according to claim 5,
characterized therein,
that a temperature sensor (16) is provided between the shanks of the U for sensing the end portion of the cutting part.

7. Device according to claim 1,
characterized therein,
that the cutting part (30) is heated by means of an electromagnetic alternating field (19), which is generated from a coil (18), which is situated in the vicinity of the part e.g. above or under a working desk (20), on which the cutting of the material (5) is carried out.

8. Device according to claim 1,
characterized therein,
that at least the front end (8;21) of the cutting part (30) is covered by a wear resistant, heat resistant material with low friction, e.g. metal plating a ceramic or the like.

9. Device according to claim 1,
characterized therein,
that the front end (8;21) of the cutting part (30) is designed or provided with a wear member, e.g. a ball of ceramic or hard metal.

10. Device according to any of the claims 1 - 5,
characterized therein,
that the cutting electrode is connected into the control circuit for measuring and controlling the temperature of the cutting part.

11. Device according to claim 10,
characterized therein,
that the control circuit comprises a measuring resistor having its resistance (R_1) connected in series with the resistance (R_2) of the cutting electrode (2), the cutting electrode (2) being made of a material with a temperature dependent resistivity, and that the resistances (R_1,R_2) can be supplied with a current (I) from a control transistor (Tr1), the control terminal of which is connected to a PI-regulator (Op2), which is provided to give an increasing output voltage on a negative input voltage and a decreasing output voltage on a positive input voltage, the input of which is connected to the output of an amplifier coupled bridge (R_1, R_2, R_3, R_4, Op1) with the bridge condition:

$$R_2/R_1 = R_4/R_3.$$

12. Device according to claim 11,
characterized therein,
that a positive current feedback circuit (25) is provided in the control circuit, that the positive current feed-back circuit (25) is intended, via a non-linear element (D_1,R_7), to control the current in the cutting electrode (2) in such manner, that either the temperature and therewith the resistance (R_2) of the cutting electrode (2) are independent of the cutting speed, or they take an optimum value depending on the cutting velocity, and that a low-pass filter (C, R_9) is provided to stabilize said control.

13. Device according to claim 11,
characterized therein,
that the change in the output voltage of the differential amplifier (Op1) which occurs at interruption of the resistance (R_2) is used to control an interrupt and/or alarm function.

Patentansprüche

1. Vorrichtung zum Schneiden von Material, welche Vorrichtung ein Schneidmittel umfasst das an einen Kurvenschreiber oder dergleichen, der die Position des Schneidmittels kontrolliert angeordnet ist, welches Schneidmittel ein Schneidelement mit einer Halterung (31) und einem im wesentlichen zylindrischen Schneidteil (30) an dessen freien Ende enthält, und Vorrichtungen zum elektrischen erhitzen des Schneidelementes auf eine Temperatur die zum Schneiden des Materiales geeignet ist, wobei ein Steuerkreis zur Steuerung des Schneidmittels in Abhängigkeit der Temperatur des Schneidelementes vorgesehen ist,
dadurch gekennzeichnet,
dass das Schneidelement aus einer Schneidelektrode besteht, die durch elektrische Induktion und/oder Widerstandsheizen erhitzt wird,
dass das Schneidmittel angeordnet ist in der Schneidelektrode einen elektrischen Strom zu erzeugen, und dass das Schneidteil (30) der Schneidelektrode eine wesentlich kleinere Querschnittsfläche als die Halterung (31) aufweist, sodass die Hitzeerzeugung hauptsächlich in dem Schneidteil der Schneidelektrode lokalisiert ist.

2. Vorrichtung nach Anspruch 1,
dadurch gekennzeichnet,
dass das Schneidteil (30) der Schneidelektrode aus einem Material hergestellt ist, das grösseren Widerstand hat als das Material der Halterung (31).

3. Vorrichtung nach Anspruch 1,
dadurch gekennzeichnet,
dass das Schneidteil (30) aus einer zylindrischen inneren Elektrode (7) besteht, die elektrisch von einer koaxial angeordneten äusseren Elektrode durch eine hitzebeständige Isolierschicht (9) isoliert ist, und
dass die innere Elektrode (7) an dem einen freien Ende durch eine Verbindung (8) elektrisch zu einem Kreis mit der äusseren Elektrode (6) verbunden ist.

4. Vorrichtung nach Anspruch 3,
dadurch gekennzeichnet,
dass die erwähnte hitzebeständige Isolierschicht (9) aus einer an einer der Elektroden angebrachte Oxidschicht besteht, und
dass die äussere Elektrode aus einer galvanisch plätierten, verdampften oder aufgespritzten Metallschicht besteht, die mit der inneren Elektrode (7) durch eine galvanische Verbindung (21) am äusseren Ende der Elektroden elektrisch verbunden ist.

5. Vorrichtung nach Anspruch 1,
dadurch gekennzeichnet,
dass das Schneidteil (30) U-förmig ausgebildet ist und aus einem Draht (7a) mit im wesentlichen halbkreisförmigem Querschnitt besteht, welcher U-förmig so gebogen ist, dass ein hauptsächlich kreisförmiger Querschnitt gebildet wird.

6. Vorrichtung nach Anspruch 5,
dadurch gekennzeichnet,
dass ein Temperaturgeber (16) zwischen den Schenkeln des U's zum Fühlen der Endpartie des Schneidteiles angeordnet ist.

7. Vorrichtung nach Anspruch 1,
dadurch gekennzeichnet,
dass das Schneidteil (30) mittels eines elektromagnetischen Wechselfelts (19) erhitzt wird, das von einer Spule (18) erzeugt wird, die in der Nähe des Schneidteiles, beispielsweise oberhalb oder unterhalb eines Arbeitstisches (20), auf welchem das Schneiden des Materiales (5) durchgeführt wird, vorgesehen ist.

8. Vorrichtung nach Anspruch 1,
dadurch gekennzeichnet,
dass zumindest das vordere Ende (8;21) des Schneidteiles (30) mit einem verschleissfesten, hitzebeständigen Material mit niedriger Reibung, z.B. Keramik oder dergleichen überzogen ist.

9. Vorrichtung nach Anspruch 1,
dadurch gekennzeichnet,
dass das vordere Ende (8;21) des Schneidteiles mit einem Verschleisskörper, z.B. einer Kugel aus Keramik oder Hardmetall ausgebildet oder versehen ist.

10. Vorrichtung nach einem der Ansprüche 1 - 5,
dadurch gekennzeichnet,
dass die Schneidelektrode in dem Steuerkreis zum Messen und Kontrollieren der Temperatur des Schneidteiles angeordnet ist.

11. Vorrichtung nach Anspruch 10,
dadurch gekennzeichnet,
dass der Steuerkreis einen Messwiderstand enthält, dessen Widerstand (R_1) in Reihe mit dem Widerstand (R_2) der Schneidelektrode (2) geschalten ist,
dass die Schneidelektrode (2) aus einem Material mit einem temperaturabhängigen Widerstand hergestellt ist, und
dass die Widerstände (R_1,R_2) mit Strom (I) von einem Regeltransistor (Tr1) gespeist werden können, dessen Steuerterminal an einen PI-Regulator (Op2) angeschlossen ist, der angeordnet ist eine steigende Ausgangsspannung bei einer negativen Eingangsspannung und eine abnehmende Ausgangsspannung bei einer positiven Eingangsspannung zu geben, und dessen Eingang an den Ausgang einer verstärkerangeschlossenen Brücke (R_1,R_2,R_3,R_4, Op1) mit der Brückenbedingung:

$$R_2/R_1 = R_4/R_3$$

angeschlossen ist.

12. Vorrichtung nach Anspruch 11,
dadurch gekennzeichnet,
dass ein positiver Stromrückkopplungskreis (25) in dem Regelkreis angeordnet ist,
dass der positive Stromrückkopplungskreis (25) angeordnet ist, über ein nichtlineares Element (D_1,R_7) den Strom in der Schneidelektrode (2) auf solche Weise zu steuern, dass entweder die Temperatur und damit der Widerstand (R_2) der Schneidelektrode (2) unabhängig von der Schneidegeschwindigkeit ist oder sie nehmen einen optimalen Wert abhängig von der Schneidgeschwindigkeit an, und
dass ein Tiefpassfilter (C,R_9) vorgesehen ist

die erwähnte Regelung zu stabilisieren.

13. Vorrichtung nach Anspruch 11,
dadurch gekennzeichnet,
dass die Änderung der Ausgangsspannung des Differentialverstärkers (Op1), die bei der Unterbrechung des Widerstandes (R_2) entsteht, zur Regelung der Unterbrechungs- und/oder Alarmfunktion angewandt wird.

Revendications

1. Dispositif pour couper des matériaux, le dispositif comprenant un moyen de coupe pouvant être monté sur une table de traçage ou appareil similaire commandant la position du moyen de coupe, le moyen de coupe comprenant un élément de coupe avec une partie servant à la préhension (31) et une partie coupante essentiellement cylindrique (30) à son extrémité libre, et un moyen pour chauffer électriquement l'élément de coupe à une température appropriée pour couper le matériau, un circuit de commande étant prévu pour commander le moyen de chauffage en fonction de la température de l'élément de coupe, caractérisé en ce que l'élément de coupe est constitué par une électrode de coupe chauffée par induction électrique et/ou par une résistance électrique, le moyen de chauffage étant prévu pour générer un courant électrique dans l'électrode de coupe, la partie coupante (30) de l'électrode de coupe ayant une section transversale considérablement plus petite que celle de la partie servant à la préhension (31), de telle sorte que la dissipation thermique est essentiellement localisée dans la partie coupante de l'électrode de coupe.

2. Dispositif selon la revendication 1, caractérisé en ce que la partie coupante (30) de l'électrode de coupe est réalisée dans un matériau ayant une résistance spécifique supérieure à celle du matériau de la partie servant à la préhension (31).

3. Dispositif selon la revendication 1, caractérisé en ce que la partie coupante (30) est constituée par une électrode cylindrique interne (7) qui est isolée électriquement d'une électrode externe (6) ayant le même axe longitudinal, au moyen d'un revêtement isolant (9) résistant à la chaleur, et en ce que l'électrode interne (7) est raccordée électriquement, à l'une de ses extrémités libres, par une connexion (8), pour former un circuit avec l'électrode externe (6).

4. Dispositif selon la revendication 3, caractérisé en ce que ledit revêtement isolant (9) résistant à la chaleur, est constitué par une couche d'oxyde appliquée sur l'une et l'autre des électrodes, et en ce que l'électrode externe est constituée par une couche métallique obtenue par revêtement galvanique, vaporisation ou pulvérisation, et reliée électriquement à l'électrode interne (7) par une connexion galvanique (21) à l'extrémité extérieure des électrodes.

5. Dispositif selon la revendication 1, caractérisé en ce que la partie coupante (30) est en forme de U et est constituée par un fil métallique (7a) de section transversale sensiblement semi-circulaire, qui est recourbé en forme de U de façon à prendre une section transversale pratiquement circulaire.

6. Dispositif selon la revendication 5, caractérisé en ce qu'un capteur de température (16) est prévu entre les bras du U pour détecter la température de l'extrémité de la partie coupante.

7. Dispositif selon la revendication 1, caractérisé en ce que la partie coupante (30) est chauffée au moyen d'un champ électromagnétique alternatif (19) généré par une bobine (18) située à proximité de cette partie, par exemple au-dessus ou en dessous d'un établi (20) sur lequel est effectuée l'opération de coupe du matériau (5).

8. Dispositif selon la revendication 1, caractérisé en ce que l'extrémité frontale (8 ; 21) au moins de la partie coupante (30) est revêtue d'un matériau résistant à l'usure et à la chaleur, ayant un faible coefficient de friction, par exemple une céramique à revêtement métallique ou équivalent.

9. Dispositif selon la revendication 1, caractérisé en ce que l'extrémité frontale (8 ; 21) de la partie coupante (30) est constituée par - ou comporte - une pièce d'usure, par exemple une bille de céramique ou de métal dur.

10. Dispositif selon l'une quelconque des revendications 1 à 5, caractérisé en ce que l'électrode de coupe est reliée au circuit de commande pour mesurer et piloter la température de l'élément de coupe.

11. Dispositif selon la revendication 10, caractérisé en ce que le circuit de commande comporte une résistance de mesure, de résistance spécifique (R1) placée en série avec la résistance

(R2) de l'électrode de coupe (2), l'électrode de coupe (2) étant réalisée dans un matériau dont la résistance dépend de la température, et en ce que les résistances R1, R2) peuvent être traversées par un courant (I) provenant d'un transistor de commande (Tr1), dont la borne de commande est reliée à un régulateur de type PI (Op2) qui est prévu pour donner une tension de sortie croissante sur une tension d'entrée négative, et une tension de sortie décroissante sur une tension d'entrée positive, et dont l'entrée est reliée à la sortie d'un pont (R1, R2, R3, R4, Op1) couplé en amplificateur, avec la condition d'équilibre du pont :

$$R2 / R1 = R4 / R3$$

12. Dispositif selon la revendication 11, caractérisé en ce qu'un circuit de rétroaction à courant positif (25) est prévu dans le circuit de commande, en ce que le circuit de rétroaction à courant positif (25) est prévu pour commander, par l'intermédiaire d'un élément non linéaire (D1, R7), le courant dans l'électrode de coupe (2) de telle sorte que la température et donc la résistance (R2) de l'électrode de coupe (2), soient indépendantes de la vitesse de coupe, ou bien qu'elles prennent une valeur optimale en fonction de la vitesse de coupe, et en ce qu'un filtre passe-bas (C, R9) est prévu pour stabiliser ladite commande.

13. Dispositif selon la revendication 11, caractérisé en ce que le changement de la tension de sortie de l'amplificateur différentiel (Op1) qui a lieu au moment de la rupture de la résistance (R2) est utilisée pour commander une fonction d'interruption et / ou d'alarme.

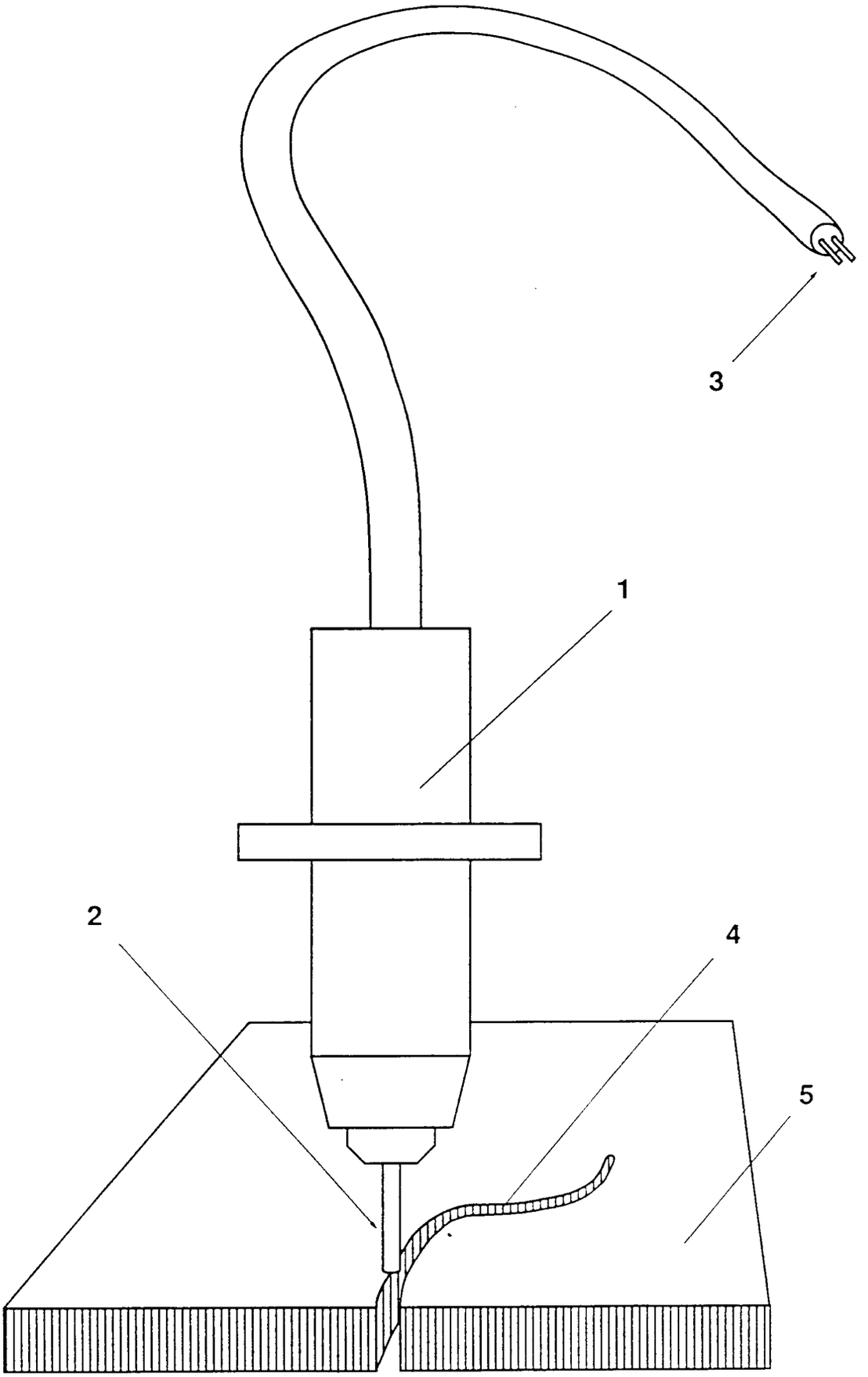


Fig. 1

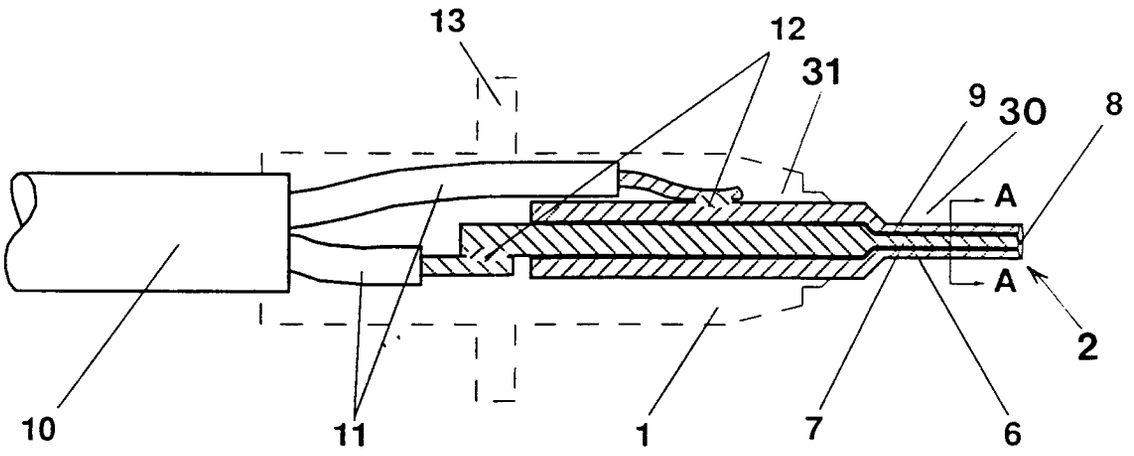


Fig. 2

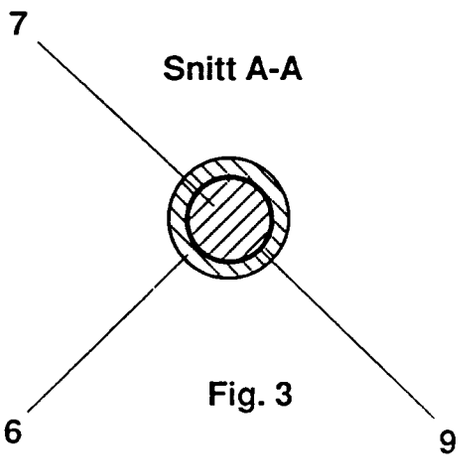


Fig. 3

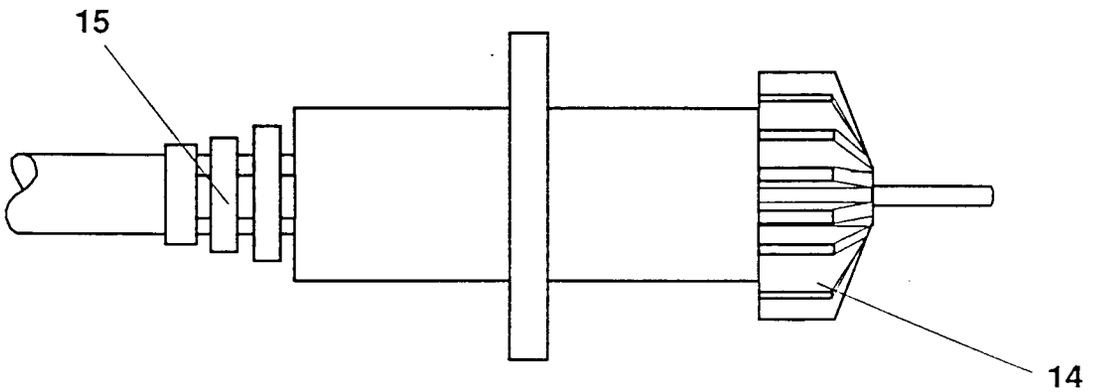


Fig. 4

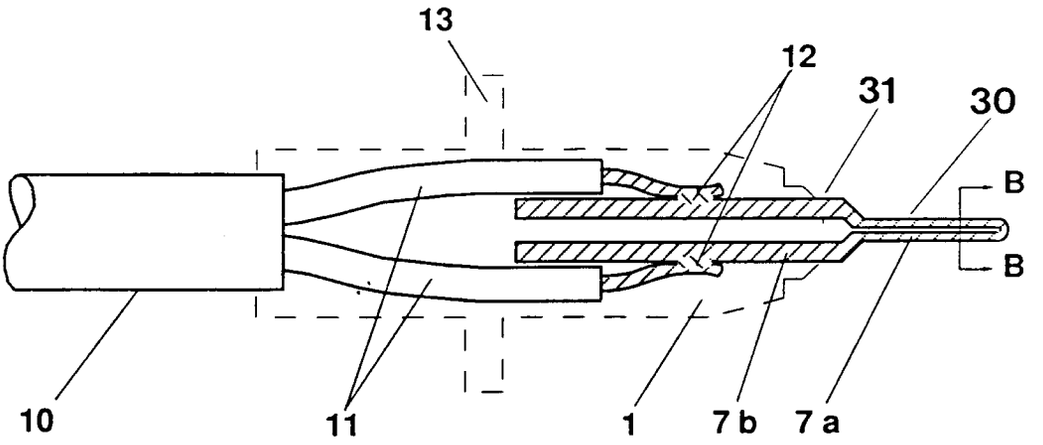


Fig. 5

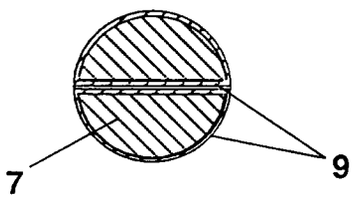


Fig. 6

Snitt B-B

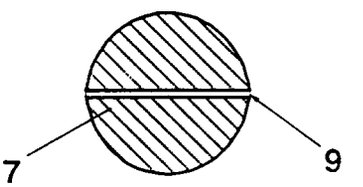


Fig. 7

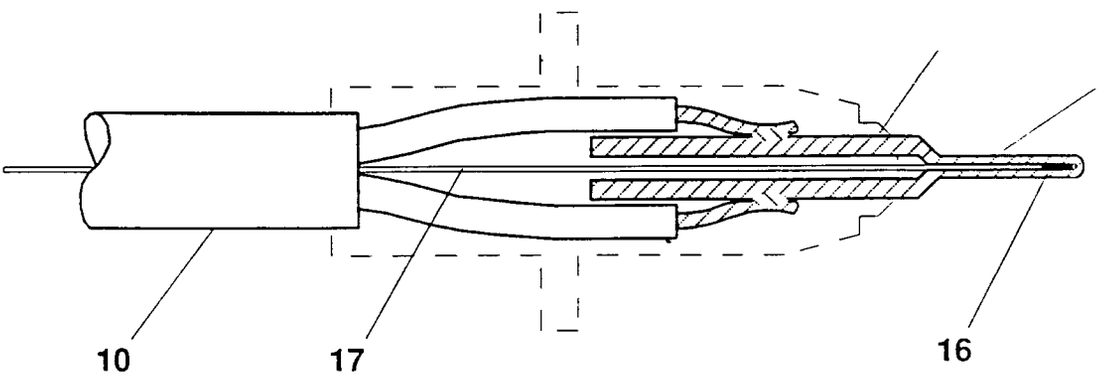


Fig. 8

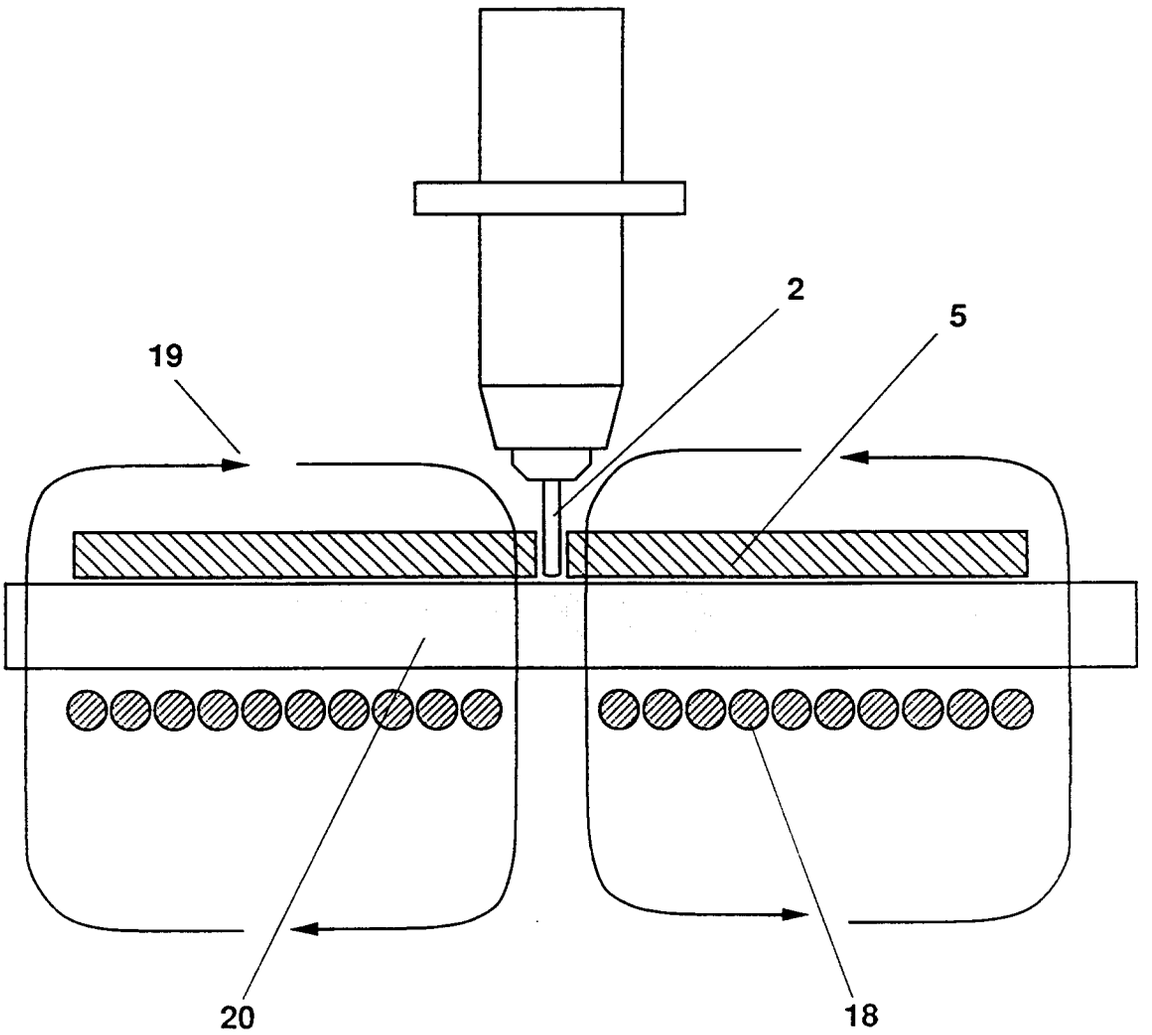


Fig. 9

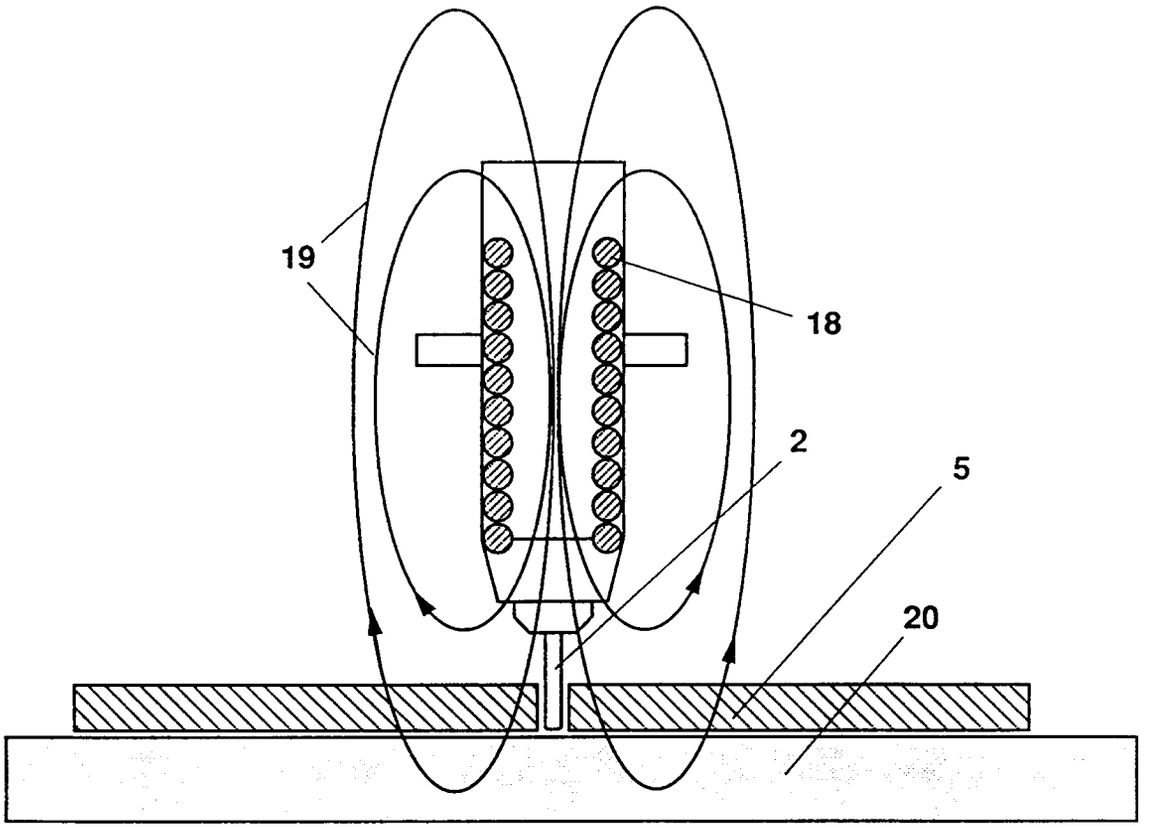


Fig. 10

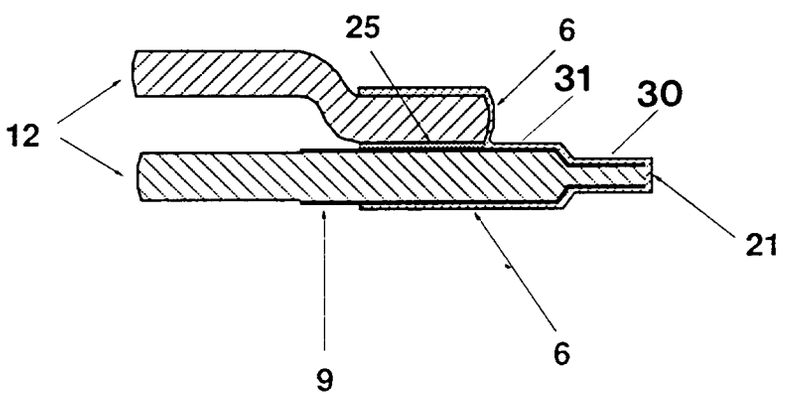


Fig. 11

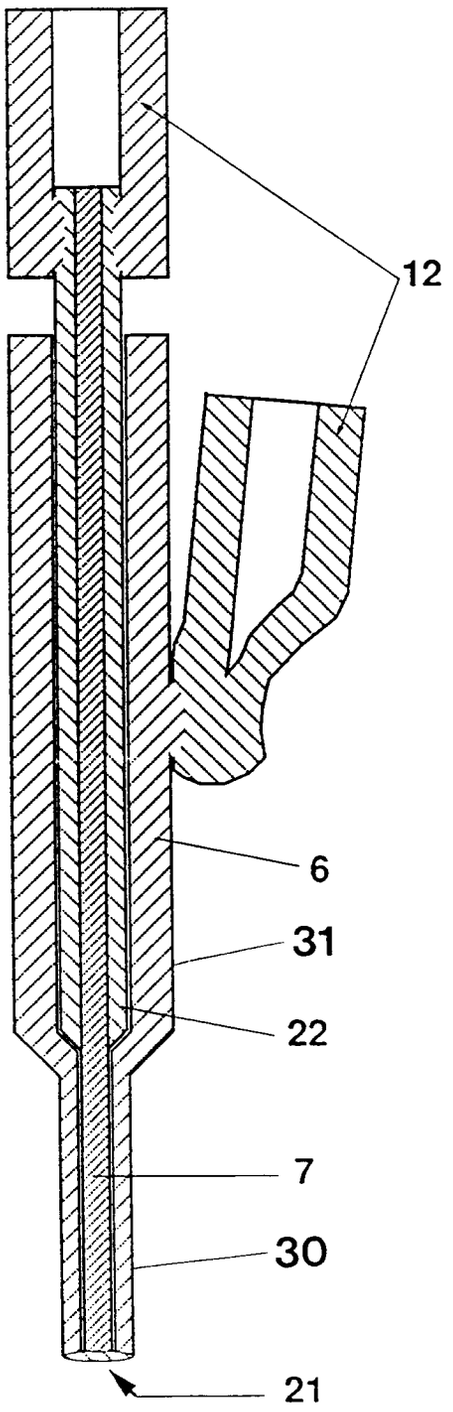


Fig. 12

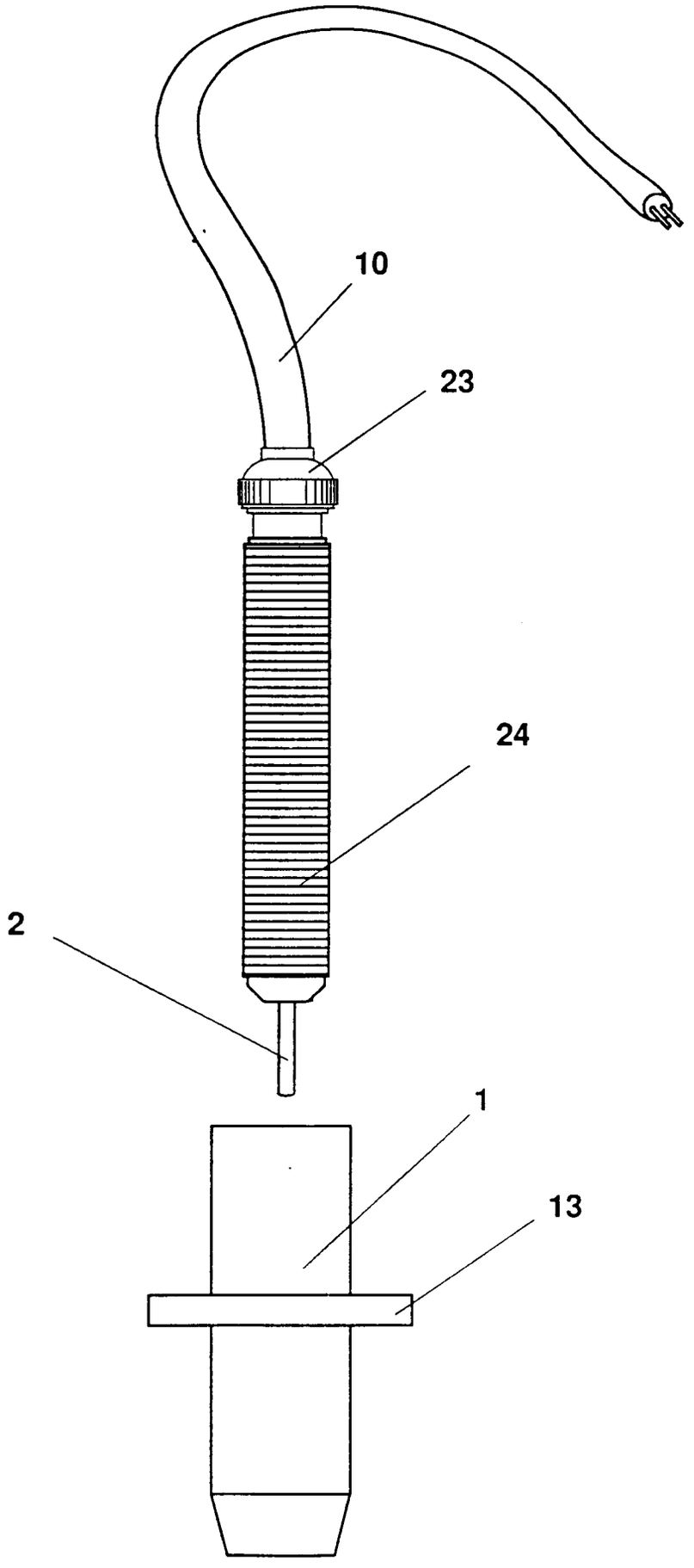


Fig. 13

FIG. 14

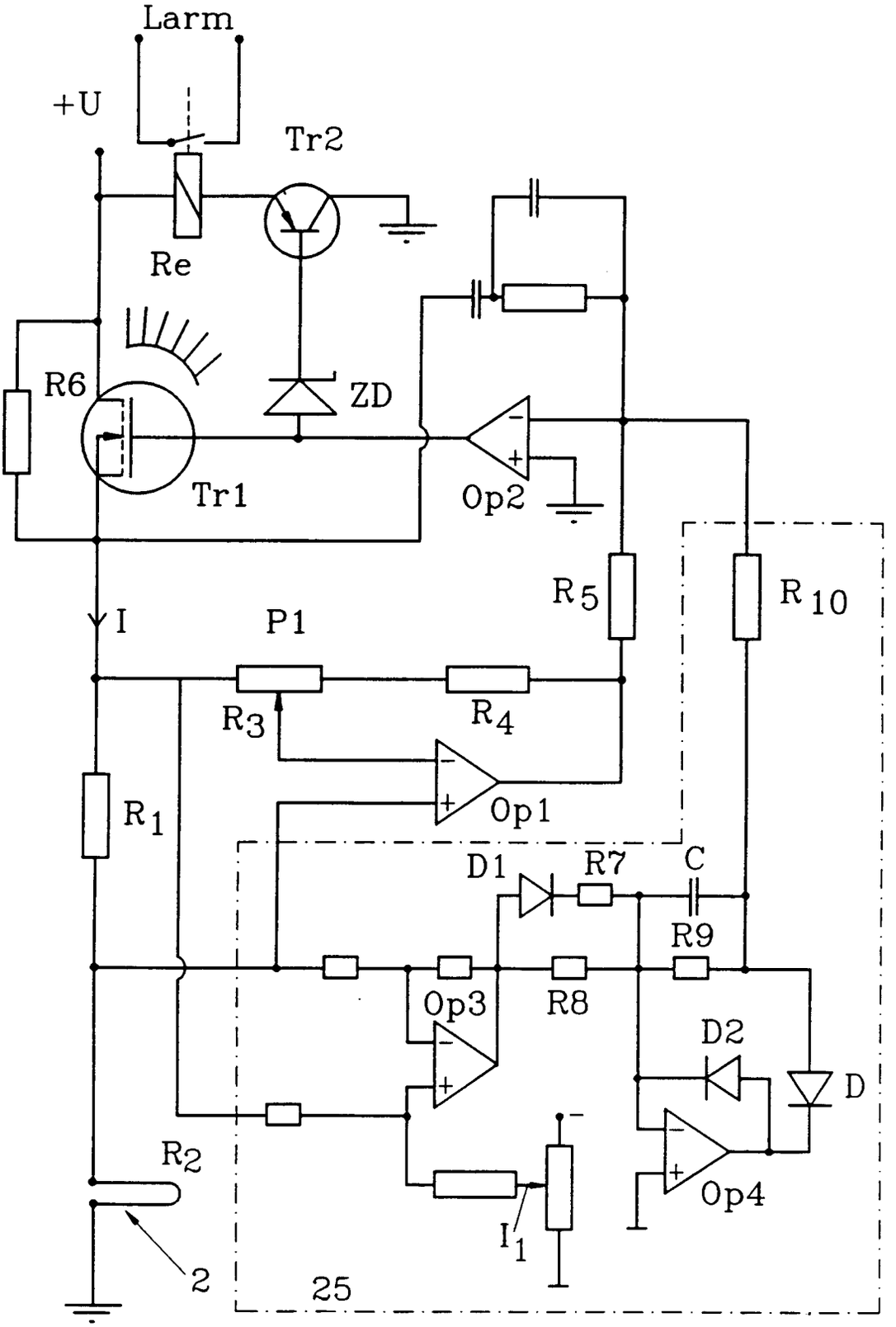

Larm
+U
Tr2
Re
R6
ZD
Tr1
Op2
I
P1
R5
R10
R3
R4
R1
Op1
D1
R7
C
R9
Op3
R8
D2
D
R2
Op4
I1
2
25

FIG. 15

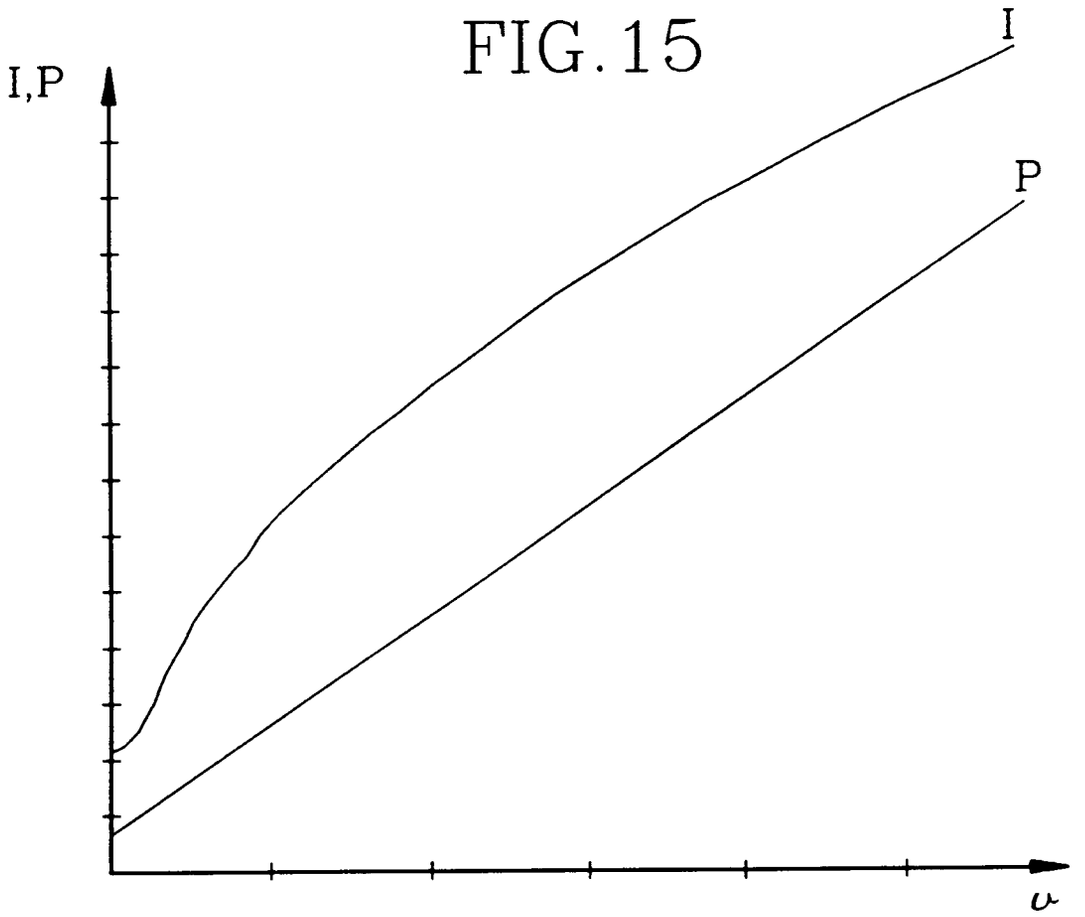


FIG. 16

