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(54) **EMBROIDERY MACHINE**

(57) In a head group comprising two or more machine heads (3, 4) provided in proximity to each other so that each of the machine heads can perform embroidery sewing on an embroidering area of an embroidery frame on which a cylindrically-shaped embroidering workpiece is set, at least one of the machine heads is a multi-needle machine head (3). There are also provided a color change mechanism (20) for selectively positioning a desired needle at a predetermined operating position in the

multi-needle machine head, a rotary hook bed (5) provided for each of the head group for shared use between the machine heads, and a horizontal movement mechanism (30) for disposing the individual machine heads and the color change mechanism for horizontal movement relative to the rotary hook beds and horizontally moving the individual machine heads and the color change mechanism together to place any one of the machine heads in each of the head groups in positional correspondence to the rotary hook bed.

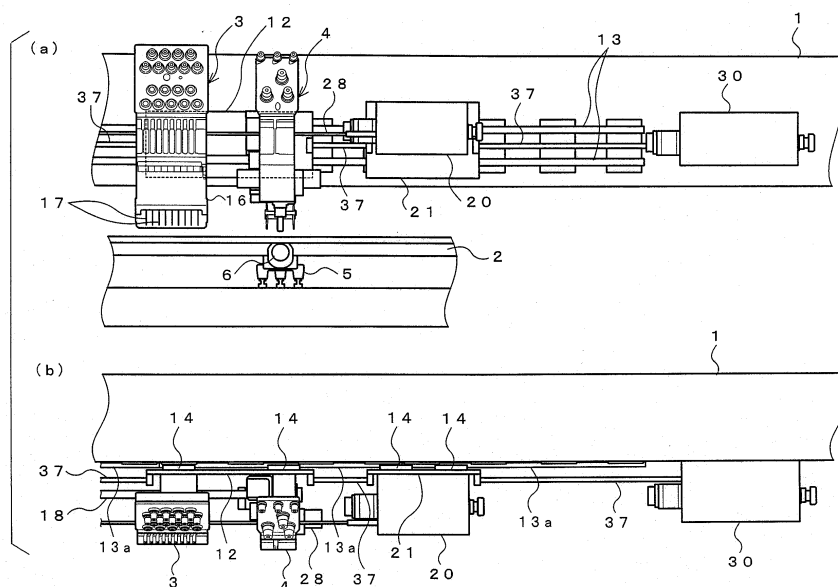


FIG. 4

## Description

### Technical Field

**[0001]** The present invention relates to embroidery sewing machines for performing sewing on cylindrically-shaped embroidering workpieces, such as bodies of sweaters and T-shirts.

### Background Art

**[0002]** In embroidering the body of a T-shirt, for example, it is necessary to position a cylindrical rotary hook bed, having a rotary hook provided therein, inside the cylindrically-shaped body set on an embroidery frame. One example of such a construction is disclosed in Japanese Utility Model Publication No. HEI-1-11751. When a shirt is set on the embroidery frame with the shirt's front body positioned over the upper surface of the rotary hook bed, as clear from the No. HEI-1-11751 publication, the shirt's back body hangs from the periphery of the embroidery frame down the rotary hook bed. Further, with the fashion individualization trends in recent years, there has been an increasing demand for so-called "combination embroideries" in the embroidery industry as well. Examples of the combination embroideries include a combination of an ordinary multi-color embroidery and a decorative embroidery made by sewing of a tape, string or other material, and an operation for making such combination embroideries is performed today by a dedicated combination-embroidery sewing machine provided with two different types of machine heads intended for multi-color embroidering and decorative embroidering.

**[0003]** Although combination embroidery can be performed by a single embroidery sewing machine as long as it is dedicated to combination-embroidery, there has so far been no combination-embroidery sewing machine capable of embroidering a cylindrically-shaped embroidering workpiece, for the following reasons. Namely, in order to embroider a cylindrically-shaped embroidering workpiece, it is necessary to position the rotary hook bed inside the cylindrically-shaped embroidering workpiece, as noted above. Thus, in order to embroider such a cylindrically-shaped embroidering workpiece using two types of machine heads, it is necessary to position two cylindrical rotary hook beds, corresponding to the two machine heads, inside the cylindrically-shaped embroidering workpiece. Therefore, there would be encountered not only the inconvenience that kinds of embroidering workpieces that can be embroidered tend to be limited, but also the inconvenience that, even with an embroiderable embroidering workpiece, a sufficient embroidering area can not be secured unless the hanging-down portion of the workpiece has a sufficient margin. One possible approach for avoiding the above inconveniences is to position only one of the hook bed, corresponding to the machine head to be next used for embroidering, inside the embroidering workpiece; however,

when the other machine head is to be next used for embroidering after completion of embroidery by the one machine head, it is necessary to deactivate the embroidery sewing machine to detach and re-attach the embroidery frame in order to switch the rotary hook bed that is to be positioned inside the embroidering workpiece, which would inevitably require extra labor and time. In addition, there are possibilities of part of the embroidering workpiece, hanging down the rotary hook bed, interfering with the rotary hook bed and being stained or impaired. For the foregoing reasons, none of the conventionally-known embroidery sewing machines can not perform combination embroidery by itself.

### 15 Disclosure of the Invention

**[0004]** In view of the foregoing, it is an object of the present invention to provide an embroidery sewing machine which can smoothly perform, without any problem, combination embroidery on a cylindrically-shaped embroidering workpiece using a plurality of types of machine heads.

**[0005]** In order to accomplish the above-mentioned object, the present invention provides an improved embroidery sewing machine for a cylindrically-shaped embroidering workpiece, which comprises: a head group comprising two or more machine heads disposed in proximity to each other so that each of the machine heads can perform embroidery sewing on an embroidering area of an embroidery frame on which the cylindrically-shaped embroidering workpiece is set, at least one of the two or more machine heads being a multi-needle machine head having a plurality of needles; a color change mechanism for selectively positioning a desired one of the needles at a predetermined operating position in the multi-needle machine head; a rotary hook bed provided for each of the head group for shared use between the machine heads in the head group and corresponding to one embroidering workpiece; and a horizontal movement mechanism for disposing individual ones of the machine heads and the color change mechanism for horizontal movement relative to the rotary hook beds and horizontally moving the individual machine heads and the color change mechanism together to place any one of the machine heads in each of the head groups in positional correspondence to the rotary hook bed.

**[0006]** By selectively placing either one of the plurality of machine heads in each of the head groups in positional correspondence to one rotary hook bed in the aforementioned manner, the present invention can perform different types of embroidery or sewing with the respective machine heads although only one rotary hook bed is to be positioned inside the embroidering workpiece. As a result, combination embroidery with the plurality of types of machine heads can be performed by one embroidery sewing machine smoothly without any problem. Further, with the arrangement that the color change mechanism for the multi-needle machine heads is caused to slide

together with the horizontal movement mechanism for the head groups, the present invention can significantly simplify the construction of the entire horizontal movement mechanism.

#### Brief Description of Drawings

#### [0007]

Fig. 1 is a front view of an embroidery sewing machine in accordance with an embodiment of the present invention;

Fig. 2 is a plan view showing the embroidery sewing machine with an upper machine frame and machine heads omitted for clarity;

Fig. 3 is a sectional side view taken along the I - I line of Fig. 1;

(a) of Fig. 4 is an enlarged front view of a color change mechanism and horizontal movement mechanism of the embroidery sewing machine, and (b) of Fig. 4 is a plan view of the color change mechanism and horizontal movement mechanism;

Fig. 5 is an enlarged side view of one of multi-needle machine heads;

Fig. 6 is an enlarged side view of one of single-needle machine heads;

(a) of Fig. 7 is a front view showing, in further enlarged scale, an example specific construction of the color change mechanism, and (b) of Fig. 7 is a sectional side view of the color change mechanism;

(a) of Fig. 8 is a front view showing, in further enlarged scale, an example specific construction of the horizontal movement mechanism, and (b) of Fig. 8 is a sectional side view of the horizontal movement mechanism;

(a) of Fig. 9 is a front view showing, in a further enlarged scale, an example specific construction of a mechanism for transmitting rotation of a main shaft motor to a machine's main shaft disposed in a left region of the front of the sewing machine, and (b) of Fig. 9 is a sectional side view of the rotation transmission mechanism;

(a) of Fig. 10 and (b) of Fig. 10 are a front view and plan view, respectively, showing an example state in which the multi-needle machine head has been placed in positional correspondence to a rotary hook bed; and

(a) of Fig. 11 and (b) of Fig. 11 are a front view and plan view, respectively, showing an example state in which a desired sewing needle (color thread) has been selectively slid via the color change mechanism of Fig. 10.

#### Best Mode for Carrying Out the Invention

**[0008]** Fig. 1 is a front view of an embroidery sewing machine in accordance with an embodiment of the present invention, Fig. 2 is a plan view showing the embroidery sewing machine with an upper machine frame 1 and machine heads 3 and 4 omitted for clarity, and Fig. 3 is a sectional side view taken along the I - I line of Fig. 1. Reference numeral 1 indicates the machine frame and 2 a machine table. The table 2 includes a vertically-movable front table 2a. Six head pairs (groups), each comprising two types of machine heads 3 and 4, are provided on a front surface of the machine frame 1. One of the machine heads 3 in each of the head pairs (groups) is a multi-needle lock-stitching machine head having a plurality of (e.g., nine) sewing needles, while the other machine head 4 is a single-needle lock-stitching machine head intended for decorative embroidery and capable of sewing a tape or the like. One rotary hook bed 5 provided with one rotary hook 6 is disposed under each of the head pairs (groups). Base sash frame 7 is provided on the table 2 and driven to move two-dimensionally in X and Y directions via frame drive sections 8 and 9. A plurality of embroidery frames 10 are supported on the base sash frame 7 in corresponding relation to the rotary hook beds 5, and a cylindrically-shaped embroidering workpiece, such as the body of a T-shirt, can be set on each of the embroidery frames 10.

**[0009]** (a) of Fig. 4 is a front view showing, in enlarged scale, parts of a color change mechanism 20 and horizontal movement mechanism 30, and (b) of Fig. 4 is a plan view of the parts of the color change mechanism 20 and horizontal movement mechanism 30. As clearly seen from Fig. 4, a pair of upper and lower guide rails 13, each composed of a plurality of rails 13a connected in series, are disposed on the front surface of the machine frame 1. The machine heads 3 and 4 of each of the head pairs are fixed to a mounting plate 12 that is in turn fixed to a slider 14 movably provided on the two guide rails 13. The machine heads 3 and 4 of each of the head pairs are slidable relative to the machine frame 1. Fig. 5 is an enlarged side view of one of the multi-needle machine heads 3, and Fig. 6 is an enlarged side view of one of the single-needle machine heads 4.

**[0010]** As shown in Fig. 5, the multi-needle machine head 3 includes an arm 15 and a needle bar case 16 slidably supported on the arm 15, and the needle bar case 16 includes a plurality of (e.g., nine) sewing needles 17. As will be later described, the needle bar case 16 is slid horizontally via the color change mechanism 20 so that any desired one of the sewing needles 17 can be selectively positioned at a predetermined operating position (selected position). Machine's main shaft 18 extends through each of the machine heads 3 and 4, and, through rotation of the machine's main shaft 18, the sewing needle 17 positioned at the operating position (selected position) in the multi-needle machine head 3 and the sewing needle 19 in the machine head 4 are moved

up and down.

**[0011]** The color change mechanism 20 for positioning a desired one of the plurality of (nine) sewing needles 17 of the machine head 3 at a selected position is provided on the front surface of the machine frame 1. The color change mechanism 20 too is fixed, via a mounting plate 21, to the slider 14 slidably provided on the guide rails 13. Thus, the color change mechanism 20 too is slidable relative to the machine frame 1. Fig. 7 shows, in a further enlarged scale, an example specific construction of the color change mechanism 20, in which (a) is a front view of the color change mechanism 20 and (b) is a sectional side view of the color change mechanism 20.

**[0012]** As shown in Fig. 7, the color change mechanism 20 includes a frame member (base) 22 of a channel-like sectional shape fixed to the mounting plate 21, a ball screw 23 rotatably supported on the frame member 22, and a moving member 26 mounted on a nut member 24 screwed on the ball screw 23 and slidable along guide shafts 25. Drive motor 27 is fixed to the frame member 22 and has its motor shaft connected to one end of the ball screw 23, to thereby constitute a drive section. Thus, by activation of the drive motor 27, the ball screw 23 is rotated so that the moving member 26 is caused to slide together with the nut member 24. Rod 28 is connected to the needle bar case 16 of the machine head 3 of each of the head pairs and has one end connected to the moving member 26, which thereby constitutes a slide drive member. As the moving member 26 is slid by being driven by the drive motor 27, the needle bar case 16 is slid in a left-right direction via the rod 28. As shown in Fig. 6, the machine head 4 has a hole 29 to permit passage there-through of the rod 28.

**[0013]** As shown in Fig. 1 or 4, the horizontal movement mechanism 30 for causing each of the head pairs and color change mechanism 20 to slide together is provided on the front surface of the machine frame 1. Fig. 8 shows, in a further enlarged scale, an example specific construction of the horizontal movement mechanism 30, in which (a) is a front view of the horizontal movement mechanism 30 and (b) is a sectional side view of the horizontal movement mechanism 30. As shown in Fig. 8, the horizontal movement mechanism 30, which is constructed in a similar manner to the color change mechanism 20, includes a frame member 31 fixed to the machine frame 1, a ball screw 32 rotatably supported on the frame member 31, and a moving member 35 mounted on a nut member 33 screwed on the ball screw 32 and slidable along guide shafts 34. Drive motor 36 is fixed to the frame member 31 and has its motor shaft connected to one end of the ball screw 32. The individual mounting plates 12 having the head pairs fixed thereto and the mounting plate 21 having the color change mechanism 20 are interconnected via a connecting rod 37, and the mounting plate 21 is connected with the moving member 35 of the horizontal movement mechanism 30 via the connecting rod 37. Thus, as the drive motor 36 of the horizontal movement mechanism 30 is driven to cause

the moving member 35 to slide, the individual machine heads 3 and the color change mechanism 20 are caused to slide together in the horizontal (leftward or rightward) direction. Then, either one of the machine heads 3 or 4 is placed in positional correspondence to the rotary hook bed 5, so that embroidery sewing is performed using the thus-positioned machine head 3 or 4. At that time, the machine's main shaft 18 is caused to slide together with the machine heads 3 and 4. Fig. 4 shows a state of the machine in which the single-needle machine head 4 is in positional correspondence to the rotary hook bed 5, while Fig. 10 or 11 shows a state of the machine in which the multi-needle machine head 3 is in positional correspondence to the rotary hook bed 5.

**[0014]** Fig. 9 shows, in enlarged scale, an example specific construction of a mechanism for transmitting rotation of a main shaft motor 43 to the machine's main shaft disposed in a left region of the front of the machine, in which (a) is a front view of the rotation transmission mechanism and (b) is a sectional side view of the rotation transmission mechanism. As clearly seen from Fig. 9, a spline shaft 38 is connected to the left end of the machine's main shaft 18. The spline shaft 38 has mounted thereon bearings 39 slidable along the axis of the spline shaft 38 and rotatable with the spline shaft 38. Main shaft pulley 40 and driven pulley 41 are fixed to the bearings 39. The main shaft pulley 40 is connected, via a timing belt 42, with the main shaft motor 43 fixed to the rear surface of the machine frame 1. The driven pulley 41 is connected with a rotary hook shaft pulley 46 via a timing belt 44 and intermediate pulley 45. The rotary hook shaft pulley 46 is fixed to one end portion of a rotary hook shaft 47. As seen in Fig. 3, the rotary hook shaft 47 extends through the individual rotary hook beds 5, and the rotary hook 6 in each of the rotary hook beds 5 is rotatable by rotation of the rotary hook shaft 47. Thus, through activation of the main shaft motor 43, the machine's main shaft 18 and rotary hook shaft 47 are rotated, so that not only the sewing needle 17 or 19 is moved up and down but also the rotary hook 6 is rotated. Via the spline shaft 38 and spline bearings 39, the driving force of the main shaft motor 43 is transmitted to the main shaft 18 with axial sliding movement of the shaft 18 permitted. In Fig. 9, a position of the spline shaft 38 when the machine head 4 is in positional correspondence to the rotary hook bed 5 (i.e., the state of Fig. 4) is indicated by a solid line, while a position of the spline shaft 38 when the machine head 3 is in positional correspondence to the rotary hook bed 5 (see Fig. 10) is indicated by an imaginary line.

**[0015]** The following paragraphs describe an example manner in which combination embroidery sewing is performed in the instant embodiment.

First, a cylindrically-shaped embroidering workpiece is set on the embroidery frame 10, and then the embroidery frame 10 is mounted on the base sash frame 7. When decorative embroidery sewing, such as sewing of a tape, is to be performed on the embroidering workpiece, the single-needle machine head 4 in each of the head pairs

is placed, via the horizontal movement mechanism 30, in positional correspondence to the associated rotary hook bed 5. Then, the main shaft motor 43 is activated so that the sewing needle 19 is moved up and down, the rotary hook 6 is rotated and the base sash frame 7 is moved on the basis of embroidery data. In this manner, decorative embroidery sewing, such as sewing of a tape, is performed by the single-needle machine head 4, during which time up-and-down movement of any one of the sewing needles 17 in the multi-needle machine head 3 that is not currently in positional correspondence to the rotary hook bed 5 is inhibited through the well-known jump control.

**[0016]** When multi-color embroidery is to be performed, the multi-needle machine head 3 in each of the head pairs is placed, via the horizontal movement mechanism 30, in positional correspondence to the associated rotary hook bed 5, and then the sewing needle 17 of a desired color thread is selectively positioned at a predetermined position (selected position) through driving by the color change mechanism 20. Fig. 11 shows a state in which the sewing needle 17 of a desired color thread has been selectively positioned at a predetermined operating position (selected position) through driving by the color change mechanism 20. Then, the main shaft motor 43 is activated, so that the sewing needle 17, positioned at the operating position (selected position), is moved up and down, the rotary hook 6 is rotated and the base sash frame 7 is moved on the basis of the embroidery data. In this manner, embroidery sewing, using the desired color thread, is performed by the multi-needle machine head 3, during which time up-and-down movement of any one of the sewing needles 19 in the single-needle machine head 4 that is not currently in positional correspondence to the rotary hook bed 5 is inhibited through the well-known jump control.

**[0017]** By selectively placing, through driving by the horizontal movement mechanism 30, either one of the two types of machine heads 3 and 4 in positional correspondence to the associated single rotary hook bed 5 as noted above, the instant embodiment permits selective embroidery sewing by the two types of machine heads 3 and 4 although only one rotary hook bed 5 is to be positioned inside the embroidering workpiece. As a result, combination embroidery sewing on the cylindrically-shaped embroidering workpiece can be performed by the single embroidery sewing machine smoothly without any problem. Further, with the arrangement that the color change mechanism 20 is caused to slide together with the machine heads 3 and 4, the instant embodiment allows a color change operation to be readily performed in the multi-needle machine head 3 with the conventional construction and control. If a construction where the color change mechanism 20 is not caused to slide is employed, then there arise needs for an extra structure to permit sliding movement of the machine heads 3 relative to the color change mechanism 20, control to calculate a sliding movement amount of the machine head 3, etc. which

would result in a considerably complicated construction of the machine. However, the present invention can eliminate such complexity and thereby achieve a simplified construction.

**[0018]** Whereas the slide drive mechanism of the color change mechanism 20 and the slide drive mechanism of the horizontal movement mechanism 30 in the embodiment have been described above as ball-screw-based rotary-to-linear converting structures, the present invention is not so limited, and the slide drive mechanisms may be other suitable structures, such as cam-based rotary-to-linear converting structures or linear-motor-based linear movement structures. Further, the two types of machine heads in each of the head pairs (groups) are not limited to a combination of multi-needle and single-needle machine heads, and alternatively both of the two machine heads may be multi-needle machine heads. In the case where the two machine heads are multi-needle machine heads, it is possible to increase the number of thread colors that can be used; in this case, one color change mechanism 20 can be shared between the paired multi-needle machine heads. Further, each of the head groups may comprise three different types of machine heads. Furthermore, the present invention is applicable to not only to multi-head sewing machines but also sewing machines provided with only one head pair or head group comprising two or more machine heads.

## Claims

1. An embroidery sewing machine for a cylindrically-shaped embroidering workpiece, said embroidery sewing machine comprising:

a head group comprising two or more machine heads disposed in proximity to each other so that each of the machine heads can perform embroidery sewing on an embroidering area of an embroidery frame on which the cylindrically-shaped embroidering workpiece is set, at least one of the two or more machine heads being a multi-needle machine head having a plurality of needles;

a color change mechanism for selectively positioning a desired one of the needles at a predetermined operating position in the multi-needle machine head;

a rotary hook bed provided for each of the head group for shared use between the machine heads in the head group and corresponding to one said embroidering workpiece; and

a horizontal movement mechanism for disposing individual ones of the machine heads and said color change mechanism for horizontal movement relative to the rotary hook beds and horizontally moving the individual machine heads and said color change mechanism to-

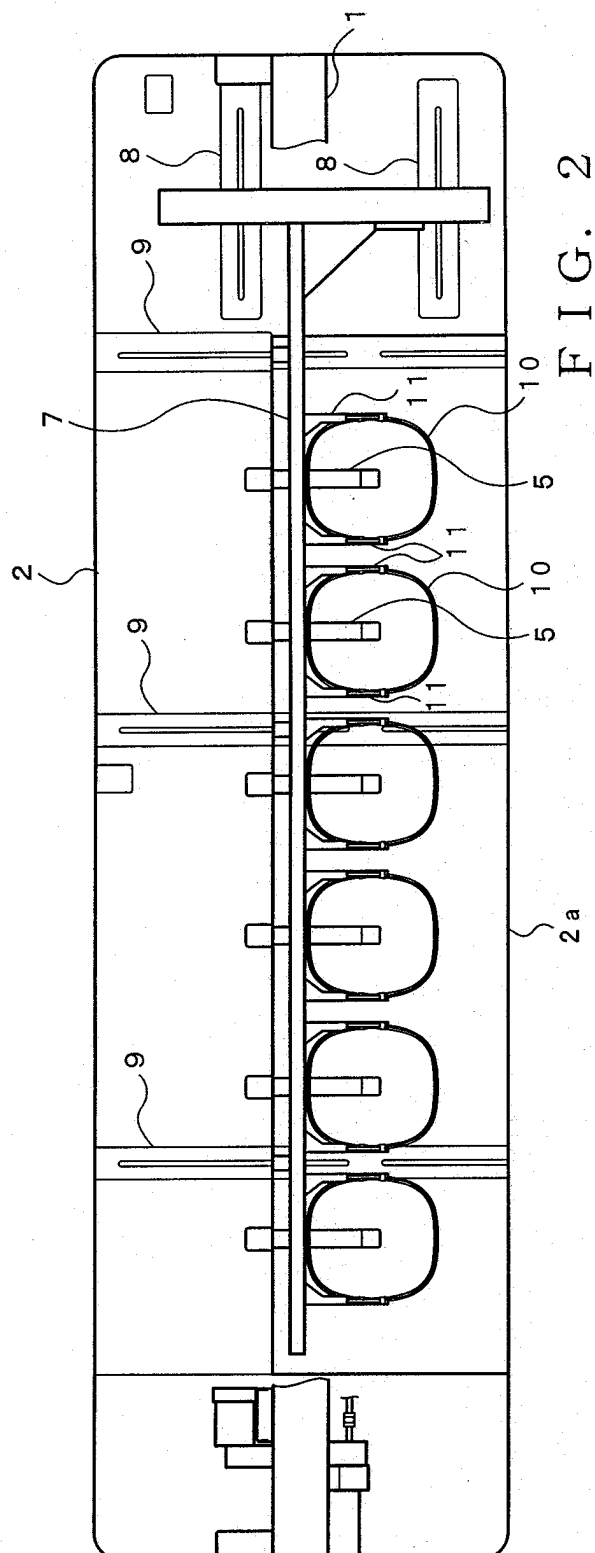
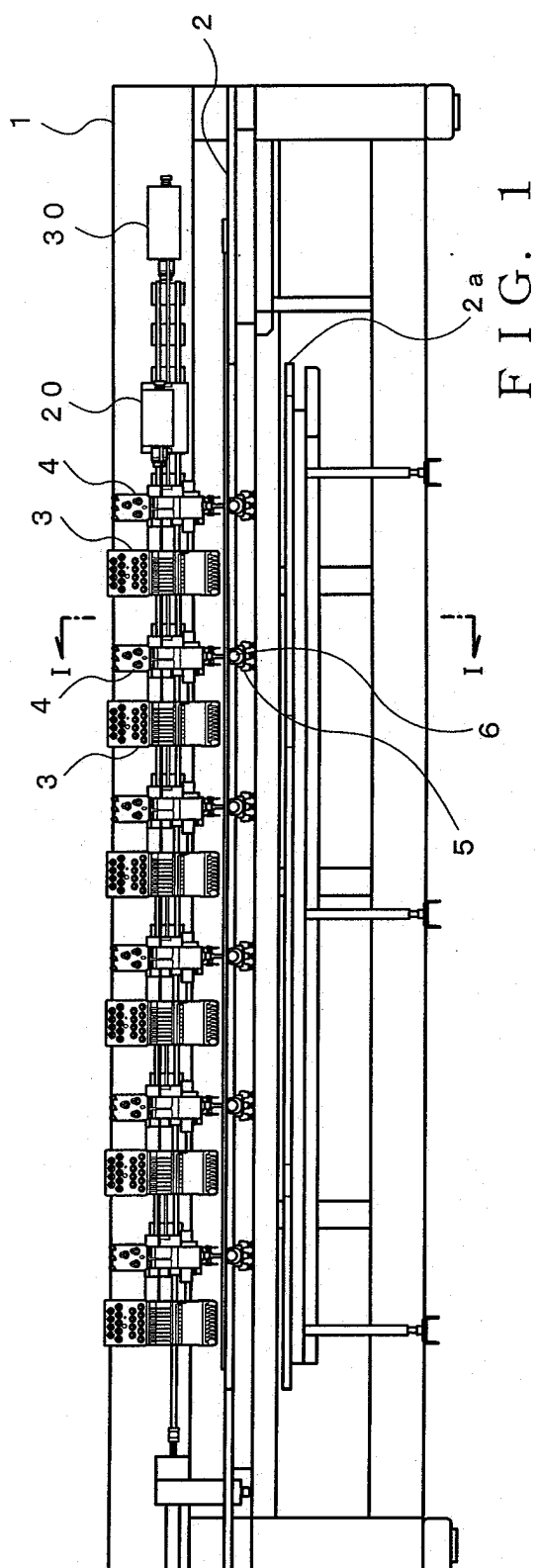
gether to place any one of the machine heads in each of the head groups in positional correspondence to said rotary hook bed.

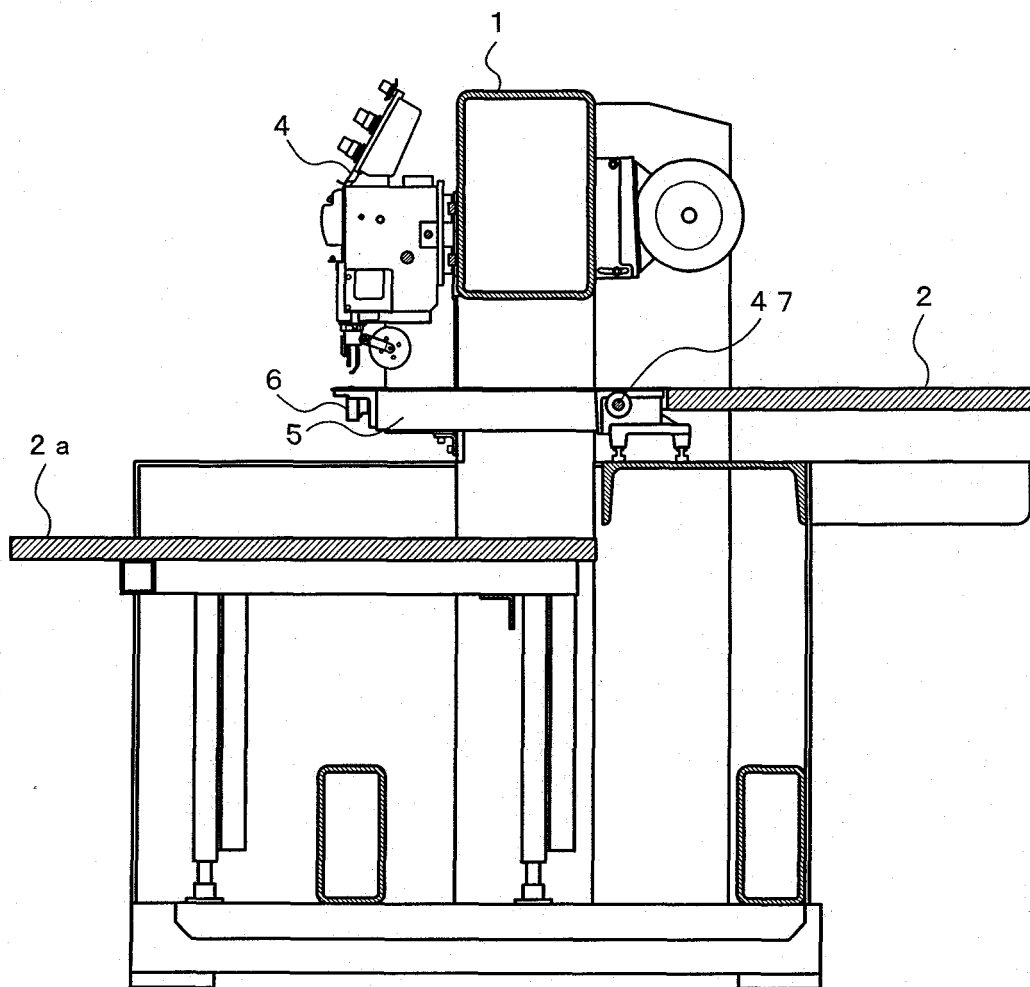
2. An embroidery sewing machine as claimed in claim 1 wherein a plurality of the head groups are arranged horizontally at predetermined intervals and a plurality of the rotary hook beds are arranged horizontally at predetermined intervals in corresponding relation to the plurality of the head groups, and wherein said horizontal mechanism moves the plurality of the head groups and said color change mechanism together horizontally relative to the rotary hook beds. 5  
10
  
3. An embroidery sewing machine as claimed in claim 1 or 2 wherein each of the multi-needle machine heads in each of the head groups includes a slidable needle bar case having a plurality of sewing needles arranged horizontally, 15  
said color change mechanism includes a slide drive member connected to the needle bar case of each of the multi-needle machine heads, a drive section for selectively positioning a desired one of the needles of each of the needle bar cases at a predetermined operating position by driving said slide drive member to slide by a predetermined amount, and a base having said drive section fixed thereto, 20  
the machine heads in each of the head groups are interconnected via a mounting plate, the mounting plate being mounted for horizontal movement relative to a machine frame so that each of the machine heads is movable horizontally relative to the machine frame, and 25  
said horizontal movement mechanism includes an interlocking member interconnecting the mounting plate and the base of said color change mechanism and a drive mechanism for horizontally moving the interlocking member, the interlocking member being horizontally moved by the drive mechanism so that each of the machine heads and said color change mechanism are horizontally moved together. 30  
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F I G. 3

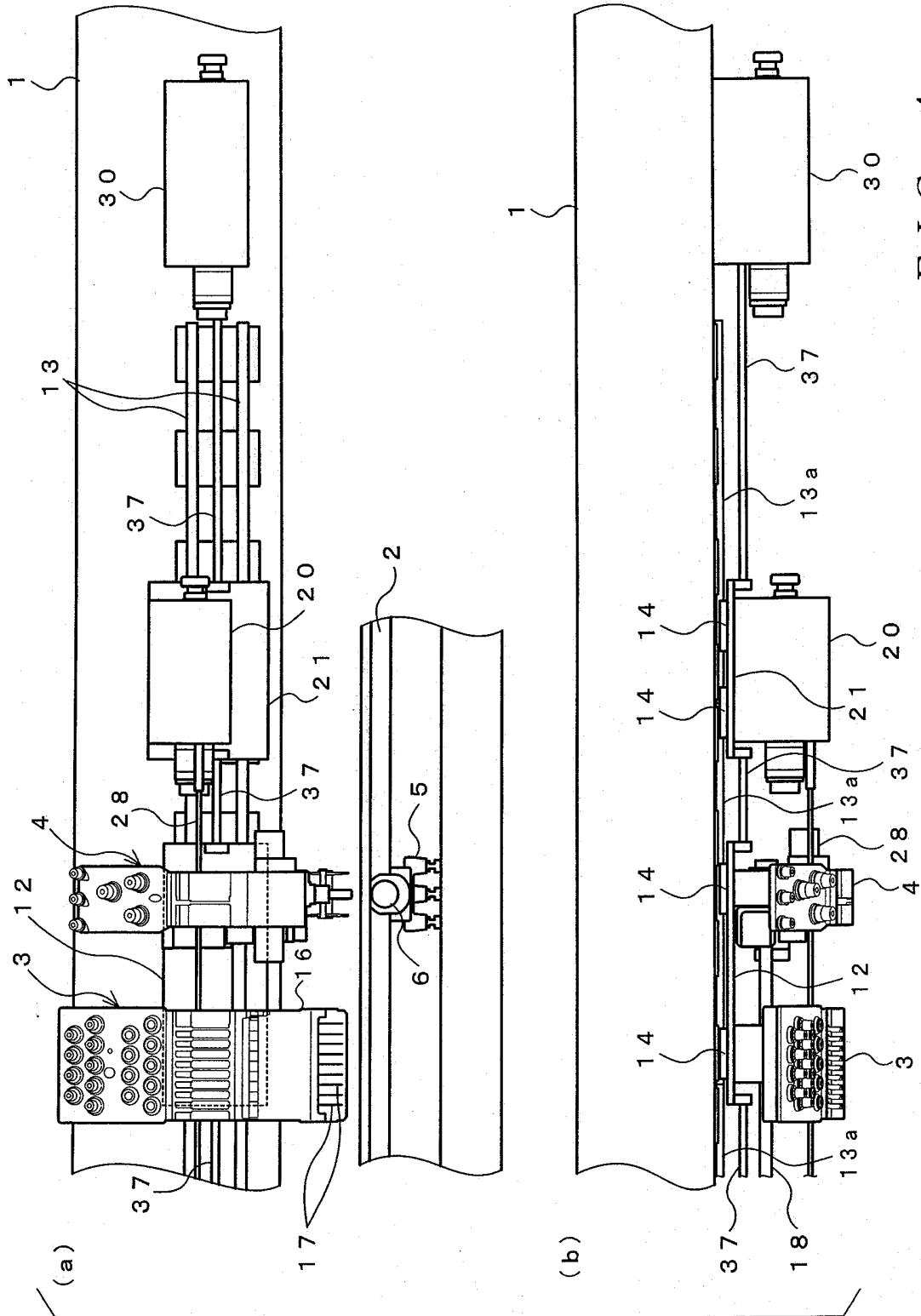


FIG. 4

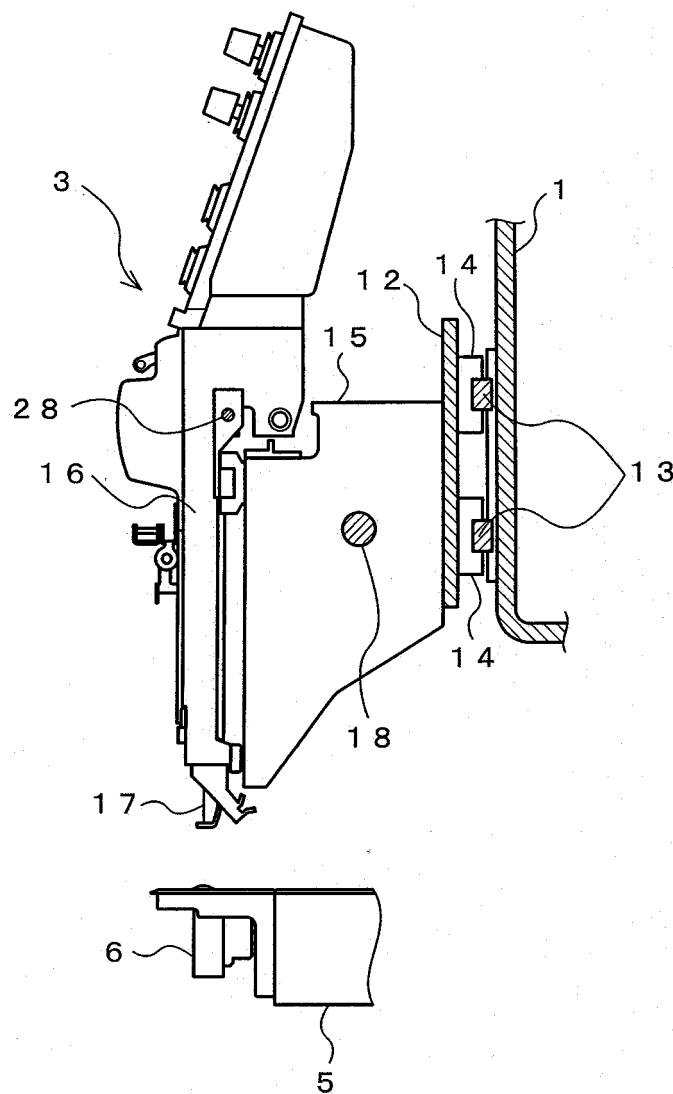


FIG. 5

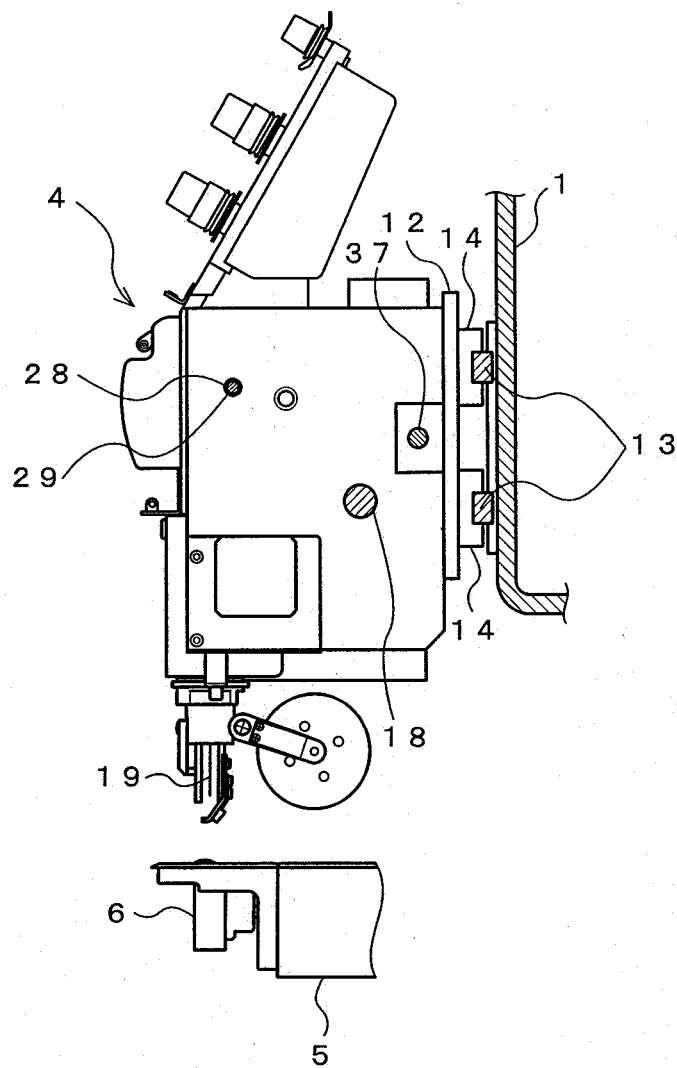


FIG. 6

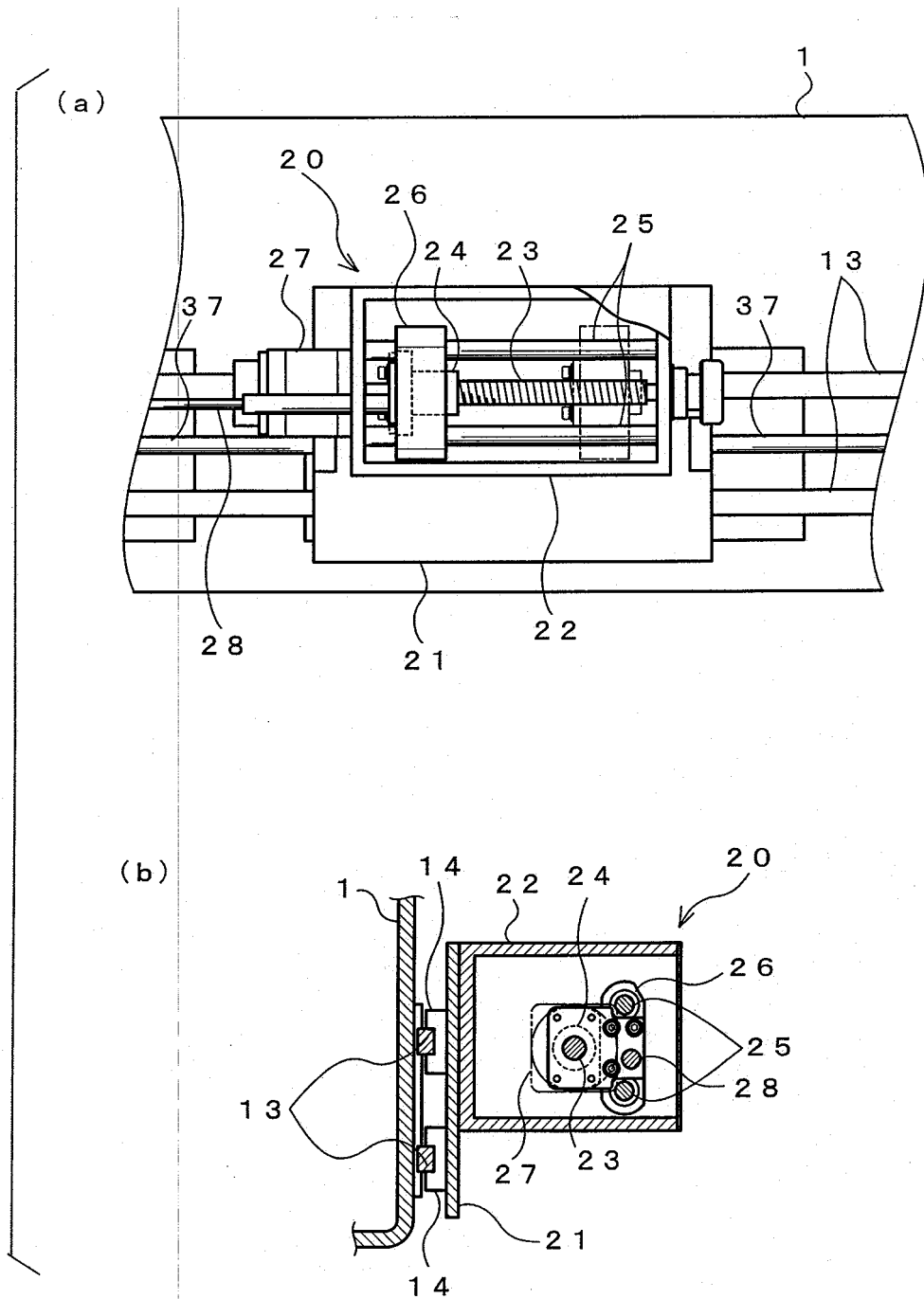
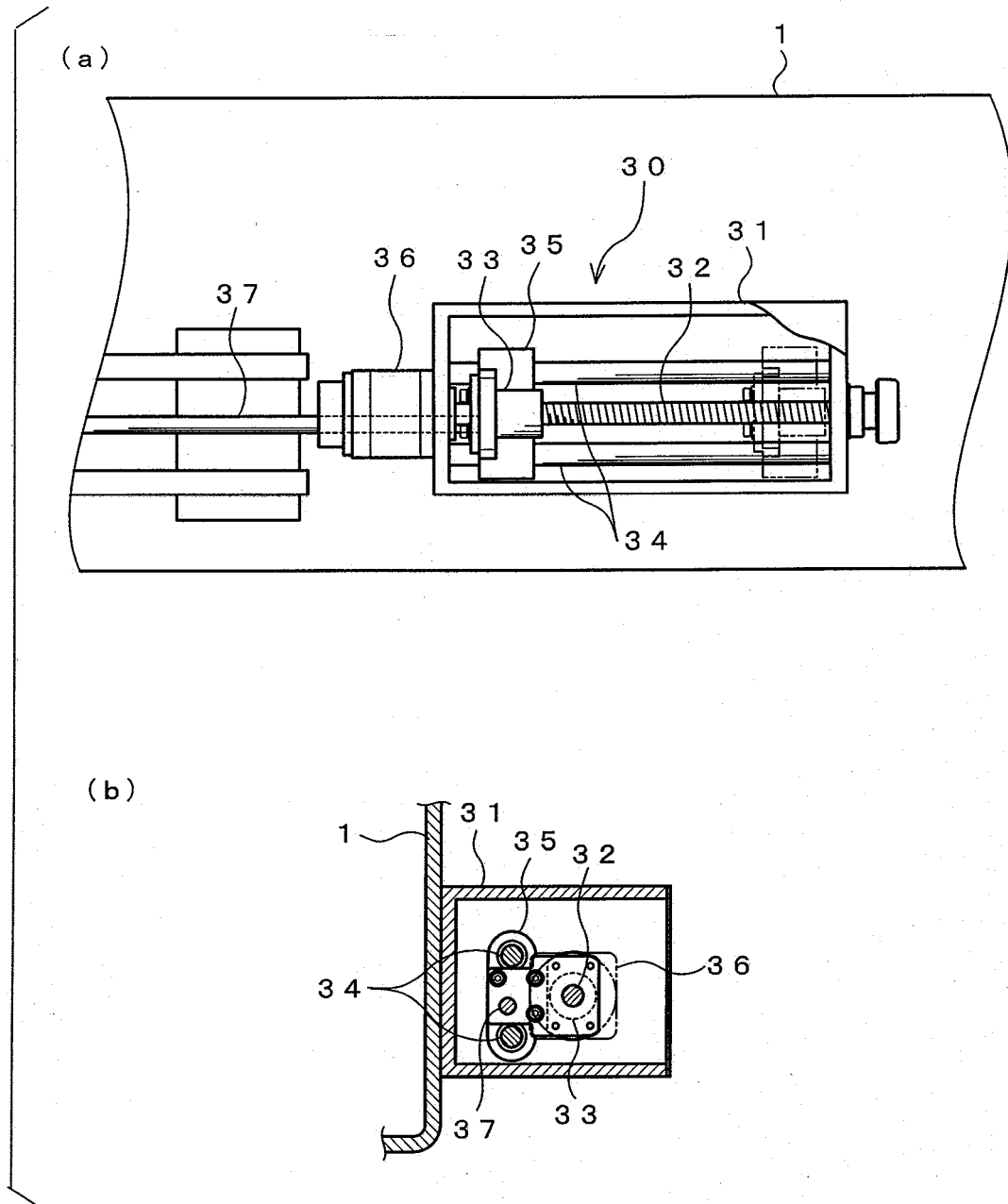


FIG. 7



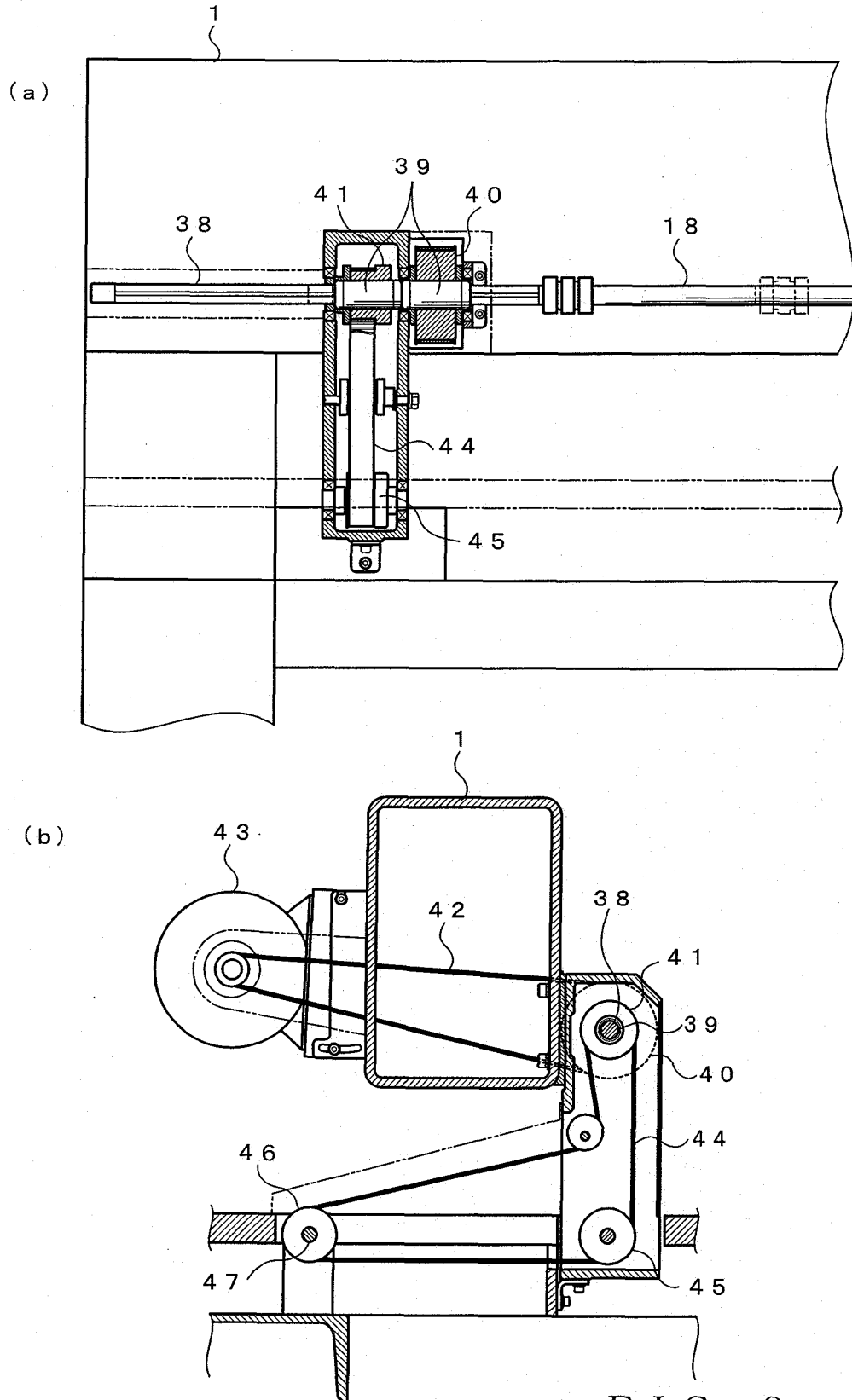
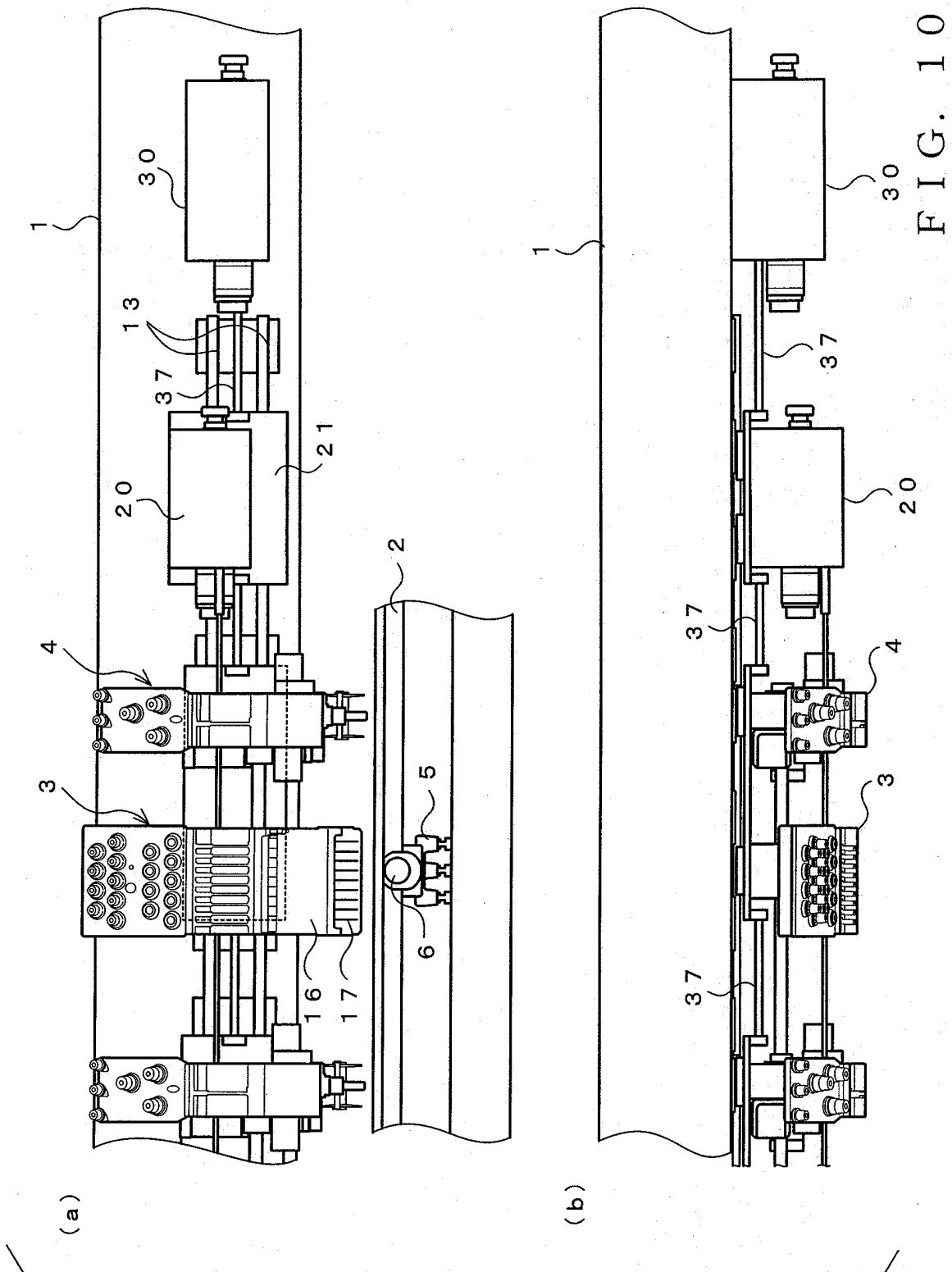
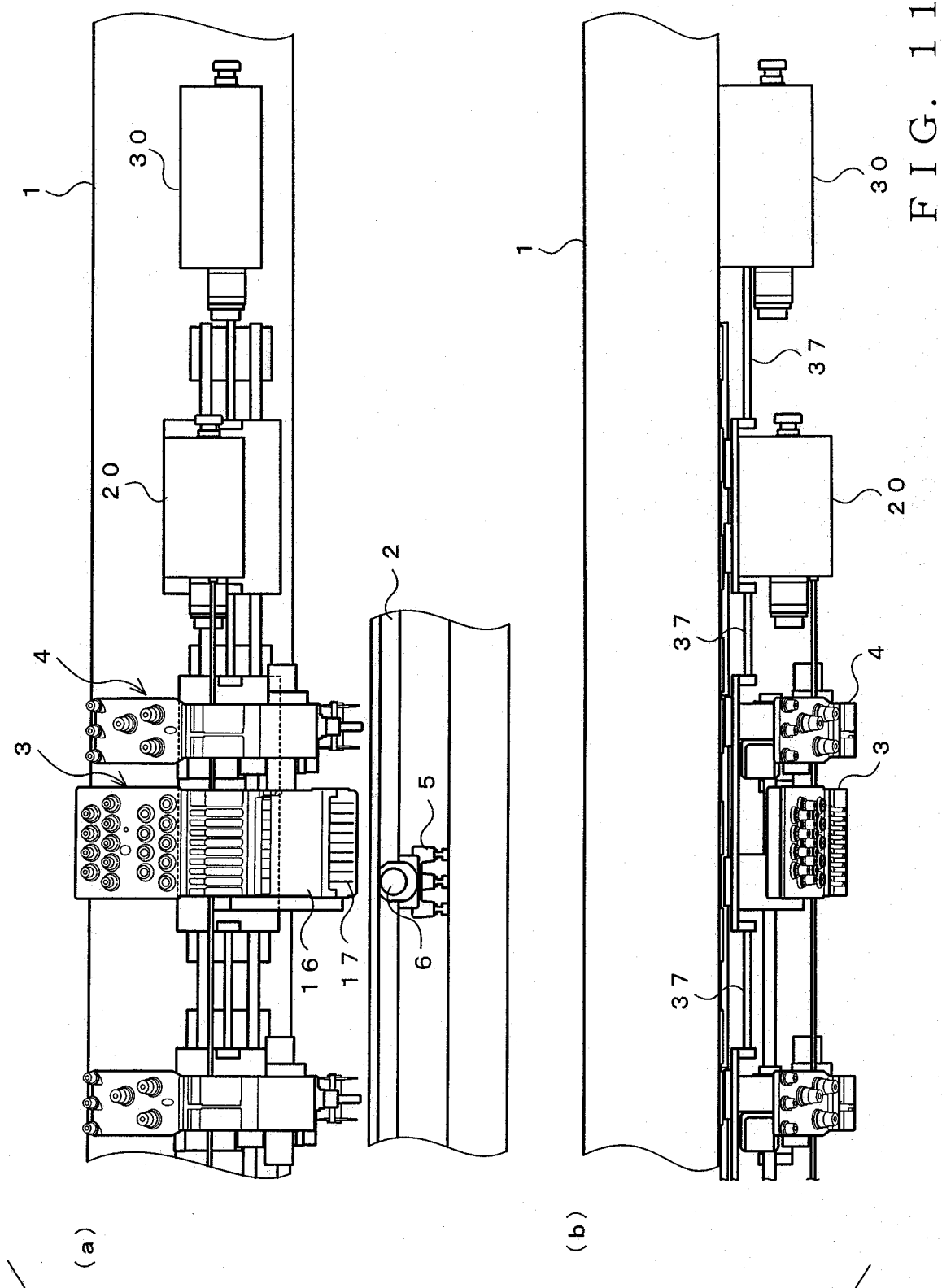


FIG. 9





## INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2005/019916

## A. CLASSIFICATION OF SUBJECT MATTER

*D05B25/00* (2006.01), *D05C7/00* (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

*D05B1/00* (2006.01) - *D05B97/12* (2006.01), *D05C7/00* (2006.01) - *D05C9/22* (2006.01)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2005

Kokai Jitsuyo Shinan Koho 1971-2005 Toroku Jitsuyo Shinan Koho 1994-2005

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                    | Relevant to claim No. |
|-----------|-------------------------------------------------------------------------------------------------------|-----------------------|
| X<br>Y    | JP 3338492 B2 (Tokai Kogyo Mishin Kabushiki Kaisha),<br>28 October, 2002 (28.10.02)<br>(Family: none) | 1, 2<br>3             |
| Y         | JP 62-42065 B2 (Hirotaka OYABU),<br>07 September, 1987 (07.09.87)<br>(Family: none)                   | 3                     |
| Y         | JP 2845063 B2 (Brother Industries, Ltd.),<br>13 January, 1999 (13.01.99)<br>(Family: none)            | 3                     |
| Y         | JP 3448317 B2 (Kabushiki Kaisha Barudan),<br>22 September, 2003 (22.09.03)<br>& US 5390613 A          | 3                     |

☒ Further documents are listed in the continuation of Box C.☐ See patent family annex.

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Date of the actual completion of the international search  
08 December, 2005 (08.12.05)Date of mailing of the international search report  
20 December, 2005 (20.12.05)Name and mailing address of the ISA/  
Japanese Patent Office

Authorized officer

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Telephone No.

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2005/019916

| C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT |                                                                                                     |                       |
|-------------------------------------------------------|-----------------------------------------------------------------------------------------------------|-----------------------|
| Category*                                             | Citation of document, with indication, where appropriate, of the relevant passages                  | Relevant to claim No. |
| Y                                                     | JP 2592583 Y2 (Tokai Kogyo Mishin Kabushiki Kaisha),<br>24 March, 1999 (24.03.99)<br>(Family: none) | 3                     |
| A                                                     | JP 1-11751 Y2 (Tokai Kogyo Mishin Kabushiki Kaisha),<br>06 April, 1989 (06.04.89)<br>(Family: none) | 1-3                   |
| P,A                                                   | JP 2005-224365 A (Yugen Kaisha TIK),<br>25 August, 2005 (25.08.05)<br>(Family: none)                | 1-3                   |

Form PCT/ISA/210 (continuation of second sheet) (April 2005)

**REFERENCES CITED IN THE DESCRIPTION**

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**Patent documents cited in the description**

- JP 1011751 U [0002]