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(54) **Corona treatment method and device**

(57) Method and device for the corona effect treatment of a substrate (S), in which an electric discharge (E) of proper intensity is produced between at least a live active electrode (10) and a passive electrode or counter electrode (11, 20, 21) placed beside said active electrode

(10) and connected to the ground, wherein at least one of said active electrode (10) and said counter electrode (11) is provided with a hollow body, basically having a tubular extended shape and made of insulating material, having a portion of a side surface, facing the substrate, coated inside with an electricity conductive layer (14).

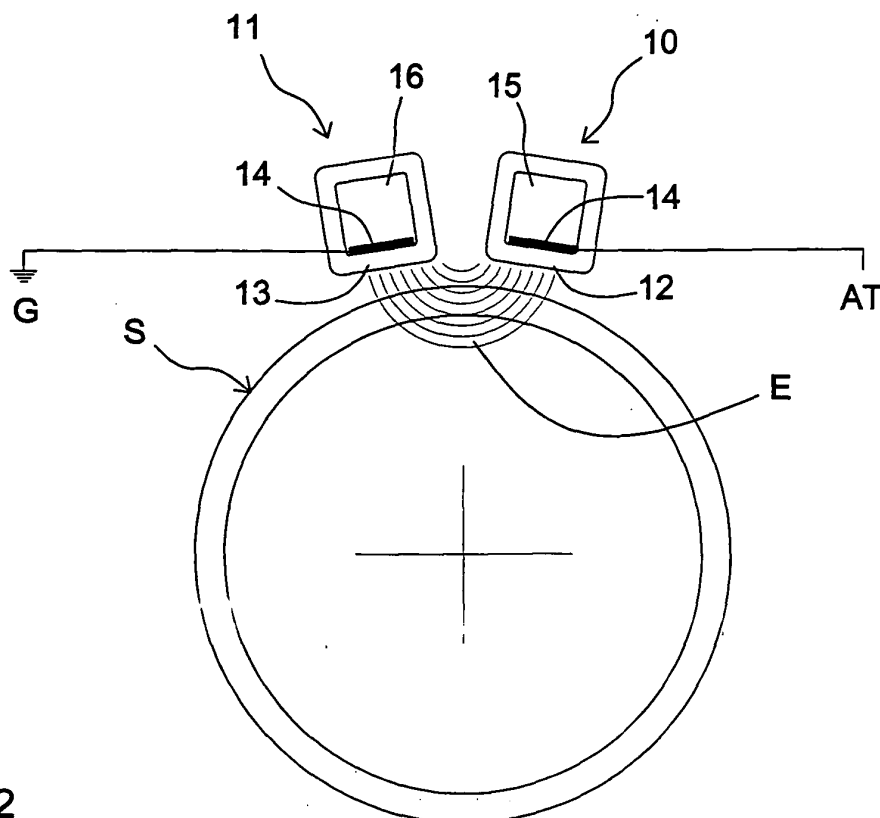


FIG. 2

Description

[0001] The invention relates to the corona treatment technique.

[0002] It is well known that the corona treatment basically consists in applying an high intensity electric discharge to the surface of a certain substrate, in order to increase the active tension and consequently to improve the fixing power of printing inks, stickers or coatings..

[0003] The substrate can be either a film or an extruded item, sheets or plates, wires, tubes, metal plates etc.

[0004] For example, the corona treatment is widely used to increase the wettability of plastic, metal or paper films, and to help the adhesion of inks, stickers, lacquers... ; it is often used for polyethylene, polypropylene, PVC or polyester films, but it is suitable for almost any plastic material and also for some non-plastic materials such as paper and aluminium.

[0005] A corona treater, as known from prior art, basically comprises a high frequency generator, a step-up transformer connected with one or more metal electrodes, and a roll (or a sheet) electrically connected to the ground and acting as a counter electrode. Said roll can be coated with insulating material (silicon, ceramic or others).

[0006] The substrate is inserted between the electrodes and the roll, with known dragging means. This way, the surface of the substrate is activated by the electric discharge generated between the electrodes in tension and the roll connected to the ground.

[0007] With reference to the known corona treaters, the enclosed schemes from a) to e) in Fig. 1 show the currently used techniques.

a) For the treatment of a non conductive substrate S, it is known a treater basically comprises a metallic electrode 1 and a metallic roll 2 acting as a counter electrode. Roll 2 is coated with a layer of a non-conductive material 3 and connected to the ground. When operating, a discharge E between electrode 1 and roll 2 is generated. As shown in the figure, substrate S is placed between the electrode and the roll, so that it is hit by the aforesaid discharge E.

b) As in the previous case, but using a naked roll (i.e. not coated with dielectric material). This solution is chosen when the non-conductive substrate S, thanks to its thickness, can act as an insulator.

c) The treater comprises many ceramic tube electrodes 4 (or another kind of insulating material) with conductive material inside them. In this case, substrate S can be conductive or non-conductive. As in the previous cases, the counter electrode comprises a metallic roll 2, placed on the opposite side of the substrate and connected to the ground.

d) As in the previous case, with a counter electrode comprising a metallic sheet 5 connected to the ground replacing roll 2.

e) The treater uses an electrode 6 comprising a ce-

ramic tube (or another kind of insulator) filled with conductive material, and next to electrode 6 is placed a counter electrode 7 comprising a similar ceramic tube filled with conductive material and connected to the ground. The corona effect develops between the sides of electrode 6 and counter electrode 7 and is directed towards substrate S by a forced air flow F. This method is suitable only for small surfaces or section bars in general.

[0008] Following those schemes, a large number of devices for the treatment of extruded, sheets, plates, tubes and so on can be produced. Machines can be devised to work on their own or connected to another unit, for example an extruder, a flexo printer, a rotogravure, a coupling machines, a sheets production line, etc.

[0009] To trigger the corona effect in devices from a) to d) a very high voltage is required. Moreover, such voltage must be increased if the dielectric substrate is thicker.

[0010] This disadvantage is the direct consequence of the treatment method used. According to such method, the electrode and the counter electrode (roll or sheet) are placed in the opposite parts of the substrate (on the upper and on the lower side), so that the discharge has to pass through the whole substrate. Therefore, the distance between the live electrodes and the counter electrode connected to the ground must not be lower than the sum of the thickness of the substrate, the air gap that must exist between the electrodes and the surface to treat, and the thickness of the non-conductive layer covering the roll (in case there is one).

[0011] As an example, we can take into consideration a typical device, in which the substrate comprises a sheet or an extruded 10 mm thick; the air gap should be 1,5 mm, and the dielectric roll covering is usually 3 mm thick. The total distance between the electrodes and the conductive part of the roll is more or less 15 mm, and considering an average dielectric rigidity of a substrate of 2.000 V/mm, the resulting trigger tension is equal to 30.000 V. So high tensions can be a problem for safety and can damage and/or burn some materials. Moreover, such tensions require a proper design of the insulation and protection means of the device, which cause overall dimensions of the machine.

[0012] In addition, the above mentioned prior art is not suitable for certain applications, in particular for the treatment of curved surfaces such as the tubes sides. These applications are not that uncommon, for example for ink-jet printing of the name of the producer, nominal data... on polyethylene tubes.

[0013] More in detail, the surface to treat is basically a narrow band along the external surface of the tube, and so the prior art turns out to be not really suitable. As a matter of fact, it is difficult to produce the desired effect, i.e. the corona discharge, on said band, due to the lack of a counter electrode in the tube in extrusion.

[0014] Device e) in Fig. 1, in which the electrodes are one beside the other, partially solves this problem since

the discharge does not have to pass through the substrate layer. Nevertheless, the discharge tends to develop between the sides of the electrodes, being said electrodes totally filled with conductive material, and it is not directed towards the underneath substrate.

[0015] For this reason it is necessary to introduce the forced air flow F; anyway, the discharge still remains localized in the space between the electrodes where it does not have any useful effect. Moreover, as previously stated, this known art can be used only for small surfaces or section bars in general and does not solve the above mentioned problems related to the tubes treatment.

[0016] The prior art turns out to be inadequate or unsatisfactory for the treatment of three-dimensional objects plane sides.

[0017] The object of the invention is to overcome all these problems.

[0018] In greater detail, the scope of the invention is to reduce the tension necessary for the trigger of the discharge and to direct it towards the substrate, without the use of a forced air flow even if the electrode and the counter electrode are one beside the other, as in the prior art.

[0019] A further aim of the invention is to treat more easily the sides of tubes or other curved surfaces, as well as complex three-dimensional objects surfaces.

[0020] Such aims are achieved using a method for the corona effect treatment of a substrate, in which an electric discharge of proper intensity is produced between at least a live active electrode and a passive electrode or counter electrode placed beside said active electrode and connected to the ground, characterized in that at least one of said active electrode and said counter electrode is provided with a hollow body, basically having a tubular extended shape and made of insulating material, having a portion of a side surface, facing the substrate, coated inside with an electricity conductive layer.

[0021] According to a preferred embodiment of the invention, said hollow structure is used at least for the active electrode, having a ceramic body in which a side of the surface towards the substrate is coated with metal, advantageously with silver.

[0022] With "hollow inner part" we mean that the inner volume created by the tubular body is not filled with conductive material, since the only conductive part is said internal coating layer. Typically, the interior is filled with air.

[0023] According to a more preferred embodiment of the invention, the method implies the use of at least one active electrode comprising a square or trapezoidal (section) bar, which is placed close or beside a counter electrode. The bar has a ceramic or another non-conductive material body, and the face towards the substrate is lined with silver or another conductive material.

[0024] According to an even more preferred embodiment of the invention, both the active electrode and the counter electrode have said hollow-body insulating structure and a conductive lining. A simplified version can be

produced using non ceramic counter electrodes such as T beams or a metallic cable.

[0025] Another aspect of the invention consists in using many active and passive electrodes of the kind just described. The electrodes are one beside the other and alternated on a certain surface, usually, but not necessarily, plane. For example, the electrodes are placed over a plane on which the substrate (a film, a sheet, an extruded, - a tube or plates) slides, and said active and passive electrode are alternated.

[0026] Said plane on which the substrate slides comprises known dragging means, such as convey rolls, take-up reels, or equivalent. This way many corona discharges hitting the substrate are produced.

[0027] According to a further aspect of the invention, the electrodes are connected to a mechanical or manual motion system. The movable electrodes enable to operate on a steady substrate; they also enable to treat the plane surfaces of three-dimensional objects, compatibly with the limits (known by the skilled man) imposed by the electrodes dimensions and shapes.

[0028] Is an object of the invention also a high-frequency generator and a high-tension transformer for the corona effect treatment, or corona treater, which has to operate according to said method.

[0029] Advantageously, the invention enable to avoid the use of rolls or plates connected to the ground, due to the fact that the electrodes are placed on the same side of the substrate (i.e. next to it, or over it), and to the fact that the electric discharge is produced directly between the active and passive electrode/s. The discharge does not have to pass through neither the whole layer of the substrate, nor the insulating layer of the roll. It follows that the triggering tension required is much lower than with the method in which electrode and counter electrode are on opposite parts of the substrate, with the same effect.

[0030] In addition, the described structure of the electrode with hollow interior and lined with conductive material only in the inner part near the substrate, produces an arch discharge projecting towards the substrate instead of concentrating in the space between the sides of the electrodes, as in the known systems shown in Fig. 1 e).

[0031] Another important advantage is the structural simplicity of the treater: the passive roll counter electrode is eliminated; the voltages used are lower and so imply fewer safety and insulating problems; the machine is more compact.

[0032] The features and advantages of the invention will become more apparent from the following detailed description of preferred embodiments, which are disclosed by way of non-limitative examples, and with the help of the accompanying drawings, in which:

Fig. 2 shows a scheme of the treatment, according to a preferred embodiment of the invention, applied on the side of a tube;

Fig. 3 shows a scheme of the treatment, according

to the invention, applied on a plane sheet or an extruded;

Fig. 4 shows a tube electrode according to the invention;

Figs. 5 and 6 show further embodiments of the invention.

[0033] With reference to figures from 2 to 4, the invention relates to a method for the corona effect treatment on a surface S, or part of it, of a substrate, such as an extruded, a tube or a sheet of material. The treatment is the effect of the electric discharge E generated between at least an active electrode 10 and a corresponding passive electrode (or counter electrode) 11, which are placed one beside the other and on the same part, with respect to the substrate, i.e. over it or near it.

[0034] The active electrode 10, as shown in the scheme, has a connection AT to a generator and possibly to a tension raiser transformer; the passive electrode 11 has an ground connection G.

[0035] Active electrode 10 comprises a ceramic bar or tube with hollow interior and a side 12 towards substrate S, lined with a conductive layer 14 connected to high tension AT. Said conductive layer is preferably made of metal or even more preferably of silver.

[0036] According to a preferred embodiment, shown in Figs. 2-4, the counter electrode or passive electrode 11 has the same structure as electrode 10, with a face 13 likewise towards substrate S and lined with a conductive layer 14.

[0037] Internal volume 15 of the electrode 10 is filled with air; internal volume 16 of the counter electrode 11 is likewise filled with air.

[0038] Electric discharge E is generated between the metallic side 12 of the active electrode 10 and the metallic side 13, placed next to it, of the counter electrode 11, hitting surface S of the substrate. As an effect of the conductive layer 14, the electric discharge E tends to produce an arch projecting towards the underlying surface S of the substrate, instead of generating useless sparks between the sides of the electrodes as it could happen, for example, if there were any conductive material in interiors 15 and 16 of the electrodes.

[0039] So, it is clear that the method provided by the invention enables a strict control of the discharges and, thanks to the proper placing of the electrodes with respect to the plane on which the substrate slides, allows to direct electricity towards the substrate to treat instead of dispersing it in spaces useless for the corona treatment, such as the sides of the electrodes.

[0040] Fig. 2 shows the position of electrodes 10 and 11 to treat the side of a tube: electrodes 10 and 11 are placed next to the tube and immediately close to its external surface S, preferably with sides 12 and 13 perpendicular to the radial direction defined by the tube.

[0041] Furthermore, in the embodiment shown in Fig. 3, there are many electrodes one beside the other and alternated on the same horizontal disposition, in order to

generate many discharges E1, E2...

[0042] Preferably, electrodes are in odd number, the external ones are connected to the ground. Thanks to this, the protective casing of the machine can be placed closer to the external electrodes, since these ones are not in tension (i.e. live). In Fig. 3 for example, discloses an active electrode 10 and two external electrodes connected to the ground 11A, 11 B.

[0043] Further lay-outs are possible, due to the fact that, basically, the invention is based on the fact that each active electrode discharges towards at least one passive electrode. E.g., with reference to a three-electrodes disposition, a reversed disposition can be used, instead of that shown in Fig. 3, with the passive electrode in the middle and two active electrodes on the sides.

[0044] The electrodes disposition in Fig. 3, or more in general with electrodes one next to the other over the substrate, in even or odd number, is suitable to treat surfaces of plane sheets, extruded or plates or the like, which are carried continuously and by known means, sliding underneath the electrodes.

[0045] The examples make it clear that when the electrodes are placed on the same part of the substrate, i.e. over it or one side of it, it is not necessary to produce the discharge throughout the whole thickness of the substrate, but on the contrary it is possible to direct the corona discharge exactly where it is required, i.e. on the surface of a tube, an extruded item or another substrate.

[0046] The treatment can be equally carried out with a steady substrate and a mobile electrode moved to treat the whole required surface. More in detail, another version (not showed) implies the connection of the active and passive electrodes to a manual or automatic moving system (mobile electrodes), to work on a steady substrate or even on plane surfaces of three-dimensional objects. The treatment of objects' surfaces, as known, is possible if said surfaces are physically reachable by the electrodes, considering the electrodes' dimensions and shapes and the limited corona discharge action field (usually 2-3 mm).

[0047] Fig. 4 shows the preferred shape of the electrode, referring indifferently to an active or a passive electrode, having face 12 or 13, towards the substrate, coated inside with an electricity conductive layer (14). In similar devices, as known to the skilled man, electrodes can have a transversal section different from the basically square section of Figs. 2-4. As an example, the electrodes can have a trapezoidal section, preferably with the smaller side facing the substrate, or a polygonal section, having one or more internal sides lined with conductive material, or even a circular section, part of which is lined with conductive material.

[0048] It is also clear that the insulating material of the electrodes can be different from the mentioned ceramic; and the conductive material of the covering layer 14 can be different from the mentioned silver. Said materials being described as preferred.

[0049] It is preferable to use the above described struc-

ture both for the active electrode and for the counter electrode, to obtain the greatest effect of arch discharge. Nonetheless, a simplified and cheaper version of the invention implies the use of non-ceramic conductive counter electrodes: as an example, Fig. 5 shows a scheme with counter electrode 20 composed by a metallic T beam; Fig. 6 shows an even cheaper version in which the counter electrode is simply a metal wire 21 connected to the ground.

[0050] Thanks to such simplified version it is possible to reduce the manufacturing cost of the device and still achieve a positive result, since the discharge, which is generated between the metallic coated face of the active electrode and the metallic counter electrode, is directed mainly towards the substrate.

[0051] The invention is suitable for treating both plastic and non-plastic materials, such as paper and aluminium, and can be used with known types of devices for corona treatment.

Claims

1. Method for the corona effect treatment of a substrate (S), in which an electric discharge (E) of proper intensity is produced between at least a live active electrode (10) and a passive electrode or counter electrode (11, 20, 21) placed beside said active electrode (10) and connected to the ground, **characterized in that** at least one of said active electrode (10) and said counter electrode (11) is provided with a hollow body, basically having a tubular extended shape and made of insulating material, having a portion of a side surface, facing the substrate, coated inside with an electricity conductive layer (14).
2. Method according to claim 1, **characterized in that** said hollow electrode (10,11) is made of ceramic material.
3. Method according to claims 1 or 2, **characterized in that** said conductive layer (14) is made of metal.
4. Method according to claim 3, **characterized in that** said conductive layer (14) is made of silver.
5. Method according to any of the previous claims, **characterized in that** said hollow electrode (10,11) comprises a polygonal section bar, in which said section has one side (12,13) facing the substrate (S) and lined with said conductive layer (14).
6. Method according to claim 5, **characterized in that** the electrode bar has a square or trapezoidal section, having its minor side facing the substrate.
7. Method according to any of the previous claims, **characterized in that** both the active electrode (10) and the counter electrode (11) have said structure with a hollow tubular body and a portion of the side surface (12,13) facing the substrate (S) and lined with conductive material (14).
8. Method according to any of the previous claims, **characterized in that** many active electrodes (10) and passive electrodes (11, 20, 21) are used.
9. Method according to claim 8, **characterized in that** the electrodes are one beside the other and alternated on the same surface, so that many electrical discharges can be generated between each active electrode (10) and at least one passive electrode, for the treatment of plane sheets, extruded, plates and the like.
10. Method according to claim 9, **characterized in that** the electrodes are in odd number, and the two outer electrodes (11A, 11 B) are passive, i.e. connected to the ground.
11. Method according to any of the previous claims, **characterized in that** the electrodes are connected to a manual or automatic moving system for the treatment of a steady substrate or objects' plane surfaces.
12. Device for the corona treatment of a substrate (S), **characterized in** having at least an active electrode (10) and a passive electrode or counter electrode (11, 20, 21) to execute a treatment according to any of the previous claims.

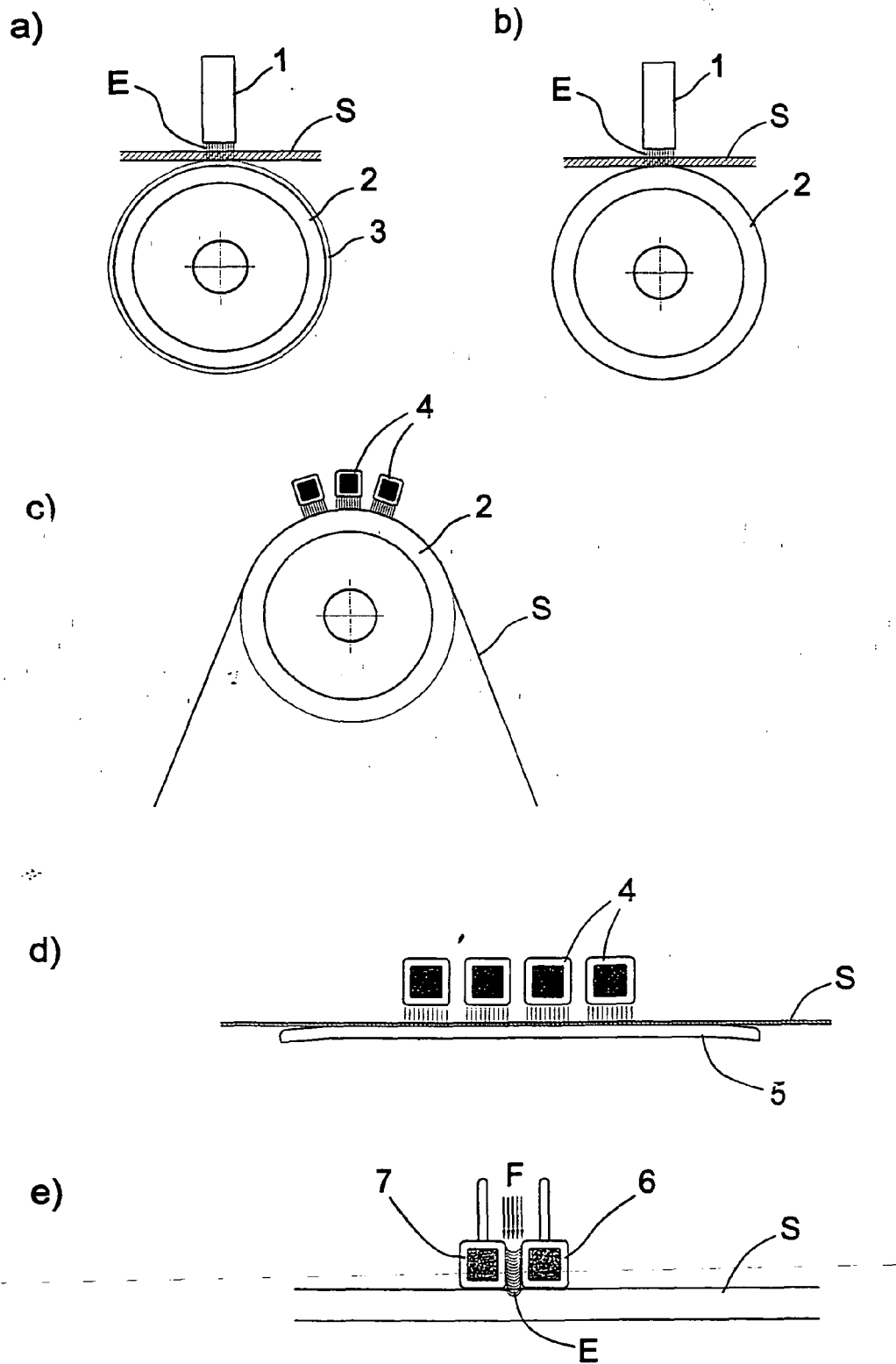


FIG. 1 (PRIOR ART)

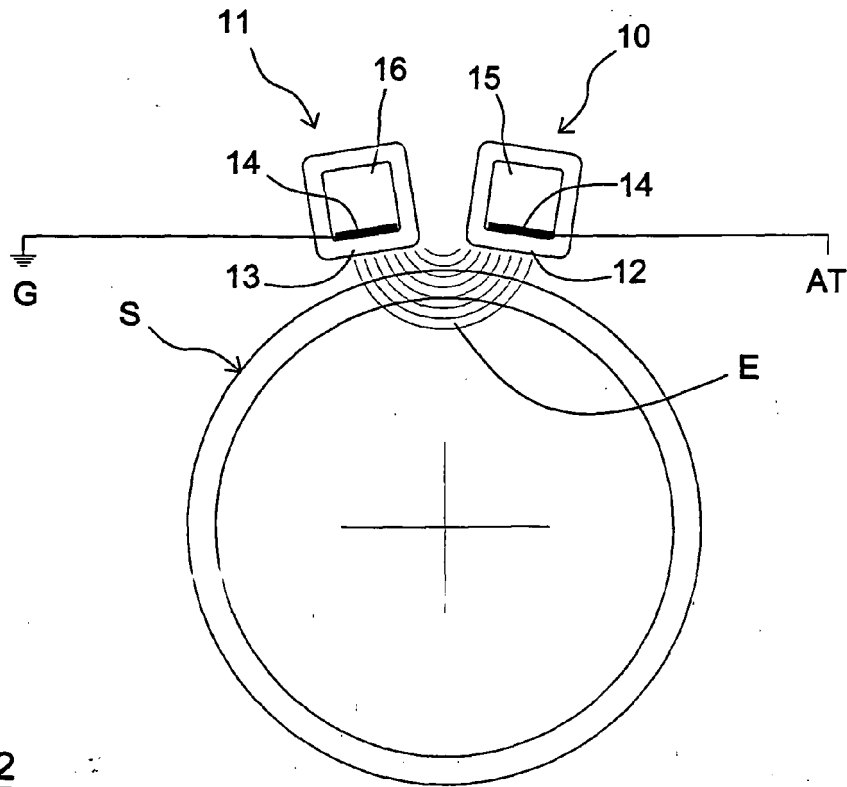


FIG. 2

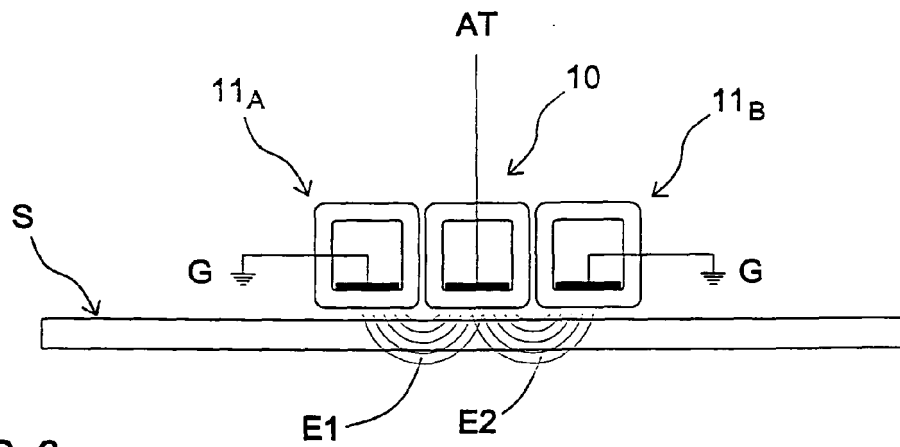


FIG. 3

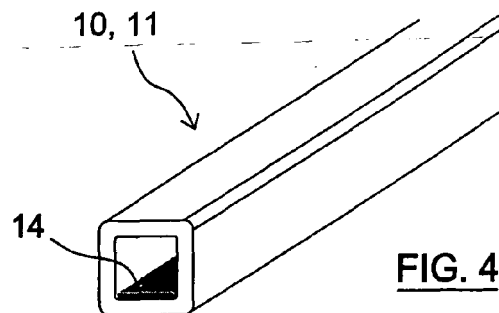


FIG. 4

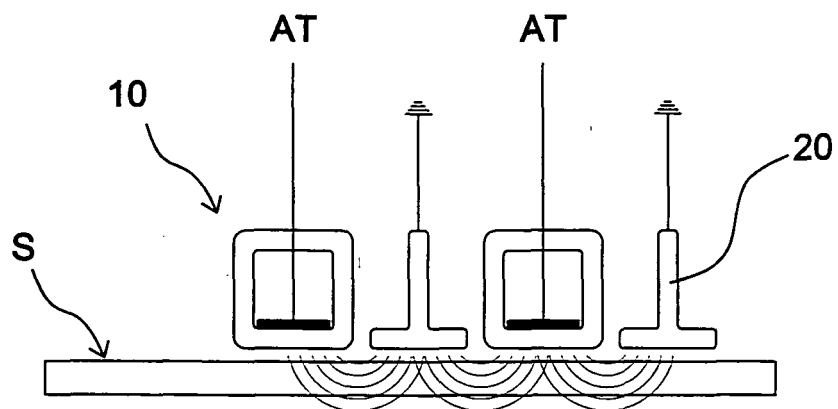


FIG. 5

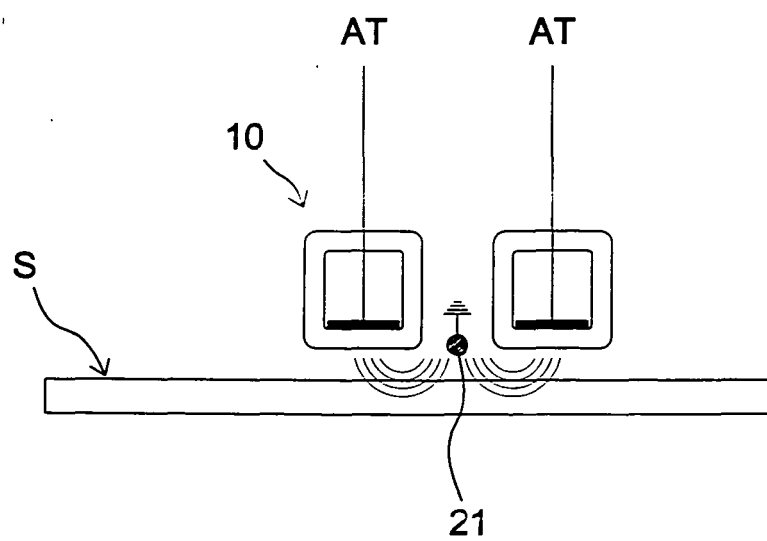


FIG. 6



European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 07 02 0765

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	US 3 376 208 A (WOOD HERBERT H) 2 April 1968 (1968-04-02) * column 2, line 9 - line 26; figures 1,2 *	1,12	INV. H01T19/00
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			TECHNICAL FIELDS SEARCHED (IPC)
			H01T B29C
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 31 January 2008	Examiner Bijn, Eric
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**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 07 02 0765

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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31-01-2008

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