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(54) **PROFILE GRINDING MACHINE**

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B24B 49/12 (2006.01)

(52) **U.S. Cl.**
USPC **451/11**; 451/6

(58) **Field of Classification Search**
USPC 451/11, 6, 236, 61, 121, 5
See application file for complete search history.

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(57) **ABSTRACT**

The profile grinding machine includes: a base; a work unit disposed on one side on the base and including a work table for gripping a work; and a stone unit disposed on the other side on the base and including a stone rotating mechanism for holding and rotating a grinding stone on its axis. The work unit includes first to third moving device for supporting and moving the work table in an X-direction and a Y-direction perpendicular to each other in a horizontal plane, and in a Z-direction normal to the horizontal plane, respectively. The stone unit includes turning mechanism for turning the grinding stone about a vertical axis substantially coinciding with the leading end portion of the grinding stone.

7 Claims, 8 Drawing Sheets

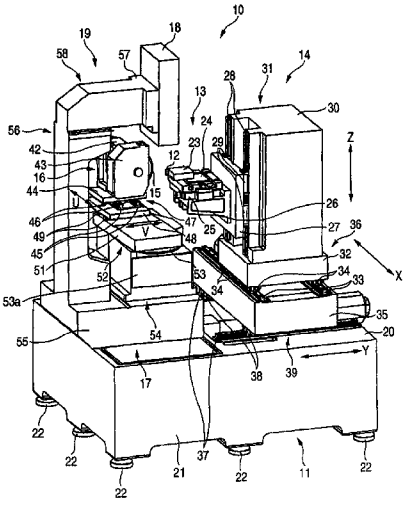

FIG. 1

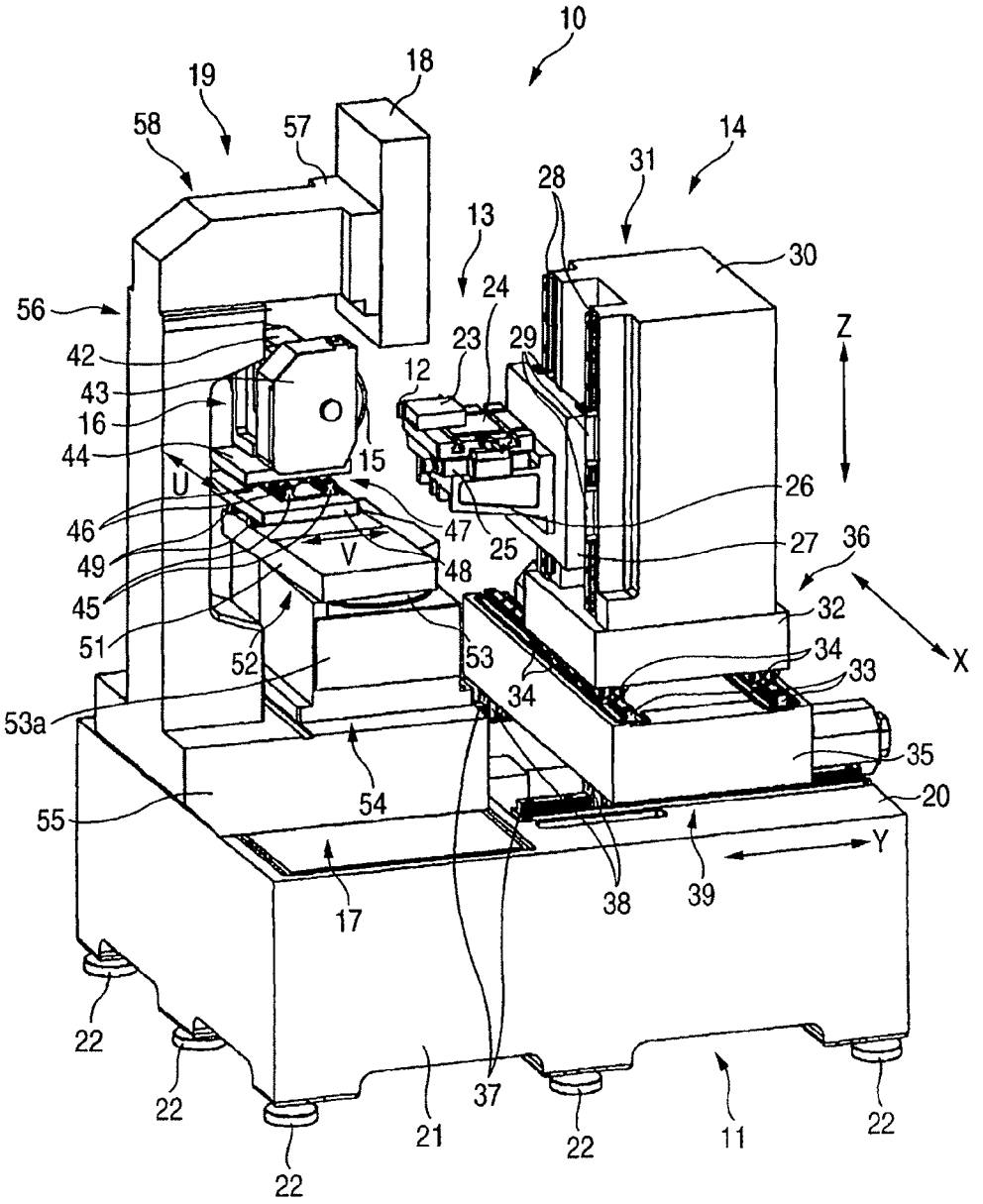
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FIG. 2C

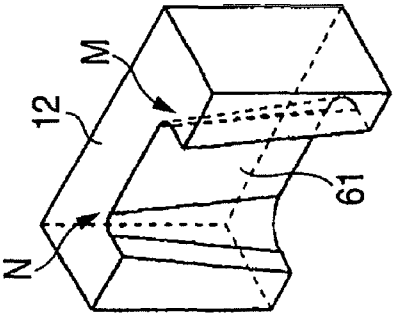

FIG. 2B

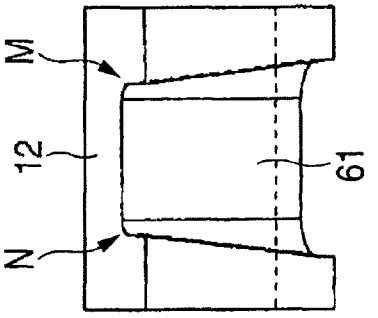

FIG. 2A

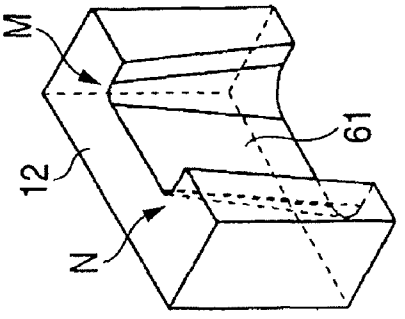

FIG. 3

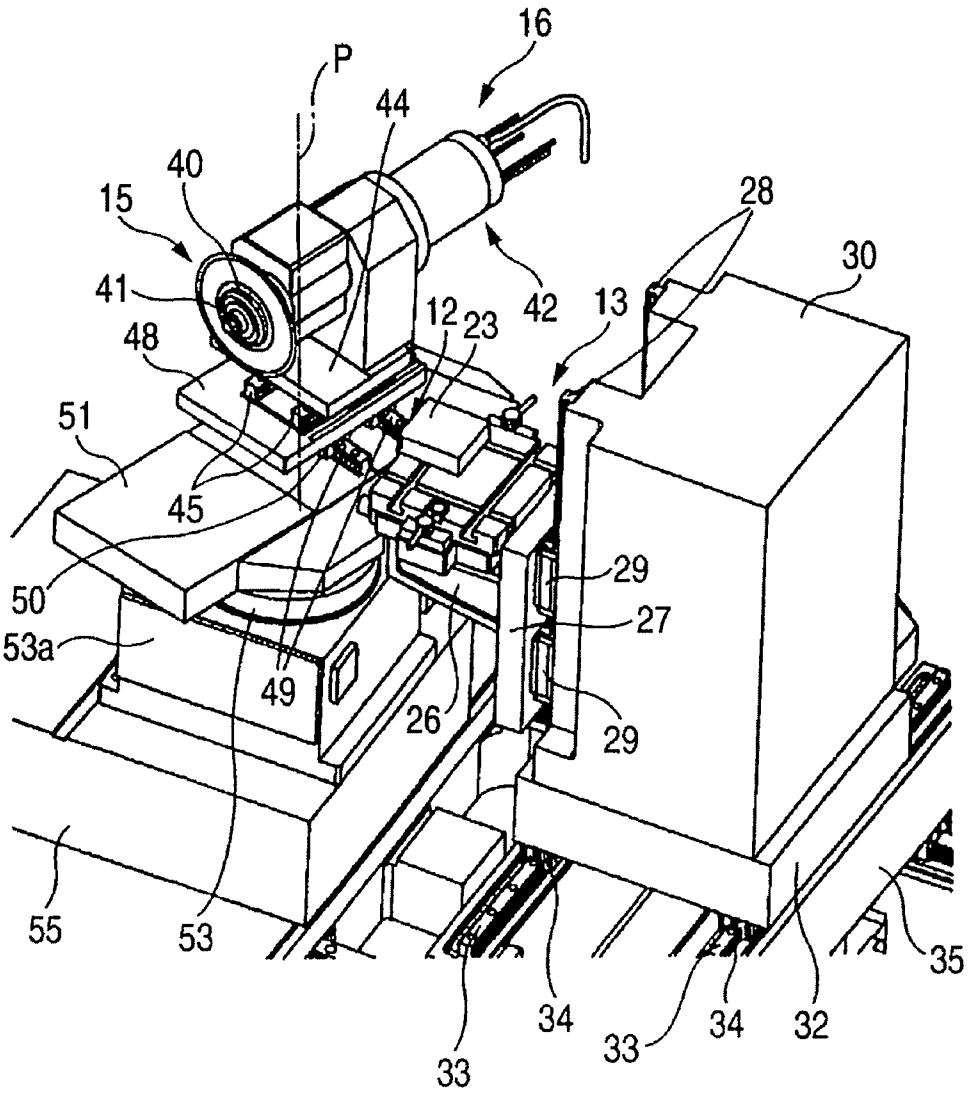
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FIG. 4

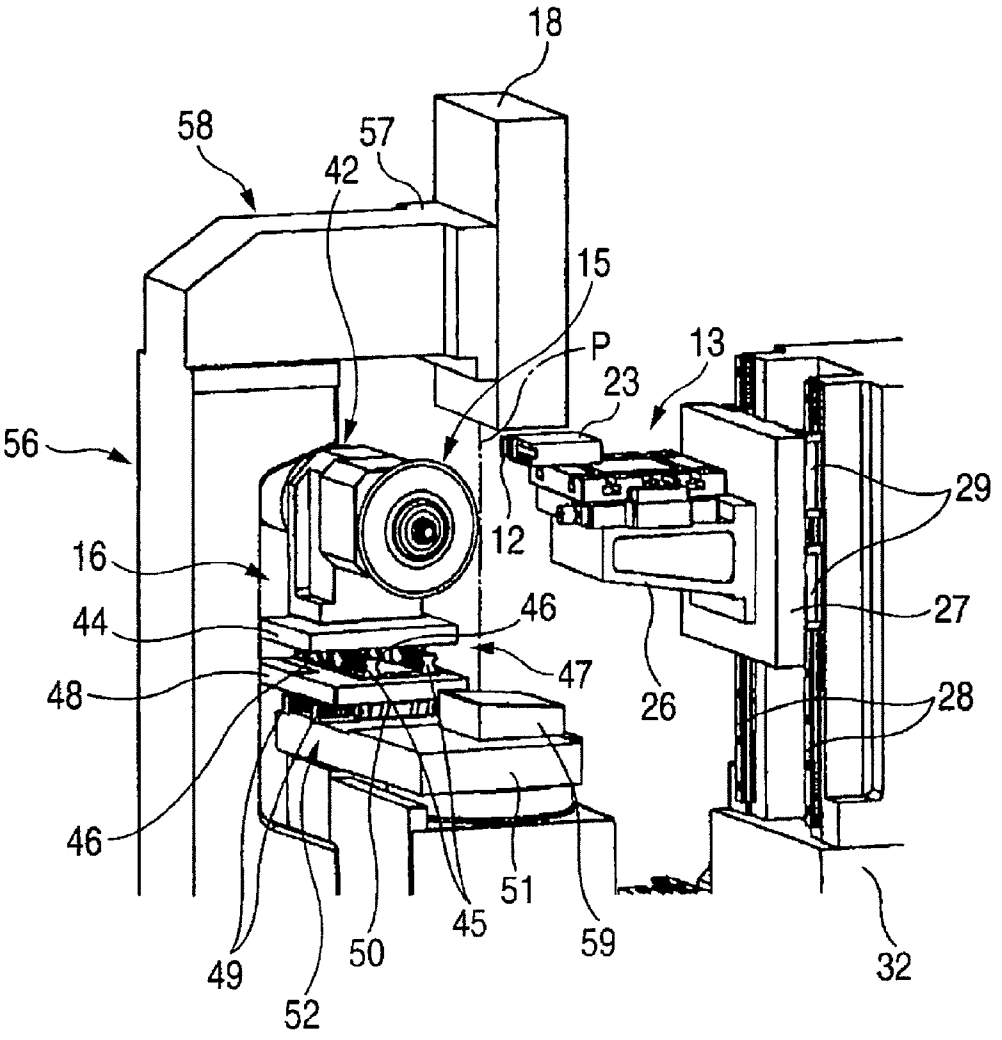
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FIG. 5

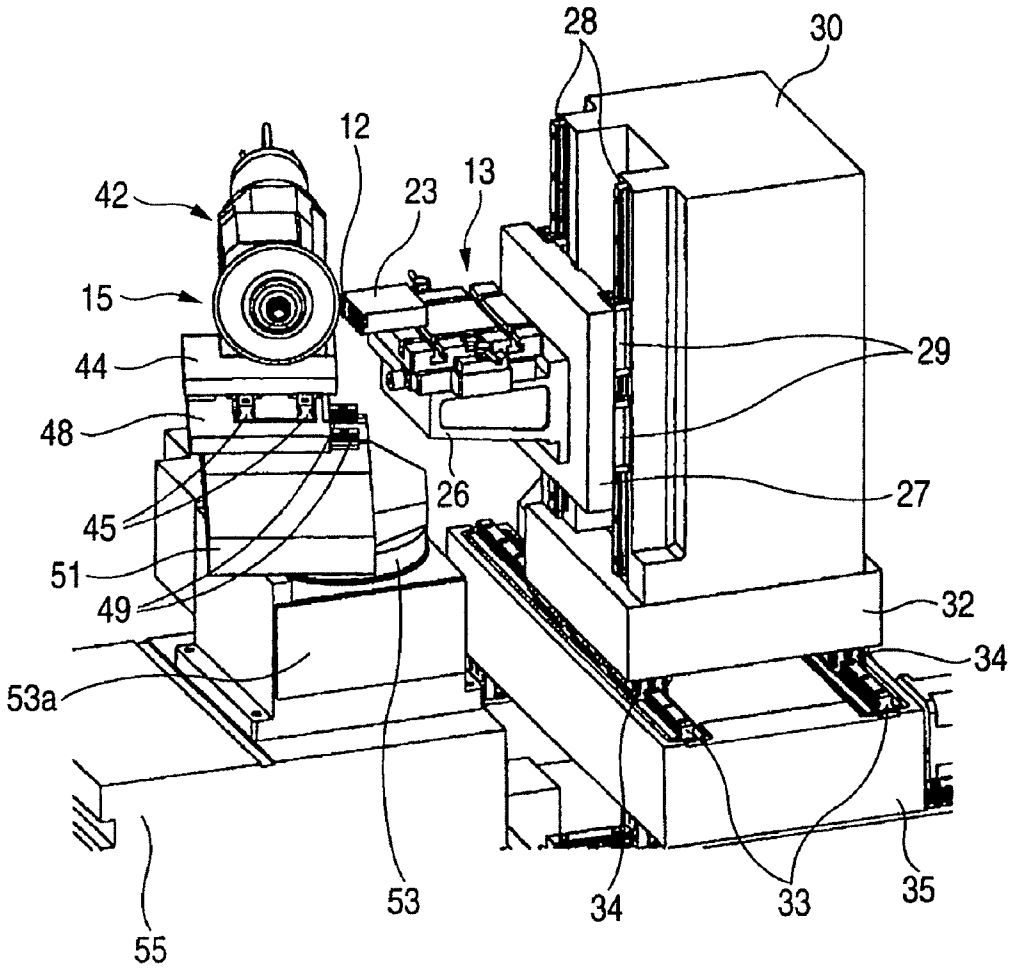


FIG. 6

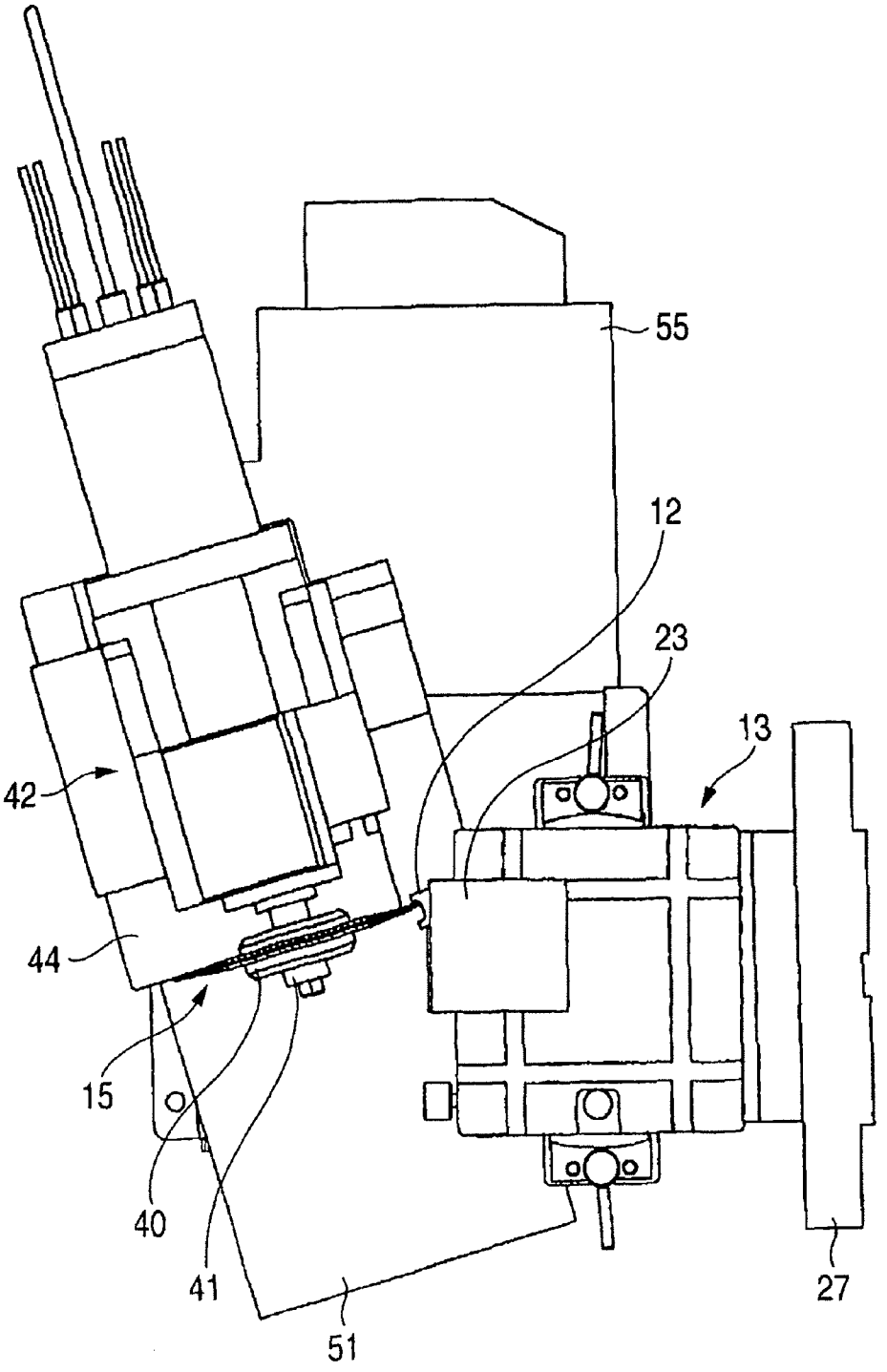


FIG. 7

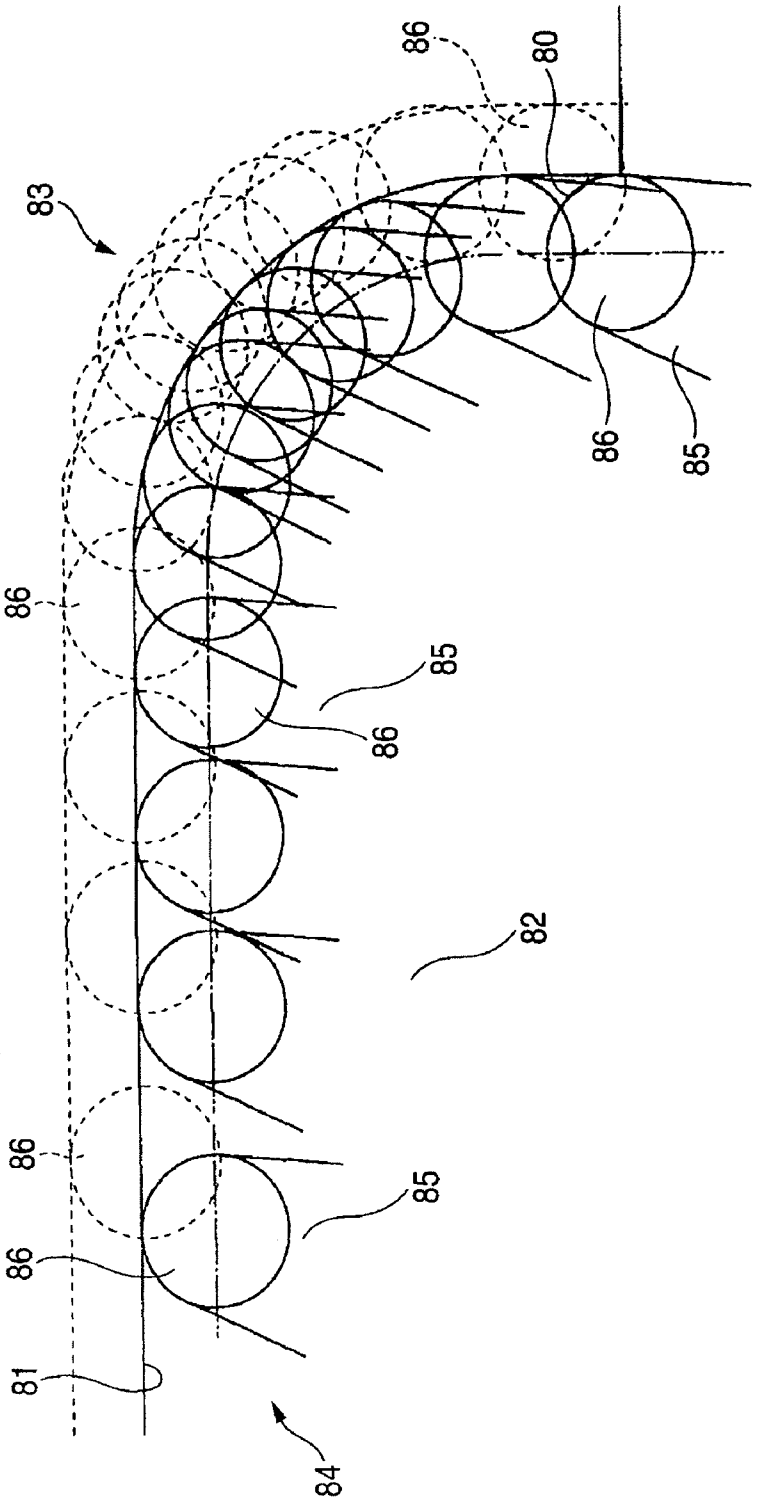


FIG. 8A

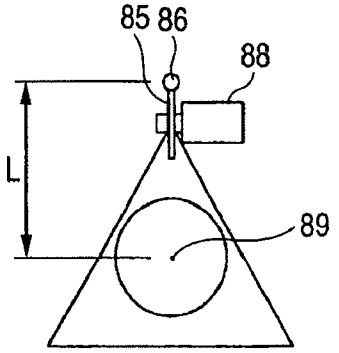


FIG. 8B

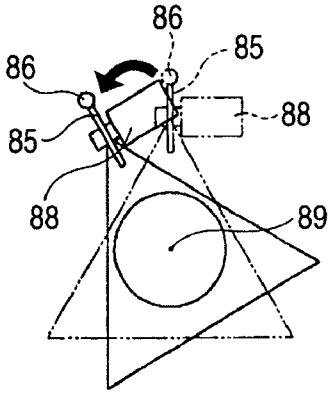
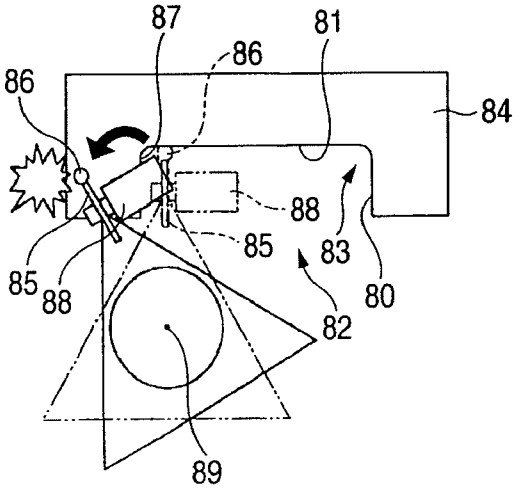


FIG. 8C



PROFILE GRINDING MACHINE

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a profile grinding machine for grinding a recess made open in the side face of a work, smoothly.

2. Related Art

Conventionally, in case a ground face inclined with respect to a vertical line is formed in the inner face of a recess made open in the side face of a work, as shown in FIG. **2**, the work is fixed on a work table, and the grinding stone is manually inclined before the grinding operation in accordance with the angle of inclination of the ground face to be formed, so that the moving direction of the leading end of the grinding stone is set in parallel with the ground face to be formed. In case the angles of inclination of the ground faces to be formed are different for the individual faces, therefore, the angles of the grinding stone have to be readjusted for the individual faces thereby to complicate the profile grinding operations. Thus, there has been proposed (as referred to JP-A-10-138112, for example) a profile grinding machine, in which a movable base is so disposed on the back of the work table for supporting and fixing the work as can rock forward and backward, and rightward and leftward with respect to the work table, in which the movable base is provided with a first rocking frame having a first rocking action device automatically adjusted to rock forward and backward with respect to a first rocking shaft, and a second rocking frame disposed on the front side of the first rocking frame and having a second rocking action device automatically adjusted to rock rightward and leftward with respect to a second rocking shaft intersecting at a right angle with the first rocking shaft, and in which a grinding stone head having a stone wheel rotationally driven is so disposed on the front side of the second rocking frame as can reciprocate upward and downward.

In case, however, the profile grinding machine described in JP-A-10-138112 is used to grind the individual inner faces of the recess thereby to form the inclined ground faces, the grinding stone is inclined in advance to the angle of inclination of the ground faces. Therefore, the depth of cut of the work by the grinding stone is set constant from the cutting side of the grinding stone to the leaving side. In case, therefore, the grinding operation to start the cutting of the grinding stone from the upper face side of the work and to extract the grinding stone from the back face side of the work is performed from one side to the other of the recess in a top plan view, as shown in FIG. **7** and FIG. **8**, there arises a problem that the grounding quantities of the lower face side (or the leaving side of a grinding stone **85**), as indicated by broken lines, of a work **84** are excessive for the designed quantity in a corner area **83**, in which two adjoining surfaces (or inner faces) **80** and **81** (or the surfaces **81** and **87**) of a recess **82** of the work **84**. This raises a limit to the precision in the inner face shape of the recess **82** after ground.

In case, moreover, the grinding operation is started from one side to the other of the recess **82**, it is so performed with the leading end portion **86** of the grinding stone **85** being inclined with respect to the surfaces **80**, **81** and **87** of the work **84** as to prevent the interference between the grinding stone

85 and one side of the work **84** and the excessive wear of the leading end portion **86** of the grinding stone **85**. As a result, when the leading end portion **86** of the grinding stone **85** approaches the other side of the recess **82**, there arise a problem that the side portion of the grinding stone **85** interferes with the other side of the recess **82** so that the grinding operation cannot be performed. This makes it necessary to turn a stone head **88** thereby to change the angle of inclination of the leading end portion **86** of the grinding stone **85** with respect to the surface **87** of the work **84**. As shown in FIG. **8**A, however, the position of the center axis of turn **89** of the stone head **88** and the center position of the leading end portion **86** of the grinding stone **85** are generally spaced by a distance L. As shown in FIG. **8**B, therefore, when the stone head **88** is turned, the center of the leading end portion **86** moves on the center axis of turn **89** along the arc having a radius of a distance L between the center axis of turn **89** and the center of the leading end portion **86** of the grinding stone **85**. As a result, there arises a problem that the grinding stone **85** collides against the other side of the recess **82**, as shown in FIG. **8**C. Before the grinding stone **85** interferes with the other side of the recess **82**, therefore, the grinding stone **85** is relieved from the work **84** so that the angle of inclination of the leading end portion **86** of the grinding stone **85** with respect to the surface of the work **84** is readjusted to reopen the grinding operation. Alternatively, the grinding operations of the inner faces of the recess **82** are individually performed by dividing them for one side area and the other side area. As a result, the preparing steps before the grinding operations increase to raise a problem that the total time period required for the grinding operations is elongated.

SUMMARY OF THE INVENTION

The invention has been conceived in view of those backgrounds, and has an object to provide a profile grinding machine capable of grinding a recess made open in the side face of a work, smoothly.

According to the invention to satisfy the aforementioned object, there is provided a profile grinding machine including:

a base;

a work unit disposed on one side on the base and including a work table for gripping a work; and

a stone unit disposed on another side on the base and including a stone rotating mechanism for holding and rotating a grinding stone about axis thereof,

wherein the work unit includes first, second and third moving devices for supporting and moving the work table in an X-direction and a Y-direction intersecting with each other in a horizontal plane, and in a Z-direction normal to the horizontal plane, respectively; and

the stone unit includes a turning mechanism capable of turning the grinding stone about a vertical axis substantially coinciding with a leading end portion of the grinding stone.

In the profile grinding machine according to the invention, the turning mechanism may include a rotating table disposed above the base for rotating about the rotation axis of the turning mechanism, and fourth and fifth moving devices disposed above the rotating table far supporting and moving the stone rotating mechanism, respectively, in a U-direction and a V-direction intersecting with each other in a horizontal plane.

According to the invention, the profile grinding machine may include an image pickup mechanism including a camera disposed above the base for taking the images of the work unit and the stone unit downward.

In the profile grinding machine according to the invention, by operating the first to third moving devices, in synchronism with the movement of the work gripped on the work table in the Z-direction, the work can be moved in the X-direction and in the Y-direction, so that the cut of depth of the work by the grinding stone can be changed upward and downward. As a result, in case the grinding operation to start the cutting operation of the grinding stone from the upper face side of the work and to extract the grinding stone from the lower face side of the work is performed from one side to the other of the recess, as viewed in a top plan view, the grinding quantities of the lower face side (or the leaving side of the grinding stone) of the corner area, in which the two adjoining surfaces (or the inner faces) of the recess of the work can be adjusted to the designed quantity thereby to form the ground faces excellent in the shaping precision with respect to the vertical direction, in the individual inner faces of the recess.

Moreover, the stone unit is provided with the turning mechanism for turning the grinding stone on the vertical line substantially coinciding with the leading end portion of the grinding stone. Therefore, even if the grinding stone is turned, the contacting position moves along the outer circumference of the leading end portion of the grinding stone so that the grinding stone can be prevented from interfering the work even if it is turned during the grinding operation. As a result, the grinding stone is gradually rotated while moving from one side to the other of the recess, so that the grinding stone can be prevented, even if it enters the other side area, from interfering with the other side of the recess. As a result, the ground faces inclined with respect to the directions normal to the individual inner faces of the recess of the work can be formed at one time by the single grinding operation.

Especially in the profile grinding machine according to one additional feature of the invention, the stone rotating mechanism can be moved over the rotating table. Even if the leading end portion of the grinding stone is worn to have its sizes changed by working it again or if the stone sizes are changed according to the work shape, the center position of the leading end portion of the grinding stone can be easily aligned with the rotation axis of the turning mechanism.

In the profile grinding machine according to another additional feature of the invention, the work positioning confirmation before the grinding operation and the work shape confirmation after the working operation can be done by taking the image of the work fixed on the work table with the camera. By taking the image of the grinding stone attached to the stone rotating mechanism with the camera, moreover, the confirmation of the shape of the leading end portion of the grinding stone, the confirmation of the stone position (e.g., the conformation of the alignment between the center position of the leading end portion of the grinding stone and the axis of rotation) can be performed. Moreover, the confirmation of the position of the grinding origin can be performed by taking the images of the work and the grinding stone simultaneously with the camera.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a profile grinding machine according to one mode of embodiment of the invention.

FIGS. **2**A to **2**C are individually perspective view of a work to be ground by the profile grinding machine.

FIG. **3** is a perspective view of a turning mechanism, which is disposed in a grinding stone unit of the same profile grinding machine.

FIG. **4** is a perspective view of an image pickup mechanism of the same profile grinding machine.

FIG. **5** is a perspective view showing the situation, in which the work is ground in its face inclined in a vertical direction by the same profile grinding machine.

FIG. **6** is a top plan view showing, the situation, in which the work is ground in its face inclined in a vertical direction by the same profile grinding machine.

FIG. **7** is an explanatory diagram showing the locus of the leading end portion of a grinding stone at the working time when a profile grinding machine according to an example of the prior art is used.

FIG. **8**A is an explanatory diagram showing a discrepancy between the position of the turning center axis of a grinding stone head and the center position of the leading end portion of a grinding stone in a profile grinding machine according to an example of the prior art, FIG. **8**B is an explanatory diagram showing the movement of the center of the leading end portion of the grinding stone at the time when the grinding stone head is turned, and FIG. **8**C is an explanatory diagram showing the situation, in which the grinding stone is brought to collide against the other side of the recess by the turn of the grinding stone head.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Subsequently, the invention is described on its mode of embodiment with reference to the accompanying drawings so that it may be understood.

Here, FIG. **1** is a perspective view of a profile grinding machine according to one mode of embodiment of the invention; FIGS. **2**A to **2**C are perspective view of a work to be ground by the profile grinding machine; FIG. **3** is a perspective view of a turning mechanism, which is disposed in a grinding stone unit of the same profile grinding machine; FIG. **4** is a perspective view of an image pickup mechanism of the same profile grinding machine; FIG. **5** is a perspective view showing the situation, in which the work is ground on its face inclined in a vertical direction by the same profile grinding machine; and FIG. **6** is a top plan view showing the situation, in which the work is ground on its face inclined in a vertical direction by the same profile grinding machine.

As shown in FIG. **1**, a profile grinding machine **10** includes: a base **11** installed in position; a work unit **14** having a work table **13** disposed on one side on the base **11** for gripping a work **12**; a stone unit **17** disposed on the other side on the base **11** for holding and rotating a grinding stone **15** on its axis; and an image pickup mechanism **19** having a camera **18** for picking up the images of the work unit **14** and the stone unit **17** downward. The profile grinding machine **10** is described in detail in the following.

The base **11** includes a base structure **21** made of a highly rigid material such as cast iron and having a flat face **20** on its upper portion, and a plurality of leg members **22** attached to the lower portion of the base structure **21** and having adjustable heights. As a result, the flat face **20** of the base structure **21** can be brought into a horizontal state by adjusting the heights of the individual leg members **22** according to the levels of the place of installation.

The work table **13** includes: a work fixing bed **23** such as a magnet chuck for gripping the work **12** directly; a first work bed **24** for supporting the work fixing bed **23**; a second work bed **25** for supporting the first work bed **24** in a manner to rotate at a fine angle in a horizontal plane (i.e., in a plane parallel to the flat face **20** of the base structure **21**; and a third work bed **26** for supporting the second work bed **25**. With this constitution, the work fixing bed **23** can be rotated at the fine

angle through the first work bed **24** so that the position of the work **12** attached to the work fixing bed **23** can be finely adjusted.

The work unit **14** is provided with a third moving device **31** including: a mounting bed **27** for fixing the base side of the third work bed **26** of the work table **13**; a Z-direction carriage **29** adapted to move back and forth on a pair of Z-direction rails **28** attached to the back side of the mounting bed **27** and arranged in parallel with a Z-direction normal to the horizontal face; and a Z-axis column **30** for supporting the Z-direction rails **28**. The work unit **14** is further provided with: a first moving device **36** including a column bed **32** for mounting the Z-axis column **30**, an X-direction carriage **34** adapted to move back and forth on a pair of X-direction rails **33** attached to the back side (or the lower face side) of the column bed **32** and arranged in parallel with the X-direction of the horizontal face, and an X-axis column **35** for supporting the X-direction rails **33**; and a second moving device (**39**) including a Y-direction including a Y-direction carriage **38** adapted to move back and forth on a pair of Y-direction rails **37** attached to the back side (or the lower face side) of the X-axis column **35** and arranged on one side on the flat face **20** of the base structure **21**, e.g., in parallel with the Y-direction perpendicular to the X-direction.

With this constitution, the work **12** can be moved back and forth in the Z-direction through the work table **13** by moving the mounting bed **27** back and forth in the Z-direction. Moreover, the X-direction carriage **34** can be moved back and forth in the Y-direction by moving the Y-direction carriage **3** back and forth in the Y-direction, and the mounting bed **27** can be moved back and forth in the X-direction by moving the X-direction carriage **34** back and forth in the X-direction. As a result, the work **12** can be moved in the X-direction and in the Y-direction in synchronism with the movement of the work **12** gripped on the work table **13**, by moving the Y-direction carriage **38** and the X-direction carriage **34**, respectively, in the Y-direction and in the X-direction while moving the mounting bed **27** back and forth in the Z-direction.

As shown in FIGS. **1**, **3** and **4**, the stone rotating mechanism **16** is provided with an electric motor **42**, which has a spindle **41** fitted in the mounting hole of a mounting member **40** (as referred to FIG. **6**) disposed at the center portion of the grinding stone **15** and connected to the mounting member **40**, and a stone cover **43**, which is attached to the electric motor **42** for covering the grinding stone **15** connected to the spindle **41**. In the stone cover **43**, moreover, there is disposed a not-shown nozzle, which is disposed close to but separately of the profile grinding machine **10** for feeding a grinding liquid fed from a not-shown grinding liquid feeder, to the leading end portion of the grinding stone **15**.

The stone unit **17** is provided with: a fourth moving device **47** including a mounting bed **44** for mounting the electric motor **42** of the stone rotating mechanism **16**, and a U-direction carriage **46** adapted to move back and forth on a pair of U-direction rails **45** attached to the back side of the mounting bed **44** and arranged in parallel with the U-direction (parallel to the X-direction in FIG. **1**); a fifth moving device **52** a U-direction rail supporting bed **48** for supporting the U-direction rails **45**, a V-direction carriage **50** adapted to move back and forth on a pair of V-direction rails **49** attached to the back side of the Y-direction rail supporting bed **48** and arranged on a horizontal plane, e.g., in parallel with the V-direction (parallel to the Y-direction in FIG. **1**) perpendicular to the U-direction, and a V-direction rail supporting bed **51** for supporting the V-direction rails **49**; and a turning mechanism **54** including a rotating table **53** mounting the V-direction rail supporting bed **51** for rotating about the rotation axis P normal to the flat face **20** of the base **11**, and a table cover **53**a for covering the side portion of the rotating table **53**. Moreover, the turning mechanism **54** is attached to one side of a rotating table platform **55** fixed on the other side of the flat face **20** of the base **11**.

With this constitution, when the rotating table **53** is rotated, the stone rotating mechanism **16** turns on the rotation axis P of the rotating table **53** so that the grinding stone **15** also turns on the rotation axis P of the rotating table **53**. By moving the mounting bed **44** and the U-direction rail supporting bed **48** respectively in the U-direction and in the V-direction, moreover, the stone rotating mechanism **16** attached to the mounting bed **44** can be moved to an arbitrary position in a horizontal plane over the rotating table **53**. By adjusting the individual moving strokes of the mounting bed **44** and the U-direction rail supporting bed **48**, moreover, the center position of the leading end portion of the grinding stone **15** can be substantially aligned with the rotation axis P of the rotating table **53**. As a result, even when the rotating table **53** is rotated, the center of the leading end portion of the grinding stone **15** can be only rotated but not turned on the rotation axis P of the rotating table **53**.

The image pickup mechanism **19** includes: a camera post **56** erected on the other side above the rotating table platform **55** in parallel with the same direction as the Z-direction and arranged to have its leading portion at a position above the stone rotating mechanism **16**; a camera supporting member **58** attached to the leading portion of the camera post **56** in the same direction as the Y-direction (or the V-direction); and the camera (e.g., a video camera having an image pickup element of a CCD and having a zooming function) **18** fixed on a camera mounting portion **57**. The image pickup mechanism **19** further includes a camera illuminator **59** (e.g., an illuminating having a light source of a highly luminous light emitting diode) mounted on the V-direction rail supporting bed **51**, for example, at the imaging time). The image pickup mechanism **19** further includes a (not-shown) display for displaying the image taken by the camera **18**, thereby to perform the work position confirmation before the grounding operation, the work shape confirmation after the grinding operation, the confirmation of the leading end shape of the grinding stone, the confirmation of the grinding stone position, and the confirmation of the position of the grinding origin.

Here, the profile grinding machine **10** has a manual control function to move the mounting bed **27**, the U-direction carriage **38** and the X-direction carriage **34** manually back and forth respectively in the Z-direction, in the Y-direction and in the X-direction thereby to rotate the rotating table **53** manually on the rotation axis P, and is provided with a not-shown numerical control device for moving the mounting bed **27**, the Y-direction carriage **38** and the X-direction carriage **34** automatically back and forth by predetermined distances respectively in the Z-direction, in the Y-direction and in the X-direction, and for rotating the rotating table **53** automatically by a preset angle on the rotation axis P thereof. As a result, when a grinding program is created on the basis of a preset drawing and inputted to the numerical control device, the operation to grind the work **12** gripped by the work table **13** can be automatically performed.

Here is described a grinding method of the case, in which ground faces inclined at a constant angle with respect to a vertical direction are formed all at once by a single grinding operation, in the individual inner faces of a recess **61** made open in the side face of the work **12**, as shown in different perspective directions in FIGS. **2**A to **2**C.

First of all, the grinding program for the numerical control device of the profile grinding machine **10** is created on the

basis of design drawings. Here, the work **12** has a mounting reference plane formed in advance to provide a reference at the time when it is mounted on the work fixing bed **23**. By fitting the mounting reference plane to the stationary reference plane of the work fixing bed **23**, the mounting direction and the mounting position of the work attached to the work fixing bed **23** can be determined with respect to the origin of the profile grinding machine **10**.

Next, the mounting bed **44** and the U-direction rail supporting bed **48** are moved back and forth respectively in the U-direction and the V-direction thereby to align the center position of the leading end portion of the grinding stone **15** of the stone rotating mechanism **16** attached to the mounting bed **44**, with the rotation axis P of the rotating table **53**. At this time, the rotating table **53** is rotated, as shown in FIG. **3**, and the state at this time is taken by the camera **18** and displayed in the display, as shown in FIG. **4**, thereby to confirm it when the rotating table **53** is rotated that the center position of the leading end portion of the grinding stone **15** is not offset from the rotation axis P of the rotating table **53**.

When the operation to align the center position of the leading end portion of the grinding stone **15** and the position of the rotation axis P of the rotating table **53** is ended, the mounting bed **27**, the Y-direction carriage **38** and the X-direction carriage are moved by the manual operations, respectively in the Z-direction, in the Y-direction and in the X-direction, the work fixing bed **23** is rotated by a fine angle through the first work bed **24** thereby to adjust the position of the work **12** attached to the work fixing bed **23**, finely so that the grinding starting point of the work **12** is adjusted to the grinding original position set on the grinding program. By taking the images of the grinding starting point of the work **12** and the leading end portion of the grinding stone simultaneously with the camera and displaying them in the display, it can be confirmed from the qualitative positional relation between the grinding starting point of the work **12** and the leading end portion of the grinding stone whether or not the grinding starting point of the work **12** is aligned with the grinding original position set on the grinding program.

When the alignment of the grinding original position is ended, the grinding starting switch of the numerical control device is turned ON. Then, the depth of cut of the grinding stone **15** is started from the upper face side of the work **15**, for example, so that the grinding operation to extract the grinding stone **15** from the back side (or the lower face side) of the work **12** is started from one side to the other side of the recess **61**. Here, the ground situation and the confirmation of the shape of the work **12** can be performed on the spot by taking the state of the work **12** being or after ground and by displaying it in the display.

Here, by moving the Y-direction carriage **38** and the X-direction carriage **34** back and forth, respectively, in the Y-direction and in the X-direction while moving the mounting bed **27** back and forth, the work **12** can be moved in the X-direction and in the Y-direction in synchronism with the Z-direction movement of the work **12** gripped on the work table **13**. Therefore, the grinding quantities of the lower face sides (or the sides, which the grinding stone leaves) of corner areas M and N of the recess **61**, in which two adjoining faces intersect, can be adjusted to the designed quantity, thereby to form such ground faces on the individual inner faces of the recess **61** as are homogeneously inclined with respect to the vertical direction.

As the grinding stone **15** moves from one side to the other side of the recess **61**, as shown in FIGS. **5** and **6**, the rotating table **53** is rotated to turn the stone rotating mechanism **16** gradually. However, the position of the rotation axis P of the rotating table **53** and the center position of the leading end portion of the grinding stone **15** are substantially match each other. Even by rotating the rotating table **53**, therefore, the grinding stone **15** is not turned while the contacting position of its leading end with the work **12** being moved only along the outer circumference of the leading end of the grinding stone **15**. As a result, even if the rotating table **53** is rotated with the grinding stone **15** being close to the other side of the recess **61** of the work **12**, it can be prevented from contacting with the other side of the recess **61** thereby to grind the recess **61** of the work **12** from one side to the other at one time, i.e., with one stroke.

Although the invention has been described in connection with its embodiment, it should not be limited in the least to the constitution described in the foregoing mode of embodiment but contains not only other modes of embodiment, as conceived within the range of the disclosure of claims, but also its modifications.

For example, the second moving device for moving the work table in the Y-direction is disposed above the base, and the first moving device for moving the work table in the X-direction is disposed on the second moving device. It is, however, arbitrary to interchange the first moving device and the second moving device. The fifth moving device for moving the stone rotating mechanism in the V-direction is disposed on the rotating table, and the fourth moving device for moving the stone rotating mechanism in the U-direction is disposed on the fifth moving device. It is, however, arbitrary to interchange the first moving device and the second moving device. It is, however, arbitrary to interchange the fifth moving device and the fourth moving device. Moreover, the U-direction and the V-direction are aligned with the X-direction and the Y-direction, respectively, but this alignment may not be made. Moreover, the U-direction and the V-direction, and the X-direction and the Y-direction are made perpendicular, respectively, in the horizontal plane, but may intersect at an arbitrary angle other than 90 degrees.

On the other hand, the recess of the work is ground from its one side to the other by the single operation. In case the recess has a complicated shape, for example, the grinding operation may also be performed by dividing the recess into a plurality of grinding areas to confirm the shape of the ground faces of the individual grinding areas.

What is claimed is:

1. A profile grinding machine comprising:

a base;

a work unit disposed on one side on the base and including a work table for gripping a work; and

a stone unit disposed on another side on the base and including a stone rotating mechanism for holding and rotating a grinding stone about *an* axis thereof,

wherein the work unit includes first, second and third moving devices for supporting and moving the work table in an X-direction and a Y-direction intersecting with each other in a horizontal plane, and in a Z-direction normal to the horizontal plane, respectively;

the stone unit includes a turning mechanism capable of turning the grinding stone about a vertical axis substantially coinciding with a leading end portion of the grinding stone, and the turning mechanism comprising*:* a rotatable table having a rotational axis *and fourth and fifth moving devices, the rotatable table being disposed above the base for rotating about the rotational axis, and the fourth and the fifth moving devices disposed above the rotatable table for supporting and moving the stone*

rotating mechanism in a U-direction and a V-direction, intersecting with each other in the horizontal plane, respectively; and

a numerical controller which controls the first, second and third moving devices in the work unit and the rotatable table in the stone unit,

wherein the numerical controller controls the work unit such that the work is moved in the X-direction and the Y-direction in synchronism with movement of the work in the Z-direction, and

the numerical controller controls the stone unit to *move the stone rotating mechanism to a predetermined position and* rotate the [rotating] *rotatable* table at a predetermined angle on the rotational axis *such that the leading end portion of the grinding stone substantially coincides with the rotational axis of rotatable table*.

[2. The profile grinding machine according to claim 1, wherein the turning mechanism includes a rotating table disposed above the base for rotating about a rotation axis of the turning mechanism, and fourth and fifth moving devices disposed above the rotating table for supporting and moving the stone rotating mechanism in a U-direction and a V-direction intersecting with each other in the horizontal plane respectively.]

3. The profile grinding machine according to claim 1, further comprising an image pickup mechanism including a camera disposed above the base for taking an image of the work unit and the stone unit.

[4. The profile grinding machine according to claim 1, wherein the rotational axis substantially coincides with the leading end portion of the grind stone.]

5. The profile grinding machine according to claim 1, wherein the rotational axis extends in the Z-direction.

6. The profile grinding machine according to claim 1, wherein the work table comprises:

a work fixing bed that directly grips the work;

a first work bed that supports the work fixing bed;

a second work bed that supports the first work bed such that the first work bed is rotatable at a fine angle in the horizontal plane;

and a third work bed that supports the second work bed, wherein the work fixing bed is configured to be rotated at the fine angle through the first work bed so that the position of the work is finely adjusted.

7. The profile grinding machine according to claim 6, wherein the third moving device comprises:

a mounting bed that fixes a base side of the third work bed of the work table;

a Z-direction carriage configured to move back and forth in the Z-direction on a pair of Z-direction rails attached to a back side of the mounting bed and arranged parallel to the Z-direction; and a Z-axis column that supports the Z-direction rails in the Z-direction.

8. The profile grinding machine according to claim 7, wherein the first moving device comprises:

a column bed that mounts the Z-axis column;

an X-direction carriage configured to move back and forth in the X-direction on a pair of X-direction rails attached to a back side of the column bed and arranged parallel to the X-direction, and an X-axis column that supports the X-direction rails in the X-direction.

9. The profile grinding machine according to claim 8, wherein the second moving device comprises:

a Y-direction carriage configured to move back and forth in the Y-direction on a pair of Y-direction rails attached to a back side of the X-axis column and arranged on the one side of the base.

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