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Upper die and machining system

Abstract

An upper die is movable through a die guide rail on a lower portion of a ram in a press machine and a connection rail connected to the die guide rail. The upper die includes, on right and left sides of a center portion as viewed in a front-rear direction, protrusions that protrude in the front-rear direction and move while being guided by grooves included in the die guide rail and the connection rail. The protrusions each include an outer guided portion on an outer side in a transportation direction relative to the center portion and an inner guided portion on an inner side closer to the center portion than the outer guided portion, and a distance in the transportation direction between the outer guided portion and the inner guided portion is greater than a clearance distance between the die guide rail and the connection rail.

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Background/Summary

BACKGROUND OF THE INVENTION
1. Field of the Invention
(1) The present invention relates to an upper die and a machining system.
2. Description of the Related Art
(2) A press machine clamps a workpiece between dies, i.e., an upper die and a lower die, and performs press machining, such as mold machining, on the workpiece. As one of the press machines, a press brake (bending machine) that performs bending on a plate-shaped workpiece is known. In a press brake, in order to perform desired bending on a workpiece, the arrangement or type of one or both of an upper die and a lower die may be changed. When attaching or changing the upper die, the upper die is transported through a die guide rail provided on a lower portion of a

ram provided in the press machine and a connection rail connected to the die guide rail (for example, see Japanese Unexamined Patent Application, First Publication No. 2019-181484).

SUMMARY OF THE INVENTION

(3) The upper die mentioned above has pins (protrusions) that protrude in a front-rear direction perpendicular to a transportation direction and an up-down direction and move while being guided by grooves provided in the die guide rail and the connection rail. On the upper die as viewed in the front-rear direction, the pins may be provided at two positions on both right and left sides of a center portion thereof, or at three positions, that is, at the center portion and at positions on both right and left sides of the center portion. In such a case, when the upper die is transported, the upper die rotates around the centroid position, and the pin on the forward side in the transportation direction may potentially fall into a clearance from the die guide rail or the connection rail and collide with an end portion of the groove. Such a collision between the pin and the groove not only causes abnormal noise (collision noise) when transporting the upper die but also results in unwanted damage to the pin (upper die) or the groove (the die guide rail or the connection rail).

(4) Preferred embodiments of the present invention provide upper dies and machining systems each capable of stabilizing an attitude of an upper die when moving between a die guide rail and a connection rail to prevent a collision between a protrusion and a groove.

(5) An upper die according to an aspect of a preferred embodiment of the present invention is an upper die that is movable through a die guide rail on a lower portion of a ram in a press machine and a connection rail connected to the die guide rail, the upper die including, on right and left sides of a center portion as viewed in a front-rear direction orthogonal to a transportation direction and an up-down direction, protrusions that protrude in the front-rear direction and are movable while being guided by grooves included in the die guide rail and the connection rail, wherein the protrusions each include an outer guided portion on an outer side in the transportation direction relative to the center portion and an inner guided portion on an inner side closer to the center portion as compared to the outer guided portion, and a distance in the transportation direction between the outer guided portion and the inner guided portion is greater than a distance length between the die guide rail and the connection rail.

(6) A machining system according to an aspect of a preferred embodiment of the present invention is a machining system including a press machine to perform press machining on a workpiece via an upper die and a lower die, and a connection rail that is connected to a die guide rail on a lower portion of a ram in the press machine, the upper die being transported through the die guide rail and the connection rail, wherein the upper die is the upper die according to the aspect of a preferred embodiment of the present invention mentioned above.

(7) According to the upper die and the machining system mentioned above, the distance in the transportation direction between the outer guided portion and the inner guided portion provided on the upper die is greater than the clearance distance between the die guide rail and the connection rail, and therefore, when the upper die is transported between the die guide rail and the connection rail, even when either one of the outer guided portion and the inner guided portion is positioned in the clearance between the die guide rail and the connection rail, the other remains in the state of being supported by the groove of the die guide rail or the connection rail. As a result, the outer guided portion or the inner guided portion is prevented from falling into the clearance. Therefore, the attitude of the upper die can be stabilized during transportation of the upper die and collision of the outer guided portion or the inner guided portion with the groove is avoided, thus preventing generation of abnormal noise and damage to the upper die, the die guide rail, and the connection rail.

(8) The protrusions may include an outer pin defining the outer guided portion and an inner pin defining the inner guided portion. In such a configuration, the protrusions can be easily provided on the upper die. The outer pin may be above the inner pin. In such a configuration, collision of the outer pin with the groove can be reliably avoided. The outer pin and the inner pin may extend

through through-holes in the front-rear direction and protrude from both a front side and a rear side, and an elastic body may be provided at least either between the outer pin and the through hole or between the inner pin and the through hole. In such a configuration, impact on one or both of the outer pin and the inner pin can be absorbed by the elastic body.

(9) An auxiliary pin that protrudes in the front-rear direction and is movable while being guided by the groove may be provided between the inner pin on the left and the inner pin on the right. In such a configuration, the load of the upper die can be distributed by the outer pin, the inner pin, and the auxiliary pin. The protrusion may be a continuous protrusion protruding in a continuous manner from the outer guided portion to the inner guided portion. In such a configuration, the length of the continuous protrusion in the transportation direction is greater than the clearance distance, and it is thus possible to reliably prevent the outer guided portion or the inner guided portion from falling into the clearance. The continuous protrusion may include a tapered surface that slopes upward on a lower surface of at least either the outer guided portion or the inner guided portion. In such a configuration, collision of the continuous protrusion with the groove can be reliably avoided. The inner guided portion on the left and the inner guided portion on the right may protrude in a continuous manner. In such a configuration, the inner guided portion that continuously protruding can reliably bear the load of the upper die.

(10) The upper die may include a locked portion extending in the front-rear direction, and the machining system may include a transporter that includes a locking portion extendible and retractable in the front-rear direction to lock the locked portion in the transportation direction, and to transport the upper die as the locking portion moves in the transportation direction while locking the locked portion. In such a configuration, the upper die can be easily transported by the transporter.

(11) The above and other elements, features, steps, characteristics and advantages of the present invention will become more apparent from the following detailed description of the preferred embodiments with reference to the attached drawings.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

(1) FIG. **1** is a front elevation view showing an example of an upper die and a machining system according to a first preferred embodiment of the present invention.

(2) FIG. **2** is a plan view showing an example of an upper die guide rail and a connection rail.

(3) FIG. **3** is a cross-sectional view of the upper die and the connection rail (die guide rail) as viewed in the transportation direction.

(4) FIG. **4** is a cross-sectional view of the upper die and a cassette as viewed in the transportation direction.

(5) FIG. **5** is a perspective view showing an example of the upper die according to the first preferred embodiment of the present invention.

(6) FIG. **6** is a front elevation view showing an example of the upper die.

(7) FIGS. **7**A and **7**B show states in which an outer pin (outer guided portion) is positioned in a clearance during transportation of the upper die, FIG. **7**A being a front elevation view, and FIG. **7**B being a plan view.

(8) FIGS. **8**A and **8**B show states in which an inner pin (inner guided portion) is positioned in a clearance during transportation of the upper die, FIG. **8**A being a front elevation view, and FIG. **8**B being a plan view.

(9) FIG. **9** is a front elevation view showing an example of an upper die according to a first modified example of a preferred embodiment of the present invention.

(10) FIGS. **10**A to **10**B show examples of an upper die according to a second modified example of

a preferred embodiment of the present invention, FIG. **10**A being a front elevation view, and FIG. **10**B being a cross-sectional view seen in the transportation direction.
(11) FIG. **11** is a perspective view showing an example of an upper die according to a third modified example of a preferred embodiment of the present invention.
(12) FIG. **12** is a front elevation view showing an example of an upper die according to a fourth modified example of a preferred embodiment of the present invention.
(13) FIG. **13** is a front elevation view showing an example of an upper die according to a fifth modified example of a preferred embodiment of the present invention.
(14) FIG. **14** is a front elevation view showing an example of an upper die according to a sixth modified example of a preferred embodiment of the present invention.
(15) FIG. **15** is a front elevation view showing an example of an upper die according to a seventh modified example of a preferred embodiment of the present invention.
(16) FIG. **16** is a plan view showing an example of an upper die according to an eighth modified example of a preferred embodiment of the present invention.
(17) FIG. **17** is a front elevation view showing an example of a machining system according to a second preferred embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

(18) The following describes preferred embodiments of the present invention and modifications thereof, with reference to the drawings. However, the present invention is not limited to the following description. In the drawings, scale is changed as necessary to illustrate the preferred embodiments and modifications thereof, such as by enlarging or emphasizing a portion, and the shapes and dimensions in the drawings may differ from those of the actual product. In the following drawings, the directions in each drawing are described, using a Cartesian coordinate system represented by a transportation direction D**1**, a front-rear direction D**2**, and an up-down direction D**3**. In the Cartesian coordinate system, the transportation direction D**1** and the front-rear direction D**2** are parallel to the horizontal plane. Also, the transportation direction D**1** may be referred to as left-right direction in some cases.
(19) FIG. **1** is a front elevation view showing an example of an upper die **20** and a machining system **200** according to a first preferred embodiment. As shown in FIG. **1**, the machining system **200** includes a press machine **100**, a connection rail **44**, and a die switching device **4**. The press machine **100** is a press brake (bending machine) capable of performing bending (mold machining) on a workpiece **10**. In the present preferred embodiment, a press brake will be described as an example of the press machine **100**. The press machine **100** is not limited to being a press brake and may be a press machine capable of performing press-cutting (punching machining) or mold machining on a workpiece **10**.
(20) The press machine **100** includes a machining tool main body **2** and a controller **3**. A front side of the machining tool main body **2** in the front-rear direction D**2** is a work space for an operator. The operator places a workpiece **10** at a predetermined position from the front side of the machining tool main body **2** and can perform bending on the workpiece **10** by clamping the workpiece **10** between an upper die **20** and a lower die **30** defining and functioning as dies described later. The machining tool main body **2** includes a main body frame **5**, a table **7**, side covers **8**, **9**, a ram **11**, and driving devices **14**.
(21) The main body frame **5** defines an outer framework of the press machine **100**, for example. The table **7** is attached to the front side (front-facing side) of the main body frame **5** and fixes the lower die guide rail **6**. The lower die guide rail **6** is provided on an upper surface of the table **7** and is structured to guide the lower die **30** along the transportation direction D**1** (left-right direction). The lower die **30**, on the upper surface side thereof, includes a V-shaped recess (not shown in the drawings) to bend the workpiece **10**, for example. The recess is elongated along the transportation direction D**1** (left-right direction). FIG. **1** shows an example in which the lower die **30** is moving while being guided by the lower die guide rail **6**, however, the present invention is not limited to

this example. For example, the present invention may also be embodied in a structure in which the lower die **30** extending in the transportation direction D**1** is fixed on the upper surface of the table **7**. The main body frame **5** or the table **7** may include a positioner (not shown in the drawings) against which the workpiece **10** abuts in the front-rear direction D**2** to be positioned.
(22) The side covers **8**, **9** are provided respectively above both sides in the left-right direction of the main body frame **5**. The side covers **8**, **9** are positioned to respectively cover above both sides in the left-right direction of the ram **11**. The main body frame **5** includes a plate-shaped guide **5***a* that extends in the up-down direction to guide the ram **11** in the up-down direction. The pair of left and right driving devices **14** are supported by the main body frame **5**. The pair of driving devices **14** cause the ram **11** to move (ascend and descend) in the Z direction. To the driving devices **14** there is applied, for example, a mechanism that raises and lowers the ram **11** by rotating a ball screw or a nut with an electric motor or the like, or a mechanism that raises and lowers the ram **11** using a hydraulic cylinder device or a pneumatic cylinder device. The driving devices **14** are controlled by the controller **3**.
(23) The ram **11** is supported on the main body frame **5** by the guide **5***a* of the main body frame **5** so as to be able to ascend and descend. A pair of rollers **11***a* are provided at both left and right ends of the ram **11**, and the pair of rollers **11***a* are arranged with the guide **5***a* provided on the main body frame **5** interposed therebetween. The ram **11** is guided in the up-down direction D**3** by the pair of rollers **11***a* rolling along the guide **5***a*. The ram **11** is, for example, a plate made of a metal or the like and has a weight of several tens of kg to several hundreds of kg, for example. The ram **11** is connected to a portion of the driving devices **14** and is suspended by the driving devices **14**. The ram **11** is raised or lowered by driving the driving devices **14** and approaches or moves away from the lower die **30** on the table **7**.
(24) On a lower portion of the ram **11** there is attached an upper die guide rail **12**. The upper die guide rail **12** is a die guide rail that guides the upper die **20**, which is a die. The upper die guide rail **12** is provided along the transportation direction D**1** (left-right direction). The upper die guide rail **12** can support the upper die **20** while suspending it therefrom. The upper die guide rail **12** can guide the upper die **20** being transported in the transportation direction D**1**. It should be noted that the upper die guide rail **12** may guide the upper die **20** in the transportation direction D**1** without supporting it. In the present specification, when transporting the upper die **20** in a predetermined direction (for example, in the transportation direction D**1**), “guiding” means directing the upper die **20** so as not to deviate from the predetermined direction. The ram **11** includes a clamp member **15** (see FIG. **3**) to hold the upper die **20** guided by the upper die guide rail **12**. The clamp member **15** is inserted into a hole **12***c* (see FIG. **3**) in the front-rear direction D**2** provided in the upper die guide rail **12** and is caused to advance and retreat in the front-rear direction D**2** by the clamp driver **16** (see FIG. **3**). The holes **12***c* are provided at a plurality of locations on the upper die guide rail **12** in the transportation direction D**1**, and the clamp member **15** is arranged in each hole **12***c*. When performing bending on the workpiece **10**, the upper die **20** according to each step of a bending process is arranged on the upper die guide rail **12**. The clamp driver **16** causes the clamp member **15** to advance, and a distal end of the clamp member **15** lifts and presses a clamp recess **27** of the upper die **20** (see FIG. **3**) to fix the upper die **20** at a predetermined position. As the clamp member **15** advances, the upper die **20** is clamped against and held between the distal end of the clamp member **15**, one side surface of a recess **12***b* of the upper die guide rail **12** facing the distal end of the clamp member **15**, and an upper surface of the recess **12***b*. The details of the upper die **20** and the state of the upper die **20** when being clamped will be described later.
(25) The upper die **20** is fixed to the ram **11** by the clamp member **15** at a predetermined position on the upper die **12**. When held on the upper die guide rail **12**, the upper die **20** is arranged so that a cutting edge **22** (see FIG. **3**), which is a lower end thereof (see FIG. **3**), faces a recess (not shown in the drawings) of the lower die **30** and, at the same time, the cutting edge **22** is arranged along the transportation direction D**1** (left-right direction). The upper die **20** fixed to ram **11** ascends or

descends together with the ram **11**. The plurality of upper dies **20** held on the upper die guide rail **12** may have the same dimension in the transportation direction D**1** (left-right direction), or the upper dies **20** having different dimensions in the left-right direction may be combined for use. In the press machine **100**, the upper die **20** descends toward the lower die **30** as the ram **11** descends and the workpiece **10** is clamped between the upper die **20** and the lower die **30**. Bending is then performed on the workpiece **10** until the upper die **20** has reached, for example, a lowest point. The angle of bending to be performed on the workpiece **10** can be changed by the amount of descent of the upper die **20**.

(26) The die switching device **4** switches the upper die **20** on the machining tool main body **2** of the press machine **100**. The die switching device **4** can also switch the lower die **30** on the machining tool main body **2**. Hereinafter, in the present preferred embodiment, a case of switching the upper die **20** will be described as an example. The die switching device **4** includes a stocker **40** and a transporting device **42**. The stocker **40** includes one or more racks **41** and a rack driver **45**. When the stocker **40** includes a plurality of racks **41**, the plurality of racks **41** are accommodated in a state of being aligned along the front-rear direction D**2**. The rack **41** is a plate-shaped body that can be stored in the stocker **40** and has one or more cassettes **43**. When one rack **41** includes a plurality of cassettes **43**, the plurality of cassettes **43** are aligned along the up-down direction D**3**.

(27) Each cassette **43** includes a rail extending in the transportation direction D**1**. The cassette **43** can support the upper die **20** while suspending it therefrom. The cassette **43** can guide the upper die **20** being transported in the transportation direction D**1**. It should be noted that the cassette **43** may guide the upper die **20** in the transportation direction D**1** without supporting it. The shape of a portion of the cassette **43** from which the upper die **20** is suspended is substantially the same as that of the upper die guide rail **12** mentioned above. In one rack **41**, the plurality of cassettes **43** are aligned along the up-down direction D**3**. The number of cassettes **43** provided in one rack **41** is determined by the size of the rack **41**, the dimensions of the upper die **20** to be suspended, and so forth. One cassette **43** can support one or more upper dies **20** while suspending them therefrom.

(28) Each cassette **43** may store a spacer (not shown in the drawings) in a state of being suspended, in addition to the upper die **20**. Each of these spacers is arranged between the upper dies **20** on the upper die guide rail **12** and is used to regulate the interval between the upper dies **20** in the transportation direction D**1** (left-right direction). Each spacer may be individually transported by the transporting device **42** as with the upper dies **20**, or, when transporting the upper die **20**, may be arranged on the front side of the upper die **20** in the transportation direction and transported together with the upper die **20**. Whether or not to use the spacers is optional.

(29) The rack driver **45** raises or lowers the rack **41** and aligns the height of one of the cassettes **43** with the height of the connection rail **44**. The rack driver **45** can also change the arrangement order of the plurality of racks **41** in the front-rear direction D**2** so as to bring one of the plurality of racks **41** to the frontmost side. For example, the rack driver **45** can switch the racks **41** by lifting the rack **41** on the frontmost side, moving it to an empty space on the far side in the stocker **40**, and then lifting another rack **41** and moving it to the frontmost side.

(30) The transporting device **42** transports the upper die **20** between the machining tool main body **2** and the rack **41**. The transporting device **42** transports the upper die **20** of the cassette **43** set at the height of the connection rail **44** by the rack driver **45** to the upper die guide rail **12** of the machining tool main body **2** via the connection rail **44**, or transports the upper die **20** on the upper die guide rail **12** to the cassette **43** via the connection rail **44**. The transporting device **42** includes a transporter **46** and a transportation guide **47**.

(31) The transporter **46** includes a slider **46***a*, an elevation rod **46***b*, a head **46***c*, and a locking portion **46***d*. The slider **46***a* can be reciprocated by a driver not shown in the drawings in the transportation direction D**1** (left-right direction) along the transportation guide **47**. The elevation rod **46***b* is provided on the slider **46***a* so as to be able to be raised or lowered and can be raised and lowered along the up-down direction D**3** by a driver not shown in the drawings. The head **46***c* is

provided at an upper end of the elevation rod **46***b* and is raised or lowered along the up-down direction as the elevation rod **46***b* is raised or lowered. The head **46***c* causes the locking portion **46***d* to advance or retreat in the front-rear direction D**2**. The locking portion **46***d* is, for example, of a bar shape having a cross-sectionally oval, elliptical or circular shape, or having a cross-sectionally polygonal shape such as a rectangular shape, and extending in the front-rear direction D**2**, and can be inserted into a locked portion **28** (see FIG. **3**) of the upper die **20** described later.
(32) The transportation guide **47** guides the transporter **46** in the transportation direction D**1** (left-right direction). The transportation guide **47** is provided, for example, on a floor surface on which the machining system **200** is installed and is provided in a linear manner along the transportation direction D**1** (left-right direction). The transportation guide **47** is parallel to the upper die guide rail **12**, the connection rail **44**, and the cassette **43**. The transporter **46** can arrange the head **46***c* (that is, the locking portion **46***d*) at any position in the transportation direction D**1** and the up-down direction D**3**, via the transportation guide **47** and the elevation rod **46***b* within each movable range thereof.
(33) The transporter **46** causes the locking portion **46***d* to advance in the front-rear direction D**2** to be inserted into the locked portion **28** of the upper die **20**, and, in this state, causes the slider **46***a* to move, to thereby be able to transport the upper die **20** in the transportation direction D**1** (See FIG. **2**). The transporting device **42** configured in such a manner is controlled by the controller **3**. In the present preferred embodiment, a structure in which a plurality of upper dies **20** are accommodated in the stocker **40** has been described as an example. However, the lower die **30** may be supported by the cassette **43** of the rack **41** and a plurality of the lower dies **30** may also be accommodated together in the stocker **40**.
(34) The connection rail **44** connects between the cassette **43** of the rack **41** and the upper die guide rail **12** of the machining tool main body **2**. The connection rail **44** is attached to the stocker **40** by a support member or the like, for example. The connection rail **44** is provided so as to extend along the transportation direction D**1**, and the height position thereof in the up-down direction D**3** is fixed. Therefore, as the rack **41** is raised or lowered, the connection rail **44** is aligned with one of the cassettes **43** of the rack **41** along the transportation direction D**1**, and also at a predetermined height position (for example, top dead point position or highest position) of the ram **11**, it is aligned with the upper die guide rail **12** along the transportation direction D**1**. The height of the connection rail **44** is preliminarily set to a height of the upper die guide rail **12** that allows switching of the upper dies **20**, and the rack driver **45** is driven so as to adjust and align the height of the cassette **43** to the height of the connection rail **44**.
(35) As with the upper die guide rail **12**, the connection rail **44** can support the upper die **20** while suspending it therefrom. The connection rail **44** can guide the upper die **20** being transported in the transportation direction D**1** (left-right direction). It should be noted that the connection rail **44** may guide the upper die **20** in the transportation direction D**1** without supporting it. The shape of a portion of the connection rail **44** from which the upper die **20** is suspended is the same or substantially the same as those of the upper die guide rail **12** and the cassette **43**. The connection rail **44** may be rotatable around an axis parallel to the up-down direction D**3**. By rotating the connection rail **44** by 180 degrees while supporting the upper die **20** thereon, the upper die **20** can be reversed in the front-rear direction D**2**. Whether or not to include such a reversing mechanism for the upper die **20** using the connection rails **44** is optional, and the connection rails **44** may not be rotatable.
(36) FIG. **2** is a plan view showing an example of the upper die guide rail **12** and the connection rail **44**. FIG. **2** also includes illustration of the cassette **43**. As shown in FIG. **1** and FIG. **2**, the connection rail **44** is arranged with a clearance S**1** from the cassette **43** in the transportation direction D**1**. The connection rail **44** is arranged with a clearance S**2** from the upper die guide rail **12** in the transportation direction D**1**. When transported from the cassette **43** to the upper die guide rail **12**, the upper die **20** is transported in the transportation direction D**1** over the clearance S**1** and

the clearance S**2** in sequence. When transported from the upper die guide rail **12** to the cassette **43**, the upper die **20** is transported in the transportation direction D**1** over the clearance S**2** and the clearance S**1** in sequence.

(37) FIG. **3** is a cross-sectional view of the upper die **20** and the connection rail **44** (die guide rail **12**) as viewed in the transportation direction D**1**. FIG. **4** is a cross-sectional view of the upper die **20** and the cassette **43** as viewed in the transportation direction D**1**. FIG. **5** is a perspective view showing an example of the upper die **20** according to the first preferred embodiment. FIG. **6** is a front elevation view showing an example of the upper die **20**. In FIG. **3** and FIG. **4**, clearances are exaggerated and enlarged, and differ from the actual clearances. As shown in FIG. **3**, in the upper die guide rail **12** and the connection rail **44** there are provided recesses **12***b*, **44***b* respectively, in each of which an upper portion of a base **21** of the upper die **20** enters and each of which extends in the transportation direction D**1**. In these recesses **12***b*, on **44***b*, on each of side surfaces opposing to each other in the front-rear direction D**2**, there are respectively provided grooves **12***a*, **44***a* extending in the transportation direction D**1**.

(38) As shown in FIG. **3** to FIG. **6**, the upper die **20** has the base **21** supported by the connection rail **44** and so forth, and the cutting edge **22**, which is a distal end opposite to the base **21**. The base **21** of the upper die **20** has protrusions **25** protruding in the front-rear direction D**2**. The protrusions **25** are arranged on each of both left and right sides of the center portion **26** as viewed in the front-rear direction D**2**. The protrusions **25** move while being guided by the groove **12***a* provided in the upper die guide rail **12** and the groove **44***a* provided in the connection rail **44**. Although not shown in FIG. **5**, the protrusions **25** move while being guided by a groove **43***a* provided in the cassette **43**.

(39) The protrusions **25** include outer guided portions **25***a* and inner guided portions **25***b*. The outer guided portions **25***a* are positioned on the outer side of the center portion **26** in the transportation direction D**1**. In the present preferred embodiment, the outer guided portions **25***a* are outer pins **25***p*. Each outer pin **25***p* is provided, for example, by inserting a rod-shaped body having a circular cross-section through a through hole **21***a* extending along the front-rear direction D**2** in a portion of the base **21**, allowing both ends of the rod-shaped body to protrude from both of the front side and the rear side of the base **21**. The inner guided portions **25***b* are positioned on the inner side closer to the center portion **26** than the outer guided portions **25***a*. In the present preferred embodiment, the inner guided portions **25***a* are inner pins **25***q*. Each inner pin **25***q* is provided, for example, by inserting a rod-shaped body having a circular cross-section through a through hole **21***b* extending along the front-rear direction D**2** in a part of the base **21**, allowing both ends of the rod-shaped body to protrude from both of the front side and the rear side of the base **21**.

(40) The outer pins **25***p* and the inner pins **25***q* are not limited to being provided by inserting rod-shaped bodies through the through holes **21***a*, **21***b*. For example, the outer pins **25***p* and the inner pins **25***q* may be formed by cutting when forming the base **21**, so that the outer pins **25***p* and the inner pins **25***q* are integrated with the base **21**. The cross-sectional shape of the outer pin **25***p* and the inner pin **25***q* is not limited to a circular shape, and it may, for example, be an oval shape, an elliptical shape, or a polygonal shape such as a rectangular shape.

(41) A distance L**1** in the transportation direction D**1** between the outer pin **25***p* and the inner pin **25***q* is greater than a clearance distance W**2** in the transportation direction D**1** of the clearance S**2** between the upper die guide rail **12** and the connection rail **44**. Therefore, when the upper die **20** moves over the clearance S**2** between the connection rail **44** and the upper die guide rail **12**, the outer pin **25***p* and the inner pin **25***q* do not fall into the clearance S**2** at the same time. That is to say, even if either one of the outer pin **25***p* and the inner pin **25***q* is positioned within the clearance S**2**, the other is supported on the groove **12***a* or the groove **44***a*. As a result, the outer pin **25***p* or the inner pin **25***q* is prevented from falling into the clearance S**2**.

(42) The distance L**1** between the outer pin **25***p* and the inner pin **25***q* is greater than a clearance distance W**1** (see FIG. **2**) in the transportation direction D**1** of the clearance S**1** between the cassette **43** and the connection rail **44**. Therefore, when the upper die **20** moves over the clearance S**1**

between the cassette **43** and the connection rail **44**, the outer pin **25***p* and the inner pin **25***q* do not fall into the clearance S**1** at the same time. That is to say, even if either one of the outer pin **25***p* and the inner pin **25***q* is positioned within the clearance S**1**, the other is supported on the groove **12***a* or the groove **44***a*. As a result, the outer pin **25***p* or the inner pin **25***q* is prevented from falling into the clearance S**1**.

(43) The base **21** of the upper die **20** includes the clamp recesses **27** and a locked portion **28**. Each clamp recess **27** extends along the transportation direction D**1**, on both the front-facing side (front side) and the rear-facing side of the base **21**. The clamp recess **27** is a portion pressed by the clamp member **15** provided on the upper die guide rail **12**. When the clamp member **15** is advanced by the clamp driver **16**, the distal end of the clamp member **15** comes into contact with a tapered portion on the upper-face side of the clamp recess **27**. The distal end of the clamp member **15** presses the clamp recess **27** in the front-rear direction D**2** while lifting it. As a result, the base **21** of the upper die **20** is pressed against the upper surface and one side surface of the recess **12***b*. That is to say, the base **21** is held by being clamped between the clamp member **15**, the upper surface, and the one side surface of the recess **12***b*, and the upper die **20** is clamped as a result. At this time, the outer pins **25***p* and the inner pins **25***q* are hovering over the lower surface of the groove **12***a*. Also, the locked portion **28** is hovering over the locking portion **46***d* of the transporter **46**, and there is a clearance between the locked portion **28** and the upper surface side of the locking portion **46***d*. When the clamp member **15** retreats (unclamped), the base **21** (upper die **20**) descends, and the outer pin **25***p* and the inner pin **25***q* return to the state of being placed (seated) on the lower surface of the groove **12***a*. This state is a state in which the upper die **20** is supported by the upper die guide rail **12**, that is, a state in which the upper die **20** is being transported. It should be noted that the clamp member **15** mentioned above is also provided on the connection rail **44**. For example, when reversing the upper die **20** supported on the connection rail **44**, the clamp member **15** is advanced to support the upper die **20** on the connection rail **44**.

(44) As shown in FIG. **4**, in the cassette **43** there is provided a recess **43***b* as a rail, in which the upper portion of the base **21** of the upper die **20** enters and which extends in the transportation direction D**1**. In this recess **43***b*, on each of side surfaces opposing to each other in the front-rear direction D**2**, there is provided a groove **43***a* extending in the transportation direction D**1**. The shapes of the recess **43***b* and the groove **43***a* are the same as those of the recesses **12***b*, **44***b* and the grooves **12***a*, **44***a* mentioned above. The outer pin **25***p* and the inner pin **25***q* of the upper die **20** are placed on the lower surface of the groove **43***a*, and, in this state, the upper die **20** is supported by and suspended from the cassette **43**. At this time, there is a clearance between the base **21** and each of the upper surface and the side surfaces of the recess **43***b*. When the upper die **20** is being transported, the upper side clearance between the locked portion **28** and the locking portion **46***d* is eliminated or reduced.

(45) The positional relationship between the recess **43***b* and the groove **43***a*, the base **21** of the upper die **20**, and the outer pin **25***p* and the inner pin **25***q* as shown in FIG. **4** is similar to that in the state where the clamp member **15** has retreated on the upper die guide rail **12** or the connection rail **44** (unclamped state). That is to say, in the state where the upper die **20** is suspended from the upper die guide rail **12** or the connection rail **44**, as with FIG. **4**, the outer pin **25***p* and the inner pin **25***q* of the upper die **20** are placed on the lower surface of the grooves **12***a*, **44***a*, and there is a clearance between the base **21** and each of the upper surface and one side surface of the recesses **12***b*, **44***b*. When the upper die **20** is being transported on the upper die guide rail **12** or the connection rail **44**, the upper side clearance between the locked portion **28** and the locking portion **46***d* is eliminated or reduced.

(46) The locked portion **28** is provided in the vicinity of the center portion **26** of the base **21** so as to pass therethrough in the front-rear direction D**2**. In the present preferred embodiment, the structure in which the locked portion **28** is a hole is described as an example, however, the present invention is not limited to this form. The locked portion **28** is provided above the centroid G of the

upper die **20**. The locked portion **28** is sized to allow the locking portion **46***d* of the transporter **46** to be inserted thereinto. For example, in the case where the cross-sectional shape of the locking portion **46***d* is a vertically elongated oval shape, the locked portion **28** is also of a vertically elongated oval shape and passes therethrough. In the present preferred embodiment, the structure in which the locking portion **46***d* is a rod-shaped body is described as an example, however, the present invention is not limited to this form. To the locking portion **46***d* and the locked portion **28**, it is possible to apply any configuration that can realize a locked state and a non-locked state (released state) between the two. The transporter **46** inserts the locking portion **46***d* into the locked portion **28**, and, in this state, by moving the transporter **46** along the transportation guide **47**, it is possible to move the upper die **20** along the transportation direction D**1**. As described above, a single pair of the locked portion **28**, which is a hole, and the locking portion **46***d*, which is a rod-shaped body, is sufficient when transporting the upper die **20**, and it is therefore possible to reduce the cost required for transporting the upper die **20**. Since only one locked portion **28** (hole) is provided in the upper die **20**, it is possible to suppress a reduction in the rigidity of the upper die **20**.

(47) In the state where the locking portion **46***d* is inserted in the locked portion **28**, there is a slight clearance between the locking portion **46***d* and the locked portion **28**. Therefore, even in the state where the oval-shaped locking portion **46***d* is inserted in the oval-shaped locked portion **28**, the upper die **20** can still rotate slightly around the locking portion **46***d*. As a result, even when being transported in the transportation direction D**1**, the upper die **20** is transported in the transportation direction D**1** while still being rotatable around the locking portion **46***d*. However, as mentioned above, even if either one of the outer pin **25***p* and the inner pin **25***q* reaches the clearances S**1**, S**2**, the other is supported on the groove **12***a* or the groove **44***a*. As a result, rotation of the upper die **20** around the locking portion **46***d* is regulated, and the outer pin **25***p* or the inner pin **25***q* is prevented from falling into the clearance S**2**.

(48) In the present preferred embodiment, the upper die **20** is transported with one locking portion **46***d*. However, instead of using such a configuration, if a plurality of (for example, two) locked portions **28** are provided in the upper die **20**, a plurality of (for example, two) locking portions **46***d* may be inserted respectively into the locked portions **28** to perform transportation in the transportation direction D**1**.

(49) The upper die **20** is not limited to including the locked portion **28** passing therethrough to insert the locking portion **46***d*. For example, a type of an upper die having a short dimension in the transportation direction D**1** such as an upper die **20**X shown in FIG. **1** may not include the locked portion **28** that passes therethrough. In such a case, the transporter **46** may transport the upper die **20**X by pushing an edge of the upper die **20**X in the transportation direction D**1** from the rear side, using the locking portion **46***d*. In the present preferred embodiment, the upper die **20** bending in the front-rear direction D**2** from the base **21** toward the cutting edge **22** is used (see FIG. **3** and so forth). However, the present invention is not limited to this example, and an upper die **20** not bending from the base **21** toward the cutting edge **22** (straight upper die **20**) may be used.

(50) Returning to FIG. **1**, the controller **3** controls operations of the machining tool main body **2** and the die switching device **4** in a comprehensive manner. The controller **3** may be connected to a host device not shown in the drawings. The host device supplies the controller **3**, for example, with design data, such as CAD data or CAM data, for the workpiece **10**.

(51) Next, an example of a method for transporting the upper die **20** according to the present preferred embodiment will be described. The controller **3** selects the upper die **20** to be used for machining, on the basis of a machining program for a machining target workpiece **10**, for example. The controller **3** drives the rack driver **45** so as to connect the cassette **43** supporting the selected upper die **20** to the connection rail **44**. The rack driver **45** positions the rack **41** having the cassette **43** supporting the selected upper die **20** on the frontmost side and raises or lowers the rack **41** so that the cassette **43** supporting the selected upper die **20** is at the same height as the that of the

connection rail **44**.

(52) Then, the controller **3** causes the head **46***c* of the transporter **46** to move in the transportation direction D**1** and the up-down direction D**3** so that the locking portion **46***d* faces the locked portion **28** of the selected upper die **20**. Then, the controller **3** causes the locking portion **46***d* to advance to insert it into the locked portion **28**. After having inserted the locking portion **46***d* into the locked portion **28**, the head **46***c* (slider **46***a*) is moved in the transportation direction D**1** to thereby transport the upper die **20** from the cassette **43** to the upper die guide rail **12** via the connection rail **44**. When transporting the upper die **20**, transportation may be performed with the locking portion **46***d* (head **46***c*) raised slightly. This operation reduces the load of the upper die **20** applied to the outer pin **25***p* and the inner pin so that it is possible to reduce friction between the outer pin **25***p* and the inner pin **25***q*, and the grooves **12***a*, **43***a*, **44***a*.

(53) When both transferring the upper die **20** from the cassette **43** to the connection rail **44** and transferring the upper die **20** from the connection rail **44** to the upper die guide rail **12**, the upper die **20** passes through the clearances S**1**, S**2**. The upper die **20** moves while being pushed by the locking portion **46***d* inserted in the locked portion **28**, however, the position of the locked portion **28** is above the centroid G of the upper die **20**. Therefore, a clockwise (as viewed in the drawings) moment is acting on the upper die **20** as being pushed by the locking portion **46***d*, and a downward force is acting on the outer pin **25***p* on the leading side. Therefore, when there is a clearance in the transportation path, this outer pin **25***p* is likely to fall into the clearance.

(54) FIGS. **7**A and **7**B show states in which the outer pin **25***p* (outer guided portion **25***a*) is positioned in the clearance S**2** during transportation of the upper die **20**, FIG. **7**A being a front elevation view, and FIG. **7**B being a plan view. As shown in FIGS. **7**A and **7**B, when transporting the upper die **20** from the connection rail **44** to the upper die guide rail **12**, first, the outer pin **25***p* on the leading side in the traveling direction is positioned in the clearance S**2**. At this time, since the distance L**1** between the outer pin **25***p* and the inner pin **25***q* is greater than the clearance distance W**2** of the clearance S**2**, even if the outer pin **25***p* is positioned in the clearance S**2**, the inner pin **25***q* remains in the state of being supported by the groove **44***a* of the connection rail **44**. As a result, the outer pin **25***p* is prevented from falling into the clearance S**2**, and the attitude of the upper die **20** is stabilized. It is thus possible to prevent the outer pin **25***p* from colliding with the end portion of the groove **12***a*.

(55) FIGS. **8**A and **8**B show states in which the inner pin **25***q* is positioned in the clearance S**2** during transportation of the upper die **20**, FIG. **8**A being a front elevation view, and FIG. **8**B being a plan view. As the upper die **20** moves forward in the traveling direction from the state shown in FIG. **7**, the inner pin **25***q* is positioned in the clearance S**2** as shown in FIGS. **8**A and **8**B. At this time, the outer pin **25***p* is already supported by the groove **12***a* of the upper die guide rail **12**. Therefore, even if the inner pin **25***q* is positioned in the clearance S**2**, the outer pin **25***p* remains in the state of being supported by the groove **12***a* of the upper die guide rail **12**. As a result, the inner pin **25***q* is prevented from falling into the clearance S**2**, and the attitude of the upper die **20** is stabilized. It is thus possible to prevent the inner pin **25***q* from colliding with the end portion of the groove **12***a*.

(56) In this way, even when the upper die **20** is transported from the connection rail **44** to the upper die guide rail **12**, it is possible to prevent abnormal noise from occurring during transportation and prevent damage to the upper die **20** and the upper die guide rail **12**. Although not shown in the drawings, if transportation of the upper die **20** toward the upper die guide rail **12** is performed from the current state, the inner pin **25***q* on the rear side is positioned in the clearance S**2**. At this time, since the outer pin **25***p* on the rear side is supported by the groove **44***a* of the connection rail **44**, the inner pin **25***q* is prevented from falling into the clearance S**2**. When the outer pin **25***p* on the rear side is positioned in the clearance S**2**, the inner pin **25***q* is supported by the groove **12***a* of the upper die guide rail **12**, and as a result, the outer pin **25***p* is prevented from falling into the clearance S**2**.

(57) When the upper die **20** is transported from the upper die guide rail **12** to the connection rail **44**,

first, the outer pin **25***p* on the leading side in the traveling direction is positioned in the clearance S**2**. At this time, the inner pin **25***q* remains in the state of being supported by the groove **12***a* of the upper die guide rail **12**. As a result, the outer pin **25***p* is prevented from falling into the clearance S**2**, and it is thus possible to prevent the outer pin **25***p* from colliding with the end portion of the groove **44***a*. When the inner pin **25***q* is positioned in the clearance S**2**, the outer pin **25***p* is supported by the groove **44***a* of the connection rail **44**. As a result, the inner pin **25***q* is prevented from falling into the clearance S**2**, and it is thus possible to prevent the inner pin **25***q* from colliding with the end portion of the groove **44***a*. If transportation of the upper die **20** toward the connection rail **44** is performed from the current state, the inner pin **25***q* on the rear side is positioned in the clearance S**2**. At this time, since the outer pin **25***p* on the rear side is supported by the groove **12***a* of the upper die guide rail **12**, the inner pin **25***q* is prevented from falling into the clearance S**2**. When the outer pin **25***p* on the rear side is positioned in the clearance S**2**, the inner pin **25***q* is supported by the groove **44***a* of the connection rail **44**, and as a result, the outer pin **25***p* is prevented from falling into the clearance S**2**.
(58) In FIGS. **7**A and **7**B and FIGS. **8**A and **8**B, the case where the upper die **20** passes through the clearance S**2** between the connection rail **44** and the upper die guide rail **12** is described as an example, however, the above description also similarly applies to case of the upper die **20** passing through the clearance S**1** between the cassette **43** and the connection rail **44**. Even in the case where either one of the outer pin **25***p* and the inner pin **25***q* is positioned in the clearance S**1**, since the distance L**1** is greater than the clearance distance W**1**, the other of the outer pin **25***p* and the inner pin **25***q* is supported by the groove **43***a* of the cassette **43** or the groove **44***a* of the connection rail **44**. As a result, the outer pin **25***p* or the inner pin **25***q* is prevented from colliding with the end portion of the groove **43***a* or the groove **44***a*.
(59) As described above, according to the upper die **20** and the machining system **200** of the present preferred embodiment, since the distance L**1** between the outer pin **25***p* (outer guided portion **25***a*) and the inner pin **25***q* (inner guided portion **25***b*) is greater than the clearance distance W**1** of the clearance S**1** or the clearance distance W**2** of the clearance S**2**, even when the upper die **20** is transported through the cassette **43**, the connection rail **44**, and the upper die guide rail **12**, the outer pin **25***p* or the inner pin **25***q* is prevented from falling into the clearances S**1**, S**2**. As a result, the attitude of the upper die **20** can be stabilized, and the outer pin **25***p* or the inner pin **25***q* can be prevented from colliding with the grooves **12***a*, **43***a*, **44***a*, thus preventing occurrence of abnormal noise and damage to the upper die **20**, the upper die guide rail **12**, and the connection rail **44**.
(60) FIG. **9** to FIG. **15** describe modified examples of the upper die **20**. In the following description of each modified example, the same configurations as those of the preferred embodiments described above are assigned with the same reference signs and the descriptions thereof are omitted or simplified. FIG. **9** is a front elevation view showing an example of an upper die **20**A according to a first modified example of a preferred embodiment of the present invention. In the upper die **20**A shown in FIG. **9**, the outer pins **25***p* are arranged above the inner pins **25***q* by a distance Z. The distance Z can be arbitrarily set within a range that allows both the outer pin **25***p* and the inner pin **25***q* can enter the grooves **12***a*, **43***a*, **44***a*. According to the upper die **20**A, the outer pins **25***p* are arranged above the inner pins **25***q*, so that the outer pin **25***p* can be further prevented from falling into the grooves **12***a*, **43***a*, **44***a*, and the outer pin **25***p* can be reliably prevented from colliding with the grooves **12***a*, **43***a*, **44***a*.
(61) FIGS. **10**A and **10**B show examples of an upper die **20**B according to a second modified example of a preferred embodiment of the present invention, FIG. **10**A being a front elevation view, and FIG. **10**B being a cross-sectional view seen in the transportation direction. In the upper die **20**B shown in FIGS. **10**A and **10**B, the outer pins **25***p* and the inner pins **25***q* are provided so as to respectively pass through through-holes **21***a*, **21***b* extending in the front-rear direction and protruding from both the front side and the rear side. Moreover, an elastic body **21***c* is arranged both between the outer pin **25***p* and the through hole **21***a* and between the inner pin **25***q* and the

through hole **21***b*. For the elastic body **21***c*, a material such as rubber, soft resin, or the like is used, for example. According to this upper die **20**B, the elastic body **21***c* can mitigate the influence of the load of the upper die **20**B applied to the outer pin **25***p* and the inner pin **25***q* and can also mitigate impact on the outer pin **25***p* and the inner pin **25***q*. It should be noted that the elastic body **21***c* is not limited to being arranged between all the outer pins **25***p* and the inner pins **25***q* and the through holes **21***a*, **21***b*. For example, the elastic body **21***c* may be arranged either between the outer pins **25***p* and the through holes **21***a* or between the inner pins **25***q* and the through holes **21***b*. Also, the elastic body **21***c* may be arranged between some (for example, one) of the plurality of outer pins **25***p* and the through hole **21***a*, or the elastic body **21***c* may be arranged between some (for example, one) of the plurality of inner pins **25***q* and the through hole **21***b*.

(62) FIG. **11** is a perspective view showing an example of an upper die **20**C according to a third modified example of a preferred embodiment of the present invention. In the upper die **20**C shown in FIG. **11**, auxiliary pins **25***c* that protrude in the front-rear direction and move while being guided by the grooves **12***a*, **43***a*, **44***a* may be provided between the inner pin **25***q* on the left and the inner pin **25***q* on the right. As with the outer pins **25***p* and the inner pins **25***q*, the auxiliary pin **25***c* may be provided as a rod-shaped body passing through the base **21** in the front-rear direction D**2** or may be provided as being integrated with the base **21** via cutting or the like. The auxiliary pin **25***c* may be of the same form as those of the outer pin **25***p* and the inner pin **25***q* or may be of a different form. Each auxiliary pin **25***c* is provided at the same height position as those of the outer pins **25***p* and the inner pins **25***q*.

(63) According to this upper die **20**C, the load of the upper die **20**C can be distributed by the outer pins **25***p*, the inner pins **25***q*, and the auxiliary pin **25***c*, and the burden on the outer pins **25***p* and the inner pins **25***q* can be reduced. In the upper die **20**C shown in FIG. **11**, the auxiliary pin **25***c* is provided at two locations across the center portion **26** in the transportation direction D**1**, however, the present invention is not limited to this configuration. For example, one, three or more auxiliary pins **25***c* may be provided.

(64) FIG. **12** is a front elevation view showing an example of an upper die **20**D according to a fourth modified example of a preferred embodiment of the present invention. In the upper die **20**D shown in FIG. **12**, each protrusion is a continuous protrusion **25**D protruding in a continuous manner in the transportation direction D**1** from the outer guided portion **25***a* to the inner guided portion **25***b*. The continuous protrusion **25**D protrudes in the front-rear direction D**2** from the base **21** and extend in the transportation direction D**1**. The continuous protrusion **25**D may be referred to as plate-shaped protrusion in some case. In this continuous protrusion **25**D, the distance L**2** between the outer guided portion **25***a* and the inner guided portion **25***b* is greater than the clearance distance W**1** of the clearance S**1** and the clearance distance W**2** of the clearance S**2**. Both ends of the continuous protrusion **25**D in the transportation direction D**1** preferably have a semicircular shape.

(65) According to this upper die **20**D, since the distance L**2** of the continuous protrusion **25**D is greater than the clearance distances W**1**, W**2**, even when the continuous protrusion **25**D is positioned in the clearances S**1**, S**2**, it is possible to prevent it from falling into the clearances S**1**, S**2**. Since the continuous protrusion **25**D is greater in the transportation direction D**1** than the outer pin **25***p* and the inner pin **25***q* described above, it is possible to bear the load of the upper die **20**D in a wide range.

(66) FIG. **13** is a front elevation view showing an example of an upper die **20**E according to a fifth modified example of a preferred embodiment of the present invention. In the upper die **20**E shown in FIG. **13**, each protrusion is a continuous protrusion (plate-shaped protrusion) **25**E protruding in a continuous manner in the transportation direction D**1** from the outer guided portion **25***a* to the inner guided portion **25***b*. The continuous protrusion **25**E protrudes in the front-rear direction D**2** from the base **21** and extend in the transportation direction D**1**. In this continuous protrusion **25**E, the distance L**3** between the outer guided portion **25***a* and the inner guided portion **25***b* is greater than

the clearance distance W**1** of the clearance S**1** and the clearance distance W**2** of the clearance S**2**. On each lower surface of the outer guided portion **25***a* and the inner guided portion **25***b* there is provided a tapered surface **25***t* that inclines upward. The angle of the tapered surface **25***t* relative to the transportation direction D**1** can be set arbitrarily.
(67) According to this upper die **20**E, since a distance L**3** of the continuous protrusion **25**E is greater than the clearance distances W**1**, W**2**, even when the continuous protrusion **25**E is positioned in the clearances S**1**, S**2**, it is possible to prevent it from falling into the clearances S**1**, S**2**. Since the continuous protrusion **25**E is greater in the transportation direction D**1** than the outer pin **25***p* and the inner pin **25***q* described above, it is possible to bear the load of the upper die **20** in a wide range. Since the tapered surface **25***t* is provided on each lower surface of the outer guided portion **25***a* and the inner guided portion **25***b*, it is possible to reliably prevent the outer guided portion **25***a* or the inner guided portion **25***b*, which are end portions of the continuous protrusion **25**E, from colliding with the grooves **12***a*, **43***a*, **44***a*. The configuration is not limited to providing the tapered surface **25***t* on both the outer guided portion **25***a* and the inner guided portion **25***b*, and the tapered surface **25***t* may be provided only on either the outer guided portion **25***a* or the inner guided portion **25***b*.
(68) FIG. **14** is a front elevation view showing an example of an upper die **20**F according to a sixth modified example of a preferred embodiment of the present invention. In the upper die **20**F shown in FIG. **14**, the protrusions **25** are such that the outer pins **25***p* are provided as outer guided portions **25***a*, however, the left and right inner guided portions **25***b* are provided as a continuous protrusion (plate-shaped protrusion) **25**F protruding in a continuous manner in the transportation direction D**1**. The continuous protrusion **25**F protrudes in the front-rear direction D**2** from the base **21** and extends in the transportation direction D**1**. A distance L**4** between the outer pin **25***p* and the inner guided portion **25***b*, which is a portion of the continuous protrusion **25**F, is greater than the clearance distance W**1** of the clearance S**1** and the clearance distance W**2** of the clearance S**2**. Both ends of the continuous protrusion **25**E in the transportation direction D**1** preferably have a semicircular shape.
(69) According to this upper die **20**F, since the distance L**4** between the outer pin **25***p* and the inner guided portion **25***b* of the continuous protrusion **25**F is greater than the clearance distances W**1**, W**2**, even when the outer pin **25***p* or the continuous protrusion **25**F is positioned in the clearances S**1**, S**2**, it is possible to prevent it from falling into the clearances S**1**, S**2**. Since the continuous protrusion **25**F is elongated in the transportation direction D**1**, it is possible to bear the load of the upper die **20** in a wide range.
(70) FIG. **15** is a front elevation view showing an example of an upper die **20**G according to a seventh modified example of a preferred embodiment of the present invention. In the upper die **20**G shown in FIG. **15**, the protrusion is such that the outer guided portions **25***a* and the inner guided portions **25***b* on left and right are a continuous protrusion (plate-shaped protrusion) **25**G that protrudes in a continuous manner in the transportation direction D**1**. The continuous protrusion **25**G protrudes in the front-rear direction D**2** from the base **21** and extends in the transportation direction D**1**. A distance L**5** between the outer guided portion **25***a*, which is a portion of the continuous protrusion **25**G, and the inner guided portion **25***b*, which is a portion of the continuous protrusion **25**G, is greater than the clearance distance W**1** of the clearance S**1** and the clearance distance W**2** of the clearance S**2**. On the lower surface of each outer guided portion **25***a* there is provided a tapered surface **25***u* that inclines upward. The angle of the tapered surface **25***u* relative to the transportation direction D**1** can be set arbitrarily.
(71) According to this upper die **20**G, since the distance L**5** between the outer guided portion **25***a* and the inner guided portion **25***b* of the continuous protrusion **25**G (that is, the length of the continuous protrusion **25**G in the transportation direction D**1**) is greater than the clearance distances W**1**, W**2**, even when the continuous protrusion **25**G is positioned in the clearances S**1**, S**2**, it is possible to prevent it from falling into the clearances S**1**, S**2**. Since the continuous protrusion

25G is elongated in the transportation direction D**1**, it is possible to bear the load of the upper die **20**G in an even wider range. Since the tapered surface **25***u* is provided on the lower surface of each outer guided portion **25***a*, it is possible to reliably prevent the outer guided portion **25***a*, which is an end portion side of the continuous protrusion **25**G, from colliding with the grooves **12***a*, **43***a*, **44***a*.
(72) FIG. **16** is a plan view showing an example of an upper die **20**H according to an eighth modified example of a preferred embodiment of the present invention. In the upper die **20**H shown in FIG. **16**, the outer pin **25***p* and the inner pin **25***q* are provided on both the left and right sides in the transportation direction D**1** of the center portion **26**. The outer pins **25***p* are provided on one side (for example, the front side) of the base **21** in the front-rear direction D**2**, and the inner pins **25***q* are provided on the other side of the base **21** (for example, the rear side). The outer pin **25***p* and the inner pin **25***q* each protrude from the base **21** in opposite directions in the front-rear direction D**2**. A distance L**6** between the outer pin **25***p* and the inner pin **25***q* is greater than the clearance distance W**1** of the clearance S**1** and the clearance distance W**2** of the clearance S**2**. The upper die **20**H includes an auxiliary pin **25***c* at the center portion **26** in the transportation direction D**1**.
(73) According to this upper die **20**H, since the distance L**6** between the outer pin **25***p* and the inner pin **25***q* is greater than the clearance distances W**1**, W**2**, even when the outer pin **25***p* or the inner pin **25***q* is positioned in the clearances S**1**, S**2**, it is possible to prevent it from falling into the clearances S**1**, S**2**. Since the number of protrusions **25** is small, the configuration of the upper die **20**H can be simplified. By providing the auxiliary pin **25***c*, the load of the upper die **20**H can be distributed by the outer pins **25***p*, the inner pins **25***q*, and the auxiliary pin **25***c*, and the burden on the outer pins **25***p* and the inner pins **25***q* can be reduced. Two or more auxiliary pin **25***c* may be provided, or the auxiliary pin **25***c* need not be provided.
(74) FIG. **17** is a front elevation view showing an example of a machining system **200**A according to a second preferred embodiment. In the following description, the same configurations as those in the first preferred embodiment described above are assigned with the same reference signs and the descriptions thereof are omitted or simplified. In the machining system **200**A shown in FIG. **17**, the connection rail **44** (see FIG. **1** and so forth) is not provided, and the stocker **40** of the die switching device **4** is installed adjacent to the press machine **100**. In such a case, the upper die guide rail **12** of the ram **11** is connected to the cassette **43** of the rack **41**. That is to say, the cassette **43** defines and functions as a connection rail in the upper die guide rail **12**.
(75) In the machining system **200**A, the upper die **20** moves through the cassette **43** and the upper die guide rail **12**. In such a case, the upper die **20** travels over a clearance S**3** between the cassette **43** and the upper die guide rail **12**. In the upper dies **20**A, **20**B, **20**C, **20**D, **20**E, **20**F, **20**G, **20**H, the distances L**1**, L**2**, L**3**, L**4**, L**5**, L**6** are all greater than the clearance distance of the clearance S**3**. Therefore, when transporting the upper die **20** between the upper die guide rail **12** and the cassette **43**, even when either one of the outer guided portion **25***a* or the inner guided portion **25***b* is positioned in the clearance S**3** between the upper die guide rail **12** and the cassette **43**, the other remains in the state of being supported by the groove **12***a* or the groove **43***a* of the upper die guide rail **12** or the cassette **43**. As a result, the outer guided portion **25***a* or the inner guided portion **25***b* is prevented from falling into the clearance S**3**.
(76) As described above, according to the machining system **200**A, as with the first preferred embodiment, when transporting the upper die **20** between the upper die guide rail **12** and the cassette **43**, the attitude of the upper die **20** can be stabilized, and the outer guided portion **25***a* or the inner guided portion **25***b* can be prevented from colliding with the groove **12***a*. As a result, it is possible to prevent abnormal noise from occurring and prevent damage to the upper die **20**, the upper die guide rail **12**, and the cassette **43**.
(77) The preferred embodiments and the modified examples of the present invention have been described above. However, the technical scope of the present invention is not limited to the description of the above preferred embodiments or the modified examples. One or more of the configurations described in the above preferred embodiments or the modified examples may be

combined where appropriate. The contents of Japanese Patent Application No. 2020-156197 and all documents cited in the detailed description of the present invention are incorporated herein by reference to the extent permitted by law. For example, in the above preferred embodiments, the case of transporting the upper die **20** has been described as an example, however, the present invention is not limited to this example, and similar configurations can also be applied to a case of transporting the lower die **30**.
(78) In the above preferred embodiments, the transporter **46** transports the upper die **20** or the like in the state in which the locking portion **46***d* is inserted in the locked portion **28** of the upper die **20** or the like. However, the present invention is not limited to this example. For example, transportation may be performed by sucking or gripping a part of the upper die **20** or the like. Furthermore, in the preferred embodiments described above, even in the case where an upward forces acts on either one of the outer guided portion **25***a* (for example, outer pin **25***p*) and the inner guided portion **25***b* (for example, inner pin **25***q*) in the clearances S**1**, S**2**, the other of the outer guided portion **25***a* and the inner guided portion **25***b* comes in contact with the upper surfaces side of the grooves **12***a*, **43***a*, **44***a*, and thus, the outer guided portion **25***a* or the inner guided portion **25***b* is prevented from ascending in the clearances S**1**, S**2**. As a result, the outer guided portion **25***a* or the inner guided portion **25***b* is prevented from colliding with the ends of the grooves **12***a*, **43***a*, **44***a*. Moreover, an upward force may be actively applied to the outer guided portion **25***a* or the inner guided portion **25***b* so that the outer guided portion **25***a* or the inner guided portion **25***b* comes in contact with the ends of the grooves **12***a*, **43***a*, **44***a*, or an upward force may be applied to the outer guided portion **25***a* or the inner guided portion **25***b* (in a state having a short distance from the upper surface or the lower surface of the grooves **12***a*, **43***a*, **44***a*) so that the outer guided portion **25***a* or the inner guided portion **25***b* does not come into contact with the ends of the grooves **12***a*, **43***a*, **44***a*. For example, in the case where the sectional shapes of the locked portion **28** of the upper die **20** and the locking portion **46***d* of the transporter **46** are oval or elliptical, a configuration may be used in which an upward force is applied to the outer guided portion **25***a* or the inner guided portion **25***b* by rotating the locking portion **46***d* around an axis parallel to the front-rear direction D**2**.
(79) While preferred embodiments of the present invention have been described above, it is to be understood that variations and modifications will be apparent to those skilled in the art without departing from the scope and spirit of the present invention. The scope of the present invention, therefore, is to be determined solely by the following claims.

Claims

1. A system comprising: an upper die; a press machine to perform press machining on a workpiece via the upper die and a lower die, the press machine including a ram and a die quide rail on a lower portion of the ram; and a connection rail connected to the die guide rail on the lower portion of the ram in the press machine; wherein the upper die that is movable through the die guide rail on a lower portion of a ram in a press machine and the connection rail connected to the die guide rail; the upper die includes a center portion, and on right and left sides of the center portion as viewed in a front-rear direction orthogonal to a transportation direction of the upper die and an up-down direction, protrusions that protrude in the front-rear direction and are movable while being guided by grooves included in the die guide rail and the connection rail; wherein each of the protrusions includes an outer guided portion on an outer side in the transportation direction relative to the center portion and an inner guided portion on an inner side closer to the center portion than the outer guided portion; and a distance in the transportation direction between the outer guided portion and the inner guided portion is greater than a clearance distance between the die guide rail and the connection rail.
2. The system according to claim 1, wherein the protrusions include an outer pin defining the outer

guided portion and an inner pin defining the inner guided portion.
3. The system according to claim 2, wherein the outer pin is above the inner pin.
4. The system according to claim 2, wherein the outer pin and the inner pin are positioned to pass through through-holes in the front-rear direction and protrude from both a front side and a rear side; and an elastic body is provided at least either between the outer pin and the through hole or between the inner pin and the through hole.
5. The system according to claim 2, wherein an auxiliary pin that protrudes in the front-rear direction and is movable while being guided by the groove is provided between the inner pin on the left and the inner pin on the right.
6. The system according to claim 1, wherein each of the protrusions is a continuous protrusion positioned to protrude in a continuous manner from the outer guided portion to the inner guided portion.
7. The system according to claim 6, wherein the continuous protrusion includes a tapered surface that slopes upward on a lower surface of at least either the outer guided portion or the inner guided portion.
8. The system according to claim 6, wherein the inner guided portion on the left and the inner guided portion on the right protrude in a continuous manner.
9. The system according to claim 1, wherein the upper die includes a locked portion extending in the front-rear direction; and the system further comprises a transporter that includes a locking portion extendible and retractable in the front-rear direction to lock the locked portion in the transportation direction, and to transport the upper die as the locking portion moves in the transportation direction while locking the locked portion.