(54) Title: METHOD AND DEVICE FOR SHIELING ENCAPSULATED ELECTRONIC COMPONENTS DURING LASER CUTTING

(57) Abstract: The present invention relates to a method and a device for cutting with a laser beam of a substantially flat carrier provided with encapsulated electronic components, in particular with electronic components which are shielded by a metallized cover element, by mutual displacement of the laser beam and the carrier, wherein during laser cutting at least a part of the encapsulated electronic components is shielded on the side facing the laser beam by means of a masking element, a layer of film material, by a shielding layer applied before laser cutting by means of spraying or by a fabric. The present invention also relates to a method and a device for cutting with a laser beam of a substantially flat carrier provided with encapsulated electronic components, in particular with electronic components which are shielded by a metallized cover element, by mutual displacement of the laser beam and the carrier, wherein at least part of the encapsulated electronic components is cleaned on the side facing the laser beam by a contamination-discharging cleaning element after at least part of the laser cutting has taken place.
before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments. For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.
Method and device for shielding encapsulated electronic components during laser cutting

The present invention relates to methods for cutting with a laser beam of a substantially flat carrier provided with electronic components, for instance encapsulated with epoxy, in particular also with electronic components which are shielded by a metallized cover element, by mutual displacement of the laser beam and the carrier. The present invention also relates to a device for cutting with a laser beam of a substantially flat carrier provided with encapsulated electronic components, comprising: a holder for holding the flat carrier with encapsulated electronic components to be cut with a laser beam, a laser beam-generating laser source, a frame connecting the holder and the laser source, and control means for mutual displacement of the laser beam generated by the laser source and the holder.

Cutting electronic carriers with encapsulated electronic components with a laser beam is a known technique which is inter alia used to release segments from a larger carrier (also designated as a board or lead frame). Laser beam cutting is applied as an alternative to the more traditional machining processing techniques such as punching, sawing and milling. Individualizing segments of the carrier with a laser offers a number of important advantages, such as a great freedom of form regarding the segments for releasing and being able to carry out the individualizing operation dry or wet as desired, which is particularly important, for instance for liquid-sensitive electronic components which can be situated on the carrier segments for releasing. Another advantage of laser cutting is that it generates a relatively small amount of waste compared to more traditional individualizing, inter alia because of the relatively small width of the cut to be made. An associated advantage is that the carrier material is utilized efficiently. An important drawback of the existing laser cutting techniques is however that the individualized encapsulated components become contaminated, in particular in the case that the encapsulated components are shielded by a metallized cover element. The demand for components with a metallized cover element increases strongly. The cover element can herein be provided with one or more openings for improved heat exchange and pressure levelling with the environment, but such openings must of course not admit contamination to the shielded electronic component. In addition, it is undesired that deposition accumulates on the outside of the metallized cover element; it can
become detached at an uncontrolled moment and is also visually undesired. The occurrence of contamination can inter alia be explained by the evaporation of material (for instance metals, hydrocarbons which may or may not be fully combusted and which come from glue, epoxy and so on) and the subsequent deposition of this material. The deposition consists of for instance the polymer and the filling material from which the plastic encapsulation is manufactured, such as inorganic oxides and more in particular silicon oxides.

For this purpose the present invention provides a method of the type stated in the preamble, wherein during laser cutting at least a part of the encapsulated electronic components is shielded on the side facing the laser beam by means of a masking element. Such a masking element can be manufactured from a material which is impossible or difficult to permeate for the laser light in question. On the other hand it is also possible to envisage the mask conversely being constructed locally from a material which is completely or well-permeable for the laser light in question.

During the laser cutting the masking element can be forced against the electronic components with a bias and thus be kept in position during the laser cutting with minimal interference to the encapsulated electronic components for shielding. As an alternative it is possible to opt for adhering or bonding the masking element to the encapsulated electronic components. This adhering of the mask to the encapsulated electronic components in particular makes it possible to bring the masking element into contact with the encapsulated electronic components before they are moved to a location where the laser cutting takes place. The laser cutting device can hereby be embodied in structurally relatively simple manner. As an advantageous alternative it is also possible to bring the masking element into contact with the encapsulated electronic components while it is being displaced to a location where the laser cutting takes place. The supply displacement of the carrier with encapsulated electronic components can thus be simultaneously applied for a second objective: arranging of the mask.

The masking element can engage on the encapsulated electronic components on one side, i.e. on the side of the encapsulated electronic components facing the laser source. It is precisely on this side that the contamination is usually the most concentrated. On the other hand it is also possible that the masking element engages round the
encapsulated electronic components completely or on at least two sides. In this manner it also becomes possible to protect from contamination one or more sides of the encapsulated electronic components standing upright from the carrier.

If the masking element can be embodied with one or more recesses it is further possible that the masking element shields the encapsulated electronic components without making contact with the encapsulated electronic components. The chance of damage to the encapsulated electronic components is thus minimal, while they can still be protected fully against contamination.

In addition, the present invention provides a method of the type stated in the preamble, wherein at least a part of the encapsulated electronic components is shielded during laser cutting on the side facing the laser beam by means of a layer of film material. The use of film material during the laser cutting is not obvious since it seemingly only results in more contamination; after all, the film material can also form a source of contamination. Neither is it very obvious to also shield a surface which is being processed there where the processing must take place; after all, this will impede the cutting processing. The present applicant has however reached the insight that the drawbacks of shielding of the cutting surface are more than compensated by the favourable effects of the shielding of the encapsulated components at the position where they are not separated.

During the laser cutting the layer of film material can be forced against the electronic components with a bias. It is possible here to envisage a frame with which the film material is placed under bias, respectively to envisage the pulling in/sucking in of the film material on the side of the carrier with encapsulated electronic components remote from the laser source. An advantage of positioning the film material in this manner is that no adhesive layer is necessary, which limits the chance of residue such as for instance adhesive material remaining after the removal of the film. On the other hand, it is possible to opt for the layer of film material to adhere to the encapsulated electronic components. The advantage of the use of an adhesive layer, optionally in combination with a carrier layer, is that a very good connection of the film material to the encapsulated electronic components can be acquired, but that, as a result of the blocking effect, there is no chance of residue in the form of an adhesive material remaining. On
the other hand, it is also possible to opt for the film material to adhere to the
encapsulated electronic components, subject to the conditions (such as for instance
process parameters, material choices, series size and so on).

5 The film material can be brought into contact with the encapsulated electronic
components before it is moved to a location where the laser cutting takes place. It is
here possible to envisage the mounting (adhering, bonding, clamping and so on) on the
carrier before the carrier with encapsulated electronic components is placed under the
laser cutting head. This measure increases the flexibility with respect to the application
of the film material.

On the other hand, it is also possible to bring the film material into contact with the
encapsulated electronic components while it is being displaced to a location where the
laser cutting takes place. This is for instance possible in that the film material is
unwound from a roll of film, which roll of film is connected to the device with which
the laser cutting processing is performed. Likewise, it is possible that the film material
is wound back onto a roller after at least part of the laser cutting has taken place. The
supply and discharge of the film material can thus be carried out in compact manner and
completely integrated with the supply and discharge of the carriers to the laser cutting
device.

In particularly advantageous manner the film material can be incompletely separated
during laser cutting of the substantially flat carrier provided with encapsulated
electronic components. This can for instance be carried out by using a film material
which is permeable for a laser beam and/or by not letting the focus of the laser beam
converge with the film material but with the carrier with encapsulated electronic
components shielded thereby. The film material must be at least partially resistant to the
type of laser beam in combination with which it is used (parameters such as a
wavelength, pulse duration and power of the laser beam play a part herein).

The film material can be left completely untouched by the laser beam, but in practice it
will often occur that, locally, the film material deforms, changes structure, discolours
and/or is only separated to such a limited extent during laser cutting of the substantially
flat carrier provided with encapsulated electronic components that the film material is
still connected sufficiently after at least part of the laser cutting has taken place that it can be removed from the encapsulated electronic components as a whole. This removal can then for instance take place in very simple manner by pulling loose the film material.

In the event that the film material is however affected considerably during the laser cutting, more in particular to such an extent that the encapsulating material loses too much of the connection for the film material to be detached from the individualized, substantially flat carrier provided with encapsulated electronic components after full separation of the carrier with encapsulated electronic components, an alternative method can also be envisaged. For this purpose the film layer is already detached after cuts are only arranged to such a limited extent that sufficient connection remains for being able to remove the film as a whole (or possibly in several parts). This is for instance possible by solely arranging cuts in a single cutting direction and in such a manner that, after arranging of the cuts, the film material is provided with two areas (untouched by the laser beam) situated on opposite sides of the film, which have not been hit by the laser beam. These untouched areas then provide connection to the film layer, which can thus be detached as a whole. In order to now arrange laser cuts in the carrier with encapsulated electronic components in a plurality of directions after all, the present invention also provides a method wherein, successively, in the substantially flat carrier provided with encapsulated electronic components: A) the side facing the laser source is shielded by film material a first time; B) cuts are arranged in a single first cutting direction in the shielded substantially flat carrier provided with encapsulated electronic components; C) the film material is removed from the encapsulated electronic components; D) the side facing the laser source is shielded by film material a second time; E) cuts are arranged in a single second cutting direction, which deviates from the first cutting direction, in the shielded substantially flat carrier provided with encapsulated electronic components; and F) the film material is removed from the encapsulated electronic components a second time. Another possibility for arranging sufficient connection in the separated film material is to not sever segments completely, for instance by leaving connecting segments intact.

In yet another variant of the method the film material is also brought into contact before the laser cutting commences with at least one of the sides of the encapsulated electronic
components standing upright from the flat carrier. The upright sides of the encapsulated electronic components, which are usually also metallized in the case of metallized encapsulations, can thus for instance also be shielded against contamination. For a good connection of the film material to the upright sides it can be forced against the carrier with encapsulated electronic components using a pressing element. Such a pressing element can advantageously be pre-formed such that the pressing element forces the film material against in particular at least one of the sides of the encapsulated electronic components standing upright from the flat carrier.

For a good connection and/or an improvement of the adhesive respectively bonding properties of the film material the present invention in a variant offers the possibility of heating the film material before the laser cutting commences. The temperature of the film material can be raised to more than 60°C, more than 100°C or even more than 120°C.

In order to simplify the detachment of the film material shortly after the laser cutting, the film material can also be actively cooled to a lower temperature, such as for instance less than 50°C, to thus influence the properties of the film material (and optionally also the properties of the contact surface of the encapsulated electronic components with the film material). As an alternative it is even possible to cool the film material to below the ambient temperature of about 20°C, or to even lower temperatures of less than 5°C.

Since contamination can also occur on the side of the carrier remote from the laser source when the carrier is fully separated (as usual), it can be advantageous to cover the carrier with encapsulated electronic components at least partly on two sides by means of a film layer during the laser cutting. For this purpose the carrier with encapsulated electronic components can be shielded on the side remote from the laser beam by means of a layer of film material before it is moved to a location where the laser cutting takes place. On the other hand it is also possible to shield the carrier with encapsulated electronic components on the side remote from the laser beam by means of a layer of film material while it is being displaced to a location where the laser cutting takes place.

In yet another more advantageous application the carrier with encapsulated electronic components is shielded on the side remote from the laser beam by means of a layer of
film material which is unwound from a roll of film. For removing the film material in simple manner on the side of the carrier removed from the laser source it is possible to wind this film material onto a roller after at least part of the laser cutting has taken place.

The encapsulated electronic components can be covered by a plastic film material with a composition as is for instance also used during encapsulation of electronic components in a mould. A layered film can here also be used. On the other hand it is also possible to envisage the use of a metal film material or a film material which contains both laminated metal and laminated plastic. Moreover, such a composite laminated plastic/metal film material can be provided with a metal layer arranged in patterns in order to thus cover a part of the encapsulated electronic components with the purpose of influencing the laser cutting in a desired manner and preventing contamination.

The present invention furthermore provides a method of the type stated in the preamble, wherein at least a part of the encapsulated electronic components is shielded on the side facing the laser beam before laser cutting commences by a shielding layer applied by means of spraying or dipping. Spraying on or dipping of a shielding layer relates to relatively simple processes and can furthermore be carried out irrespectively of the product. The shielding layer can for instance be applied in simple manner as a liquid mist. After at least part of the laser cutting has taken place the shielding layer can be actively removed from the encapsulated electronic components; for instance by means of a solvent. It is also possible, at least if the shielding layer is connected sufficiently after at least part of the laser cutting has taken place, to remove the shielding layer from the encapsulated electronic components mechanically, for instance by pulling it loose or lifting it up from the encapsulated electronic components individualized by laser light. For this purpose the shielding layer can for instance acquire sufficient connection in that it hardens over time or hardens under the influence of temperature, light and/or atmospheric conditions. Other alternatives for hardening of a layer applied by means of spraying or dipping can otherwise also be envisaged, such as supplying a specific chemical substance in the form of a gas, liquid or additive. The use of a catalyst to achieve the hardening can on the other hand also be envisaged. Alternatively, it is further possible to envisage that the shielding layer consists of a volatile material which
disappears (evaporates) after some time and without further interference.

The present invention furthermore provides a method of the type stated in the preamble, wherein at least a part of the encapsulated electronic components is shielded on the side facing the laser beam by a fabric before the laser cutting commences. Instead of shielding by a film material or a masking element, a fabric can also ensure the desired shielding of the encapsulated electronic components. For the purpose of fastening, the layer of fabric can be forced against the electronic components with a bias during the laser cutting, or the layer of fabric can respectively be adhered or stuck to the encapsulated electronic components. For the advantages and drawbacks of these different fastening manners, see above. The advantage of using fabric is that it is particularly suitable for retaining contaminated particles such that a relatively small amount of contamination is released. This results in a further improvement of the process control.

Corresponding to the above described film material and the masking elements, the fabric can also be brought into contact with the encapsulated electronic components before it is moved to a location where the laser cutting takes place, or the fabric can respectively be brought into contact with the encapsulated electronic components while it is being displaced to a location where the laser cutting takes place. For arranging the fabric it is simple if this material is unwound from a roll of fabric. Likewise, it can be wound onto a (different) roller again after use. The fabric can possibly be re-used after cleaning.

A further improvement of the result of the covering and/or the collection of contaminations can further be acquired if the fabric is moistened before the fabric is brought into contact with the encapsulated electronic components. Water can herein be used as wetting agent, but it is also possible to envisage the use of a liquid with specific properties (such as for instance bonding power or evaporation).

It is noted that all other methods as claimed for the film material and the masking element, however in respect of the application of the fabric, also independently form part of the present patent application. For the sake of clarity the methods in question are for this purpose embodied with fabric instead of with film material respectively.
masking elements.

The present invention also provides a method of the type stated in the preamble, wherein at least a part of the encapsulated electronic components is cleaned by a contamination-discharging cleaning element after at least partial laser cutting on the side facing the laser beam. If the individualized encapsulated electronic components are possibly still not sufficiently free of contamination after the laser cutting, despite the measures applied in the previously described methods, other (possibly additional) measures can also be taken, such as the measure that the contamination is discharged by bringing the encapsulated electronic components into contact with a contact element, which contact element binds at least part of the contamination more strongly than the encapsulated electronic components. This is for instance possible in that the contact element deals with the contamination by means of bonding power. It can also be advantageous if the contact element is moistened, see inter alia also the above listed advantages with reference to moistening of fabric functioning as cover element during the laser cutting.

It is further possible that the contact element actively discharges contaminations, for instance in that it is provided with suction means. A positive influence on the cleaning can also be acquired by moving the contact element over the surface of the encapsulated electronic components. For this purpose a relative displacement of the brush and the surface of the encapsulated electronic components must be realized. Imagine herein for instance intermittent (reciprocal) or rotating brushing of the surface.

In yet another advantageous application the contact element has an endless contact surface which runs a path, wherein the contact surface engages the encapsulated electronic components in a sector of the path. Contamination can then be removed from the surface in another sector of the path.

Described in the above is a plurality of methods, each one being based on the same inventive concept; discharging contamination in relation to the laser cutting of a substantially flat carrier provided with encapsulated electronic components, for instance encapsulated with epoxy, in particular also with electronic components which are shielded by a metallized cover element, such that this contamination does not remain on
one or more surfaces of an encapsulated electronic component. This application also
comprises the combined application of at least two of the methods as described
independently in the above.

The present invention also provides a device of the type stated in the preamble, wherein
the laser cutting device comprises means for supplying and discharging a mask covering
the encapsulated electronic components at least partly. Such a mask can for instance be
carried by operating means for supplying and discharging of a mask, which are arranged
for this purpose. Such a mask can be re-usable. It is also possible that the device is
provided with a plurality of masks which are applied in succession and which are for
instance cleaned, cooled, heated or are otherwise prepared when they are not deployed
in the laser cutting process. The means necessary for such a preparation, such as
cleaning means, cooling means, heating means and so on, can also form part of the
device according to the invention. The mask can be manufactured from a metal or
another material or combination of materials of choice.

The mask can be provided with recesses for receiving encapsulated electronic
components for shielding. The mask can thus be placed partially or completely over the
encapsulated electronic components for shielding. The device can also comprise suction
means for the discharge of contamination. As already described in the above in
combination with the supply means for film material, it can also be advantageous in a
laser cutting device, which comprises means for supplying and discharging a mask, if
the laser source is provided with an adjustable focal distance to thus limit damage to the
mask (or the masks). Likewise, it is also advantageous in this device if the laser source
is provided with a regulable galvo head in order to thus harm the mutual orientation of
the carrier with encapsulated electronic components and the mask as little as possible.

The present invention moreover provides a laser cutting device of the type stated in the
preamble, which comprises means for the supply of film material. It is also
advantageous if the laser cutting device comprises means for the discharge of film
material. Such a film supply and discharge combined with a laser cutting device is less
obvious since the film impedes the laser cutting process and also results in a more
complex structure of the laser cutting device. Nevertheless, the unexpectedly great
advantages of the shielding of at least parts of the encapsulated electronic components
outweigh the evident drawbacks thereof. The film supply can consist of a supply for film material of any composition; for instance plastic film, metal film, a film composed of plastic and metal, or a film material from another material respectively another material combination.

In a further embodiment variant the laser cutting device is provided with means for supplying and discharging two layers of film material parallel to each other on either side of the carrier with encapsulated electronic components, which means take a double form. The substantially flat carrier provided with encapsulated electronic components, in particular with electronic components which are shielded by a metallized cover element, can thus be covered on two sides which results in a separated product which is clean on two sides.

It is also possible to embody the laser cutting device such that it comprises a plurality of means placed in succession for the successive supply and discharge of different layers of film material. Different film material can thus be used in different cutting operations.

A plurality of supply and discharge rollers can thus be placed in a cutting path in succession and it is thus possible that automated supply and discharge means supply and discharge film (for instance in the form of windows over which film is stretched, which are placed on and removed from the product for cutting by a robot arm). This is particularly advantageous if cuts are made in the film material in subsequent laser cutting operations while it is still desired to remove the film material as a whole. Another condition for advantageously applying and removing film material a plurality of times in succession is if different laser cutting processes, which have such different process parameters that different film material is required for a sufficient result, are subsequently carried out.

For a good connection of the film material to the encapsulated electronic components it is possible to provide the laser cutting device with a pressing element with which the film material can be forced against the encapsulated electronic components. Such a pressing element can moreover be provided with a pre-formed surface so as to force the film material against at least one of the sides of the encapsulated electronic components standing upright from the flat carrier.
To make the film material easier to process the laser cutting device can be provided with heating means for raising the temperature of the film material. Heating of the film material influences the material properties of the film, which can for instance result in a softening of the film (for instance for an improved connection to the surface of the encapsulated electronic components) or in an improved adhesive or bonding power of the film material. Likewise, the laser cutting device can advantageously be provided with cooling means for cooling of film material; this cooling will usually (but not exclusively) be applied after the laser cutting has taken place. The cooling of the film material can once more result in the desired alteration of properties, such as for instance simplified detachment or the prevention of remaining residue.

Further improvements of the cutting result can be obtained if the laser source is provided with an adjustable focal distance. The focal distance of a laser beam can for instance be allocated at a distance from the film material in order to thus harm the film material as little as possible. The laser source can advantageously also be provided with a regulable galvo head, the carrier with film material hereby requires less displacement since the laser beam can thus be displaced in simple manner. This has the advantage that the mutual positioning of the film material and the carrier with encapsulated electronic components can be maintained in relatively simple manner.

The present invention moreover also provides a device of the type stated in the preamble, wherein the laser cutting device comprises means for the supply of fabric. The advantages of the use of fabric are already described above. Such a laser cutting device can comprise means for the discharge of fabric. Means can also be provided for the moistening of fabric to thus positively influence the properties of the fibrous material. It is here possible to envisage one or more spray heads, a wetting tank and so on. For reasons already listed previously it is once more also advantageous in this type of laser cutting device if the laser source is provided with an adjustable focal distance and/or with a regulable galvo head.

Finally, the present invention also provides a device of the type stated in the preamble, wherein the laser cutting device comprises a displaceable contact element, which contact element is provided with a contact surface which binds at least a part of the contamination on the encapsulated electronic components more strongly than the encapsulated electronic components. With such a contact element, contamination
located on the encapsulation of an electronic components can be removed. This is for instance possible with a contact element which comprises a bonding and/or a contamination-absorbing contact surface. In order to acquire a brushing cleaning effect, be it additional or not, it is moreover advantageous if the contact element can be displaced relative to the surface of the encapsulated electronic components.

The contact element can take an endless form such that it comprises a contact surface which can be displaced along a transport route, wherein the contact surface connects to the encapsulated electronic components over part of the transport route. Such a contact element can be displaced relative to the encapsulated electronic components in very simple manner. If the contact surface also connects to suction means over part of the transport route, at least a part of the contamination of the contact surface can there be removed and be discharged. It is also possible to provide the laser cutting device with means for moistening the displaceable contact element in order to thus improve the active properties of the contact element.

Regarding the above described various types of laser cutting device it is also true that the technical measures of the different types can be combined as desired, and that such combinations can as such also form part of the scope of protection sought by this application.

The present invention will be further elucidated on the basis of the non-limitative exemplary embodiments shown in the following figures. Herein:
figure 1A shows a perspective view of a part of a flat carrier provided with encapsulated electronic components shielded by a metallized cover element;
figure 1B shows a cross-section through a part of the carrier as shown in figure 1A;
figure 1C shows a cross-section through the part of the carrier shown in figure 1B during arranging of a cut by means of a laser beam according to the prior art;
figure 2A shows a cross-section through the part of the carrier shown in figure 1B which is according to the invention shielded on one side by a film material;
figure 2B shows a cross-section through the part of the carrier shown in figure 2A and shielded by means of film material while a cut is made according to the invention by means of a laser beam, wherein the connection of the film layer remains practically or completely intact;
figure 2C shows a cross-section through the part of the carrier shown in figure 2A and shielded by means of film material while a cut is made according to the invention by means of a laser beam, wherein the film layer is also cut separated;

figure 3A shows a cross-section through the part of the carrier shown in figure 1B which is shielded according to the present invention by a film material, wherein the sides of the cover elements standing upright from the carrier also connect to the film material by means of heating;

figure 3B shows a cross-section through the part of the carrier shown in figure 1B which is shielded according to the present invention by a film material, wherein the sides of the cover elements standing upright from the carrier also connect to the film material by means of pressing;

figure 3C shows a cross-section through the part of the carrier shown in figure 1B which is shielded on two sides according to the present invention by a film material;

figure 4A shows a perspective view of a part of a mask for covering according to the invention during the laser cutting of encapsulated electronic components on a flat carrier which are shielded by a metallized cover element;

figure 4B shows a perspective view of a part of an alternative embodiment of a mask for covering according to the invention during the laser cutting of encapsulated electronic components on a flat carrier which are shielded by a metallized cover element;

figure 4C shows a cross-section through the part of the carrier shown in figure 1B, which is shielded by the mask shown in figure 4B;

figure 5A shows schematically the cleaning by means of a contact element according to the present invention of a metallized cover element surrounding an electronic component;

figure 5B shows schematically the cleaning of such a cover element by means of a contact element in alternative manner;

figure 6 shows schematically a laser cutting device according to the invention with a supply roller and a discharge roller for film material;

figure 7A shows a top view of a film material in which cuts are arranged by means of laser cutting such that the film remains sufficiently connected for being removed as a whole;

figure 7B shows a top view of an alternative embodiment variant of a film material in which cuts are arranged by means of laser cutting such that the film remains sufficiently connected for being removed as a whole;
figure 8A shows a top view of a film part after the film part is separated by a laser beam in successive phases; figure 8B shows a perspective view of a shield plate in which cutting slots are recessed in two directions for transmitting a laser beam; and figure 8C shows a cross-section through a part of the shield plate as shown in figure 8B. Figure 1A shows a part of a flat carrier 1 provided with encapsulated electronic components 2 (shown schematically) which are shielded by metallized cover elements 3. Metallized cover elements 3 can be manufactured fully from metal but can also consist of a layered structure of which at least one layer consists of a metal. Cover elements 3 are in this figure provided with an opening 4 which can inter alia be useful for heat discharge of the heat given off by electronic components 2. For the inventive concept the presence of an opening 4 is however not a relevant factor. For a further elucidation a cross-section through a part of the carrier as shown in figure 1A is incorporated in figure 1B. Between cover elements 2 is left free a space 5 (for economic reasons preferably a small space 5), where a separating line is arranged by means of laser cutting. This is shown in figure 1C. A cut 7 is arranged in carrier 1 by means of a laser beam 6, as a result of which contamination 8 precipitates on cover elements 3. Contamination 11 also precipitates on a side 10 of carrier 1 remote from a laser source 9. Figure 2A shows a cross-section through the part of carrier 1 with cover elements 3 shown in figure 1B, which cover elements 3 are shielded by a film material 20. As is further elucidated in figure 2B a cut 7 is arranged in carrier 1 by means of a laser beam 6, wherein the connection of film layer 20 remains intact. Film layer 20 can remain intact because the material from which it is manufactured transmits laser beam 6 completely or at least largely unhindered. This effect can be amplified further in that focus 21 of laser beam 6 is situated at the position of carrier 1, i.e. on the side of film layer 20 remote from laser source 9. Film material 20 can possibly also deform under the influence of laser beam 6, however without losing the connection. A very advantageous effect of using film layer 20 in this manner is that it shields openings 4 in cover elements 3 against contamination such that no contamination can reach the inside of cover elements 3. It is further advantageous that the side of cover elements 3 facing laser source 9 is protected completely from contamination. On the other hand,
contamination of side walls 23 of cover elements 3 standing upright from carrier 1 will
still occur, as well as of side 10 of carrier 1 remote from laser source 9.

Figure 2C again shows a cross-section through the part of carrier 1 with cover elements
3 as shown in figure IB, which cover elements 3 are shielded by a film material 22.
This film layer 22 is separated by laser beam 6. For a further description of the
occurring contaminating effects reference is made to the description associated with
figure 2B. A drawback of film 22 can be that it cannot be removed as quickly as film
20, as shown in figure 2B.

Figure 3A shows a cross-section through the part of carrier 1 shown in figure IB, which
is shielded by a film material 30. By means of heating elements 31 and heat reflectors
32 the film material is heated locally at the position of the cuts to be arranged and is for
instance pulled downward by means of a vacuum. Side walls 23 of cover elements 3
standing upright from carrier 1 are thus also completely shielded against contamination
during the laser cutting. Figure 3B shows a pressing element 35 whereby (optionally in
combination with the heating as described with reference to figure 3A) film material 30
can also be brought into contact with upright side walls 23 of cover elements 3.

Figure 3C again shows the cross-section through the part of carrier 1 shown in figure
IB, which is here however shielded on two sides by film layers 33, 34; first film layer
33 as previously shown in figures 3A and 3B in combination with a second film layer
34 on the side of carrier 1 remote from laser source 9. It will be apparent that this two-
sided shielding creates an even better barrier against contamination than in the
previously shown covering variants.

Figure 4A shows a perspective view of a part of a mask 40 for covering according to the
invention during the laser cutting of encapsulated electronic components 2 on a flat
carrier 1 which are shielded by a metallized cover element. Mask 40 is provided with
segments 41 which can be placed on metallized cover elements 3 (not shown in this
figure) of encapsulated electronic components such that cover elements 3 are shielded
on the side facing laser source 9. Figure 4B shows a part of a mask 42 which is provided
with segments 43 with a central opening 44. As figure 4C shows, segments 43 can be
placed entirely over metal cover elements 3 such that they are protected from
contamination completely.

Figure 5A shows schematically the cleaning by means of contact element 50 in the form of an endless conveyor belt 51 of a metal cover element 3 which is fixed on a carrier 1 and is contaminated due to laser cutting. Contaminations 52 on the outside on the side of cover element 3 facing contact element 50 can be cleaned by being carried along conveyor belt 51 according to arrow P1. For this purpose conveyor belt 51 has for instance a bonding and/or contamination-absorbing form such that contaminations 52 detach from metal cover element 3 upon contact with conveyor belt 51 and remain on conveyor belt 51 (see reference 53), such that they are discharged by conveyor belt 51. Belt 51 is forced against the side of cover element 3 facing contact element 50 by a pressing element 55. Near conveyor belt 51 is also arranged a suction unit 54 with which conveyor belt 51 can in turn be cleaned for a new cycle. Suction unit 54 can otherwise also be arranged near the bottom part of conveyor belt 51 or even have a suction action through conveyor belt 51 (provided this belt has a porous form). The latter variant with suction through conveyor belt 51 can be embodied in particularly favourable manner with a conveyor belt which is manufactured from (or is manufactured at least partly from) a fabric.

Figure 5B shows schematically the cleaning by means of a cleaning film 56 of a metal cover element 3 which is fixed on a carrier 1 and is contaminated due to laser cutting, corresponding to what is shown in figure 5A. Contaminations 52 on the outside on the side of cover element 3 facing contact element 50 can be cleaned by being carried along cleaning film 56 according to arrow P1. Clean film 56 is for this purpose unwound from a supply roller 57 and forced against cover element 3 by a pressing element 58. For this purpose pressing element 58 is embodied such that it is provided with a central suction opening and a porous underside. It is particularly advantageous if film 56 is also porous; contamination 52 can then be suctioned off through film 56. Film 56 can optionally also be adhesive or be embodied as a fabric. Finally, the contaminated film is wound back onto a discharge roller 59.

Figure 6 shows a laser cutting device 60 provided with a laser source 61 with integrated galvo head. Carrier 62 for individualizing, with metal shielding elements 63 whereby encapsulated electronic components (not visible) are shielded, is carried by a product
holder 64. Laser cutting device 60 is provided with a supply roller 65 for film material 66 and a discharge roller 67 whereby used film material 66 can be removed. The invention otherwise also comprises a similar laser cutting device with two supply and discharge rollers for arranging a film layer 66 on two sides of carrier 62 with metal shielding elements 63.

Figure 7A shows a top view of film material 70 in which cuts 71, 72 are arranged by means of laser cutting such that film 70 remains sufficiently connected for being removed as a whole. Figure 7B shows a top view of an alternative embodiment variant of a film material 70 in which cuts 73, 74 are arranged by means of laser cutting such that film 70 remains sufficiently connected for being removed as a whole. Figure 8A shows a top view of a shielding film 80 after shielding film 80 is separated by a laser beam in successive phases. Shielding film 80 is moved along intermittently in a direction of movement P2. During a first cutting phase a part 81 of the shielding film is located above the components for individualizing such that longitudinal cuts 82 are made in shielding film 80 and the components to be individualized and to be shielded by film 80. Part 81 of film 80 still is connected sufficiently to be detached from the components as a whole, so that film 80 can be moved along (P2) and a subsequent film part 83 can be placed on top of the components (of which one is shown schematically with reference numeral 84). Transverse cuts 85 are then made in subsequent film part 83 by a laser beam. After transverse cuts 85 are made, subsequent film part 83 also is still connected sufficiently to be detached as a whole from individualized components 84.

Figure 8B shows a perspective view of a shield plate 86 in which cutting slots 87 respectively 88 are recessed in two directions for transmitting a laser beam (not shown in this figure). The cutting by means of shield plate 86 has some similarity to cutting with film material 80 in successive phases as described with reference to figure 8A. Firstly, a first part 89 of shield plate 86 is placed on the components for individualizing. One or more laser beams are then moved through cutting slots 87 in one direction. If shield plate 87 is manufactured from a material which reflects or is at least not permeable for the laser beam (such as for instance metal) this can have the additional advantage (in addition to the shielding effect sought) that the cutting edges in the product to be arranged by the laser beam are straighter and are less chamfered. This effect can be compared in part to the traditional cutting along a ruler with a knife. After
the cuts are arranged in a first direction, a second part 90 of shield plate 86 is brought into contact with the already partly individualized components. This exchange of shielding parts 89, 90 is for instance possible by rotating shield plate 86 around a rotation shaft 91 located centrally in plate 86. Another possibility for displacing for instance plate 86 relative to the components to be shielded by the plate is to shift it reciprocally, for instance using a drive cylinder.

Figure 8C shows a cross-section through a part of shield plate 86 as shown in figure 8B. Next to a cutting slot 87 it can here also be seen that side 92 (not shown in figure 8B and in this figure the underside) to be turned such that it faces the components for covering can be provided with receiving spaces for containing the components for shielding; this serves to increase the shielding action of shield plate 86. Shield plate 86 can otherwise also have a completely flat form on underside 92.
Claims

1. Method for cutting with a laser beam of a substantially flat carrier provided with encapsulated electronic components, in particular with electronic components which are shielded by a metallized cover element, by mutual displacement of the laser beam and the carrier, wherein during laser cutting at least a part of the encapsulated electronic components is shielded on the side facing the laser beam by means of a masking element.

2. Method as claimed in claim 1, characterized in that the masking element is forced against the electronic components with a bias during the laser cutting.

3. Method as claimed in claim 1 or 2, characterized in that the masking element adheres to the encapsulated electronic components.

4. Method as claimed in any of the foregoing claims, characterized in that the masking element bonds to the encapsulated electronic components.

5. Method as claimed in any of the foregoing claims, characterized in that the masking element is positioned relative to the encapsulated electronic components before it is moved to a location where the laser cutting takes place.

6. Method as claimed in any of the foregoing claims, characterized in that the masking element is positioned relative to the encapsulated electronic components while it is being displaced to a location where the laser cutting takes place.

7. Method as claimed in any of the foregoing claims, characterized in that the masking element engages round the encapsulated electronic components on one side.

8. Method as claimed in any of the foregoing claims, characterized in that the masking element engages round the encapsulated electronic components on at least two sides.

9. Method as claimed in any of the foregoing claims, characterized in that the
masking element engages round the encapsulated electronic components completely.

10. Method as claimed in any of the foregoing claims, characterized in that the masking element shields the encapsulated electronic components without making contact with the encapsulated electronic components.

11. Device for cutting with a laser beam of a substantially flat carrier provided with encapsulated electronic components, in particular with electronic components which are shielded by a metallized cover element, comprising:

- a holder for holding the flat carrier with encapsulated electronic components to be cut with a laser beam,
- a laser beam-generating laser source,
- a frame connecting the holder and the laser source, and
- control means for mutual displacement of the laser beam generated by the laser source and the holder,

characterized in that the laser cutting device comprises means for the supply and discharge of a mask covering the encapsulated electronic components at least partially.

12. Laser cutting device as claimed in claim 11, characterized in that the means for the supply and discharge of a mask are also provided with at least one re-usable mask.

13. Laser cutting device as claimed in claim 12, characterized in that the mask is manufactured from a metal.

14. Laser cutting device as claimed in claim 12 or 13, characterized in that the mask is provided with recesses for receiving encapsulated electronic components for shielding.

15. Laser cutting device as claimed in any of the claims 11 - 14, characterized in that the device comprises suction means.

16. Laser cutting device as claimed in any of the claims 11 - 15, characterized in that the laser source is provided with an adjustable focal distance.
17. Laser cutting device as claimed in claim 11 - 16, characterized in that the laser source is provided with a regulable galvo head.

18. Method for cutting with a laser beam of a substantially flat carrier provided with encapsulated electronic components, in particular with electronic components which are shielded by a metallized cover element, by mutual displacement of the laser beam and the carrier, wherein at least a part of the encapsulated electronic components is shielded during laser cutting on the side facing the laser beam by means of a layer of film material.

19. Method as claimed in claim 18, characterized in that the layer of film material is forced against the electronic components with a bias during the laser cutting.

20. Method as claimed in claim 18 or 19, characterized in that the layer of film material adheres to the encapsulated electronic components.

21. Method as claimed in any of the claims 18 - 20, characterized in that the layer of film material bonds to the encapsulated electronic components.

22. Method as claimed in any of the claims 18 - 21, characterized in that the film material is brought into contact with the encapsulated electronic components before it is displaced to a location where the laser cutting takes place.

23. Method as claimed in any of the claims 18 - 22, characterized in that the film material is brought into contact with the encapsulated electronic components while being displaced to a location where the laser cutting takes place.

24. Method as claimed in any of the claims 18 - 23, characterized in that the film material is unwound from a roll of film.

25. Method as claimed in any of the claims 18 - 24, characterized in that the film material is wound onto a roller after at least part of the laser cutting has taken place.
26. Method as claimed in any of the claims 18 - 25, characterized in that the film material is incompletely separated during laser cutting of the substantially flat carrier provided with encapsulated electronic components.

27. Method as claimed in any of the claims 18 - 26, characterized in that the film material is only separated to such a limited extent during laser cutting of the substantially flat carrier provided with encapsulated electronic components that the film material is still connected sufficiently after at least part of the laser cutting has taken place that it is removed from the encapsulated electronic components as a whole.

28. Method as claimed in any of the claims 18 - 27, characterized in that the film material is detached from the substantially flat carrier provided with encapsulated electronic components after cuts were arranged solely in a single cutting direction.

29. Method as claimed in claim 27 or 28, characterized in that, after cuts are arranged in a sole cutting direction, the film material is provided with two areas situated on opposite sides of the film, which have not been hit by the laser beam.

30. Method as claimed in any of the claims 27 - 29, wherein, successively, in the substantially flat carrier provided with encapsulated electronic components:
A) the side facing the laser source is shielded by film material a first time;
B) cuts are arranged in a single first cutting direction in the shielded substantially flat carrier provided with encapsulated electronic components;
C) the film material is removed from the encapsulated electronic components;
D) the side facing the laser source is shielded by film material a second time;
E) cuts are arranged in a single second cutting direction, which deviates from the first cutting direction, in the shielded substantially flat carrier provided with encapsulated electronic components; and
F) the film material is removed from the encapsulated electronic components a second time.

31. Method as claimed in any of the claims 27 - 30, characterized in that the film material is also brought into contact with at least one of the sides of the encapsulated electronic components standing upright from the flat carrier.
32. Method as claimed in any of the claims 27 - 31, characterized in that the film material is forced against the carrier with encapsulated electronic components using a pressing element.

33. Method as claimed in claims 31 and 33, characterized in that the pressing element is pre-formed such that the pressing element also forces the film material against at least one of the sides of the encapsulated electronic components standing upright from the flat carrier.

34. Method as claimed in any of the claims 27 - 33, characterized in that the pressing element is pre-formed such that the pressing element also forces the film material against at least one of the sides of the encapsulated electronic components standing upright from the flat carrier.

35. Method as claimed in any of the claims 27 - 34, characterized in that the film material is heated before the laser cutting commences.

36. Method as claimed in any of the claims 27 - 35, characterized in that the carrier with encapsulated electronic components is covered at least partially on two sides by means of a film layer during the laser cutting.

37. Method as claimed in any of the claims 27 - 36, characterized in that the carrier with encapsulated electronic components is shielded on the side remote from the laser beam by means of a layer of film material before it is moved to a location where the laser cutting takes place.

38. Method as claimed in any of the claims 27 - 37, characterized in that the carrier with encapsulated electronic components is shielded on the side remote from the laser beam by means of a layer of film material while being moved to a location where the laser cutting takes place.

39. Method as claimed in any of the claims 27 - 38, characterized in that the carrier with encapsulated electronic components is shielded on the side remote from the laser beam by means of a layer of film material which is unwound from a roll of film.
40. Method as claimed in any of the claims 27-39, characterized in that the film material on the side of the carrier with encapsulated electronic components remote from the laser beam is wound onto a roller after at least part of the laser cutting has taken place.

41. Method as claimed in any of the claims 27-40, characterized in that at least a part of the encapsulated electronic components is covered by a plastic film material.

42. Method as claimed in any of the claims 27-41, characterized in that at least a part of the encapsulated electronic components is covered by a metal film material.

43. Method as claimed in any of the claims 27-42, characterized in that at least a part of the encapsulated electronic components is covered by a laminated plastic/metal film material.

44. Method for cutting with a laser beam of a substantially flat carrier provided with encapsulated electronic components, in particular with electronic components which are shielded by a metallized cover element, by mutual displacement of the laser beam and the carrier, wherein at least a part of the encapsulated electronic components is shielded on the side facing the laser beam before laser cutting commences by a shielding layer applied by means of spraying.

45. Method as claimed in claim 44, characterized in that the shielding layer is applied as a liquid mist.

46. Method as claimed in claim 44 or 45, characterized in that the shielding layer is actively removed from the encapsulated electronic components after at least part of the laser cutting has taken place.

47. Method as claimed in claim 46, characterized in that the shielding layer is actively removed from the encapsulated electronic components by means of a solvent after at least part of the laser cutting has taken place.
48. Method as claimed in claim 46 or 47, characterized in that the shielding layer is connected sufficiently after at least part of the laser cutting has taken place so that the shielding layer is removed from the encapsulated electronic components in mechanical manner.

49. Method for cutting with a laser beam of a substantially flat carrier provided with encapsulated electronic components, in particular with electronic components which are shielded by a metallized cover element, by mutual displacement of the laser beam and the carrier, wherein at least a part of the encapsulated electronic components is shielded by a fabric on the side facing the laser beam before laser cutting commences.

50. Method as claimed in claim 49, characterized in that the layer of fabric is forced against the electronic components with a bias during the laser cutting.

51. Method as claimed in claim 49 or 50, characterized in that the layer of fabric adheres to the encapsulated electronic components.

52. Method as claimed in any of the claims 49 - 51, characterized in that the layer of film material bonds to the encapsulated electronic components.

53. Method as claimed in any of the claims 49 - 52, characterized in that the fabric is brought into contact with the encapsulated electronic components before it is moved to a location where the laser cutting takes place.

54. Method as claimed in any of the claims 49 - 53, characterized in that the fabric is moistened before the fabric is brought into contact with the encapsulated electronic components.

55. Method as claimed in any of the claims 49 - 54, characterized in that the fabric is brought into contact with the encapsulated electronic components while being moved to a location where the laser cutting takes place.

56. Method as claimed in any of the claims 49 - 55, characterized in that the fabric is unwound from a roll of fabric.
57. Method for cutting with a laser beam of a substantially flat carrier provided with encapsulated electronic components, in particular with electronic components which are shielded by a metallized cover element, by mutual displacement of the laser beam and the carrier, wherein at least a part of the encapsulated electronic components is cleaned on the side facing the laser beam by a contamination-discharging cleaning element after at least part of the laser cutting has taken place.

58. Method as claimed in claim 57, characterized in that the contamination is discharged by bringing the encapsulated electronic components into contact with a contact element, which contact element binds at least part of the contamination more strongly than the encapsulated electronic components.

59. Method as claimed in claim 58, characterized in that the contact element deals with contamination by means of bonding power.

60. Method as claimed in claim 57 or 58, characterized in that the contact element is moistened.

61. Method as claimed in any of the claims 57 - 60, characterized in that the contact element also actively discharges contaminants.

62. Method as claimed in any of the claims 57 - 61, characterized in that the contact element is moved over the surface of the encapsulated electronic components.

63. Method as claimed in any of the claims 57 - 62, characterized in that the contact element has an endless contact surface which runs a path, wherein the contact surface engages the encapsulated electronic components in a sector of the path.

64. Method as claimed in claim 63, characterized in that contamination is removed from the contact surface in a sector of the path.

65. Method as claimed in any of the claims 57 - 64, characterized in that the contamination-discharging cleaning element discharges contamination by means of suction.
66. Method for cutting with a laser beam of a substantially flat carrier provided with encapsulated electronic components, in particular with electronic components which are shielded by a metallized cover element, by mutual displacement of the laser beam and the carrier, wherein at least two of the methods as claimed in respectively: claims 1 - 10; claims 18 - 43; claims 44 - 48; claims 49 - 56; and claims 57 - 65 are applied in combination with each other.

67. Method for cutting with a laser beam of a substantially flat carrier provided with encapsulated electronic components, in particular with electronic components which are shielded by a metallized cover element, comprising:
- a holder for holding the flat carrier with encapsulated electronic components to be cut with a laser beam,
- a laser beam-generating laser source,
- a frame connecting the holder and the laser source, and
- control means for mutual displacement of the laser beam generated by the laser source and the holder,
  characterized in that the laser cutting device comprises means for the supply of film material.

68. Laser cutting device as claimed in claim 67, characterized in that the laser cutting device comprises means for the discharge of film material.

69. Laser cutting device as claimed in claim 67 or 68, characterized in that the laser cutting device comprises means for supplying and discharging two layers of film material parallel to each other on either side of the carrier with encapsulated electronic components, which means take a double form.

70. Laser cutting device as claimed in any of the claims 67 - 69, characterized in that the laser cutting device comprises a plurality of means placed in succession for the successive supply and discharge of different layers of film material.

71. Laser cutting device as claimed in any of the claims 67 - 70, characterized in that the laser cutting device comprises a pressing element for forcing the film material against the encapsulated electronic components.
72. Laser cutting device as claimed in any of the claims 67 - 71, characterized in that the pressing element is provided with a pre-formed surface so as to force the film material against at least one of the sides of the encapsulated electronic components standing upright from the flat carrier.

73. Laser cutting device as claimed in any of the claims 67 - 72, characterized in that the laser cutting device comprises heating means for heating film material.

74. Laser cutting device as claimed in any of the claims 67 - 73, characterized in that the laser cutting device comprises cooling means for cooling foil material.

75. Laser cutting device as claimed in any of the claims 67 - 74, characterized in that the laser cutting device comprises heating means for heating film material.

76. Laser cutting device as claimed in any of the claims 67 - 75, characterized in that the laser source is provided with an adjustable focal distance.

77. Laser cutting device as claimed in any of the claims 67 - 76, characterized in that the laser source is provided with a regulable galvo head.

78. Device for cutting with a laser beam of a substantially flat carrier provided with encapsulated electronic components, in particular with electronic components which are shielded by a metallized cover element, comprising:
- a holder for holding the flat carrier with encapsulated electronic components to be cut with a laser beam,
- a laser beam-generating laser source,
- a frame connecting the holder and the laser source, and
- control means for mutual displacement of the laser beam generated by the laser source and the holder,
characterized in that the laser cutting device comprises means for the supply of fabric.

79. Laser cutting device as claimed in claim 78, characterized in that the laser cutting device comprises means for the discharge of fabric.
80. Laser cutting device as claimed in claim 78 or 79, characterized in that the laser cutting device comprises means for moistening fabric.

81. Laser cutting device as claimed in any of the claims 78 - 80, characterized in that the laser source is provided with an adjustable focal distance.

82. Laser cutting device as claimed in any of the claims 78 - 81, characterized in that the laser source is provided with a regulable galvo head.

83. Device for cutting with a laser beam of a substantially flat carrier provided with encapsulated electronic components, in particular with electronic components which are shielded by a metallized cover element, comprising:
- a holder for holding the flat carrier with encapsulated electronic components to be cut with a laser beam,
- a laser beam-generating laser source,
- a frame connecting the holder and the laser source, and
- control means for mutual displacement of the laser beam generated by the laser source and the holder,
characterized in that the laser cutting device comprises a displaceable contact element, which contact element is provided with a contact surface which binds at least part of the contamination on the encapsulated electronic components more strongly than the encapsulated electronic components.

84. Laser cutting device as claimed in claim 83, characterized in that the contact element comprises an adhesive contact surface.

85. Laser cutting device as claimed in claim 83 or 84, characterized in that the contact surface is provided with a contamination-absorbing contact surface.

86. Laser cutting device as claimed in any of the claims 83 - 85, characterized in that the contact element is displaceable relative to the surface of the encapsulated electronic components.

87. Laser cutting device as claimed in any of the claims 83 - 86, characterized in
that the contact element is endless and comprises a contact surface which can be
displaced along a transport route, wherein the contact surface connects to the
encapsulated electronic components over part of the transport route.

5 88. Laser cutting device as claimed in claim 87, characterized in that the contact
surface connects to suction means over part of the transport route.

89. Laser cutting device as claimed in any of the claims 83 - 88, characterized in
that the laser cutting device is provided with means for moistening the displaceable
contact element.
INTERNATIONAL SEARCH REPORT

International application No
PCT/NL2007/050122

A CLASSIFICATION OF SUBJECT MATTER
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According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B23K HOIL

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
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C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Date of the actual completion of the international search
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