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Cutting machining apparatus

Abstract

A cutting machining apparatus includes: a holding unit including a workpiece holder, a tool holder, and a unit body; a head positioned facing the holding unit and including a chuck holding a tool; an interior case of a box shape including, in a peripheral wall, a first opening through which the holding unit is inserted and a second opening through which the head is inserted and housing the workpiece holder, the tool holder, and the chuck disposed inside; a first cover occluding between the head and the outer periphery of the first opening of the interior case, a second cover occluding between the holding unit and the outer periphery of the second opening of the interior case, and a cooling source cooling the tool holder from within the unit body via a heat transfer member.

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References Cited

U.S. PATENT DOCUMENTS

Patent No.	Issued Date	Patentee Name	U.S. Cl.	CPC
11766753	12/2022	Li	409/228	B23Q 11/1076
11864729	12/2023	Shelton, IV	N/A	A61B 1/000094
12002571	12/2023	Shelton, IV	N/A	A61B 18/1445
12207881	12/2024	Shelton, IV	N/A	G16H 20/40
12257013	12/2024	Scheib	N/A	G01S 17/86
2015/0183130	12/2014	Gadd	83/100	B24B 55/02
2017/0333053	12/2016	Li	N/A	A61B 17/16
2019/0175272	12/2018	Khan	N/A	A61B 34/35
2019/0343112	12/2018	Woods	N/A	A61B 17/16
2023/0165594	12/2022	Harris	606/180	G05B 19/182
2024/0108364	12/2023	Penner	N/A	A61B 17/1775

FOREIGN PATENT DOCUMENTS

Patent No.	Application Date	Country	CPC
S62074943	12/1986	JP	N/A

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Background/Summary

FIELD OF THE INVENTION

(1) The present disclosure relates to a cutting machining apparatus.

BACKGROUND OF THE INVENTION

(2) To greatly reduce the burden on a patient by eliminating the need for reoperation to remove a thread after a fractured bone has been fused, threads are being made for joining bones with each other by cutting machining a bone fragment obtained by cutting out a bone of a patient themselves, and these threads are used to join a fractured bone of the patient. In such a case, the burden on the patient is required to be reduced by minimizing the size of the bone fragment cut out from the patient's bone for making the thread. In addition, a machining center capable of stably performing high-precision machining of workpieces has been proposed (refer to, for example, Utility Model Application Publication No. S62-74943).

(3) Incidentally, when machining a bone fragment using, for example, a machining center as described in Utility Model Application Publication No. S62-74943, there is a risk that excessive heat generated due to friction between the tool and the bone fragment may be applied to the bone fragment. Further, it has been reported that when excessive heat is applied to a bone fragment, activation of the bone fragment is inhibited, reducing the rate of fusion of the thread after joining a fractured part using the thread made from the bone fragment. Therefore, a cutting machining apparatus capable of suppressing the temperature rise of a bone fragment when machining the bone fragment is required. In addition, when a thread is made by cutting machining, foreign matters present in an area where the thread is made need to be minimized from a viewpoint of preventing infection of the patient caused by bacteria attached to the produced thread. However, in the machining center described in Utility Model Application Publication No. S62-74943, since the machining area is exposed to outside air, there is a risk that the thread is contaminated by foreign matters present around the bone fragment to be machined.

(4) The present disclosure is made in consideration of the above problems. Thus, an objective of the present disclosure is to provide a cutting machine apparatus capable of suppressing the temperature rise of a workpiece during machining while increasing the cleanliness of an area where cutting machining is conducted.

SUMMARY OF THE INVENTION

(5) In order to achieve the above objective, the cutting machining apparatus according to the present disclosure includes: a holding unit including a workpiece holder that holds a workpiece, a tool holder having a bottomed cylindrical shape and holding a tool in a state in which the tool is inserted inside, and a unit body that secures the tool holder in such a way that, in a state in which the tool is not inserted into the tool holder, the inside of the tool holder is in communication with the outside and the outer wall of the tool holder is isolated from the outside; a head positioned facing the holding unit and including a chuck holding the tool held by the tool holder; an interior case including, in a peripheral wall, a first opening through which the holding unit is inserted and a second opening through which the head is inserted and housing the workpiece holder, the tool holder, and the chuck disposed inside; a first cover formed of a soft material and occluding between the holding unit and an outer periphery of the first opening in the interior case; a second cover formed of a soft material and occluding between the head and an outer periphery of the second opening in the interior case; and a cooling mechanism cooling the tool holder from within the unit body.

(6) According to the present disclosure, at least the workpiece holder, the tool holder, and the chuck of the holding unit are disposed inside the interior case. The first cover occludes between the holding unit and the outer periphery of the first opening in the interior case, and the second cover occludes between the head and the outer periphery of the second opening in the interior case. The tool holder is secured to the unit body in such a way that, in a state in which the tool is not inserted therein, the inside of the tool holder is in communication with the outside of the unit body and the outer wall of the tool holder is isolated from the outside of the unit body. This makes it possible to form an area for cutting machining, inside the interior case, that is isolated from the outside of the interior case, thereby suppressing foreign matters present outside of the interior case from entering into the area where cutting machining is conducted. Furthermore, the cooling mechanism cools the tool holder that holds the tool from within the unit body, thereby suppressing the temperature rise of a workpiece during machining while increasing the cleanliness of the area where the cutting machining is conducted.

Description

BRIEF DESCRIPTION OF DRAWINGS

- (1) A more complete understanding of this application can be obtained when the following detailed description is considered in conjunction with the following drawings, in which:
- (2) FIG. 1 is a schematic diagram of a cutting machining apparatus according to Embodiment 1 of the present disclosure;
- (3) FIG. 2 is a partially broken side view of the cutting machining apparatus according to Embodiment 1;
- (4) FIG. 3 is a side view of a holding unit according to Embodiment 1;
- (5) FIG. 4A is a cross-sectional view of a tool holder and a heat transfer member according to Embodiment 1;
- (6) FIG. 4B is a perspective view of the tool holder according to Embodiment 1;
- (7) FIG. 5A is a front view illustrating a head of the cutting machining apparatus descending to hold a tool according to Embodiment 1;
- (8) FIG. 5B is a front view illustrating the cutting machining apparatus machining a workpiece according to Embodiment 1;
- (9) FIG. 6 is a partially broken side view of a cutting machining apparatus according to Embodiment 2 of the present disclosure;
- (10) FIG. 7A is a front view illustrating a head of the cutting machining apparatus descending to hold a tool according to Embodiment 2;
- (11) FIG. 7B is a front view illustrating the cutting machining apparatus machining a workpiece according to Embodiment 2;
- (12) FIG. 8 is a partially broken side view of a cutting machining apparatus according to Embodiment 3 of the present disclosure;
- (13) FIG. 9 is a cross-sectional view of a tool holder and a heat transfer member according to Embodiment 3;
- (14) FIG. 10 is a partially broken side view of a cutting machining apparatus according to Embodiment 4 of the present disclosure;
- (15) FIG. 11 is a flowchart illustrating an example of a flow of cutting machining processing performed by the cutting machining apparatus according to Embodiment 4; and
- (16) FIG. 12 is a cross-sectional view of a tool holder and a heat transfer member according to a variation.

DETAILED DESCRIPTION OF THE INVENTION

Embodiment 1

(17) A cutting machining apparatus according to an embodiment of the present disclosure is described below with reference to the drawings. The cutting machining apparatus according to the present embodiment includes: a holding unit including a workpiece holder that holds a workpiece; a tool holder holding a tool; and a box-shaped unit body; a head positioned facing the holding unit and including a chuck that holds a tool held by the tool holder; an interior case of a box shape including, in a peripheral wall, a first opening through which the head is inserted and a second opening through which the holding unit is inserted and housing the workpiece holder, the tool holder, and the chuck disposed inside; a first cover formed of a soft material and occluding between the head and the outer periphery of the first opening in the interior case; a second cover formed of a soft material and occluding between the holding unit and the outer periphery of the second opening in the interior case; and a cooling mechanism for cooling the tool holder from within the unit body. Here, the tool holder has a bottomed cylindrical shape and holds the tool in a state in which the tool is inserted inside. The unit body is box-shaped, and, secures the tool holder in such a way that, in a state in which the tool is not inserted into the tool holder, the inside of the tool holder is in communication with the outside of the tool holder and the outer wall of the tool holder is isolated from the outside.

(18) As illustrated in FIG. 1, a cutting machining apparatus **1** according to the present embodiment includes a holding unit **3** that holds a workpiece **W**, a head **5** that is positioned facing the holding unit **3** and holds a tool **20**, a controller (not illustrated) that controls the operation of the holding unit **3** and the head **5**, and a display panel **11**. In addition, the cutting machining apparatus **1** includes a chassis **10** of a rectangular box shape that has an opening **10b** in the +Y direction-side side wall formed for inserting and removing a workpiece **W** and housing the holding unit **3**, the head **5**, and the controller disposed inside. Although not illustrated in FIG. 1, the opening **10b** can be occluded by a door **15** described later. Furthermore, as illustrated in FIG. 2, the cutting machining apparatus **1** includes: an interior case **13** of a rectangular box shape one side of which is open and in which portions of the holding unit **3** and the head **5** are disposed; a first cover **141** and a second cover **142** formed of a soft material; and a door **15** covering the opening **10b** from the +Y direction side. The cutting machining apparatus **1** also includes a lift drive **44** that raises and lowers the head **5** in a vertical direction, an X-direction drive **71** that drives the head **5** along the X-axis direction, and a Y-direction drive **76** that drives the head **5** along the Y-axis direction. The chassis **10** has the interior case **13** disposed inside and the display panel **11** mounted on the +Z direction side of the opening **10b** in the +Y direction-side side wall. The display panel **11** displays, for example, a progress status of the cutting machining processing performed on the workpiece **W**.

(19) The interior case **13** has a machining area **S1** formed inside where machining of the workpiece **W** is conducted. The machining area **S1** is enclosed by the interior case **13** and the door **15**. The interior case **13** is disposed inside the chassis **10** in a posture in which the open portion is oriented toward the opening **10b** side of the chassis **10** and has openings **13a** and **13b** provided in the +Z direction side peripheral wall and the -Y direction side peripheral wall, respectively. Here, the opening **13a** is a first opening through which the head **5** is inserted, and the opening **13b** is a second opening through which the holding unit **3** is inserted. In addition, a support member **12** that supports the head **5**, the holding unit **3**, and the like is disposed in an area **S2** outside the interior case **13** within the chassis **10**.

(20) The head **5** includes a long rotary spindle **52** provided with a chuck **53**, at one end of the longitudinal direction, that holds the tool **20** and a spindle drive **51** that rotates the rotary spindle **52** about a central axis along the longitudinal direction thereof. The chuck **53** includes a chuck (not illustrated) and an actuator (not illustrated) that drives the chuck, and the chuck opens and closes according to a control signal input from the controller. The head **5** is secured to a slider **422** that is slidably held on a rail **421** extending along the Z axis direction on the +Y direction side of the base **41**. The lift drive **44** includes: a long feed screw (not illustrated) arranged along the Z-axis direction and screwed to a nut (not illustrated) provided on a portion of the slider **422**; and a motor (not illustrated) coupled to the feed screw to rotate the feed screw. The lift drive **44** then raises and lowers the slider **422** and the head **5** secured to the slider **422** along the Z-axis direction by rotating the feed screw arranged along the Z-axis direction.

(21) The base **41** is also secured via a bracket **43** to a slider **722** that is slidably held on a rail **721** extending along the X-axis direction. The X-direction drive **71** includes: a long feed screw (not illustrated) arranged along the X-axis direction and screwed to a nut (not illustrated) provided on a portion of the bracket **43**; and a motor (not illustrated) coupled to the feed screw to rotate the feed screw. The X-direction drive **71** then moves the slider **722** and the base **41** secured to the slider **722** along the X-axis direction by rotating the feed screw arranged along the X-axis direction. As a result, the X-direction drive **71** moves the base **41** and the head **5** together along the X-axis direction via the feed screw. The rail **721** is supported by sliders **772** that are slidably held on two rails **771** of which longitudinal ends extend along the Y-axis direction. The Y-direction drive **76** includes: a long feed screw (not illustrated) arranged along the Y-axis direction and screwed to a nut (not illustrated) provided on a portion of the base **41**; and a motor (not illustrated) coupled to the feed screw to rotate the feed screw. The Y-direction drive **76** then moves the sliders **772** and the rail **721** supported by the sliders **772** along the Y-axis direction by rotating the feed screw arranged

along the Y-axis direction. As a result, the Y-direction drive **76** moves the rail **721**, the slider **722**, the base **41**, and the head **5** together via the feed screw along the Y-axis direction.

(22) As illustrated in FIG. **3**, the holding unit **3** includes: a workpiece holder **32** that holds a workpiece **W**; a tool holder **33** that has a substantially bottomed circular shape and holds the tool **20** in a state in which the tool **20** is inserted inside; a box-shaped unit body **31**; a heat transfer member **34**; and a cooling source **35**. As illustrated in FIG. **2**, the holding unit **3** includes: a rotary drive **81** that causes the entire unit body **31** to rotate about a rotational axis (hereinafter, referred to as “B axis”) **JB** extending along the longitudinal direction of the unit body **31**; and a rotary drive **86** that causes the workpiece holder **32** to rotate about a rotational axis extending along a direction orthogonal to the longitudinal direction of the unit body **31** (hereinafter, referred to as the “C axis”) **JC**.

(23) The rotary drive **86** includes a motor that is disposed inside the unit body **31** and rotates a shaft (not illustrated) that extends along the C axis and of which tip is coupled to the workpiece holder **32**. The rotary drive **81** includes a motor that supports the $-Y$ direction-side end of a shaft **82** having a cylindrical shape and extending along the B axis to rotate the shaft **82** about the B axis. The unit body **31** is secured to the $+Y$ direction-side end of the shaft **82**. The rotary drive **81** is supported by the support member **12** provided on the outside of the interior case **13** within the chassis **10**.

(24) The unit body **31** includes a hollow rectangular first section **311** and a rectangular box-shaped second section **312** that is continuous to the first section **311** at the $+Y$ direction-side end of the first section **311**, as illustrated in FIG. **3**. The first section **311** is secured to the shaft **82** at the $-Y$ direction side end of the first section **311**, as illustrated in FIG. **2**. Then, when the shaft **82** of the rotary drive **81** rotates about the B axis, the unit body **31** rotates about the B axis accordingly. The first section **311** has three openings **311a** formed in the side wall along the Z-axis direction. The workpiece holder **32** is a chuck that grips the proximal end of a long workpiece **W**. The workpiece holder **32** is secured to the peripheral wall of the second section **312** of the unit body **31**.

(25) The tool holder **33** is secured to the unit body **31** in such a way that, in a state in which the tool **20** is not inserted in the tool holder **33**, the inside of the tool holder **33** is in communication with the outside of the unit body **31** and the outer wall of the tool holder **33** is isolated from the outside of the unit body **31**. Here, as illustrated in FIGS. **4A** and **4B**, the tool **20** includes: a disc-shaped tool body **22**; a blade **21**, for cutting a workpiece, formed continuously with the tool body **22** and protruding from one side in the thickness direction of the tool body **22**; and a shank **23** formed continuously with the tool body **22** and protruding from the other side in the thickness direction of the tool body **22** and held by the chuck **53** of the head **5**. The tool holder **33** includes: a tool body housing **331** formed of metal such as aluminum, copper, or the like, and housing the tool body **22** of the tool **20** disposed inside; a blade housing **332** housing the blade **21** of the tool **20** disposed inside; and an outer flange **333**. Here, the tool body housing **331** has a bottomed cylindrical shape and has a bottom wall **331a** as a first bottom, through which a through hole **331b** penetrates in a thickness direction of the bottom wall **331a**, and the tool body **22** of the tool **20** is disposed inside the tool body housing **331** in a state in which the tool body **22** abuts at least one of the bottom wall **331a** and the side wall **331c**. The blade housing **332** has a bottomed cylindrical shape of which inner diameter smaller than the inner diameter of the tool body housing **331**. The blade housing **332** has a bottom wall **332a** as a second bottom wall, and the entire end opposite the bottom wall **332a** is formed continuously with the outer periphery of the through hole **331b** in the bottom wall **331a**. The outer flange **333** extends from the end of the tool body housing **331**, opposite the bottom wall **331a**, in a direction orthogonal to the cylindrical axis of the tool body housing **331** and away from the cylindrical axis of the tool body housing **331**. The tool holder **33** is secured by securing the outer flange **333** to the peripheral wall of the unit body **31** in a state in which the outer flange **333** is exposed outside the unit body **31** through the opening **311a** provided in the peripheral wall of the unit body **31**. Here, between the outer flange **333** and the outer periphery of the opening **311a** of

the unit body **31** may be sealed by a sealing member (not illustrated).

(26) The heat transfer member **34** is formed of metal such as aluminum, copper, or the like, in a rectangular shape and is arranged to cover the tool body housing **331** and blade housing **332** of the tool holder **33**. In addition, the heat transfer member **34** has recesses **34a** that open to portions corresponding to the three openings **311a** of the unit body **31** and into which the tool holders **33** are inserted. The tool holder **33** is inserted inside the recess **34a** of the heat transfer member **34**, and the outer flange **333** is secured to the heat transfer member **34** in a state in which the outer flange **333** is in close contact with the outer periphery of the recess **34a** in the heat transfer member **34**. The cooling source **35** includes a Peltier element, for example, and is arranged in a state in which the cooling source **35** is in contact with the heat transfer member **34** inside the unit body **31** to maintain the heat transfer member **34** at a preset temperature. The heat transfer member **34** and the cooling source **35** form a cooling mechanism for cooling the tool holder **33** from within the unit body **31**. The tool holder **33** then holds the tool **20** in a state in which the shank **23** is exposed outside the holding unit **3** within the interior case **13**, as illustrated in FIG. 2.

(27) The first cover **141** is formed of a soft material such as a thin rubber film, a vinyl film, or the like, and is preferably sterilized using, for example, ethylene oxide gas. The first cover **141** is cylindrical having a shape in which one end in the cylindrical axial direction is reduced in diameter toward the other end, the entire one end in the cylindrical axial direction is secured to the outer periphery of the opening **13a** of the interior case **13**, and the other entire end in the cylindrical axial direction is secured to the spindle drive **51** of the head **5**. The second cover **142** is also formed of a soft material such as a thin rubber film, a vinyl film, or the like, and is preferably sterilized using, for example, ethylene oxide gas. The second cover **142** is cylindrical having a shape in which one end in the cylindrical axial direction is reduced in diameter toward the other end, and the entire one end in the cylindrical axial direction is secured to the outer periphery of the opening **13b** of the interior case **13** and the entire other end in the cylindrical axial direction is secured to the unit body **31** of the holding unit **3**.

(28) The controller includes: for example, a programmable logic controller (PLC) including a central processing unit (CPU) unit and an input/output control unit; and an input device, such as a keyboard and a touch panel, connected to the PLC. The controller outputs control signals to driving circuits for driving the spindle drive **51**, the lifting drive **44**, the X-direction drive **71**, the Y-direction drive **76**, the rotary drives **81**, **86**, and the chuck **53**, respectively to control the operations thereof.

(29) Next, an operation of the cutting machining apparatus **1** according to the present embodiment is described with reference to FIGS. 5A and 5B. Here, an example of machining performed by drilling a workpiece **W** by a drill, which is the tool **20**, along the longitudinal direction of the long workpiece **W** is described. It is assumed that tools **20** to be used are held in the three tool holders **33** of the holding unit **3**, and the workpiece **W** is held in the workpiece holder **32**. Furthermore, it is assumed that the holding unit **3** is maintained in a posture in which the tool holder **33** is oriented toward the +Z direction. First, as illustrated in FIG. 5A, in a state in which the head **5** is positioned on the +Z direction side of the tool holder **33** of the holding unit **3**, the cutting machining apparatus **1** lowers the head **5** in the -Z direction as indicated by the arrow **AR 11**, causing the head **5** to hold one of the tools **20**. The cutting machining apparatus **1** then raises the head **5** holding the tool **20** in the +Z direction. Subsequently, by rotating the holding unit **3** about the B axis **JB** as indicated by the arrow **AR12** in FIG. 5B, the cutting machining apparatus **1** sets the workpiece holder **32** holding the workpiece **W** in a posture oriented toward the +Z direction. The cutting machining apparatus **1** then moves the head **5** in the X-axis direction and the Y-axis direction in such a way that the position of the tool **20** is in alignment with the workpiece **W** in the Z-axis direction, as indicated by the arrow **AR13**. Next, the cutting machining apparatus **1** performs cutting machining of the workpiece **W** by lowering the head **5** in the -Z direction and causing the tip of the tool **20** to contact the workpiece **W**, as indicated by the arrow **AR 14**, while rotating the rotary spindle **52**

without moving the workpiece holder **32**.

(30) Note that, when machining is conducted by drilling into the side wall along the longitudinal direction of the workpiece **W**, the cutting machining apparatus **1** maintains the holding unit **3** in a posture in which the workpiece holder **32** is oriented toward the $\pm X$ direction. Subsequently, the cutting machining apparatus **1** performs cutting machining on the workpiece **W** with the tool **20** by lowering the head **5** in the $-Z$ direction and causing the tip of the tool **20** to contact the workpiece **W**, while rotating the rotary spindle **52** without moving the workpiece holder **32**. When the tool **20** is a threading tap, the cutting machining apparatus **1** can also thread the workpiece **W** at a high speed by lowering the head **5** in the $-Z$ direction and causing the tip of the tool **20** to contact the workpiece **W**, while rotating the rotary spindle **52**, as well as, rotating the workpiece holder **32** in a direction opposite to the rotating direction of the rotary spindle **52**.

(31) As described above, according to the cutting machining apparatus **1** according to the present embodiment, the workpiece holder **32**, the tool holder **33**, and the chuck **53** are disposed inside the interior case **13**, the first cover **141** occludes between the head **5** and the outer periphery of the opening **13a** in the interior case **13**, and the second cover **142** occludes between the holding unit **3** and the outer periphery of the opening **13b** in the interior case **13**. The tool holder **33** is secured to the unit body **31** in such a way that, in a state in which the tool **20** is not inserted in the tool holder **33**, the inside of the tool holder **33** is in communication with the outside of the unit body **31** of the holding unit **3** and the outer wall of the tool holder **33** is isolated from the outside of the unit body **31**. As a result, the machining area **S1** where cutting machining is conducted and that is isolated from the outside of the interior case **13** can be formed inside the interior case **13**, thereby suppressing foreign matters present outside the interior case **13** from entering into the machining area **S1**. In addition, since the heat transfer member **34** and the cooling source **35** cool the tool holder **33** that holds the tool **20** from within the unit body **31**, the temperature rise of the workpiece **W** during machining of the workpiece **W** is suppressed while increasing the cleanliness of the machining area **S1**.

(32) Incidentally, cooling of a tool **20** by air blow or coolant is often carried out to suppress an excessive temperature rise of the tool **20** and a workpiece **W** during cutting machining. However, when the workpiece **W** is a bone fragment, as in the cutting machining apparatus **1** according to the present embodiment, there is a concern that the workpiece **W** becomes excessively dry with an air-blow cooling method. In addition, with a cooling method using coolant, contamination of the workpiece **W** is a concern. To counter such concerns, with the cutting machining apparatus **1** according to the present embodiment, the tool **20** can be cooled while the tool **20** is disposed in the clean machining area **S1**, and thus drying or contamination of the workpiece **W** can be suppressed.

(33) In addition, the tool **20** according to the present embodiment is formed by continuously integrating the tool body **22**, the blade **21**, and the shank **23**. As a result, the frictional heat generated at the blade **21** during machining of the workpiece **W** by the tool **20** is efficiently transmitted to the tool body **22** and the shank **23**, and thus the frictional heat generated at the blade **21** can be efficiently dissipated to the head **5** via the tool body **22** and the shank **23**. Thus, an excessive temperature rise of the tool **20** and the workpiece **W** during cutting machining can be suppressed.

Embodiment 2

(34) The cutting machining apparatus according to the present embodiment differs from Embodiment 1 in that the present embodiment includes a first holding unit that holds a workpiece and a second holding unit that is separate from the first holding unit and holds a tool. The second holding unit according to the present embodiment includes: a tool holder of a bottomed cylindrical shape; and a unit body that has a box shape and secures the tool holder in a state in which the outer wall of the tool holder is isolated from the outside, in which the inside of the tool holder is in communication with the outside in a state in which a tool is not inserted in the tool holder. In addition, the inside of the unit body is filled with refrigerant in such a manner the refrigerant

contacts at least a portion of the tool holder.

(35) As illustrated in FIG. 6, a cutting machining apparatus **2001** according to the present embodiment includes a head **5**, a holding unit **2003** that holds a workpiece **W**, a holding unit **2006** that holds a tool **20**, a controller (not illustrated), a chassis **2010**, an interior case **2013**, a first cover **141**, a second cover **142**, and a door **15**. Note that, in FIG. 6, the same components as those in Embodiment 1 are denoted by the same numeral signs as those in FIG. 2. The cutting machining apparatus **2001** also includes a lift drive **44**, an X-direction drive **71**, and a Y-direction drive **76**, in a similar manner to Embodiment 1. The chassis **2010** and the interior case **2013** are respectively provided with opening **2010c** and opening **2013c** through which the exhaust pipe **2062** of the holding unit **2006**, as described below, is inserted. The holding unit **2003** and the holding unit **2006** are spaced apart from each other in the interior case **2013**, and the head **5** can be arranged at a first position facing the holding unit **2003** and at a second position facing the holding unit **2006**.

(36) The holding unit **2003** is a first holding unit that includes a workpiece holder **32** and a box-shaped unit body **2031**. The unit body **2031** includes a hollow rectangular first section **2311** and a rectangular box-shaped second section **312** that is continuous to the first section **2311** at the +Y direction side-end of the first section **2311**. The first section **2311** is secured to a shaft **82** at the -Y direction-side end of the first section **2311**. The workpiece holder **32** is secured to the peripheral wall of the second section **312** of the unit body **2031**.

(37) The holding unit **2006** is a second holding unit that includes: a tool holder **33** that holds the tool **20**; a unit body **2061** that has a rectangular box shape and is filled with refrigerant **Re** inside; and an exhaust pipe **2062** that is in communication with the inside of the unit body **2061** for discharging the vaporized refrigerant out of the unit body **2061**. The unit body **2061** may have a structure that suppresses the transmission of heat from the outside of the unit body **2061** to the refrigerant **Re**, for example, by forming an air gap (not illustrated) maintained at a relatively high vacuum degree (for example, a vacuum degree of about 10⁻³ Pa) inside the peripheral wall. The inside of the unit body **2061** is filled with refrigerant **Re** in such a manner that the refrigerant **Re** contacts at least a portion of the tool holder **33**. For example, liquid nitrogen can be employed as the refrigerant **Re**. The exhaust pipe **2062** is inserted into the opening **2013c** of the interior case **2013** and the opening **2010c** of the chassis **2010**, and the other end opposite to the end in communication with the inside of the unit body **2061** is disposed outside the chassis **2010**. Here, a sealing member (not illustrated) is fitted between the opening **2013c** of the interior case **2013** and the exhaust pipe **2062**.

(38) Next, an operation of the cutting machining apparatus **2001** according to the present embodiment is described with reference to FIGS. 7A and 7B. Here, an example of machining in which the tool **20** is a drill and the tool **20** drills along the longitudinal direction of a long workpiece **W** is described. It is assumed that tools **20** to be used are held in the three tool holders **33** of the holding unit **2006**, and the workpiece **W** is held in the workpiece holder **32**. Furthermore, it is also assumed that the holding unit **2003** is maintained in a posture in which the workpiece holder **32** holding the workpiece **W** is oriented toward the +Z direction. First, as illustrated in FIG. 7A, in a state in which the head **5** is arranged at a second position **Pos2** on the +Z direction side of the tool holder **33** of the holding unit **2006**, the cutting machining apparatus **2001** lowers the head **5** in the -Z direction as indicated by the arrow **AR 21**, causing the head **5** to hold one of the tools **20**. The cutting machining apparatus **2001** then raises the head **5** holding the tool **20** in the +Z direction. Subsequently, the cutting machining apparatus **2001** moves the head **5** in the X-axis direction and the Y-axis direction so that the tool **20** is arranged at a first position **Pos1** that is in alignment with the workpiece **W** in the Z-axis direction, as indicated by the arrow **AR22**. Subsequently, the cutting machining apparatus **2001** performs cutting machining on the workpiece **W** with the tool **20** by lowering the head **5** in the -Z direction and causing the tip of the tool **20** to contact the workpiece **W**, as indicated by the arrow **AR23**, while rotating the rotary spindle **52** without moving the workpiece holder **32**.

(39) Note that, when machining is conducted by drilling into the side wall along the longitudinal direction of the workpiece W, the cutting machining apparatus **2001** maintains the workpiece holder **32** in a posture oriented toward the $\pm X$ direction by rotating the holding unit **2003** by 90 degrees about the B axis JB. The cutting machining apparatus **2001** then performs cutting machining on the workpiece W with the tool **20** by lowering the head **5** in the $-Z$ direction and causing the tip of the tool **20** to contact the workpiece W, while rotating the rotary spindle **52** without moving the workpiece holder **32**. When the tool **20** is a threading tap, the cutting machining apparatus **2001** can also thread the workpiece W at a high speed by lowering the head **5** in the $-Z$ direction and causing the tip of the tool **20** to contact the workpiece W, while rotating the workpiece holder **32** along with rotating the rotary spindle **52**.

(40) As described above, with the cutting machining apparatus **2001** according to the present embodiment, the holding unit **2006** holding the tool **20** is separate from the holding unit **2003** holding the workpiece W. As a result, compared to the holding unit **3** according to Embodiment 1, there are fewer constraints on the number of the tool holders **33** provided in the holding unit **2006** or on the arrangement of the tool holders **33**. Thus, the holding unit **2006** can hold more tools **20**.
Embodiment 3

(41) The cutting machining apparatus according to the present embodiment differs from Embodiment 1 in that a gas inlet hole is provided in the peripheral wall of the unit body of the holding unit for introducing gas present outside the unit body into the inside of the unit body. Meanwhile, the cutting machining apparatus according to the present embodiment includes an airflow generator that generates an airflow that flows from the inside of the interior case into the inside of the unit body through the gas inlet hole, exchanges heat with a tool holder, and then is discharged outside the unit body.

(42) As illustrated in FIG. 8, a cutting machining apparatus **3001** according to the present embodiment includes a head **5**, a holding unit **3003** that holds a workpiece W and a tool **20**, a controller (not illustrated), a chassis **3010**, an interior case **13**, a first cover **141**, a second cover **142**, a door **3015**, an intake fan **3161**, and an exhaust fan **3162**. Note that, in FIG. 8, the same components as those in Embodiment 1 are denoted by the same numeral signs as those in FIG. 2. The cutting machining apparatus **3001** also includes a lift drive **44**, an X-direction drive **71**, and a Y-direction drive **76**, in a similar manner to Embodiment 1. The chassis **3010** has a rectangular box shape and has an opening **3010c** formed in a portion of the peripheral wall to which an exhaust fan **3162** is secured. The exhaust fan **3162** is secured to the opening **3010c** to discharge gas present in an area S2 outside the interior case **13** within the chassis **3010** out of the chassis **3010**. The door **3015** has an opening **3015a** formed in part, and a filter member **3151** and an intake fan **3161** are attached to cover the opening **3015a**. The intake fan **3161** causes gas present outside the chassis **3010** to flow through the filter member **3151** into the machining area S1 inside the interior case **13**. When causing the gas outside the chassis **3010** to flow inside the interior case **13**, the filter member **3151** suppresses foreign matters present outside the chassis **3010** from entering the machining area S1 inside the interior case **13**. This intake fan **3161** and the aforementioned exhaust fan **3162** function as an airflow generator that generates an airflow that flows from the machining area S1 inside the interior case **13** into the inside of the unit body **3031** and out to the outside of the unit body **3031**. Here, the amount of gas inflow by the intake fan **3161** is set to be greater than the amount of gas outflow by the exhaust fan **3162**. As a result, the pressure inside the interior case **13** is set to be a positive pressure relative to the pressure outside the interior case **13**.

(43) The holding unit **3003** includes a workpiece holder **32**, a tool holder **33**, a unit body **3031**, a heat transfer member **3034**, and a filter member **3036**. The unit body **3031** includes a hollow rectangular first section **3311** and a rectangular box-shaped second section **3312** that is continuous to the first section **3311** at the $+Y$ direction-side end of the first section **3311**. Three openings **311a** are formed in the side wall of the first section **3311** along the Z-axis direction. In addition, the unit body **3031** has, in the peripheral wall, a gas inlet hole **3312a** for introducing gas present outside the

unit body **3031** into the inside of the unit body **3031** and a gas outlet hole **3311b** for discharging gas that has been drawn inside the unit body **3031** out of the unit body **3031**. Here, the tool holder **33** and the heat transfer member **3034** are disposed between the gas inlet hole **3312a** and the gas outlet hole **3311b** in the unit body **3031** in the Y-axis direction.

(44) The heat transfer member **3034** is formed of metal such as aluminum, copper, and the like, in a rectangular shape and has a rectangular body **3341** and a plurality of heat dissipation fins **3342** protruding from the body **3341**, as illustrated in FIG. 9. Note that in FIG. 9, the same components as those in Embodiment 1 are denoted by the same numeral signs as those in FIG. 4A. The body **3341** is arranged to cover the tool body housing **331** and the blade housing **332** of the tool holder **33**. In addition, the body **3341** has recesses **3034a** that open to portions corresponding to three openings **311a** of the unit body **3031** and into which the tool holders **33** are fitted. The tool holder **33** is then fitted inside the recess **3034a** of the body **3341** and secured to the body **3341** in a state in which the outer flange **333** is in close contact with the outer periphery of the recess **3034a** in the body **3341**. Returning to FIG. 8, the filter member **3036** is attached to the unit body **3031** to cover the gas inlet hole **3312a** to suppress foreign matters present inside the unit body **3031** from flowing into the machining area S1 inside the interior case **13**.

(45) The cutting machining apparatus **3001** according to the present embodiment generates an airflow by driving the exhaust fan **3162**, as indicated by the dashed line arrows. Specifically, an airflow occurs that flows from the outside of the chassis **3010** into the machining area S1 inside the interior case **13**, thereafter, flows from the gas inlet hole **3312a** of the unit body **3031** of the holding unit **3003** into the inside of the unit body **3031**, and then flows through the gas outlet hole **3311b** of the unit body **3031** out to the area S2 outside the interior case. Here, the gas drawn into the unit body **3031** from the machining area S1 inside the interior case **13** through the gas inlet hole **3312a** exchanges heat with the heat transfer member **3034** and then is discharged out of the unit body **3031**. As a result, the tool holder **33** and the tool **20** held in the tool holder **33** are cooled via the heat transfer member **3034**.

(46) As described above, with the cutting machining apparatus **3001** according to the present embodiment, the tool holder **33** is cooled by an airflow flowing from the machining area S1 inside the interior case **13** to the inside of the unit body **3031** through the gas inlet hole **3312a**, exchanging heat with the tool holder **33** and the heat transfer member **3034**, and then being discharged to the outside of the unit body **3031**. As a result, the tool holder **33** holding the tool **20** can be cooled, thereby suppressing the temperature rise of the workpiece W during machining of the workpiece W.

Embodiment 4

(47) The cutting machining apparatus according to the present embodiment differs from Embodiment 1 in that the present embodiment includes a thermometer that measures the temperature of a tool during machining of a workpiece. When the temperature of the tool measured by the thermometer is greater than or equal to a preset reference temperature, the cutting machining apparatus according to the present embodiment controls the operation of the head to suspend machining of the workpiece and replace the tool.

(48) As illustrated in FIG. 10, a cutting machining apparatus **4001** according to the present embodiment includes a head **5**, a holding unit **3** that holds a workpiece W and a tool **20**, a controller (not illustrated), a chassis **10**, an interior case **13**, a first cover **141**, a second cover **142**, a door **15**, and a thermometer **4101**. Note that, in FIG. 10, the same components as those in Embodiment 1 are denoted by the same numeral signs as those in FIG. 2. The cutting machining apparatus **4001** also includes a lift drive **44**, an X-direction drive **71**, and a Y-direction drive **76**, in a similar manner to Embodiment 1. The thermometer **4101** has an infrared sensor (not illustrated) that is connected to a proximal end of a fiber optic FB of which tips are located near the tool **20** attached to the head **5** and that detects infrared light emitted from the tool **20** and propagating through the fiber optic FB. The thermometer **4101** then calculates the temperature of the tool **20** using the infrared light detected by the infrared sensor based on the preset intensity of the wavelength and outputs

temperature information indicating the calculated temperature to the controller.

(49) When the temperature of the tool measured by the thermometer **4101** is greater than or equal to the preset reference temperature, the controller controls the operation of the head **5** to suspend the machining of the workpiece **W** and replace the tool.

(50) The following describes an operation of the cutting machining apparatus **4001** according to the present embodiment in detail with reference to FIG. **11**. Here, a case where the cutting machining apparatus **4001** performs cutting machining that executes at least one machining step on a workpiece **W** is described. First, when the cutting machining processing is started, the cutting machining apparatus **4001** specifies a tool to be used at an initial machining step (step **S1**). Next, the cutting machining apparatus **4001**, after setting the holding unit **3** in a posture in which the tool holder **33** is oriented toward the head **5**, moves the head **5** in alignment with the +Z direction of the tool holder **33** holding the specified tool **20**, and then lowers the head **5** in the -Z direction to cause the head **5** to hold the specified tool **20** (step **S2**). Then, the cutting machining apparatus **4001** raises the head **5** in the +Z direction and rotates the holding unit **3** about the B axis JB to set the holding unit **32** in a posture in which the workpiece holder **32** holding the workpiece **W** is oriented toward the +Z direction. The cutting machining apparatus **4001** also moves the head **5** in the X-axis direction so that the position of the tool **20** is in alignment with the workpiece **W** in the Z-axis direction. Subsequently, the cutting machining apparatus **1** starts cutting machining on the workpiece **W** by lowering the head **5** in the -Z direction and causing the tool **20** to contact the workpiece **W** while rotating the rotary spindle **52** or the workpiece holder **32** (step **S3**).

(51) Thereafter, the cutting machining apparatus **4001** measures the temperature of the tool **20** using the thermometer **4101** (step **S4**). Next, the cutting machining apparatus **4001** determines whether or not the measured temperature T_h of the tool **20** is greater than or equal to the preset reference temperature T_{th} (step **S5**). Here, if the cutting machining apparatus **4001** determines that the measured temperature T_h of the tool **20** is greater than or equal to the reference temperature T_{th} (step **S5**: Yes), the cutting machining apparatus **4001** raises the head **5** in the +Z direction and ends the machining step (step **S6**). Subsequently, the cutting machining apparatus **4001** stores the tool **20** held by the head **5** in a tool holder **33** by, after setting the holding unit **3** in a posture in which the tool holder **33** is oriented toward the head **5**, moving the head **5** to the +Z direction-side of the tool holder **33** that holds no tool **20** and lowering the head **5** in the -Z direction (step **S7**). The cutting machining apparatus **4001** then raises the head **5** in the +Z direction and moves the head to the +Z direction side of the tool holder **33** that holds another tool **20** of the same type, and then lowers the head **5** in the -Z direction to hold the another tool **20** of the same type (step **S8**). Next, the cutting machining apparatus **4001** sets the holding unit **3** in a posture in which the workpiece holder **32** holding the workpiece **W** is oriented toward the +Z direction by raising the head **5** in the +Z direction and then rotating the holding unit **3** about the B axis JB. The cutting machining apparatus **4001** also moves the head **5** in the X-axis direction so that the position of the tool **20** is in alignment with the workpiece **W** in the Z-axis direction. Subsequently, the cutting machining apparatus **1** starts cutting machining on the workpiece **W** again by lowering the head **5** in the -Z direction and causing the tool **20** to contact the workpiece **W** while rotating the rotary spindle **52** or the workpiece holder **32** (step **S3**).

(52) Whereas, if the cutting machining apparatus **4001** determines in the processing of step **S5** that the measured temperature T_h of the tool **20** is less than the reference temperature T_{th} (step **S5**: No), the cutting machining apparatus **4001** determines whether or not the processing step has ended (step **S9**). Here, if the cutting machining apparatus **4001** determines that the machining step has not yet ended (step **S9**: No), the cutting machining apparatus **4001** executes the processing of step **S4** again. On the other hand, when the cutting machining apparatus **4001** determines that the machining step has ended (step **S9**: Yes), the cutting machining apparatus **4001** raises the head **5** in the +Z direction and ends the machining step (step **S10**). The cutting machining apparatus **4001** then stores the tool **20** held by the head **5** in the tool holder **33** by, after setting the holding unit **3** in

a posture in which the tool holder **33** is oriented toward the head **5**, moving the head **5** to the +Z direction side of the tool holder **33** that holds no tool **20** and lowering the head **5** in the -Z direction (step **S11**). Next, the cutting machining apparatus **4001** determines whether or not there is another machining step remaining in the cutting machining processing (step **S12**). Here, if the cutting machining apparatus **4001** determines that there is another machining step (step **S12**: Yes), the cutting machining apparatus **4001** specifies a tool to be used in the another machining step (step **S1**) and executes a series of processing from step **S2** onwards. On the other hand, if the cutting machining apparatus **4001** determines that all the machining steps performed in the machining processing have been completed (step **S12**: No), the cutting machining apparatus **4001** ends the cutting machining processing.

(53) As described above, with the cutting machining apparatus **4001** according to the present embodiment, the temperature of the tool **20** can be maintained below the reference temperature during machining of the workpiece **W**, thereby suppressing damage to the workpiece **W** due to an excessive increase in the temperature of the workpiece **W** during machining of the workpiece **W**.

(54) Although embodiments of the present disclosure have been described above, the present disclosure is not limited to the configurations of the aforementioned embodiments. For example, as illustrated in FIG. **12**, the tool body housing **5331** of the tool holder **5033** may be such that only the abutment portion **5311d** in the side wall **5331c** abutting the tool **20** may be formed of metal. The portion other than the abutment portion **5311d** in the tool body housing **5311**, that is, the portion other than the abutment portion **5311d** in the tool body housing **5331**, the blade housing **332**, and the outer flange **333**, may be formed of resin. Note that, in the tool body housing **5331** of the tool holder **5033**, the portion abutting the tool **20** in the bottom wall **331a** or both the bottom wall **331a** and the side wall **5331c** may be formed of metal, and the other portion may be formed of resin.

(55) With such a configuration, the tool holder **5033** can be reduced in weight, and thus the entire cutting machining apparatus can be reduced in weight.

(56) In each embodiment, an example in which the entire tool holder **33** is formed of metal is described without limitation. However, for example, at least one of the tool body housing **331**, the blade housing **332**, and the outer flange **333** may include a first substrate material formed of resin and a second substrate material formed of a mesh-like braided metal wire embedded within the first substrate material. Here, as the resin forming the first substrate material, for example, polypropylene can be employed. In addition, as the metal wire, for example, an aluminum wire can be employed.

(57) With such a configuration, the tool holder **33** can be reduced in weight, and thus the entire cutting machining apparatus can be reduced in weight.

(58) Although each embodiment describes an example of including three tool holders **33** housing three tools, the number of tool holders **33** is not limited to three, and may be two or fewer, or may be four or more. Although an example in which the tool holders **33** are arranged in a single side wall in the peripheral wall of the unit body **31** has been described, the positions in which the tool holders **33** are arranged in the unit body **31** are not limited thereto. For example, the tool holders **33** may be secured to each of the two opposing sides of the peripheral wall of the unit body **31**. In addition, the unit body **31** may be a general bottomed cylindrical shape as a whole, and the tool holder **33** may be disposed along the circumferential direction on the side wall.

(59) Embodiment 3 describes an example in which the holding unit **3003** includes: a heat transfer member **3034** including a rectangular body **3341**; and a plurality of heat dissipation fins **3342** protruding from the body **3341**. However, the heat transfer member **3034** is not limited thereto and may not have the heat dissipation fins **3342**. In addition, although Embodiment 3 describes an example in which the holding unit **3003** includes the heat transfer member **3034**, the holding unit **3003** may not be limited thereto and may not have the heat transfer member **3034**. In such a case, the holding unit **3003** may have a unit body that has a plurality of openings in the peripheral wall through which tool holders **33** are inserted, and the plurality of tool holders **33** may each be secured

to the unit body in a state in which the outer flange 333 is affixed to the outer periphery of each opening in the peripheral wall of the unit body.

(60) The foregoing describes some example embodiments for explanatory purposes. Although the foregoing discussion has presented specific embodiments, persons skilled in the art will recognize that changes may be made in form and detail without departing from the broader spirit and scope of the invention. Accordingly, the specification and drawings are to be regarded in an illustrative rather than a restrictive sense. This detailed description, therefore, is not to be taken in a limiting sense, and the scope of the invention is defined only by the included claims, along with the full range of equivalents to which such claims are entitled.

(61) The present disclosure is suitable as a cutting machining apparatus for cutting machining of bones.

Claims

1. A cutting machining apparatus comprising: a holding unit including: a workpiece holder holding a workpiece; a tool holder of a bottomed cylindrical shape holding a tool in a state in which the tool is inserted inside; and a unit body securing the tool holder in such a way that, in a state in which the tool is not inserted in the tool holder, an inside of the tool holder is in communication with an outside and an outer wall of the tool holder is isolated from the outside; a head including a chuck positioned facing the holding unit and the chuck holding the tool held by the tool holder; an interior case including, in a peripheral wall, a first opening through which the holding unit is inserted and a second opening through which the head is inserted, the interior case housing the workpiece holder, the tool holder, and the chuck disposed inside; a first cover formed of a soft material and occluding between the holding unit and an outer periphery of the first opening in the interior case; a second cover formed of a soft material and occluding between the head and an outer periphery of the second opening in the interior case; and a cooling mechanism cooling the tool holder from within the unit body.

2. The cutting machining apparatus according to claim 1, wherein the tool includes: a tool body of a plate shape; a blade for cutting the workpiece, the blade being formed continuously with the tool body and protruding from one surface side in a thickness direction of the tool body; and a shank formed continuously with the tool body and protruding from the other surface side in the thickness direction of the tool body, the shank being held by the chuck, and the tool holder holds the tool in a state in which the shank is exposed outside the holding unit within the interior case.

3. The cutting machining apparatus according to claim 2, wherein the tool holder includes: a tool body housing of a bottomed cylindrical shape including a through hole formed in a first bottom wall penetrating in a thickness direction of the first bottom wall, the tool body being disposed inside the tool body housing in a state in which the tool body abuts at least one of the first bottom wall and a side wall; a blade housing of a bottomed cylindrical shape in which an entire end portion opposite a second bottom wall side is formed continuously with an outer periphery of the through hole in the first bottom wall, the blade being disposed inside the blade housing; and an outer flange extending from an end opposite the first bottom wall side of the tool body housing in a direction orthogonal to a cylindrical axis of the tool body housing, as well as, away from the cylindrical axis of the tool body housing, the cooling mechanism includes a heat transfer member arranged to cover at least one of the tool body housing and the blade housing, and the outer flange is secured to an exposed portion of the heat transfer member outside the unit body.

4. The cutting machining apparatus according to claim 3, wherein the tool body housing portion includes a portion formed of metal in the first bottom wall or side wall abutting the tool and the other portion formed of resin.

5. The cutting machining apparatus according to claim 3, wherein at least one of the tool body housing, the blade housing, and the outer flange includes: a first substrate material formed of resin;

and a second substrate material formed of a mesh-like braided metal wire and embedded within the first substrate material.

6. A cutting machining apparatus, comprising: a first holding unit including a workpiece holder that holds a workpiece; a second holding unit including: a tool holder of a bottomed cylindrical shape holding a tool in a state in which the tool is inserted inside; and a unit body securing the tool holder in a state in which an outer wall of the tool holder is isolated from the outside, in which an inside of the tool holder is in communication with an outside in a state in which the tool is not inserted in the tool holder; a head including a chuck that can be arranged at a first position facing the first holding unit and at a second position facing the second holding unit and holds the tool held by the tool holder; an interior case including, in a peripheral wall, a second opening through which the head is inserted and housing at least the workpiece holder, the tool holder, and the chuck disposed inside; and a cover formed of a soft material and occluding between the head and an outer periphery of the second opening in the interior case, wherein refrigerant is filled inside the unit body in a manner that the refrigerant contacts at least a portion of the tool holder.

7. A cutting machining apparatus, comprising: a holding unit including: a workpiece holder holding a workpiece; a tool holder of a bottomed cylindrical shape holding a tool inside in a state in which the tool is inserted inside; and a unit body securing the tool holder in a state in which an outer wall of the tool holder is isolated from the outside, in which an inside of the tool holder is in communication with an outside in a state in which the tool is not inserted in the tool holder, and the unit body is provided with a gas inlet hole in a peripheral wall for introducing an external gas present outside; a head including a chuck positioned facing the holding unit and the chuck holding the tool held by the tool holder; an interior case including, in a peripheral wall, a first opening through which the holding unit is inserted and a second opening through which the head is inserted, the interior case housing the workpiece holder, the tool holder, and the chuck disposed inside; a first cover formed of a soft material and occluding between the holding unit and an outer periphery of the first opening in the interior case; a second cover formed of a soft material and occluding between the head and an outer periphery of the second opening in the interior case; and an airflow generator generating an airflow that flows from an inside of the interior case to an inside of the unit body through the gas inlet hole, exchanges heat with the tool holder, and then is discharged outside the unit body.

8. The cutting machining apparatus according to claim 7, wherein the airflow generator comprises: an intake fan that causes gas present outside the interior case to flow inside the interior case; and an exhaust fan that causes gas present inside the interior case to flow inside the unit body through the gas inlet hole and to be discharged outside the unit body, a pressure inside the interior case is set to be a positive pressure relative to a pressure outside the interior case by setting an amount of gas inflow by the intake fan to be greater than an amount of gas outflow by the exhaust fan.

9. The cutting machining apparatus according to claim 7, wherein the unit body further comprises a gas outlet hole for discharging, outside of the unit body, gas that has been drawn inside the unit body, and the tool holder is disposed between the gas inlet hole and the gas outlet hole of the unit body.

10. The cutting machining apparatus according to claim 1, further comprising: a thermometer measuring a temperature of the tool during machining of the workpiece; and a controller, when the temperature of the tool is greater than or equal to a preset reference temperature, controlling an operation of the head to suspend machining of the workpiece and replace the tool.

11. The cutting machining apparatus according to claim 8, wherein the unit body further comprises a gas outlet hole for discharging, outside of the unit body, gas that has been drawn inside the unit body, and the tool holder is disposed between the gas inlet hole and the gas outlet hole of the unit body.

12. The cutting machining apparatus according to claim 2, further comprising: a thermometer measuring a temperature of the tool during machining of the workpiece; and a controller, when the

temperature of the tool is greater than or equal to a preset reference temperature, controlling an operation of the head to suspend machining of the workpiece and replace the tool.

13. The cutting machining apparatus according to claim 3, further comprising: a thermometer measuring a temperature of the tool during machining of the workpiece; and a controller, when the temperature of the tool is greater than or equal to a preset reference temperature, controlling an operation of the head to suspend machining of the workpiece and replace the tool.

14. The cutting machining apparatus according to claim 4, further comprising: a thermometer measuring a temperature of the tool during machining of the workpiece; and a controller, when the temperature of the tool is greater than or equal to a preset reference temperature, controlling an operation of the head to suspend machining of the workpiece and replace the tool.

15. The cutting machining apparatus according to claim 5, further comprising: a thermometer measuring a temperature of the tool during machining of the workpiece; and a controller, when the temperature of the tool is greater than or equal to a preset reference temperature, controlling an operation of the head to suspend machining of the workpiece and replace the tool.

16. The cutting machining apparatus according to claim 6, further comprising: a thermometer measuring a temperature of the tool during machining of the workpiece; and a controller, when the temperature of the tool is greater than or equal to a preset reference temperature, controlling an operation of the head to suspend machining of the workpiece and replace the tool.

17. The cutting machining apparatus according to claim 7, further comprising: a thermometer measuring a temperature of the tool during machining of the workpiece; and a controller, when the temperature of the tool is greater than or equal to a preset reference temperature, controlling an operation of the head to suspend machining of the workpiece and replace the tool.

18. The cutting machining apparatus according to claim 8, further comprising: a thermometer measuring a temperature of the tool during machining of the workpiece; and a controller, when the temperature of the tool is greater than or equal to a preset reference temperature, controlling an operation of the head to suspend machining of the workpiece and replace the tool.

19. The cutting machining apparatus according to claim 9, further comprising: a thermometer measuring a temperature of the tool during machining of the workpiece; and a controller, when the temperature of the tool is greater than or equal to a preset reference temperature, controlling an operation of the head to suspend machining of the workpiece and replace the tool.

20. The cutting machining apparatus according to claim 11, further comprising: a thermometer measuring a temperature of the tool during machining of the workpiece; and a controller, when the temperature of the tool is greater than or equal to a preset reference temperature, controlling an operation of the head to suspend machining of the workpiece and replace the tool.
