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(54) APPARATUS FOR FEEDING WORKPIECES INTERMITTENTLY

(71) We, YOSHIDA KOGYO K.K., a corporation duly organized under the laws of Japan and existing at No. 1, Kanda Izumicho, Chiyoda-ku, Tokyo, Japan, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement: —

The present invention relates to an apparatus for feeding workpieces intermittently.

According to the invention, there is provided an apparatus for feeding workpieces intermittently comprising support means for the workpieces, first and second feed rods extending parallel to the support means, a plurality of projections provided on each of said first and second feed rods spaced at intervals therealong, the projections on the rods being disposed out of transverse mutual alignment, means for moving said feed rods axially in a feed direction and both rods in a retraction direction between forward and retracted positions to provide stroke at least equal to said interval, means for moving the projections into and out of the path of movement for the workpieces along the support means, movement in a feed direction of one feed rod being transmitted to the other feed rod by a workpiece so that the workpiece is held between projections on said first and second rods during the feed direction of movement of the rods and release of the workpieces during retraction of the rods is achieved by a lost motion arrangement in the retraction drive to said other feed rod.

Preferably a pair of parallel first feed rods and a pair of parallel second feed rods are provided and the means for moving the projections into and out of the path of movement of the work pieces comprises means for rotating said first and second feed rods about their axes.

The apparatus according to the present invention is particularly useful for feeding workpieces such as sash bars intermittently sideways one by one to stations in which their ends can by machined for assembly.

An embodiment of the invention will now be described by way of example, with reference to the drawings, in which: —

Figure 1 is a top plan view of an apparatus constructed in accordance with the present invention;

Figure 2 is an enlarged fragmentary perspective view of a portion of the apparatus shown in Figure 1;

Figure 3 is a cross-sectional view of the portion shown in Figure 2;

Figure 4 is a top plan view, partly broken away and shown in cross section, of a drive mechanism employed in the apparatus of Figure 1;

Figure 5 is a cross-sectional view taken along line V—V of Figure 4;

Figure 6 is a cross-sectional view taken along line VI—VI of Figure 4;

Figures 7*A* to 7*E* show sequential operation of feed and support rods in the apparatus;

Figure 8 is a front elevational view of a workpiece holder on feed rods with a spacer therein;

Figure 9 is a cross-sectional view taken along line IX—IX of Figure 8; and

Figure 10 is a front elevational view of a modified base.

The present invention is particularly useful when embodied in an apparatus such as shown in Figure 1 generally indicated by the numeral 11. The apparatus 11 includes an elongate transfer table 12, a workpiece loading table 13 coupled to one end of the transfer table 12, and a workpiece unloading table 14 coupled to the other end of the transfer table 12. A plurality of elongate workpieces 15 such as sash bars are placed successively on the loading table 13 and fed intermittently sideways one by one over the transfer table 12 to a series of stations where various machine tools as indicated by the numerals 16, 17 are provided alongside of the transfer table 12, the machine tools working on the workpieces 15 for cutting their ends, attaching necessary parts, or performing other machining operations thereon.

A pair of parallel first feed rods 18, 19 extend in a direction in which the workpieces 15 are to be transferred, and are slidably supported on supports 20 on the transfer

table 12 and spaced laterally a distance from each other, which distance is shorter than individual workpieces 15 to carry them jointly thereon. The transfer table 12 has a pair of support rails 21, 22 extending along the opposite sides of the table 12 and projecting upwardly beyond the feed rods 18, 19 the support rails 21, 22 being mounted on the supports 20. Each of the feed rods 18, 19 has both ends supported respectively in bearing units 23, 24 for axial movement and for rotation about its own axis.

Each feed rod has thereon a plurality of first workpiece-engaging projections 25 spaced therealong one from another at an interval which is equal to an interval at which the adjacent machine tools 16, 17 are spaced apart from each other. Under the workpiece unloading table 14, there is a drive mechanism 26 that enables the feed rods 18, 19 to move in unison axially between advanced and retracted positions for a stroke which is greater than the interval at which the projections 25 are spaced one from another. The projections 25 on the feed rod 18 are held respectively in transverse alignment with the projections 25 on the feed rod 19 at all times while the feed rods 18, 19 reciprocate together.

As shown in Figure 2, each projection 25 includes a base 27 fixed to the feed rod, the projections 25 being greater in height than the support rails 21, 22. The bases 27 are directed toward the workpiece loading table 13. Each of the feed rods 18, 19 has a workpiece catching member 28 at one end thereof near the bearing unit 23, the workpiece catching member 28 including a projection 29 extending from a base 30 secured to the feed rod. The projections 29 of the workpiece catching members 28 engage the workpieces 15 one at a time to pull the workpiece 15 over the transfer table 12.

As shown in Figures 1 and 2, a pair of parallel second feed rods 31, 32 extend in the workpiece transferring direction, and are supported on the supports 20 and spaced laterally apart from each other to carry the individual workpieces 15 jointly thereon, the second feed rods 31, 32 extending adjacent and parallel to the feed rods 18, 19, respectively. Each of the second feed rods 31, 32 has both ends supported respectively in the bearing units 23, 24 for axial movement and for rotation about its own axis. Each second feed rod has thereon a plurality of second workpiece-engaging projections 33 spaced one from another at a spaced interval therealong which is equal to the interval at which the adjacent machine tools 16, 17 are spaced apart from each other. The projections 33 on the second feed rod 31 are held respectively in transverse alignment with the projections 33 on the second feed rod 32.

Each projection 33 on the second feed rods 31, 32 includes a base 34 fixed to the second feed rods, and extends upwardly beyond the support rails 21, 22. The bases 34 are directed toward the workpiece unloading table 14. The first projections 25 on the first feed rods 18, 19 are located out of transverse alignment with the second projections 33 on the second feed rods 31, 32. The projections 25 and 33 can jointly provide a plurality of workpiece holders 35 that are receptive of the workpieces 15 therein for advancing movement along the transfer table 12. The second projections 33 are positioned a distance ahead of the associated first projections 25 in the workpiece feeding direction, the distance being greater than the width of the workpieces 15.

Figures 4 and 5 illustrate the drive mechanism 26 including a central cylinder actuator 36 with a piston rod 37 connected at its one end to a central rack 38 which is in driving mesh with a piston 39 rotatably mounted on the workpiece unloading table 14. Fixed to the pinion 39 is a shaft 40 having its ends connected to a pair of pinions 41 (only one shown in Figure 4) which drivingly mesh with a pair of racks 42, 42 to which ends of the first feed rods 18, 19 that project beyond the bearing units 24, 24 are coupled via nuts 43, 43 each having one end connected to and rotatable relatively to the rack 42. The other ends of the nuts 43, 43 threadedly receive therein a pair of axternally threaded spindles 44, 44 fixed coaxially to the ends of the first feed rods 18, 19, respectively. Fine adjustment of the position of the projections 25 on each of the first feed rods 18, 19 can be made by turning the nut 43 relatively to the threaded spindle 44 so as to move the feed rod axially toward or away from the rack 42. The cylinder actuator 36 is actuatable by a control unit (not shown), energization of which is controlled by a pair of limit switches 45, 46 (Figure 5) that can be activated by engagement with a land 47 on the central rack 38. Thus, the central rack 38 is restricted in its movement between advanced and retracted positions.

When the cylinder actuator 36 is actuated to move the piston rod 37 from the position of Figure 4, the central rack 38 is moved from the retracted to the advanced position, thereby enabling the racks 42, 42 to pull the feed rods 18, 19 from their retracted position shown in Figure 1 to the advanced position, a distance between the retracted and advanced positions of the feed rods 18, 19 being greater than the interval between adjacent machine tools 16, 17 or between adjacent projections 25 on the feed rods 18, 19.

Each of the second feed rods 31, 32 has an end projecting beyond the bearing unit 24, the end having an externally threaded spindle 48 fixed coaxially thereto. The spindle 48 extends threadedly into a nut

49 at one end thereof with the other end engageable with the rack 42 endwise. The nut 49 is also engageable with a spring-biased rod 50 of a cushioning device 51 mounted in a rack holder 52 fixed to the table 14.

The bearing units 24, 24 shown in Figure 4 are the mirror image of each other, and one of them which is shown in cross section will be described below. The bearing unit 24 includes a pair of spaced bearing walls 53, 54 mounted in the table 12, through which extend the first feed rod 18 and the second feed rod 31 at their end portions, both rods being journaled for rotation about their axes. The bearing unit 24 contains a gearing 55 including a gear 56 disposed around the first feed rod 18, the gear 56 being fixed by means of a key 57 for corotation with the first feed rod 18. The feed rod 18 has an elongate keyway 58 which is greater in length than the transfer interval of the workpieces 15, the keyway 58 allowing the feed rod 18 to move axially with respect to the gear 56. Likewise, a gear 59 is disposed around the second feed rod 31, the gear 59 being fixed by means of a key 60 to the feed rod 31 for corotation therewith. The feed rod 31 has an elongate keyway 61 which is substantially equal in length to the transfer interval of the workpieces 15, the keyway 61 allowing the feed rod 31 to move axially with respect to the gear 59.

As shown in Figure 6, a cylinder actuator 62 is mounted in the transfer table 12 and has a piston rod 63 to which is secured a rack 64 having a pair of toothed sides that mesh drivingly with the gears 56, 59 respectively. One end of the piston rod 63 which is remote from the rack 64 extends downwardly beyond the cylinder and has a large-diameter portion 65 which is engageable with a pair of limit switches 66, 67 for control of the cylinder actuator 62.

When the cylinder actuator 62 is energized to move its piston rod 63 from the position of Figure 6, the rack 64 is moved downwardly and causes the gear 56 on the feed rod 18 to rotate in one direction and the gear 59 on the feed rod 31 to rotate in the opposite direction simultaneously. Upon arrival of the rack 64 at its lower limit that is governed by the limit switch 67, each of the projections 25, 33 on the feed rods is pivoted down to a position in which it releases the workpiece 15, as illustrated in Figure 3.

Operation of the apparatus will be described with reference to Figures 7*A* to 7*E* in which only the first feed rod 18 and the second feed rod 31 are shown for clarity. The workpiece 15 placed successively on the workpiece loading table 13 are pushed sideways forwardly by means of a suitable intermittently feeding machine which operates in timed relation to the drive mechanism 36. With the central piston rod 37 extended, the cylinder 62 is actuated to rotate the first and second feed rods 18, 31 about their axes, thereby causing the projections 25, 33 and the workpiece catching member 28 to pivot down to a lowered position in which they release workpieces 15 previously fed thereby (Figure 7*A*). When movement of the rack 64 reaches its lower limit, the limit switch 67 is turned on to de-energize the cylinder 62 and energize the central cylinder 36 which then contracts its piston rod 37. The feed rod 18 with the projections 25 and the workpiece catching member 28 down moves first from the advanced to the retracted position. Then, the feed rod 31 with the projections 33 down is moved from the advanced to the retracted position by engagement of the nut 49 with the rack 42 being in motion, whereupon the feed rods 18 and 31 are moved backward together with the projection 25 spaced from the associated projections 33 a distance greater than the width of the workpieces 15, as shown in Figure 7*B*. An interval between the advanced and retracted positions of the feed rod 31 is smaller than the workpiece transfer interval. Upon arrival of the feed rods 18, 31 at the retracted position, the central cylinder 36 is de-energized by the limit switch 45 and the workpiece catching member 28 is located in a position just under an ensuing workpiece 15 from the loading table 13. When a timer switch (not shown) is turned off after completion of the operation of the machine tools that have acted on the workpieces 15 over the transfer table 13, the cylinder 62 is actuated to extend its piston rod, thereby rotating the feed rods 18, 31 in the opposite directions to bring the projections 25, 33 and the workpiece catching member 28 into a raised position in which the projections 25 and the associated projections 33 receive loosely therebetween workpieces 15 over the transfer table 12 and the workpiece catching member 28 catches the ensuing workpiece 15 from the table 13; that is the projection 29 on the workpiece catching member 28 enters a slot 68 (Figure 2) in the workpiece 15 (Figure 7*C*).

Upward movement of the piston rod 63 of the cylinder 62 causes the limit switch 66 to be turned on, whereupon the cylinder 62 is de-energized and the cylinder 36 is energized, whereupon its piston rod 37 starts to extend, thereby advancing the first feed rod 18 from the retracted position. The advancing first feed rod 18 then causes its projections 25 to engage and push the workpieces 15 forwardly which then engage and push the projections 22 on the second feed rod 31, whereby the feed rods 18, 31 travel together toward their advanced position (Figure 7*D*). During advancing movement of the feed rods 18, 31, the projections 25, 33 jointly

support the workpiece holders 35 that hold the workpieces 15, respectively, and feed them toward next processing stations along the transfer table 12 in which various machining and assembling operations are to be effected. Thus, with this arrangement, the first and second feed rods 18, 31 are effectively coupled with each other by the workpiece although with lost motion between the two rods. When the feed rods 18, 31 reach their advanced position (Figure 7*E*), the limit switch 46 is turned on to de-energize the central cylinder 36 thereby bringing the movement of the feed rods 18, 31 to a stop. Excessive advancing movement of the feed rod 31 due to inertia is prevented by engagement of the nut 49 with the spring-biased rod 50 of the cushioning device 51.

The above cycle of operation is repeated to feed the workpieces 15 intermittently in sequence towards the successively located processing stations for automatic finishing of the workpieces 15.

As shown in Figures 8 and 9, a spacer 69 extends across two adjacent feed rods 18, 31 and is disposed between the projections 25, 33 that jointly provide each workpiece holder 35. The spacer 69 has a pair of grooves 70, 71 receiving the feed rods 18, 31 therein, respectively, the spacer having a width slightly greater than that of the workpieces 15. With the spacer 69, the workpiece 15 carried by the workpiece holder 35 is prevented from engagement with the projection 33 so that there will be no possibility of damage which the workpiece 15 could otherwise receive while being fed by the workpiece holder 35.

Figure 10 illustrates a modified base 72 fixed to the feed rod 31, the base 72 being directed toward the associated projection 25 on the feed rod 18. The base 72 is greater in height than the support rails 21, 22 to carry thereon the workpiece 15 at a level higher than the rails 21, 22 during advancing movement of the feed rods 18, 31 and processing operation of the machining tools.

Although the preferred arrangement employs a pair of first feed rods and a pair of second feed rods, a single first rod and a single second rod can be employed in some applications.

Although in the preferred arrangement described, the feed rods are disposed below the level of the support rails 22, 22 it is possible albeit less convenient for the feed rods to be disposed above the support rails and in this case the projections would be moved downwardly to engage the workpieces. Other means could be employed for moving the projections into engagement with the workpieces for example the feed rods themselves could be raised and lowered instead of rotated.

WHAT WE CLAIM IS:—

1. An apparatus for feeding workpieces intermittently comprising support means for the workpieces, first and second feed rods extending parallel to the support means, a plurality of projections provided on each of said first and second feed rods spaced at intervals therealong, the projections on the rods being disposed out of transverse mutual alignment, means for moving said feed rods axially in a feed direction and both rods in a retraction direction between forward and retracted positions to provide stroke at least equal to said interval, means for moving the projections into and out of the path of movement for the workpieces along the support means, movement in a feed direction of one feed rod being transmitted to the other feed rod by a workpiece so that the workpiece is held between projections on said first and second rods during the feed direction of movement of the rods and release of the workpieces during retraction of the rods is achieved by a lost motion arrangement in the retraction drive to said other feed rod.

2. An apparatus according to claim 1, wherein a pair of parallel first feed rods and a pair of parallel second feed rods are provided.

3. Apparatus according to claim 1 or claim 2, wherein the means for moving the projections into and out of the path of movement of the workpieces comprises means for rotating said first and second feed rods about their axes.

4. An apparatus according to any one of claims 1 to 3, wherein a cushioning device is mounted on the table, and has a spring-biased rod capable of acting on an end of the second feed rod (or rods) when the second feed rod (or rods) reaches it forward position.

5. Apparatus according to claim 3 or claim 4, when appendant thereto, wherein the means for rotating the first and second rods about their axes comprises a pair of gear arrangements each with a cylinder actuator mounted on the table and having a piston rod, a rack coupled to the piston rod and having a pair of first and second toothed faces, a first gear mounted for corotation with the or one of the first rod(s) and held in driving mesh with the first toothed face of the rack, and a second gear mounted for corotation with the or one of the second rod(s) and held in driving mesh with the second toothed face of the rack, the said first and second rods being axially movable relatively to the first and second gears respectively.

6. An apparatus according to any preceding claim, wherein the support means for the workpiece comprise a pair of rails

extending along parallel to the first and second feed rods.

7. An apparatus according to claim 6, wherein a plurality of bases are mounted on either of the first and second feed rods, these bases being located respectively in workpiece holders formed by projections on the rod(s) and wherein each of the bases has a height greater than that of each of the rails.

8. An apparatus substantially as described herein with reference to the drawings.

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1581698 COMPLETE SPECIFICATION
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Sheet 1

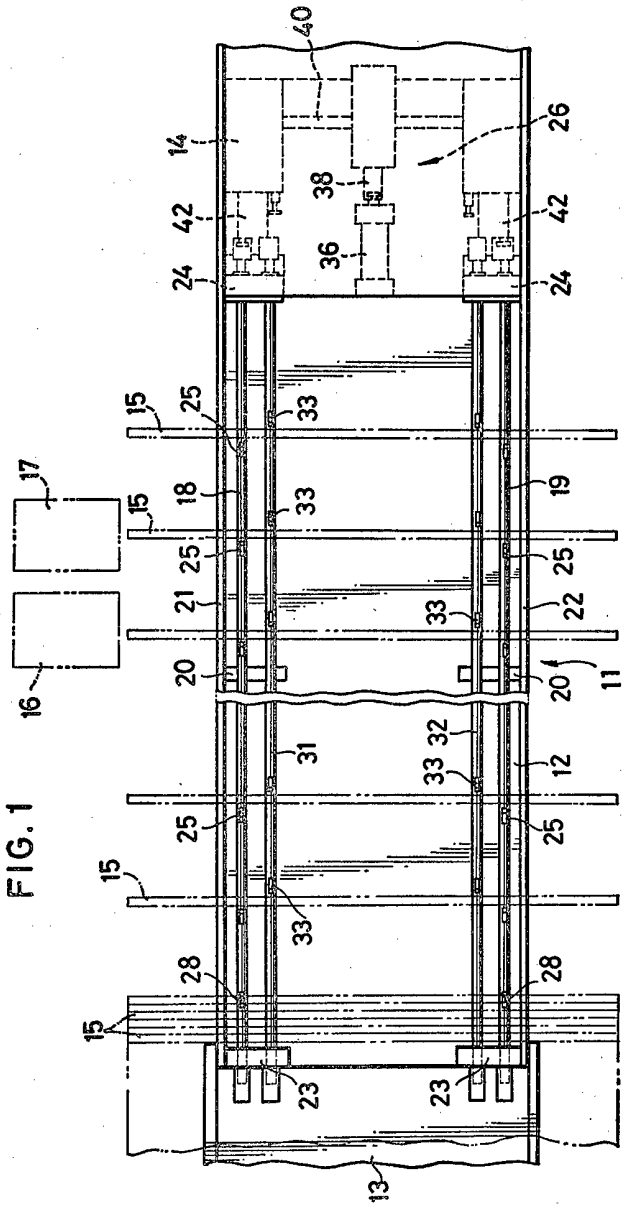

FIG. 1

1581698 COMPLETE SPECIFICATION

7 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 2

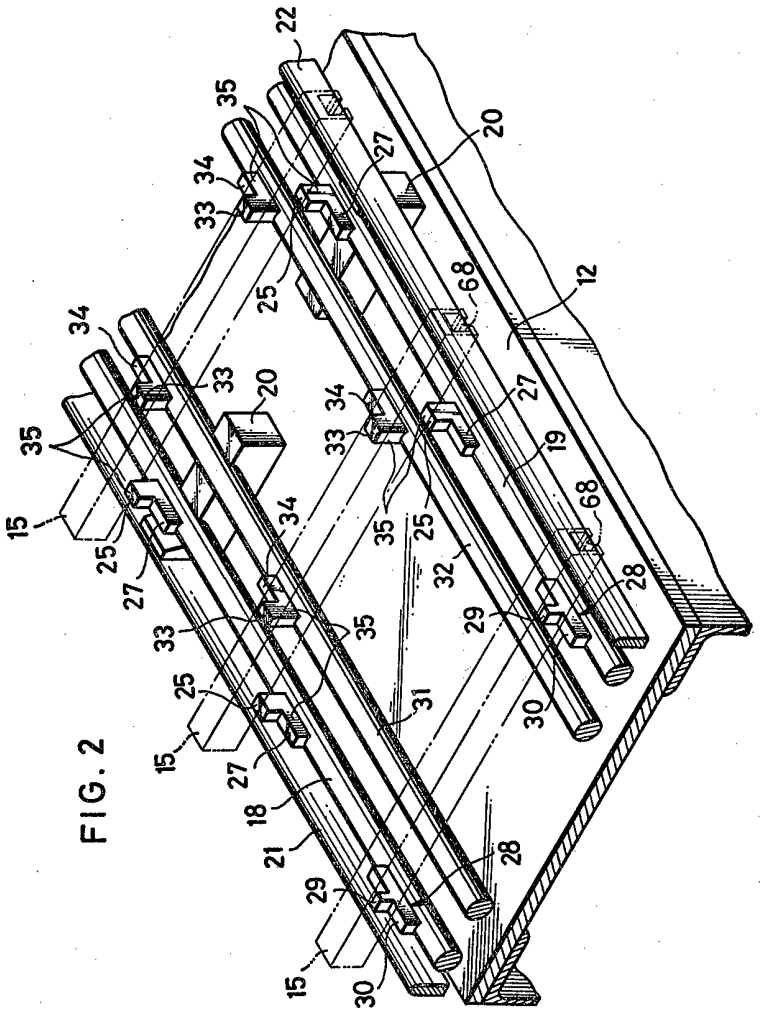

FIG. 2

1581698 COMPLETE SPECIFICATION
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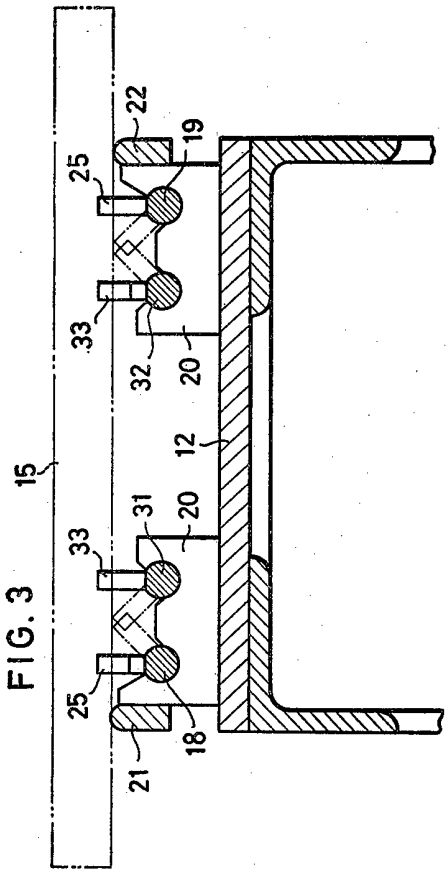

FIG. 3

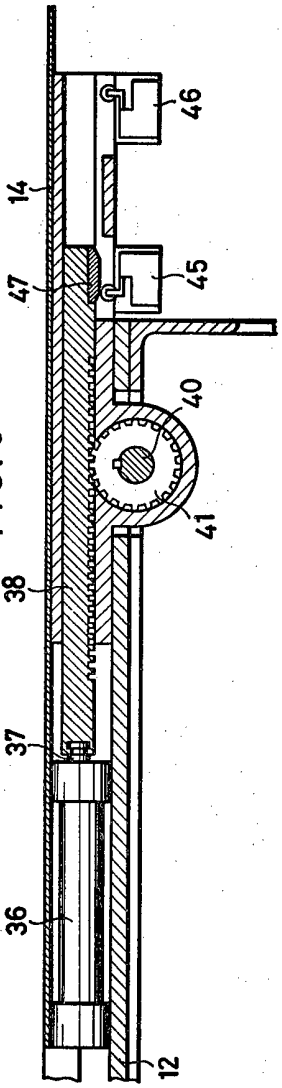

FIG. 5

FIG. 4

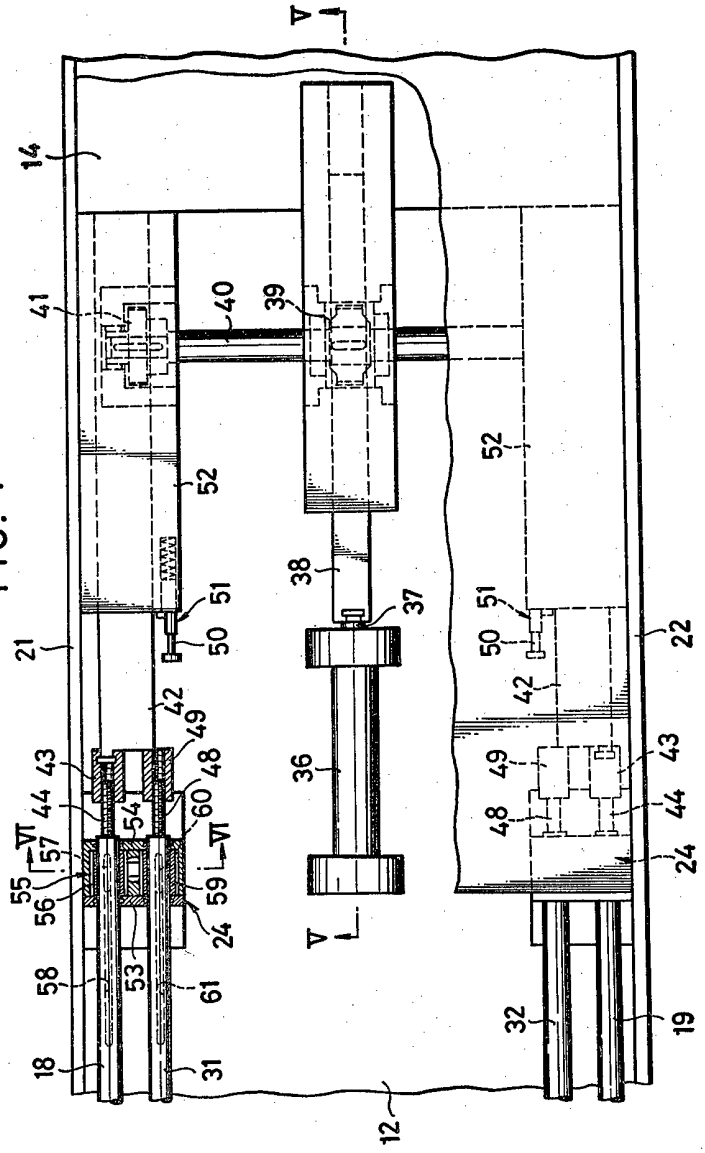
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FIG. 7A

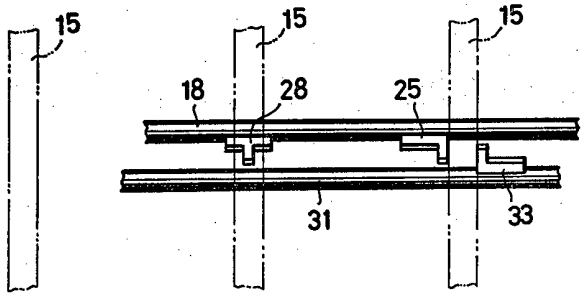


FIG. 7B

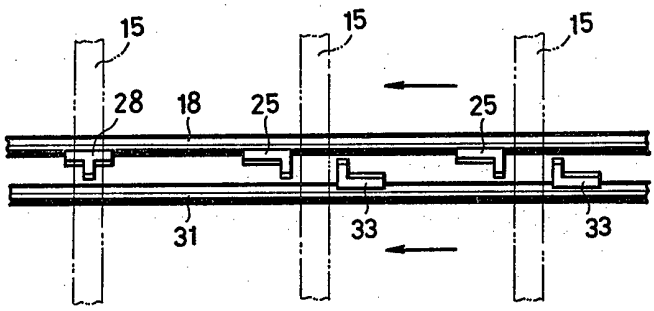


FIG. 7C

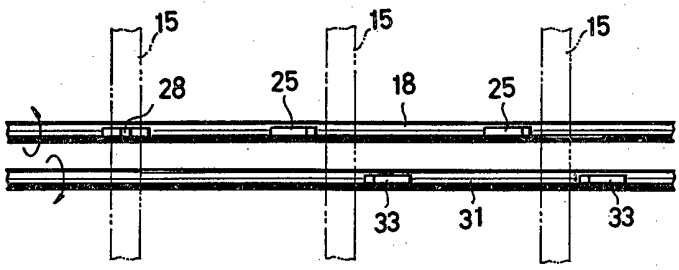


FIG. 7D

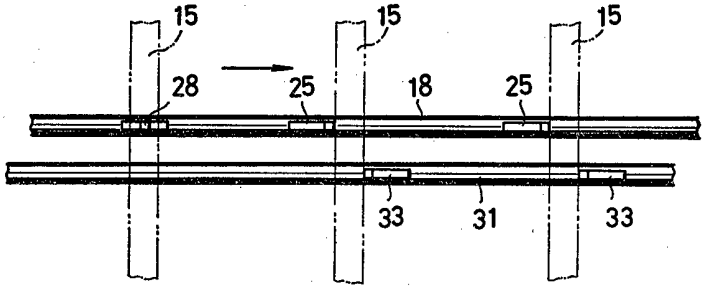


FIG. 7E

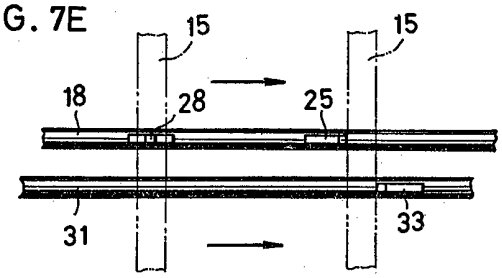
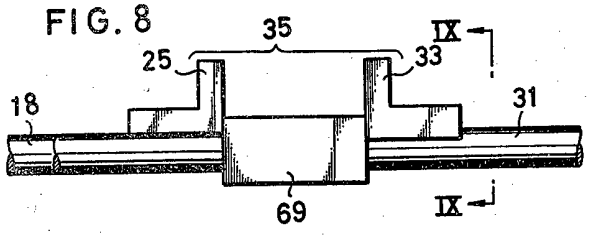


FIG. 8



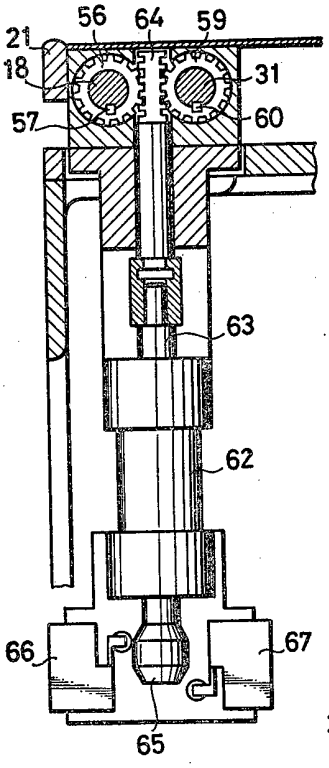


FIG. 6

FIG. 9

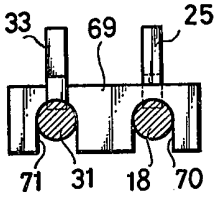


FIG. 10