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(73) Proprietor: **SODICK COMPANY, LTD.**
1-5-1 Shin-Yokohama,
Kohoku-ku
Yokohama, Kanagawa 222 (JP)

(72) Inventor: **Hosaka, Akio**
86-38-4 Tohka Kanazu-cho
Sakai gun, Fukui 919-06 (JP)

(74) Representative: **AMMANN PATENTANWAELTE AG BERN**
Schwarztorstrasse 31
CH-3001 Bern (CH)

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Description

The invention generally relates to electroerosion machines and, more particularly, to wire-cut electric discharge machines which are capable of independent motion in the X and Y axes.

Description of Prior Art

In general, electrical discharges between a workpiece and an electrode remove pieces of the workpiece, thereby resulting in the cutting of the workpiece. In wire-cut electric discharge machines, a generally vertically extending wire is used as the electrode and as it moves relative to the workpiece, a contour is cut in the workpiece. The operation of machining using wire-cut electroerosion machine may be analogized with the cutting that occurs using a blade in a jigsaw or bandsaw as it cuts a contour in a workpiece.

A conventional EDM machine, such as the one depicted in Fig. 1 or the one described in DE-A 3524377, has a double deck construction comprising a saddle 4 and a table 6. The saddle 4 moves relative to the fixed bed 2 in the X-axis and the table 6 moves relative to the saddle 4 in the Y-axis. A machining tank 8 is located on the table 6 and holds a machining fluid. A workpiece 12 is mounted within the machining tank 8 by a mounting table 10.

A wire electrode feeding mechanism 16 is located on a side of a fixed column 14 for dispensing a wire electrode 18 through an upper guide 20, the workpiece 12, a lower guide 22, to a lower arm 24. The upper guide 20 can move not only in the vertical direction, which is the Z-axis, but also in a U-axis and in a V-axis for performing taper cuts. The lower arm 24 is fixed to the column 14 and to a slide plate. The slide plate enables the machining tank 8 to move in the X-axis relative to the lower arm 24 and provides a liquid tight seal between the lower arm 24 and the machining tank 8. Thus, by moving the saddle 4 in the X-axis and the table 6 in the Y-axis, machining of the workpiece may occur in an X-Y plane. Alternatively, the lower arm may instead be L-shaped and extend down from the fixed column 14 into the machining tank 8 without passing through a side of the tank 8.

The double deck arrangement of the saddle 4 and table 6 is suitable only for small light workpieces. As the workpieces become larger and heavier, the machining tank 8 must expand to accommodate the workpieces. Consequently, the saddle 4 and the table 6 must also be enlarged to maintain a full range of motion within the X-Y plane and must be enlarged so that they can support the heavier load.

The machining area is preferably about 1 meter high to enable easy access by an operator. When larger or heavier workpieces are used, the double deck construction must increase in height in order to be able to withstand the heavier load. With a higher operating area, either a platform is needed to allow the operator to access the machining area or some portions of the machine would have to be embedded. In either event, access to the machining area is hindered.

Additionally, when the workpiece is moved to its furthest position on the Y-axis, forward and rear access to the workpiece is hindered. Thus, it is difficult to insert and remove workpieces from the machining tank 8.

Another example of a conventional EDM machine is illustrated in Fig. 2 or described in EP-A 0261547. The EDM machine depicted in Fig. 2 comprises a table 32 that moves a machining tank 34 along a Y-axis over a pair of rails that are affixed to a fixed bed 30. An upper guide 40 and a lower guide 42 are attached to a moving block 38 through an upper arm and lower arm, respectively. The moving block 38 moves along an X-axis on a pair of guide rails that are affixed to a vertical surface of a column 36. The motion in the X-axis is independent of the motion in the Y-axis.

With the EDM machine of Fig. 2, separate mechanisms are provided for moving the workpiece along the X-axis and the upper and lower guides along the Y-axis. This enables the EDM machine to handle larger and heavier loads without increasing the overall size of the machine.

The EDM machine of Fig. 2, however, still inhibits access to the workpiece when it is moved to its further position in the Y-axis. Also, both ends of the machining tank 34 are blocked by the column 36 to further hinder access to the workpiece. Additionally, an automatic pallet changer for automatically changing the workpieces would be difficult to use with the embodiment of Fig. 2. Further, since the moving block 38 was mounted on its side to the column 36, sub-micron accuracy in the machining is difficult to attain.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide an EDM machine which allows for easy access to the workpiece.

It is another object of the present invention to provide an EDM machine which is highly accurate.

It is yet another object of the present invention to provide an EDM machine which provides separate and independent motion along the X-axis and along the Y-axis.

It is still a further object of the present invention to provide an EDM machine in which operabil-

ity is not degraded, when designed to machine large workpieces.

Additional objects, advantages and novel features of the invention will be set forth in part in the description which follows, and in part will become apparent to those skilled in the art upon examination of the following or may be learned by practice of the invention. The objects and advantages of the invention may be realized and attained by means of the instrumentalities and combinations particularly pointed out in the appended claims.

To achieve the foregoing and other objects and in accordance with the purpose of the present invention, as embodied and broadly described herein, an electroerosion machine comprises a table for moving a workpiece along an X-axis and a Y-axis transfer mechanism for moving an upper guide and a lower guide along the Y-axis. The Y-axis transfer mechanism moves on a horizontal planar surface of the column. A wire feed mechanism feeds a wire electrode through the upper guide, workpiece, and then to the lower guide.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated in, and form a part of the specification, illustrate an embodiment of the present invention and, together with the description, serve to explain the principles of the invention. In the drawings:

Fig. 1 illustrates a side view of a conventional wire- cut electric discharge machine;

Fig. 2 illustrates a schematical view of another conventional electric discharge machine;

Fig. 3 illustrates a side view of an embodiment of the present invention;

Fig. 4 illustrates a front view of the embodiment of Fig. 3;

Fig. 5 illustrates a cut-away view of the embodiment of Fig. 3; and

Fig. 6 illustrates a cross-sectional view of the embodiment of Fig. 3.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Reference will now be made in detail to the preferred embodiment of the invention, an example of which is illustrated in the accompanying drawings.

An embodiment of the present invention is illustrated in Figures 3 to 6. An exemplary wire-cut EDM machine according to the present invention includes of a fixed bed 50 upon which a pair of rails 54 are affixed for guiding a table 56 along an X-axis. Preferably, for example, linear bearings and a servo motor may be provided for moving the table 56 along the X-axis. A machining tank 58, preferably having a rectangular shape and an open top end, is attached to the table 56 and has a mounting fixture 62 for holding a workpiece 60. A side wall of the machining tank 58 may be used as a door 64 for accessing the workpiece 60.

A fixed column 66 extends to a height above the machining tank 58 and preferably has a hollow construction as shown in Fig. 5. As best seen in Fig. 3, Y-axis transfer mechanism 68 travels along a guide, for example, a pair of rails 72 on top of a horizontal plane of the column 66 as depicted in Fig. 5. The Y-axis transfer mechanism also includes a moving block 70 which preferably comprises, for example, linear bearings and a servo motor for moving the transfer mechanism along the Y-axis.

With reference to Fig. 4, a wire bobbin 74, located at the forward end of the moving block 70, which also includes a plurality of rollers through which a wire electrode 73 is unwound. A wire feed device 76, also preferably positioned at the forward end of the moving block 70, dispenses the wire electrode to a block 78 which is movable in the Z-axis direction and down through an upper arm 80. The block 78 moves the upper arm 80 and an upper wire guide 82 up and down along the Z-axis. A block 90 (Fig. 3) movable in the U-V plane is located between the upper arm 80 and the moving block 78 and moves the upper arm 80 and upper wire guide 82 in the U-V plane, which is parallel to the X-Y plane, in order to perform taper cuts. An automatic wire threading mechanism 84 may be provided for automatically threading the wire electrode 73.

A lower wire guide 92 receives the wire electrode 73 after it passes through the workpiece 60. From the lower wire guide 92, the wire electrode 73 passes through an L-shaped lower arm 94 (best seen in Fig. 5), which has its upper end integral with the moving block 70 (see Fig. 3). The lower arm 94 passes through an opening 96 in the column 66 before reaching the moving block 70. The lower arm 94 also passes through a second opening 98 in the column 66 and through an opening 106 in a side wall of the machining tank 58 (see Fig. 6). The lower arm 94 and the moving block 70 move along the Y-axis as a single assembly.

As best seen in Fig. 6, section 100 of the lower arm 94 extends from inside the column 66 to the inside of the machining tank 58. The section 100 preferably comprises a hollow outer cylinder 102 with an inner cylinder 104 inserted therein. The inner cylinder 104 extends slightly further inside the machining tank 58 than the outer cylinder 102. The lower wire guide 92 is positioned at the end of the inner cylinder 104 for receiving the wire electrode 73 from the upper wire guide 82. The wire then travels through the inner cylinder 104 to a

take-up mechanism positioned downstream.

The opening 106 on the side wall of the machining tank 58 is wider than the maximum amount of motion along the X-axis so as to not cause any interference with the lower arm 94. As shown in Fig. 6, a slide plate 110, preferably formed of stainless steel, is attached to the fixed column 66 through a support 108. The slide plate 110 is also slidable relative to the machining tank 58 through a liquid-tight seal 112. The seal 112 and slide plate 110 enable the lower arm 94 to move along the X-axis in a sealed relationship with the machining tank 58.

Bellows 114, preferably made of compound rubber, extend from the tip of the outer cylinder 102 to the slide plate 110 to provide a liquid-tight seal therebetween. The bellows 114 seal an opening 113 between the outer cylinder 102 and the slide plate 110 and allow the lower arm unit to move along the Y-axis while preventing the machining fluid from draining out of the machining tank 58.

In operation, the wire electrode 73 is dispensed from the wire electrode feeder 76 through the automatic wire threader to the upper guide 82, through the workpiece 60, lower guide 92, down through the inner cylinder 104 of the lower arm 94, and then discharged outside of the machine.

To perform cuts along the X-axis, the table 56, having the machining tank 58 with the workpiece 60 mounted inside, is moved on a pair of rails 54 along the X-axis. The slide plate 110 and seal 112 enable movement along the X-axis in a sealed arrangement with the machining tank 58. To perform cuts along the Y-axis, the moving block 70 is movable along a pair of rails 72 which run parallel to the Y-axis. The upper arm 80, together with the upper wire guide 82, and the lower arm 94, together with the lower wire guide 92, move as a unit along the Y-axis together with the moving block 70. The contraction and expansion of the bellows 114 enable the lower arm 94 to move along the Y-axis in a sealed arrangement with the machining tank 58.

The distance between the upper wire guide 82 and the lower wire guide 92 is adjustable by means of the moving block 78, which moves the upper wire guide 82 up or down in the Z-axis. By moving the upper wire guide 82 in the U-V plane without moving the lower wire guide 92, the moving block 90 enables the EDM machine to perform taper/cuts.

In practice, machining will be accomplished by combinations of all types of motions. With the present invention, the machining tank 58 moves only along the X-axis and the wire electrode 73 is independently moved along the Y-axis. Together these movements define relative movement between the wire electrode and workpiece in the X-Y plane. The single deck construction of the invention, as opposed to the double deck construction of Fig. 1, reduces the need to expand the machine's size with larger and heavier workpieces. The single deck construction also reduces the height of the machine and therefore reduces the need for a platform or for any embedding of the machine. Even when the workpiece is moved to its furthest position along the Y-axis, the operator may still easily access the workpiece.

The invention uses a moving block 70 which moves along a pair of rails 72 and which are placed on a horizontal plane of the column 66. This is in contrast to the conventional design of Fig. 2 which places the rails onto a vertical surface of the column. By placing the rails on a horizontal surface, rattling of the moving block 70 is eliminated and the machining accuracy is improved. Also, since the column 66 is positioned generally behind the machining tank 58 and since the upper and lower guides, 82 and 92, respectively, are disposed within the column, both sides of the machining tank 58 are easily accessible and available, for example, for use with an automatic pallet changer.

The foregoing description of a preferred embodiment of the invention has been presented for purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise form disclosed, and obviously many modifications and variations are possible in light of the above teaching. For example, the lower arm may be L-shaped and need not pass through a side wall of the machining tank 58. Also, instead of moving the machining tank 58 along the X-axis, a linear guide may be located between the upper and lower stages of the column for providing motion along the X-axis. The embodiment was chosen and described in order to best explain the principles of the invention and its practical application to thereby enable others skilled in the art to best utilize the invention in various embodiments and with various modifications as are suited to the particular use contemplated. The scope of the invention is only limited by the claims appended hereto.

Claims

1. An electric discharge machine having a worktable (56) for supporting a workpiece (60), said worktable (56) being movable in the direction of a first axis, a wire electrode (73) extending in a direction generally orthogonal with respect to said worktable (56) and moveable in the direction of a second axis orthogonal to said first axis and the Longitudinal axis of said wire electrode (73), said first axis and said second

axis defining a plane in which a contour is cut in said workpiece (60) by said wire electrode (73), said wire electrode (73) extending between an upper support (80, 82) and a lower support (92, 94), a column (66) for supporting said upper support (80, 82) and said lower support (92, 94), wherein said column (66) includes a planar surface disposed parallel to said plane and having means (72) for guiding said upper and lower supports in a direction parallel to said second axis.

2. An electric discharge machine as set forth in claim 1, wherein a pair of rails (72) are located on said planar surface for guiding said upper support (80, 82) and said lower support (92, 94) as an integral unit along said second axis.

3. An electric discharge machine as set forth in claim 1, wherein said lower support (92, 94) is partially disposed within said column (66).

Patentansprüche

1. Funkenerosionsmaschine, gekennzeichnet durch einen Arbeitstisch (56), auf dem ein Werkstück (60) aufliegt, wobei der Arbeitstisch (56) in Richtung einer ersten Achse beweglich ist, eine Drahtelektrode, die in einer zum Arbeitstisch (56) allgemein senkrecht stehenden Richtung angeordnet und in Richtung einer zweiten, zur genannten ersten Achse und zur Längsachse der Drahtelektrode senkrecht stehenden Achse beweglich ist, wobei die erste und die zweite Achse eine Ebene definieren, in welcher mit der Drahtelektrode (73) eine Kontur im Werkstück (60) ausgeschnitten wird, und die Drahtelektrode (73) zwischen einem oberen Träger (80, 82) und einem unteren Träger (92, 94) verläuft, eine Säule (66), an welcher der obere Träger (80, 82) und der untere Träger (92, 94) befestigt sind, wobei die Säule (66) eine ebene Fläche aufweist, die parallel zur genannten Ebene verläuft und Mittel (22) zur Führung des oberen und unteren Trägers in einer parallel zur zweiten Achse liegenden Richtung aufweist.

2. Funkenerosionsmaschine nach Anspruch 1, dadurch gekennzeichnet, dass die ebene Fläche ein Schienenpaar (72) zur Führung des oberen (80, 82) und unteren (92, 94) Trägers als integrale Einheit in der zweiten Achse aufweist.

3. Funkenerosionsmaschine nach Anspruch 1, dadurch gekennzeichnet, dass der untere Träger (92, 94) teilweise innerhalb der Säule (66) liegt.

Revendications

1. Machine d'usinage par électroérosion, caractérisée par une table de travail (56) soutenant une pièce à usiner (60), ladite table de travail (56) étant déplaçable dans la direction d'un premier axe, par un fil-électrode (73) s'étendant dans une direction généralement orthogonale par rapport à ladite table de travail (56) et déplaçable en direction d'un deuxième axe orthogonal audit premier axe et à l'axe longitudinal du fil-électrode (73), le premier axe et le deuxième axe définissant un plan dans lequel un contour est découpé dans la pièce à usiner (60) par le fil-électrode (73), le fil-électrode (73) s'étendant entre un support supérieur (80, 82) et un support inférieur (92, 94), par une colonne (66) soutenant ledit support supérieur (80, 82) et ledit support inférieur (92, 94), ladite colonne (66) présentant und surface plane disposée parallèlement audit plan et comprenant des moyens (72) pour guider lesdits supports supérieur et inférieur dans une direction parallèle audit deuxième axe.

2. Machine d'usinage par électroérosion selon la revendication 1, caractérisée en ce qu'une paire de rails (72) est disposée sur ladite surface plane afin de guider le support supérieur (80, 82) et le support inférieur (92, 94) le long dudit deuxième axe en tant qu'unité intégrale.

3. Machine d'usinage par électroérosion selon la revendication 1, caractérisée en ce que le support inférieur (92, 94) est partiellement disposé à l'intérieur de la colonne (66).

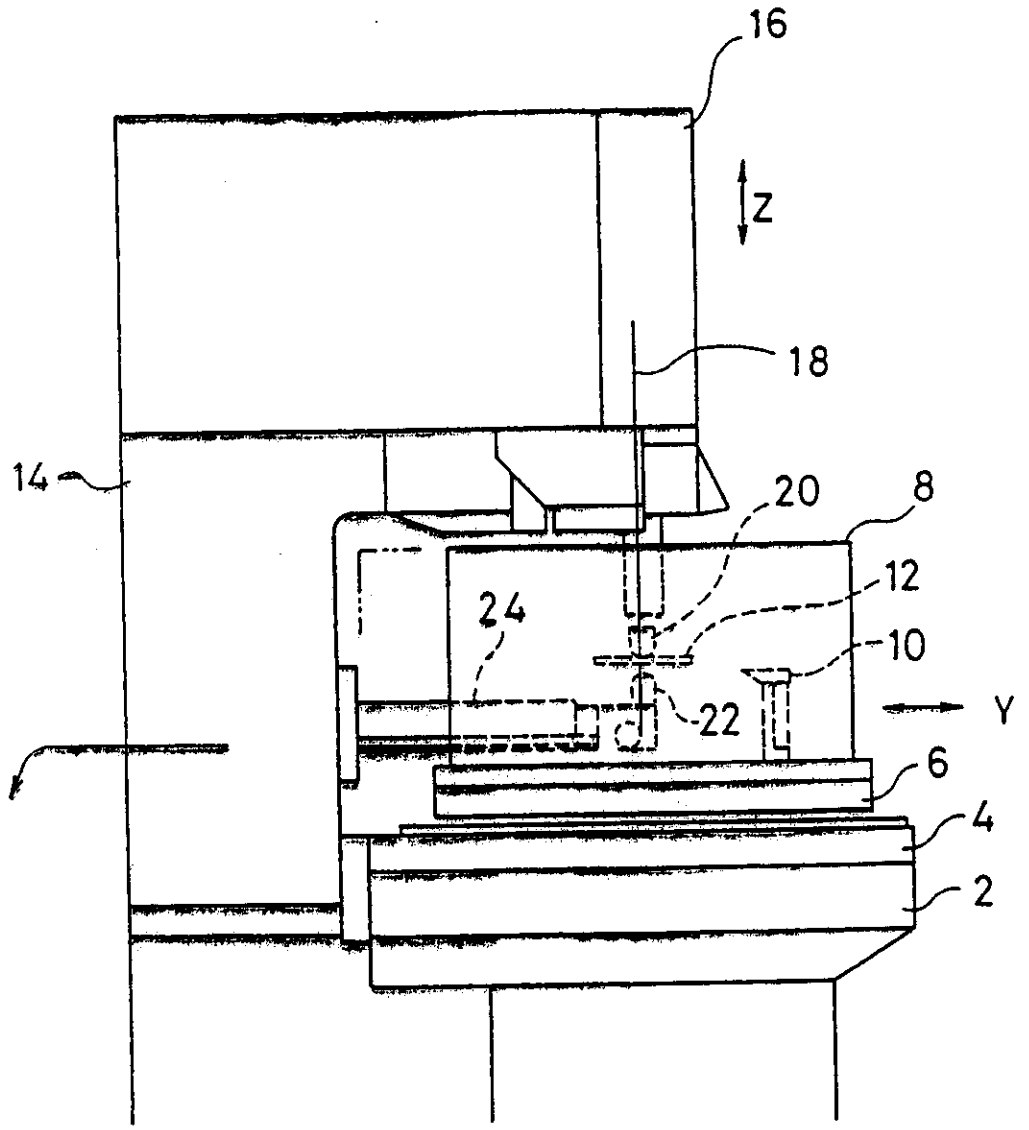

FIG. 1

(PRIOR ART)

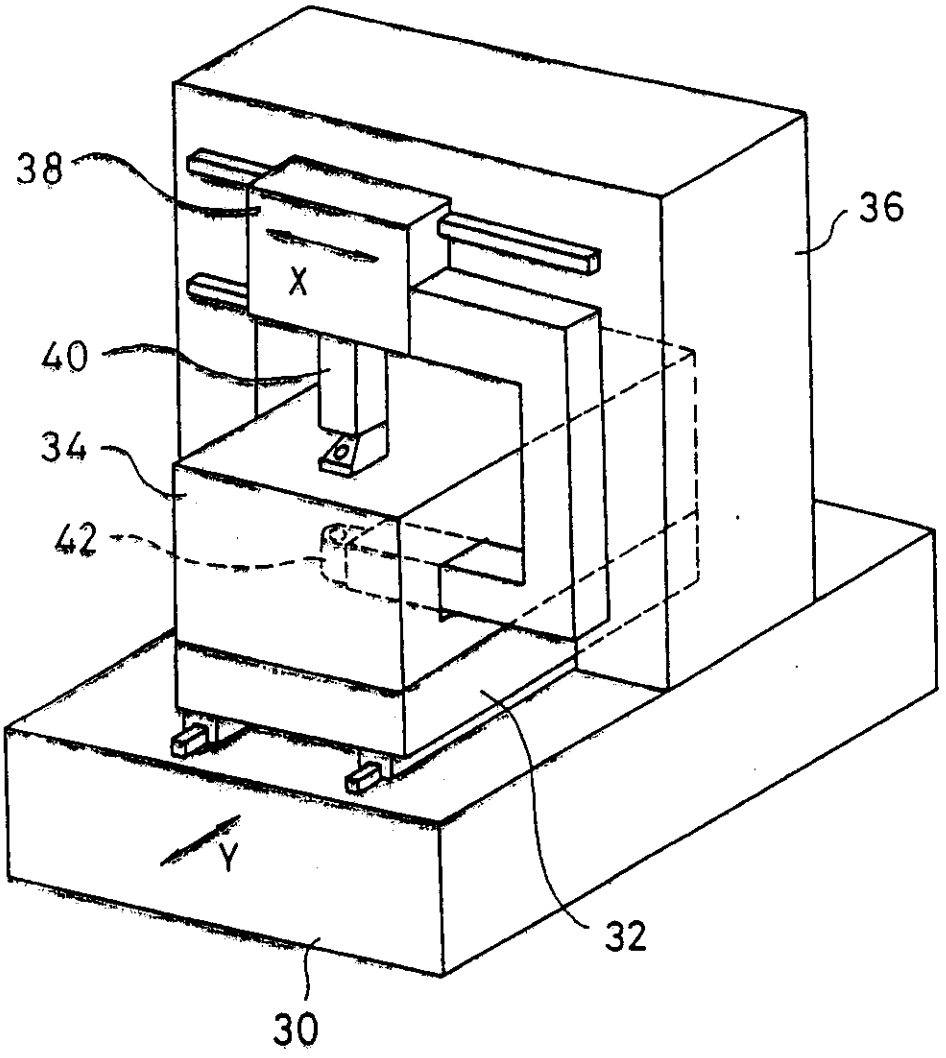

FIG. 2
(PRIOR ART)

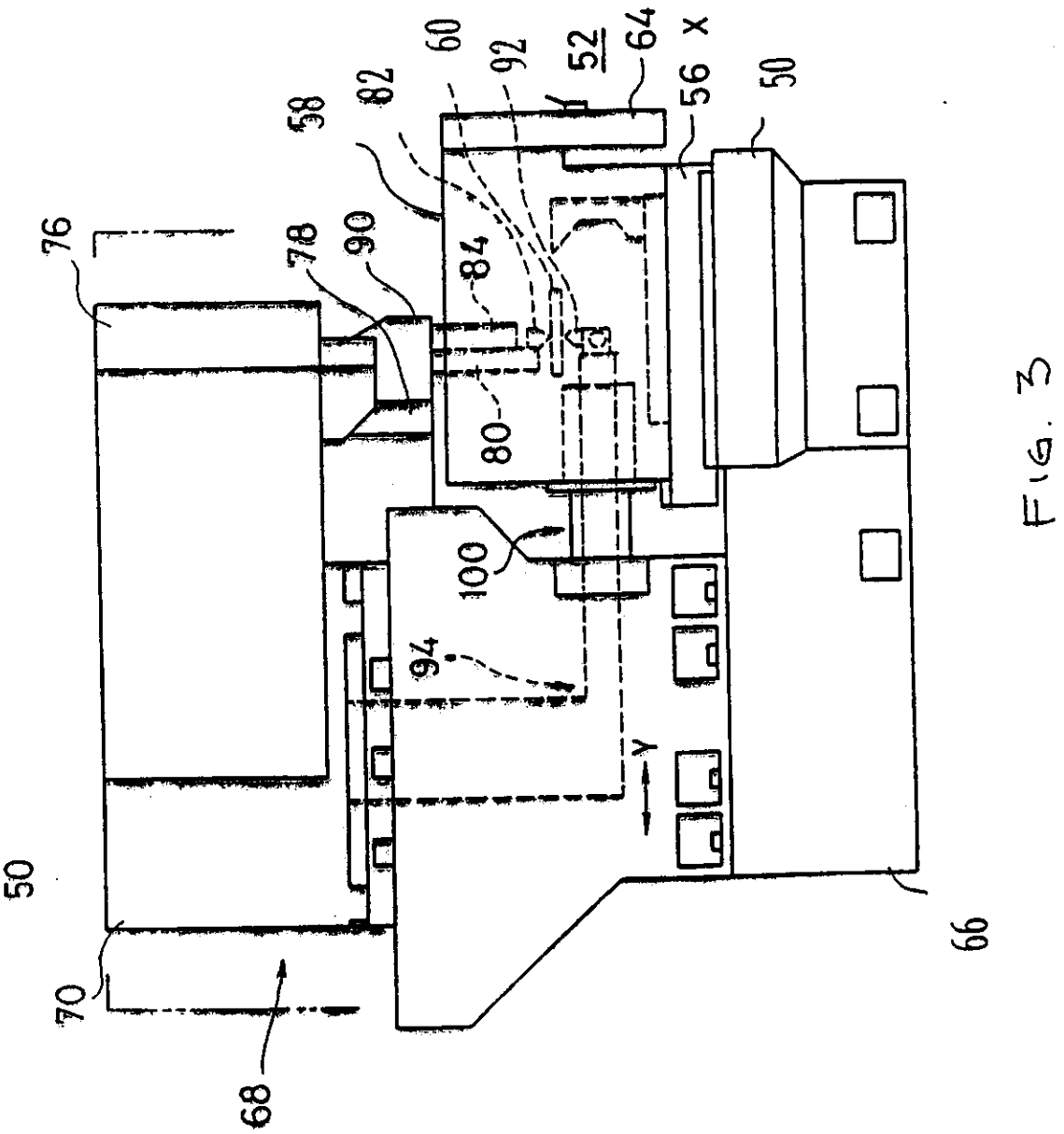

Fig. 3

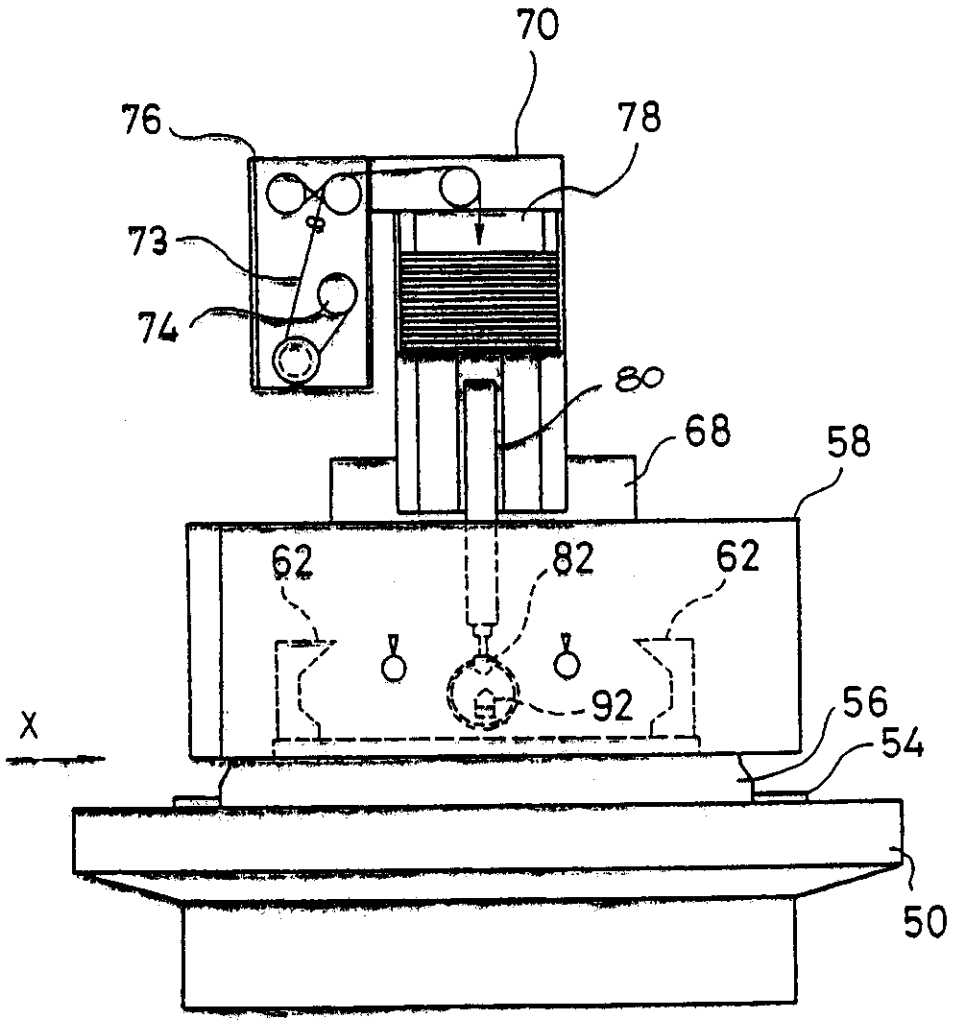

FIG. 4

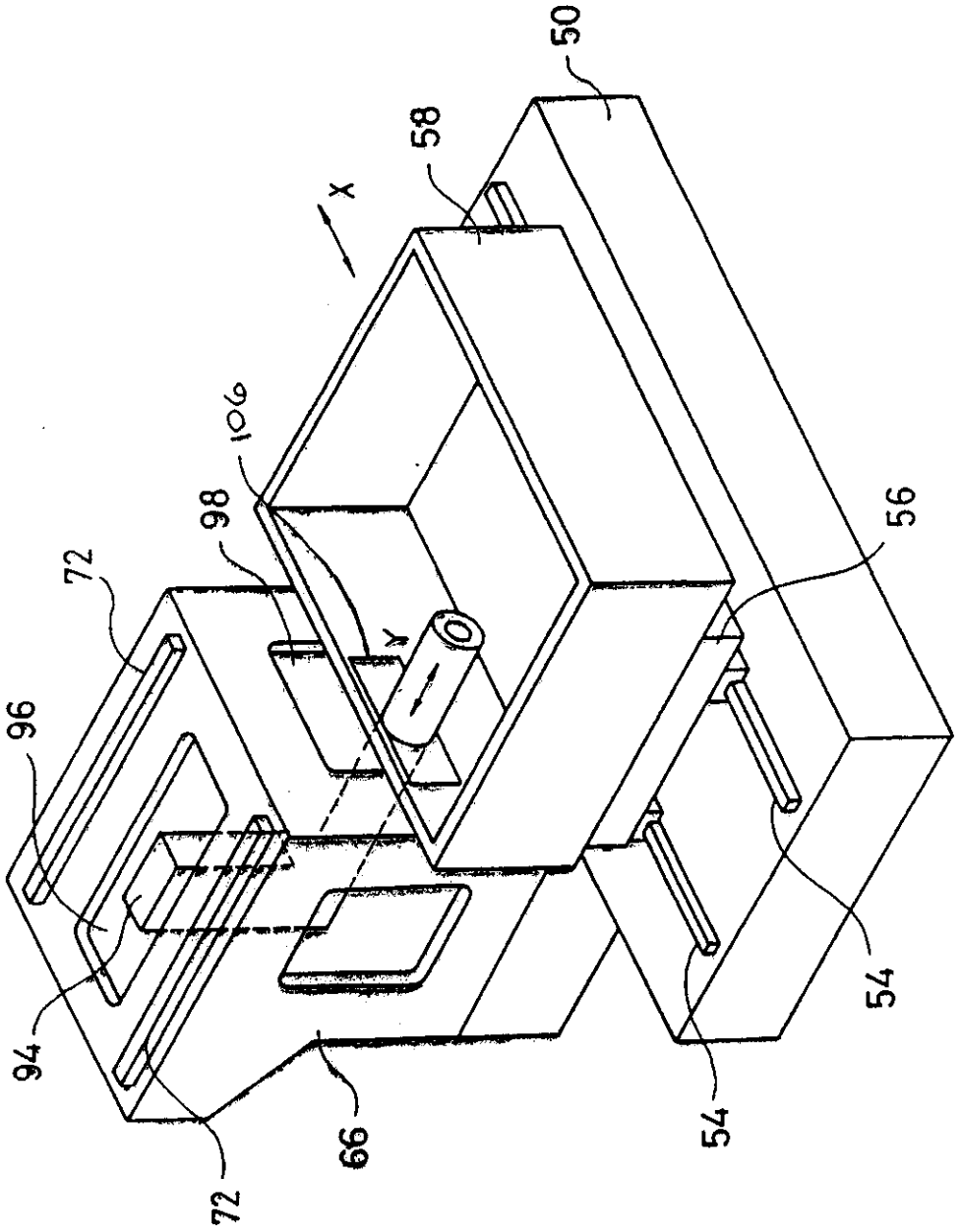

FIG. 5

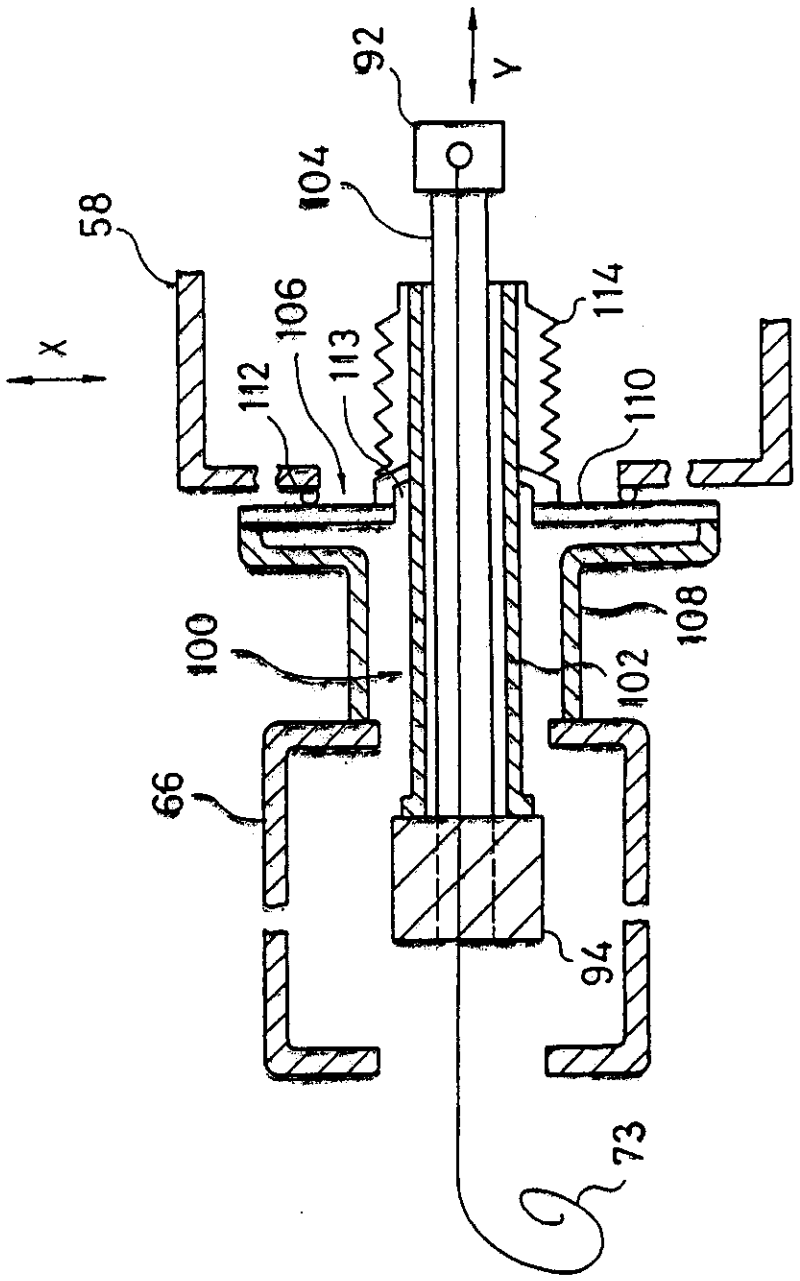

FIG. 6

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Applicant/Proprietor
SODICK COMPANY, LTD., 1-5-1 Shin-Yokohama, Kohoku-ku, Yokohama, Kanagawa 222, Japan [ADP No. 60069952001]

Inventor
AKIO HOSAKA, 86-38-4 Tohka Kanazu-cho, Sakai gun, Fukui 919-06, Japan [ADP No. 60185485001]

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Address for Service
STEVENS, HEWLETT & PERKINS, 1 St Augustine's Place, BRISTOL, BS1 4UD, United Kingdom [ADP No. 00001545002]

EPO Representative
AMMANN PATENTANWAELTE AG BERN, Schwarztorstrasse 31, CH-3001 Bern, Switzerland [ADP No. 58223603001]

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PROPRIETOR(S)

SODICK COMPANY, LTD., 1-5-1 Shin-Yokohama, Kohoku-ku, Yokohama, Kanagawa 222, Japan

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