Abstract: The invention relates to a work piece support (1) for supporting a generally plate-like work piece (2) for processing by a thermal cutting tool (4), comprising a plurality of rows of supporting elements (5) which are movable between a supporting position in which they support the work piece and a non-supporting position in which they do not support the work piece, and a processing unit to control movement of the supporting elements based on the position of the thermal cutting tool. The work piece support according to the invention is characterized in that one or more of the supporting elements comprises an electromagnet arranged to perform individual movement between the supporting position and the non-supporting position.
The present invention relates to a work piece support for supporting a generally plate-like work piece for processing by a thermal cutting tool, comprising a plurality of rows of supporting elements which are movable between a supporting position in which they support the work piece and a non-supporting position in which they do not support the work piece, and a processing unit to control movement of the supporting elements based on the position of the thermal cutting tool.

The work piece support described in the preamble is known in the relevant art and is used in numerical controlled (NC) devices for supporting work pieces that are to be cut into a plurality of components by a thermal cutting tool. Examples of thermal cutting tools are plasma cutting tools and laser cutting tools.

A known problem with thermal cutting tools is that, since the entire material is cut through, the thermal energy reaches the supporting elements of the work piece support. This leads to a number of disadvantages. The supporting elements can be contaminated over time and need to be cleaned regularly. The supporting elements can also be damaged, which limits their life cycle and necessitates frequent replacement. During cutting small cut pieces of material may weld onto the supporting elements, which necessitates cleaning when changing work pieces. As thermal cutting is often performed automatically, personnel may not always be available. Consequently the necessary cleaning may not be performed, leading to problems, even stagnation or blocking of the automatic cutting process. On top of this the supporting elements receiving the thermal energy may cause deviations to the underside of the work piece leading to additional finishing processes or even to rejection of cut components. The supporting elements also reflect the thermal energy of the cutting tool possibly leading to stagnation of the cutting process and also to additional finishing operations or rejection of cut components.

The problems signaled above are solved in the relevant art by using supporting elements which are movable between a supporting position and a non-supporting position.

A work piece support according to the preamble of claim 1 is for instance known from the international patent application WO2007/134628, in which rows of supporting elements are shiftable in transverse direction of the work piece support. European patent application EP1 731256 describes a work piece support according to the preamble of claim 1, wherein the movement of rows of supporting elements is...
pneumatically controlled. European patent application EP0327895 describes a work piece support according to the preamble of claim 1 having mechanically movable rows of supporting elements.

The work piece supports according to the prior art all have the drawback that by moving entire rows of supporting elements already cut pieces lying on top of supporting elements are also moved. This induces the risk of destabilizing the position of cut components, especially when the cut components are relatively small sized, whereby the cut components may fall between the rows of supporting elements leading to a stagnation of the entire cutting process. Especially when the process is unattended and automatic this may lead to a significant loss of time and money.

The invention has for its purpose to provide a work piece support according to the preamble of claim 1 that lifts this drawback.

The work piece support according to the invention is characterized in that one or more of the supporting elements comprise an electromagnet arranged to perform individual movement between the supporting position and the non-supporting position.

By using individually movable electromechanical supporting elements only those supporting elements that are too close to the thermal cutting tool have to be moved to the non-supporting position, while all other supporting elements can maintain their supporting position. Consequently a work piece is always maximally supported by the work piece support according to the invention ensuring a high quality cutting process.

It is noted that international patent application WO2007/1 34630 describes a work piece support according to the preamble of claim 1, wherein striking elements are provided to force individual supporting elements into an inactive position by bending or breaking them.

The work piece support according to WO2007/1 34630 only allows one time movement from the supporting position to the non-supporting position which is not repetitive and therefore only economical for cutting large numbers of identical plate-like work pieces. Contrary thereto the work piece support according to the invention allows for repetitive movement of the supporting elements between the supporting position and the non-supporting position and is consequently flexibly adjustable and thus suitable for cutting a variety of components out of small batches or even single pieces of plate-like work pieces.

It is noted that Japanese patent application JP01-113195 describes a work piece support for supporting a work piece for processing by a thermal cutting tool, comprising supporting elements which are movable between a supporting position in
which they support the work piece and a non-supporting position in which they do not support the work piece, wherein lift members are provided to let the supporting elements descend based on the position of the thermal cutting tool. However, from JP01-1 13195 the exact functioning of the lift members cannot be derived. It is neither clear whether or not the supporting elements are individually movable.

According to a practical embodiment of the work piece support according to the invention one or more of the supporting elements comprise a movable plunger of magnetizable material having a head part arranged to make contact with the work piece in the supporting position.

According to a further embodiment the head part is provided with a detachable cap, preferably made of copper. The detachable cap provides protection against damaging the underside of the work piece. By choosing a suitable material, such as copper, attachment of work piece material to the supporting elements can be prevented.

According to an energy saving embodiment one or more of the supporting elements are biased so as to occupy the supporting position.

Additional safety measures are incorporated in yet a further embodiment, wherein the supporting elements are placed in a frame, which is provided with detection means to detect the non-supporting position of one or more of the supporting elements.

According to a reliable and cost efficient embodiment the processing unit receives the coordinates of the actual position of the thermal cutting tool from control means, for instance numerical control means, for controlling movement of the thermal cutting tool.

According to an independent embodiment the processing unit receives the coordinates of the actual position of the thermal cutting tool from position sensors arranged on the work piece support along each axis of movement of the thermal cutting tool. According to a further independent embodiment the processing unit is arranged to determine the actual position of the thermal cutting tool by sensing means for sensing parameters such as temperature and/or light intensity. According to yet a further independent embodiment the processing unit receives the coordinates of the actual position of the thermal cutting tool from a camera with image recognition software arranged on the work piece support.

These independent embodiments of the work piece support can also be incorporated in known NC thermal cutting devices by replacing the original work piece support.

According to a further preferred embodiment the amount of electrical power supplied to one or more of the supporting elements can be controlled separately.
preferably by means for varying energy supply in time using Pulse Width Modulation (PWM). Pulse Width Modulation allows the supporting elements to be moved with a minimum chance of overheating them.

The invention will further be described referring to the attached drawings, wherein.

Figure 1 shows a schematic view of a work piece support according to the invention in a first preferred embodiment;

Figure 2 shows a schematic view of a part of the work piece support according to figure 1 in more detail;

Figures 3A and 3B show a part of the embodiment of figure 2 in more detail in two different states; and

Figure 4 shows a part of the embodiment of figures 3A and 3B in more detail.

Figure 1 shows a schematic view of a work piece support according to the invention in a preferred embodiment. Work piece support 1 is a supporting table for supporting a generally plate-like work piece, such as sheet 2, for processing by a thermal cutting tool 4. In the preferred embodiment shown the thermal cutting tool is a laser cutting tool 4 emitting a laser beam for cutting sheet 2 into a plurality of components having a predetermined shape. The laser cutting tool 4 is carried by a head rail 3. The head rail 3 is provided with head rail feet 13 which are guided in guiding rails 23, which extend on both longitudinal sides of the supporting table 1. Movement of the head rail 3 and of the laser cutting tool 4 is controlled by a main processing unit (not shown) based on techniques known in the relevant art, such as CNC techniques (CNC = Computer Numerical Control). Perhaps superfluously it is noted here that the work piece support according to the invention is also suitable for use with other thermal cutting tools, such as a plasma cutting tool, for instance a plasma torch.

The work piece support according to the invention comprises several rows of supporting elements 5. In the figures only two rows of supporting elements 5 are shown, but in practice several rows are placed parallel to the rows illustrated in order to support the sheet 2 over its entire surface.

Figures 2, 3A and 3B show part of the support 1 in more detail. In figure 3A the supporting elements 5 occupy a supporting position. In figure 3B one of the supporting elements 5 occupies a non-supporting position, wherein the plunger is partly withdrawn in its housing.

Each row of supporting elements 5 is determined by a frame 6 in which the supporting elements 5 are arranged. The frame 6 comprises holding elements 16,
which extend transversely to the frame 6 and have an opening to accommodate a single supporting element 5. Preferably the frame 6 is strip shaped.

According to the present invention each supporting element 5 comprises an electromagnet arranged to perform individual movement between the supporting position shown in figure 3A and the non-supporting position shown figure 3B.

Each supporting element 5 comprises a plunger 15 of magnetizable material. The plunger 15 is movably arranged within a supporting element housing 35. The supporting element 5 comprises a plunger 15 having a head part 45, which is arranged to make contact with the work piece 2 in the supporting position. Preferably the head part 45 is provided with a detachable cap 55, made of suitable material, such as copper. Figure 4 shows an embodiment of cap 55 in more detail, wherein cap 55 is provided with a recess 65 for accommodating the head part 45 of plunger 15. Preferably the plunger 15 is biased in the supporting position. This biasing can be achieved by using a spring 25.

Known solenoids can be used for the purpose of providing a supporting element 5. A solenoid is in this context defined as a long wire, wound in a pattern, for instance a helical pattern, to form a winding, usually surrounded by a housing having a magnetizable core inside the winding. When carrying a current the solenoid becomes an electromechanical device, in which electrical energy is converted into mechanical work, i.e. movement of the magnetizable core or plunger 15 in longitudinal direction of the housing 35. Suitable solenoids are available in the art.

According to the invention the processing unit 10 is arranged to control movement of a respective supporting element 5 to the non-supporting position based on the position of the thermal cutting tool 4. The coordinates of the actual position of the thermal cutting tool can be obtained directly from the main processing unit as during the CNC processing the actual position of the thermal cutting tool needs always to be available. The coordinates of the actual position of the thermal cutting tool can also be determined by measurement. Preferably a set of position sensors is arranged onto the work piece support along each axis of movement of the thermal cutting tool to measure the actual position thereof. Alternatively the coordinates of the actual position of the thermal cutting tool can be obtained via a camera with image recognition software. Measurement of suitable parameters indicating the vicinity of the thermal cutting tool can also be performed to determine the coordinates of the actual position of the thermal cutting tool. Examples of suitable parameters are temperature or amount of light intensity, which can both be measured by suitable sensors.

The available position data can be supplied to the processing unit 10 to initiate movement between the supporting and the non-supporting position of one or more
supporting elements 5 which are within a certain area to be defined around the actual position of the thermal cutting tool 4.

Preferably the work piece support according to the invention is further provided with detecting means for detecting the non-supporting position of each supporting element 5. To this end at the underside of each supporting element 5 a printed circuit board is provided with a position sensor, such as an optical position sensor. Suitable position sensors are available in the art.

In order to prevent overheating of the electromagnetical supporting elements the amount of electrical power supplied thereto is controlled separately, preferably by varying energy supply in time using Pulse Width Modulation (PWM). Alternatively the amount of electrical power supplied to one or more of the supporting elements can be controlled by varying the controlling voltage or current.

It is noted for the sake of completeness that the invention is of course not limited to the described and shown preferred embodiment, but extends to any embodiment falling within the scope of protection as defined in the claims and as seen in the light of the foregoing description and accompanying drawings.
1. Work piece support for supporting a generally plate-like work piece for processing by a thermal cutting tool, comprising a plurality of rows of supporting elements which are movable between a supporting position in which they support the work piece and a non-supporting position in which they do not support the work piece, and a processing unit to control movement of the supporting elements based on the position of the thermal cutting tool, characterized in that one or more of the supporting elements comprise an electromagnet arranged to perform individual movement between the supporting position and the non-supporting position.

2. Work piece support according to claim 1, wherein one or more of the supporting elements comprise a movable plunger of magnetizable material having a head part arranged to make contact with the work piece in the supporting position.

3. Work piece support according to claim 2, wherein the head part is provided with a detachable cap, preferably made of copper.

4. Work piece support according to claim 1, wherein one or more of the supporting elements are biased so as to occupy the supporting position.

5. Work piece support according to claim 1, wherein the supporting elements are placed in a frame, which is provided with detection means to detect the non-supporting position of one or more of the supporting elements.

6. Work piece support according to claim 1, wherein the processing unit receives the coordinates of the actual position of the thermal cutting tool from control means, for instance numerical control means, for controlling movement of the thermal cutting tool.

7. Work piece support according to claim 1, wherein the processing unit receives the coordinates of the actual position of the thermal cutting tool from position sensors arranged on the work piece support along each axis of movement of the thermal cutting tool.
8. Work piece support according to claim 1, wherein the processing unit is arranged to determine the actual position of the thermal cutting tool by sensing means arranged on the work piece support for sensing parameters, such as temperature and/or light intensity.

9. Work piece support according to claim 1, wherein the processing unit receives the coordinates of the actual position of the thermal cutting tool from a camera with image recognition software arranged on the work piece support.

10. Work piece support according to claim 1, wherein the amount of electrical power supplied to one or more of the supporting elements can be controlled separately, preferably by means for varying energy supply in time using Pulse Width Modulation (PWM).
### A. CLASSIFICATION OF SUBJECT MATTER

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### B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

- B23 K
- B23 Q
- H01 F

### C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<td>Y</td>
<td>J.P. 1 113 195 A (MATSUSHITA ELECTRIC IND CO LTD) 1 May 1989 (1989-05-01) abstract</td>
<td>1-5, 10</td>
</tr>
<tr>
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<td>J.P. 63 052790 A (MITSUBISHI ELECTRIC CORP) 5 March 1988 (1988-03-05) abstract</td>
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<td>Y</td>
<td>WO 2009/095725 A1 (WAMALA DANIEL HU) ; CSORDAS ANTON HU 6 August 2009 (2009-08-06) pages 1-2 ; figure 6</td>
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### X

- Further documents are listed in the continuation of Box C.
- See patent family annex.

* Special categories of cited documents:
- "Y": document defining the general state of the art which is not considered to be of particular relevance
- "E": earlier document but published on or after the international filing date
- "L": document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O": document referring to an oral disclosure, use, exhibition or other means
- "P": document published prior to the international filing date but later than the priority date claimed

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Name and mailing address of the ISA:

European Patent Office, P.B. 5818 Patentlaan 2
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Fax: (+31-70) 340-3016

Authorized officer:

Lasa Goñi, Andoni
### INTERNATIONAL SEARCH REPORT

**Box No. II** Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. □ Claims Nos.: because they relate to subject matter not required to be searched by this Authority, namely:

2. □ Claims Nos.: because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. □ Claims Nos.: because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

**Box No. III** Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. □ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. □ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.

3. □ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

   1-5, 10

4. □ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

**Remark on Protest**

- □ The additional search fees were accompanied by the applicant’s protest and, where applicable, the payment of a protest fee.
- □ The additional search fees were accompanied by the applicant’s protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- □ No protest accompanied the payment of additional search fees.

Form PCT/ISA/21 0 (continuation of first sheet (2)) (April 2005)
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<td>Y</td>
<td>EP 1 343 180 A1 (YUKEN KOGYO CO LTD [JP]) 10 September 2003 (2003-09-10) paragraphs [0001], [0024], [0053]</td>
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<td>Y</td>
<td>EP 0 908 904 A2 (HUSCO INT INC [US]) 14 April 1999 (1999-04-14) paragraphs [0001], [0013], [1426]; figure 1</td>
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<td>EP 1 731 256 A1 (DIETLE HANS [DE]) 13 December 2006 (2006-12-13) claims 1,6,11</td>
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<td>WO 2004/113015 A2 (PAR SYSTEMS INC [US]) 29 December 2004 (2004-12-29) page 9, lines 14-21; figures 1-5</td>
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<td>05-02-2009</td>
<td>DE 102007050347 A</td>
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<td>JP 63052790 A</td>
<td>05-03-1988</td>
<td>NONE</td>
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<tr>
<td>WO 2009095725 A</td>
<td>06-08-2009</td>
<td>EP 2238603 A</td>
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<td>HU 226838 A</td>
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<tr>
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<td>CN 1479929 A</td>
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<td>US 2005015962 A</td>
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</table>
This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. Claims: 1-5

Workpiece support according to claim 1, wherein the supporting elements have a workpiece contacting head with a detachable cap.

Problem solved: prevent damaging the underside of the workpiece (see p. 3, lines 10-14).

---

2. Claims: 6-9

Workpiece support according to claim 1 with means to detect the actual position of the thermal cutting tool.

Problem solved: provide alternative means for detecting the position of the thermal cutting tool.

---

3. Claim: 10

Workpiece support according to claim 1, wherein the amount of electrical power supplied to the supporting elements can be controlled separately.

Problem solved: prevent overheating of the supporting elements (see p. 3, line 37, p. 4, line 3).

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