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BACKGROUND OF THE INVENTION

1. FIELD OF THE INVENTION:

5 The present invention relates to a work handler for transporting works such as, for example, switching buttons, panels, and bezels used in, for example, automobile-mountable audio systems and air conditioners, to a laser processing apparatus. Specifically, the present invention relates to a work handler for transporting works mounted
10 on a jig to a laser processing location and processing a painted surface of the works with laser.

2. DESCRIPTION OF THE RELATED ART:

15 Works such as, for example, switching buttons, panels, and bezels of automobile-mountable audio systems and air conditioners often bear symbols, characters and the like. Generally, the works are provided with the symbols, characters and the like as follows. First, a surface of each work is painted and then irradiated with laser light to
20 remove the paint in a pattern corresponding to the symbols, characters and the like.

Conventionally, the works are transported to the laser processing location mainly by the following two types
25 of work handlers: (1) turntable system and (2) carrier system.

(1) Turntable system

30 A plurality of jigs on which works are mountable are fixed on a turntable, and the turntable is turned so that the jigs are forwarded to the laser processing location one by one. An operator mounts the works in a number corresponding to one jig; and after the works are processed,

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the operator removes the works from the jig.

The turntable system has the following advantages: (i) only a small number of jigs are required;
5 (ii) while works on one jig are processed, different works can be mounted on another jig; and (iii) the production cost of the work handler is relatively low.

10 However, the work handler of the turntable system has the following disadvantages.

(i) While the jigs are forwarded, or while the works are mounted on or removed from the jigs, the jigs may be undesirably loosened from the turntable. In such a case,
15 the laser light cannot be directed to a prescribed portion of each work.

(ii) Since the time period allowed for mounting the works on the jig or removing the works from the jig is limited,
20 the results of these operations cannot be checked in detail.

(iii) The positions of the works with respect to the jig cannot be controlled in units as small as 100 μ m.

25 (iv) The positioning of jigs with respect to the turntable needs to be done each time the jigs are put on the turntable.

30 (v) Constant attendance by an operator is needed for mounting and removing the works.

(vi) The number of works which can be processed in one procedure is limited.

(2) Carrier system

A plurality of jigs, each having works mounted thereon, are set in a stacking case. The jigs are transported to a laser processing device one by one. After the works are processed, the jigs are accommodated back in the stacking case. An operator supplies jigs having unprocessed works mounted thereon when necessary and packs the works which have been processed near the stacking case.

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The carrier system has the following advantages: (i) since the works are mounted on the jigs separately from the transportation operation, constant attendance by an operator is not needed for mounting and removing the works; (ii) a relatively high positioning precision is realized; (iii) since the works can be painted in the state of being mounted on the jig, the same jig can be used both for painting and laser processing; (iv) a large number of works of a plurality of types can be processed in the same procedure.

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However, the carrier system has the following disadvantages: (i) replacing the works and replacing the jigs are time-consuming; (ii) since the jig is moved by a robot, the jig needs to be sufficiently strong to withstand mechanical positioning, and also the freedom of design in the size of the jig is limited; (iii) the cost for the work handler is relatively high; and (iv) the system is not suitable for small lot processing or test processing.

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SUMMARY OF THE INVENTION

A work handler according to the present invention

includes a small-sized jig to which a plurality of works are detachably mountable, the small-sized jig having a positioning mark; a large-sized jig to which a plurality of small-sized jigs are detachably mountable; a robot for
5 moving the large-sized jig to a laser irradiation location; a control device including a position detection device for detecting the positioning mark of the small-sized jig, the control device further feeding back a distance between the detected position of the positioning mark and a preset
10 processing position, and adjusting the position of the positioning mark, and a laser irradiation device for irradiating the works with laser light at the preset processing position. The detection, feedback and adjustment are repeated until the positioning mark is at
15 the preset processing position.

In one embodiment of the invention, the positioning mark is a columnar body having a through-hole for allowing light to be transmitted therethrough.
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In one embodiment of the invention, the position detection device includes a CCD camera.

In one embodiment of the invention, the large-sized jig is a quadrangular plate, and the small-sized jigs are each a generally quadrangular plate obtained as a result of injection molding.
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In one embodiment of the invention, the work handler further includes a device for, when all the works mounted on all the small-sized jigs which are mounted on the large-sized jig are processed, automatically replacing the large-sized jig with another large-sized jig.
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Thus, the invention described herein makes possible the advantages of providing a work handler which allows a great number of a variety of types of works to be processed in one procedure at a sufficiently high precision without requiring constant attendance by an operator, which also allows works to be replaced in a shorter period of time, and which can be produced at reduced cost.

These and other advantages of the present invention will become apparent to those skilled in the art upon reading and understanding the following detailed description with reference to the accompanying figures.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a plan view of a large-sized jig of a work handler in an example according to the present invention, in the state of having a plurality of small-sized jigs mounted thereon;

Figure 2 is a plan view of a small-sized jig of the work handler according to the present invention;

Figure 3A is a plan view of the large-sized jig shown in Figure 1, with no small-sized jigs being mounted;

Figure 3B is a partial plan view of a large-sized jig in another example of the present invention; and

Figure 4 is a schematic view of the work handler according to the present invention.

DESCRIPTION OF THE EMBODIMENTS

Hereinafter, the present invention will be described by way of illustrative examples with reference to the accompanying drawings.

In this specification, the terms "small-sized" and "large-sized" are used simply for expressing the size relationship between the two different types of jigs and are not intended to represent any practical size.

Figure 4 is a schematic view of a work handler 100 in an example according to the present invention. The work handler 100 includes a small-sized jig 10, on which a plurality of works 1 can be detachably mounted, and a large-sized jig 20 on which a plurality of small-sized jigs 10 can be detachably mounted. In Figure 4, a plurality of large-sized jigs 20 are vertically stacked in a stacking case 7.

The work handler 100 further includes a robot 4 for transporting one of the large-sized jigs 20 in the stacking case 7 to a laser processing location, a control device 5 for detecting and adjusting the position of the small-sized jig 10, a laser irradiation device 3 for performing laser processing of works 1 on the small-sized jig 10, and a light source 8 provided so as to be below the large-sized jig 20 located in the laser processing location. The control device 6 is connected to the laser irradiation device 3 and the robot 4. The detection of the position of the small-sized jig 10 is performed by a position detection device 6 included in the control device 5.

Figure 1 is a plan view of the large-sized jig 20. In Figure 1, a plurality of small-sized jigs 10 are mounted on the large-sized jig 20, and a plurality of works 1 are mounted on each of the plurality of small-sized jigs 10.

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Figure 2 is an enlarged plan view of one small-sized jig 10. Each small-sized jig 10 is made of a plastic material and formed by injection molding, and has a substantially quadrangular, circular, or polygonal planar shape. As shown in Figure 2, the small-sized jig 10 includes a quadrangular frame 12, first supporting members 13, second supporting members 14, and a cylindrical body 11. The first supporting members 13 and second supporting members 14 extend perpendicular to each other within the frame 12. Although not shown, engaging members each engageable with one work 1 are provided on the first supporting members 13, on the second supporting members 14 or the intersections thereof. The engaging members can be projections or recesses. In accordance with the positions of the engaging members, the works 1 can be arranged regularly or randomly. The cylindrical body 11 is used as a positioning mark described below. The cylindrical body 11 slightly projects from a planar top surface of the small-sized jig 10 and has a through-hole 15 running through the small-sized jig 10 in a direction perpendicular to the planar direction thereof (i.e., in a direction perpendicular to the page of Figure 2). Light emitted from the light source 8 (Figure 4) and transmitted through the through-hole 15 is used to detect the position of the small-sized jig 10 as described below.

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The plurality of works 1 are mounted on the small-sized jig 10 and are provided to a painting stage in that state. When the works 1 are painted the small-sized

jig 10 is also inevitably painted. Since the cylindrical body 11 slightly projects with respect to the planar top surface of the small-sized jig 10, a paint obliquely sprayed can be prevented from clogging the through-hole 15. Therefore, even after the works on the small-sized jig 10 are painted, the position of the small-sized jig 10 can be detected using the light transmitted through the through-hole 15. The works 1 and the small-sized jig 10 are then mounted on the large-sized jig 20.

Figure 3A is a plan view of the large-sized jig 20 in the state where no small-sized jig 10 is mounted. As shown in Figure 3A, the large-sized jig 20 includes a quadrangular frame 21, first crosspieces 22 and second crosspieces 23, a stepped portion 24 provided along three sides of the frame 21, and openings 25. The first crosspieces 22 and the second crosspieces 23 extend perpendicular to each other in a lattice pattern and thus define the openings 25. The stepped portion 24 is at a slightly higher level than a surface of the first crosspieces 22 and the second crosspieces 23, so that the small-sized jigs 10 are fit into the large-sized jig 20 sufficiently easily. The openings 25 are provided in the number of, for example, 16 to 25, and are each provided for receiving one small-sized jig 10. The large-sized jig 20 is formed of a relatively strong material such as, for example, a wood, a metal or a plastic material.

The small-sized jigs 10 and the large-sized jig 20 are sized so that when the plurality of small-sized jigs 10 are mounted on the large-sized jig 20, there is a gap between adjacent small-sized jigs 10, and also between an inner side face of the frame 21 and an outer side face of the small-sized jig 10. Thus, even when the size of the

small-sized jigs 10 is changed to some extent, the small-sized jigs 10 can still be mounted on the large-sized jig 20 with no inconveniences. Accordingly, the work handler 100 can be used for various types of works 1.

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The large-sized jig can be formed of a transparent plastic material and has a flat surface with no crosspieces. In this case, a wider variety of shapes of small-sized jigs 10 are mountable.

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In the state where the small-sized jigs 10 are mounted on the large-sized jig 20, the through-hole 15 of each small-sized jig 10 is positioned in the respective opening 25.

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Returning to Figure 4, the robot 4, the control device 5 including the position detecting detection 6, and the laser irradiation device 3 can be known devices as exemplified below.

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Hereinafter, an operation of the work handler 100 will be described. The structures of the robot 4, the control device 5, the position detection device 6, and the laser irradiation device 3 are exemplary and do not limit the present invention.

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First, an operator mounts a plurality of works 1 on a small-sized jig 10. A surface of the works 1 can be painted in this state.

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Then, the operator mounts a plurality of (for example, 16 to 25; 16 in Figure 4) small-sized jigs 10 on the large-sized jig 20. Each small-sized jig 10 has a

plurality of works 1 mounted thereon. A plurality of large-sized jigs 20, each having such a plurality of small-sized jigs 10, are stacked in the stacking case 7.

5 One of the large-sized jigs 20 in the stacking case 7 is transported to the laser irradiation location below the laser irradiation device 3 by the robot 4. Although not shown, the robot 4 has two arms and grabs the frame 21 of the large-sized jig 20 with the two arms to transport the
10 large-sized jig 20 to the laser irradiation location.

 In the laser irradiation location, the position of the through-hole 15 of the cylindrical body 11 of each of the small-sized jigs 10 is detected by the position detection
15 device 6 one by one. The position detection device includes a CCD camera, which detects the light emitted by the light source 8 and transmitted through the through-hole 15 of the cylindrical body 11 of one of the small-sized jig 10.

20 An image taken by the CCD camera is sent to and stored in a personal computer (not shown) connected to the control device 6. The personal computer finds the position of the small-sized jig 10 based on the image from the CCD camera by calculation and thus determines the distance between the
25 current position of the small-sized jig 10 and a preset processing position at which the positioning mark (i.e., the cylindrical body 11 having the through-hole 15) of the small-sized jig 10 should be located. The distance is fed back to the robot 4, so that the robot 4 can adjust the
30 position of the small-sized jig 10 to be at the preset processing position. The procedure including the detection of the position, feedback of the distance, and adjustment of the position is repeated until the cylindrical body 11

is precisely located at the preset processing position.

When the cylindrical body 11 of the small-sized jig 10 is precisely located at the preset processing position, the laser irradiation device 3 performs laser processing of the works 1; i.e., irradiates the surface of the works 1 on the small-sized jig 10 with laser light. Thus, the paint on the surface of the works 1 is etched away in a prescribed pattern corresponding to the desired symbols, characters and/or marks.

After all the works 1 on one of the small-sized jig 10 are processed, the robot 4 moves the large-sized jig 20 so that the position of the next small-sized jig 10 is detected and adjusted.

After all the works 1 on all the small-sized jigs 10 mounted on the large-sized jig 20 are processed in this manner, the large-sized jig 20 is automatically replaced with another large-sized jig 20 in the stacking case 7 by an automatic replacement device (not shown) connected to the control device 6.

Each small-sized jig 10 has one positioning mark in this example, but can have a plurality of positioning marks. The positioning mark is the cylindrical body 11 having the through-hole 15 in this example, but a slit, for example, can be used instead of the through-hole 15. The positioning mark can have any appropriate shape. Instead of the cylindrical body 11, a body of a different columnar or any other appropriate shaped can be used.

The large-sized jig 20 has a quadrangular shape in

this example, but can have any other appropriate shape as long as the large-sized jig 20 has a frame having a stepped portion along at least two adjacent sides. In this case, the small-size jigs 10 are arranged along the two sides.

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Figure 3B is a partial plan view of a large-sized jig 30 in another example according to the present invention. The large-sized jig 30 includes a stepped portion 34 on first crosspieces 32 and second crosspieces 33 which are provided perpendicular to each other in a lattice, in addition to the stepped portions 24. In this case, areas defined by the stepped portion 24 and the stepped portion 34 and areas defined by intersecting portions of the stepped portion 34 are each larger than the external size of the small-sized jig 10. In this structure, the works 1 can be mounted on the small-sized jig 10 more easily than in the structure shown in Figure 1.

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The works 1 can be mounted on the small-sized jigs 10 by the robot 4, and the small-sized jigs 10 can also be mounted on the large-sized jigs 20 by the robot 4.

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According to the present invention, the small-sized jigs 10 having the works 1 mounted thereon are transported by the robot 4 to the laser irradiation location in the state of being mounted on the large-sized jig 20. The work handler according to the present invention provides the following effects.

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(1) Replacement of works can be done simply by replacing the small-sized jigs to be mounted on the large-sized jig, and thus in a shorter period of time than by the conventional techniques. In the case where the

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position of the positioning mark and the pattern of each type of small-sized jigs are stored in the personal computer, the time period required for replacing the small-sized jigs can be further shortened.

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(2) The freedom of design in the size of the small-sized jigs is increased, and therefore a variety of types of works can be processed in one procedure with an increased level of precision.

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(3) A great number of works can be processed in one procedure.

15 (4) Since the robot transports the large-sized jig, the small-sized jigs are not required to be sufficiently strong to withstand mechanical positioning. Therefore, the small-sized jigs can be lightweight, which improves the positioning precision for laser processing. Such small-sized jigs can be produced by injection molding and thus
20 at reduced cost as compared to the conventional jigs. Since an identical mold can be used for producing a plurality of types of small-sized jigs except for the engaging members, the production cost of the small-sized jigs can be reduced. Therefore, the production cost of the work handler can be
25 reduced.

(5) The work handler is suitable for small lot processing and test processing.

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(6) Constant attendance by an operator is not required for mounting works on and removing the works from the jig.

(7) Since the works are positioned by detecting the position of the small-sized jig having the works thereon, the positional relationship between the small-sized jigs and the large-sized jig can be loose.

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(8) Since the position of the small-sized jig is detected by light transmitted through the through-hole of the cylindrical body of the small-sized jig, the works can be painted while being mounted on the small-sized jig.

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(9) In the case where the types of the small-sized jigs are read by a bar-code reader, the positions of the works mounted on various types of small-sized jigs on one large-sized jig can be detected relatively easily. The positions of the works with respect to each small-sized jig can be controlled in units as small as 100 μ m by appropriately setting the robot and the personal computer.

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Various other modifications will be apparent to and can be readily made by those skilled in the art without departing from the scope and spirit of this invention. Accordingly, it is not intended that the scope of the claims appended hereto be limited to the description as set forth herein, but rather that the claims be broadly construed.

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WHAT IS CLAIMED IS:

1. A work handler, comprising:

a small-sized jig to which a plurality of works are detachably mountable, the small-sized jig having a positioning mark;

a large-sized jig to which a plurality of small-sized jigs are detachably mountable;

a robot for moving the large-sized jig to a laser irradiation location;

a control device including a position detection device for detecting the positioning mark of the small-sized jig, the control device further feeding back a distance between the detected position of the positioning mark and a preset processing position, and adjusting the position of the positioning mark, and

a laser irradiation device for irradiating the works with laser light at the preset processing position,

wherein the detection, feedback and adjustment are repeated until the positioning mark is at the preset processing position.

2. A work handler according to claim 1, wherein the positioning mark is a columnar body having a through-hole for allowing light to be transmitted therethrough.

3. A work handler according to claim 1 or 2, wherein the position detection device includes a CCD camera.

4. A work handler according to any one of claims 1 through 3, wherein the large-sized jig is a quadrangular plate, and the small-sized jigs are each a generally quadrangular plate obtained as a result of injection molding.



5. A work handler according to any one of claims 1 through 4, further comprising a device for, when all the works mounted on all the small-sized jigs which are mounted on the large-sized jig are processed, automatically replacing the large-sized jig with another large-sized jig.