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(54) **Automatic machine for slitting flexible material into strips.**

(57) Machine (10) for longitudinally slitting, by means of a plurality of cutters and rotary countercutters respectively, a continuous strip (16) of flexible material fed to it.

The cutters and countercutters are individually supported by carriages (27) movable along respective first and second guides so as to position themselves on the two sides of the strip to be slit.

Each carriage (27) comprises a geared motor for moving the carriage along the guide and position control sensors connected to a monitoring device (25) actuating said motors in order to position the cutters and countercutters in the cutting position and to adjust said position when the machine is in operation. Each carriage is advantageously provided with pneumatic brakes for locking it in place.

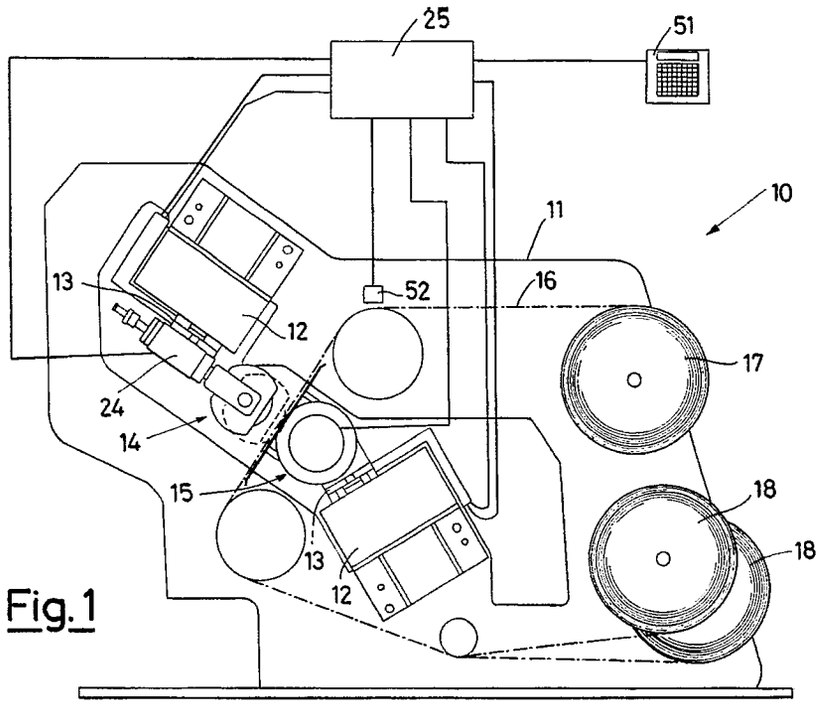

Fig.1

EP 0 453 004 A1

There are known machines for longitudinally slitting continuous strips of flexible material, such as paper, cardboard, plastic film, etc..

These machines comprise a plurality of rotary blades, called cutters, each having a respective countercutter on the opposite side of the strip of paper to be cut, said strip generally being unrolled from a feeder reel at the inlet of the machine and the plurality of strips cut from it each being rolled onto a respective outlet reel.

The cutters and countercutters are usually supported so as to be able to manually adjust their position in a crosswise direction to the strip to be cut, to enable the machine to be preset for slitting strips of different widths.

This presetting operation is usually carried out by the operator, by hand and with the machine at a standstill, before the slitting operations begin.

Moreover, since the slitting action of the cutters and countercutters is achieved by their lateral confrontation (with an action that could be likened to that of the blades of a pair of scissors), at least one of them (usually the cutter) has a crosswise adjustment device (for example, pneumatically controlled) for bringing it closer to the lateral surface of its respective countercutter. This device (usually of the all-or-nothing type), however, offers the possibility of adjusting the degree of contact upon which the quality of the cut notably depends.

The operations to be carried in starting up a machine of known technique can therefore be summarized as:
positioning the countercutters in the transversal position corresponding to the desired slitting position; subsequently positioning the cutters in place close to their respective countercutters; placing the strip between the cutters and countercutters; operating the device to bring the cutters and countercutters close together so as to start up the slitting; and lastly, starting the strip moving.

Once the slitting has begun if, for any reason whatsoever, the resulting strips are not of the right width, it is necessary to turn off the machine and repeat the described positioning operations all over again. This obviously results in an enormous waste of time.

Moreover, if the slitting operation has to be carried out on several reels and if each cut has to coincide with reference marks on the strip unrolled from each reel (printings, perforations, etc.) the result will be that, due to the typical tolerances in preparing these references, when changing from one reel to the next it will be necessary to reposition the cutters and countercutters, thus preventing the possibility of a continuous slitting operation using, for example, automatic reel changing devices.

Moreover, most of the machines of known technique have a mechanism which couples the cutters to their respective countercutters to be operated in order to move them simultaneously while operating only one of them. With this kind of mechanism, however, the strip being slit must be removed completely, thus making the adjusting operations even longer.

The general scope of this invention is to obviate the aforementioned problems by providing a transverse slitting machine for slitting a strip of flexible material, which has cutters and countercutters which are individually movable to enable them to move close together and to shift laterally to vary their cutting position, with the utmost speed and precision, even while the machine is in operation.

This scope is achieved, according to the invention, by providing a machine for longitudinally slitting, by means of a plurality of cutters and respective opposing rotary countercutters, a continuous strip of flexible material fed between them, characterized by the fact that the cutters and countercutters are individually supported by carriages movable along a first and a second guide, respectively, disposed on the two sides of the strip to be slit, substantially parallel to its surface and crosswise to its length, each carriage comprising an electric motor with a kinematic coupling to couple it to and move it along its respective guide and a position sensor to detect its position, each of the cutters and respective countercutters being movable towards and away from each other in a direction perpendicular to the continuous strip to be cut, by means of a linear actuator, all the motors, all the sensors and all the linear actuators being operatively connected to a monitoring device which controls the position of the cutters and countercutters. The innovatory principles of this invention and its advantages with respect to the known technique will be more clearly evident from the following description of a possible exemplificative embodiment applying such principles, with reference to the accompanying drawings, in which:

- figure 1 shows a schematic lateral elevational view of a slitting machine according to the invention;
- figure 2 shows a substantially frontal partial cutaway view of a part of the machine of figure 1;
- figure 3 shows a schematic cross-sectional view of a detail of the machine of figure 1;
- figure 4 shows a section plan cutaway view along the line IV-IV of figure 3;
- figure 5 shows a schematic view of a part of the machine of figure 1;
- figure 6 shows a partial cross-sectional view along a median plane of a detail of the machine of figure 1.

With reference to the figures, a machine made

according to this invention and generically indicated by reference 10 is shown schematically in figure 1, where the wall in the foreground has been removed to show the parts in question. Said machine 10 comprises a supporting structure 11 on which are supported two box-shaped beams 12 in which slide (as can be clearly seen in figure 2) a plurality of carriages 27 with a protruding portion 13, each supporting cutter units 14 and countercutter units 15, respectively. Running between the units 14 and 15 is a strip to be cut 16 which winds off a reel 17, while the plurality of cut strips each wind onto an outlet reel 18.

Since the plurality of carriages 27, upper and lower, are essentially identical to one another, hereinafter only one of them will be described. In the figures showing more than one carriage the parts having the same name will be indicated by the same reference number followed by the suffix "prime". As can be clearly seen in figure 2, each countercutter unit comprises a rim 19 which is made to rotate by a coaxial motor 20 (of the type for example with an external rotor). Each cutter unit comprises an idle wheel 21 supporting a circumferential blade 22. The idle wheel is connected to the shank 23 of a linear actuator 24 so as to bring it close to the strip to be cut in a direction perpendicular to the sliding surface of the latter.

Figure 3 shows the portion of the carriage 27 inside its respective supporting beam 12, to which is connected, through a slot 28 traversing the entire length of the beam, a flange 26 for supporting the cutter or countercutter unit. The carriage 27 runs along a ball-bearing guide 29 secured inside the beam 12 and comprises an electric geared motor 30 with pinion 31 meshing with a rack extending transversally to the beam 12.

The carriage comprises, moreover, a position sensor 33 sliding along an optical line 34 extending transversally to the beam to indicate the position of the carriage with respect to the beam 12.

The carriage also comprises hydraulic brakes composed of pistons 35 which are fed through pipes 36, 37 and which when actuated press against an internal wall of the beam so as to lock the position of the carriage.

As can be clearly seen in figures 4 and 5, the slot 28 along which the carriages slide is closed by a thin metal plate 37 passing through each carriage in correspondence with a shaped passage 38 with end rollers 39. Disposed at the edges of the slot 28 are magnetic bands 40 to ensure that the metal plate 37 adheres to the beam, thus preventing cutting scraps from penetrating inside the beam.

As can be seen in particular in figure 5, each carriage 27 comprises on one side a proximity sensor 41 and on the other side an activating bracket 42, so that each carriage can detect the excessive closeness of another carriage sliding along the same beam. For example, figure 5 shows part of a second carriage with protruding portion 13' and with its bracket 42' actuating the sensor 41 of the carriage with protruding portion 13.

As shown in figure 6, each idle wheel 21 supporting a cutter advantageously comprises a spring-operated mechanism enabling the blade to slide axially, so as to absorb working and position tolerances of the cutters and countercutters. In particular, each wheel 21 comprises a hollow pin 43, integral with the shank 23, and supporting, by means of a bearing 44 to enable their relative axial sliding, a hub 45 in turn supporting, by means of bearings 46, a frame 47 to which the blade 22 is secured.

Disposed inside the hollow pin 43 is a thrust spring 48 acting between a second pin 49 secured to the hub 45 and a bush 50, the latter being screwable in order to adjust the compression of the spring 48.

In this way, the lateral stresses on the blade 22 act, against the action of the spring 48, to cause the part 45 to slide axially on the hollow pin 43. By adjusting the compression of the spring, it is possible to establish the degree of stress required in order to cause such sliding, so as to prevent any slight unevenness in the texture of the material to be slit from causing shifting which would give rise to wavy and inaccurate cuts.

As shown schematically in figure 1, the entire machine 10 is monitored by a monitoring device 25, for example microprocessor-controlled, which monitors the motors of the carriages, the linear actuator of the cutters, the motors for rotation of the countercutters and all the position and proximity sensors, as well as the mechanism for unwinding and rewinding the strip of material being cut. Said device 25, for example controllable by means of a keyboard and display unit 51, will not be further described, since it is of known technique and, especially in view of the following description, easily imaginable by any technician expert in the art.

The machine described above operates in the following way. First the strip to be cut (for example, a strip of paper, cardboard, etc.) is positioned between the cutters and countercutters.

Then the position of the plurality of upper and lower carriages is controlled by means of the keyboard 51, so as to position them in the required cutting position; the cutters to be used (since the number of cutters can be greater than the number of cuts required) are then lowered by operating the pistons 24, and lastly, the cutting operation is started up.

The position requested for each cut, by means of the keyboard or other data input device (for

example, a magnetic support), is processed by the device 25 which monitors the movement of the carriages by means of the motors 30 while it receives a feedback signal of their position by means of the sensors 33 which read the relative positions along the optical line 34. Any errors or failures, or simply any careless commands given by the operator, which would lead to the collision of two carriages moving along the same supporting beam, are neutralized by the proximity sensors 41 which, by means of a signal to the device 25, stop the carriages whenever they detect a bracket 42 approaching.

Thanks to the possibility of accurate positioning offered by a feedback system as described, it is possible to bring the cutters and countercutters close together without the need for further shifting devices, such as for example pneumatic cylinders, disposed in the idle wheel supporting the cutters, as are, on the contrary, required in the known technique.

It is consequently possible to achieve a precise adjustment of the contact force between the cutters and countercutters thereby obtaining a better quality cut. Any small differences, due for example to a lack of perfect parallelism between the cutters and the countercutters, are absorbed by the spring device shown in figure 6. Once the positioning has been carried out, the device 25 actuates the brakes 35 so as to firmly secure the carriages in the required positions.

During the slitting, if the reference marks to be followed on the strip should shift, due to a printing error or in changing from one reel to the next, it is sufficient to send a signal to the monitoring device 25 whereupon it will make the necessary adjustments, moving the cutters and respective countercutters in synchronism so as to ensure continuity of the cutting.

The signal indicating the shifting of the references marks can be sent either by hand by means of the keyboard 51, after visual detection by the operator, or automatically by means of optical systems 52, for example with photoelectric cells, which detect the position of such reference marks and communicate it to the device 25. These optical systems are per se of known technique and therefore not further described, since they are easily imaginable by any expert technician.

The foregoing description of an embodiment applying the innovatory principles of this invention is obviously given merely by way of example in order to illustrate such innovatory principles and should not therefore be understood as a limitation to the sphere of the invention claimed herein.

For example, the mechanism moving the strip to be cut is of known technique and therefore shown only schematically in the drawings. The number of driven and non-driven rollers can obviously be extremely varied and their disposition can differ in order to adapt the machine to particular requirements, made necessary for example by the material of which the strip to be cut is made.

The number of carriages actually possessed by the machine will be in relation to the maximum number of cuts envisaged for that particular machine.

According to a possible variation of the machine described above, the device 25 could, for example for structural economy, be made with a piloting circuit for one motor only switchable in sequence from one carriage to the other. In this way, the device 25 connects the piloting circuit to one carriage, to enable it to move the carriage into position, locks it in place with the corresponding brake 35, switches the electric actuator on to another carriage, moves it, etc. until it has positioned and locked in place all the carriages on the machine.

Claims

1. A machine for longitudinally slitting, by means of a plurality of cutters (14) and respective opposing rotary countercutters (15), a continuous strip (16) of flexible material fed between them characterized by the fact that the cutters (14) and countercutters (15) are individually supported by carriages (27) movable along a first and a second guide (29), respectively, disposed on the two sides of the strip (16) to be slit, substantially parallel to its surface and crosswise to its length, each carriage (27) comprising an electric motor (30) with a kinematic coupling to couple it to and move it along its respective guide (29) and a position sensor (33) to detect its position, each of the cutters and respective countercutters being movable towards and away from each other in a direction perpendicular to the continuous strip to be cut, by means of a linear actuator (24), all the motors (30), all the sensing devices (33) and all the linear actuators (24) being operatively connected to a monitoring device (25) which controls the position of the cutters (14) and countercutters (15).

2. Machine as claimed in claim 1, characterized by the fact that the linear actuators (24) shift the cutters with respect to the countercutters (15).

3. Machine as claimed in claim 1, characterized by the fact that said sensing device (33) comprises a sensor for detecting reference marks disposed along an optical line (34) disposed

parallel to its respective guide (34).

4. Machine as claimed in claim 1, characterized by the fact that the kinematic coupling comprises a pinion (31) actuated by the motor (30) and meshing with a rack (32) disposed parallel to its respective guide (29).

5. Machine as claimed in claim 1, characterized by the fact that each carriage (27) comprises a braking device which is operated to lock it in place along its respective guide (29).

6. Machine as claimed in claim 5, characterized by the fact that each braking device comprises at least one movable piston (35) which is operated by fluid under pressure to press its braking surface against a corresponding fixed surface on the machine.

7. Machine as claimed in claim 1, characterized by the fact that each guide (29) is contained, together with the corresponding carriages (27), in a box-shaped beam (12) with a longitudinal aperture (28) for the passage, for each carriage (27), of a cutter and countercutter support (26).

8. Machine as claimed in claim 7, characterized by the fact that the longitudinal aperture (28) is closed by a thin metal plate (37) passing slidingly through passages (38) in each support (26).

9. Machine as claimed in claim 8, characterized by the fact that the edges of the longitudinal aperture (28) comprise magnets (40) to attract the metal plate (37), made of ferromagnetic material.

10. Machine as claimed in claim 1, characterized by the fact that each carriage (27) comprises a proximity sensor (41), connected to the monitoring device (25), for detecting whenever it is within a minimum distance from the other carriages (27).

11. Machine as claimed in claim 1, characterized by the fact that each cutter is supported by its respective carriage (27) by interposition of limited sliding means (21) which slide, against the action of a spring, in a direction parallel to the guide.

12. Machine as claimed in claim 11, characterized by the fact that the limited sliding means (21) comprise a hollow pin (43) integral with the cutter support and supporting, by means of an axially sliding bearing (44), a hub (45) in turn supporting, by means of roller bearings (46), a frame (47) to which is secured the cutter, an axial thrust spring (48) acting between the hub (45) and the hollow pin (43).

13. Machine as claimed in claim 12, characterized by the fact that the axial thrust spring (48) acts on said hollow pin (43) through a bush (50) which is axially adjustable in order to adjust the axial compression of the spring (48).

14. Machine as claimed in claim 1, characterized by the fact that disposed along the path of the continuous strip (16) are sensors (52) for detecting reference marks on it, said sensors (52) being connected to the monitoring device (25) to command the shifting of the carriages (27) in order to make cuts in pre-established positions with respect to said reference marks.

15. Machine as claimed in claim 1, characterized by the fact that said monitoring device (25) comprises a presetting and manual control unit (51), composed of a keyboard and a display.

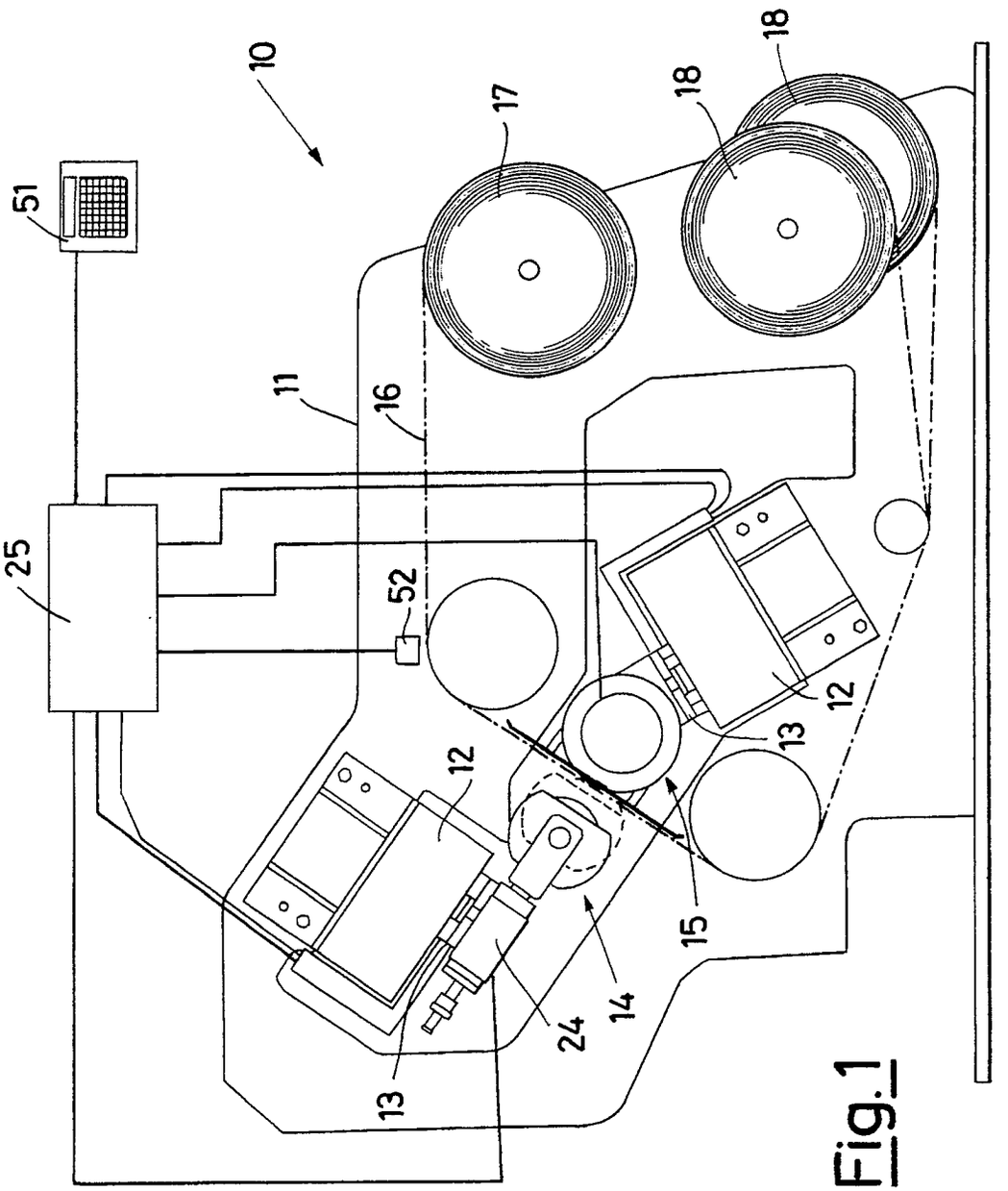

Fig.1

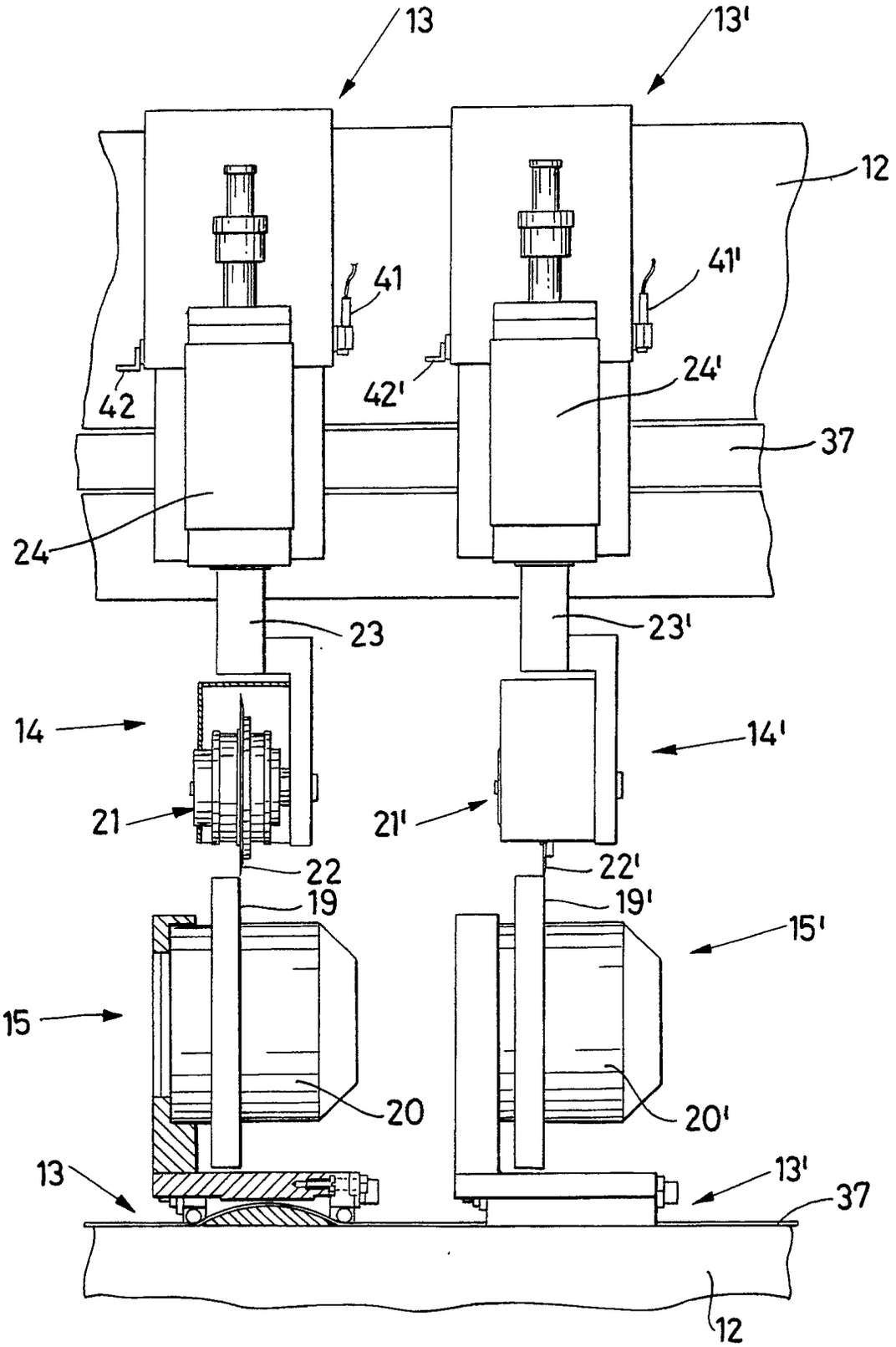
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Fig.2

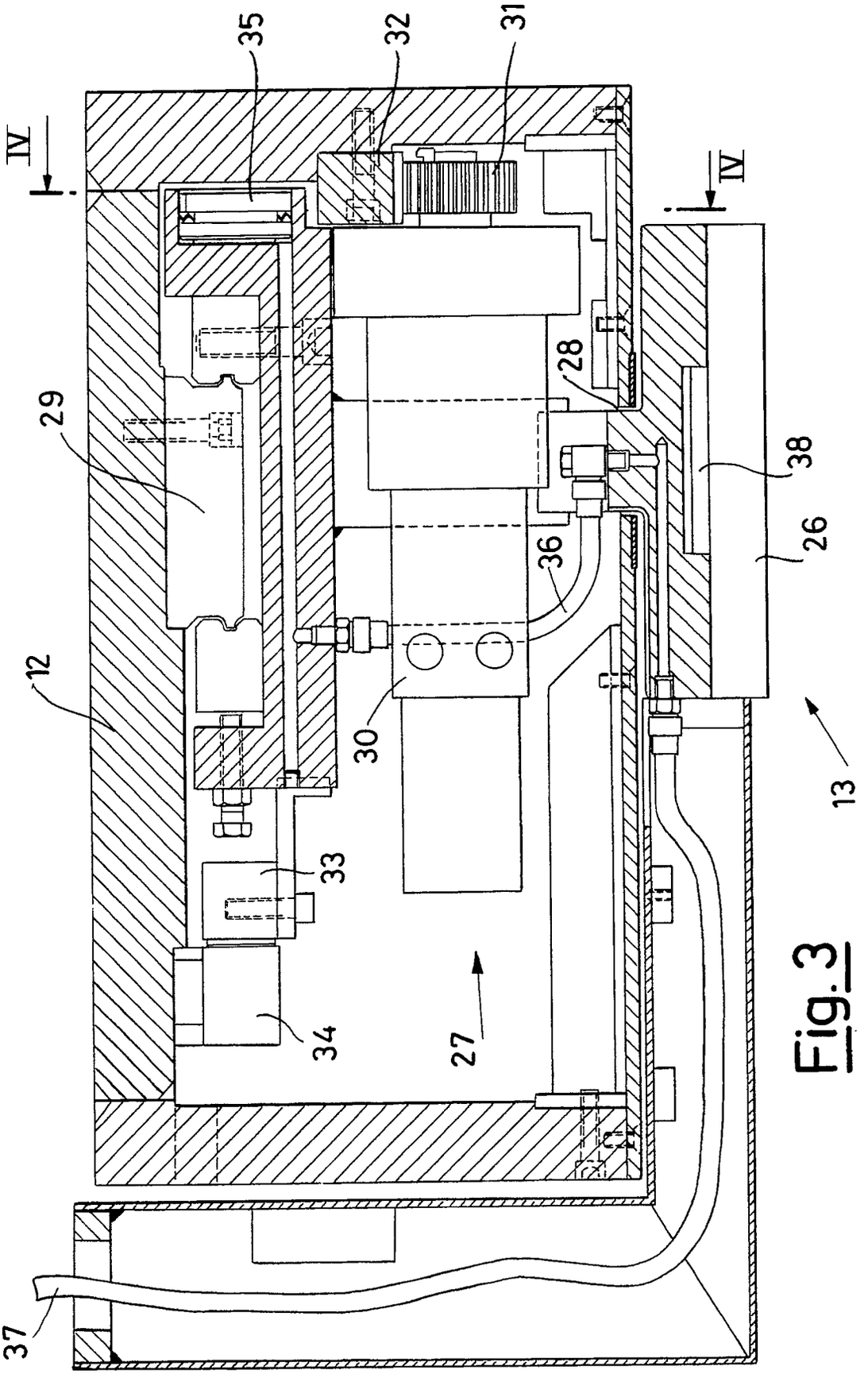

Fig.3

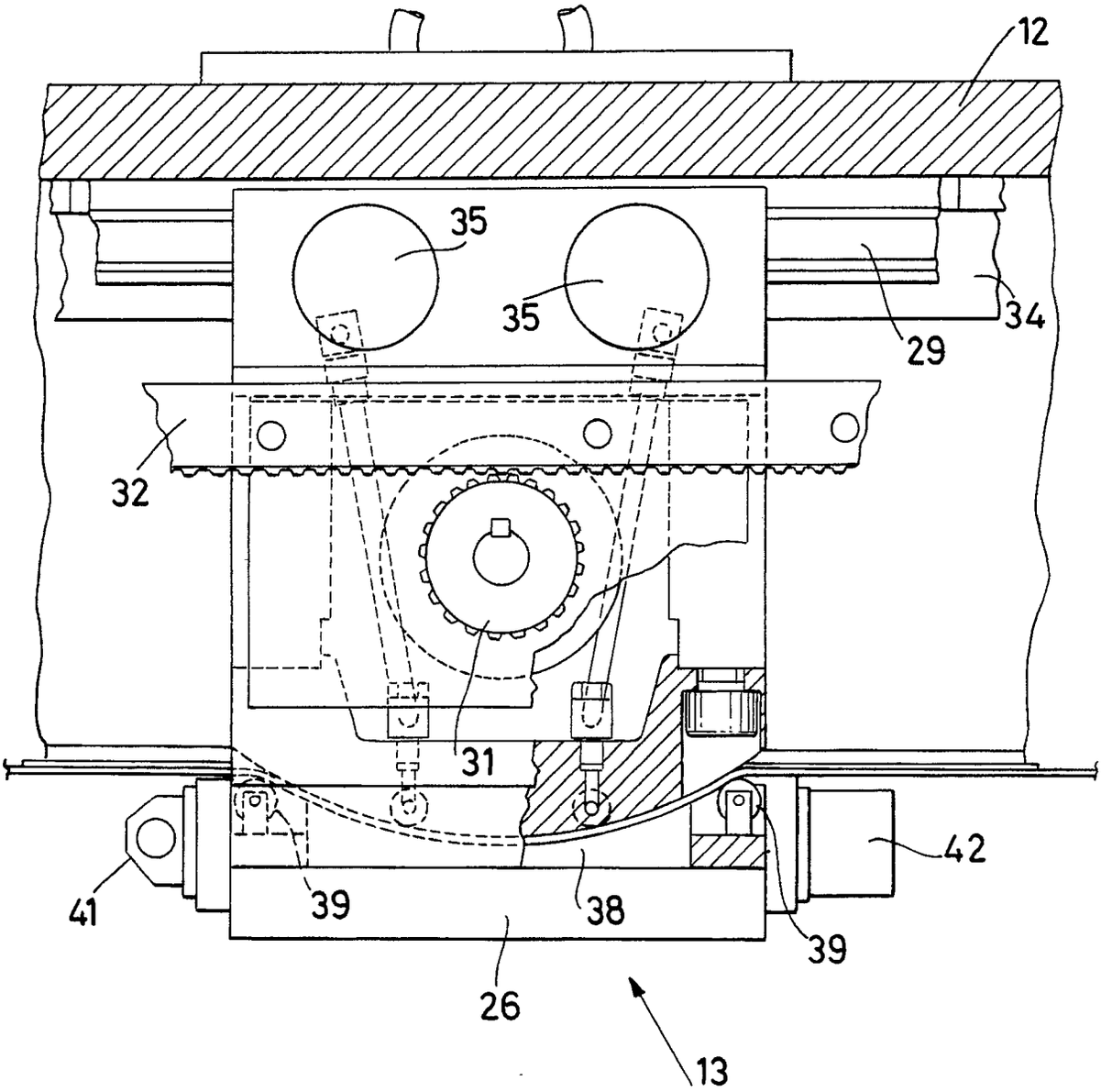

Fig.4

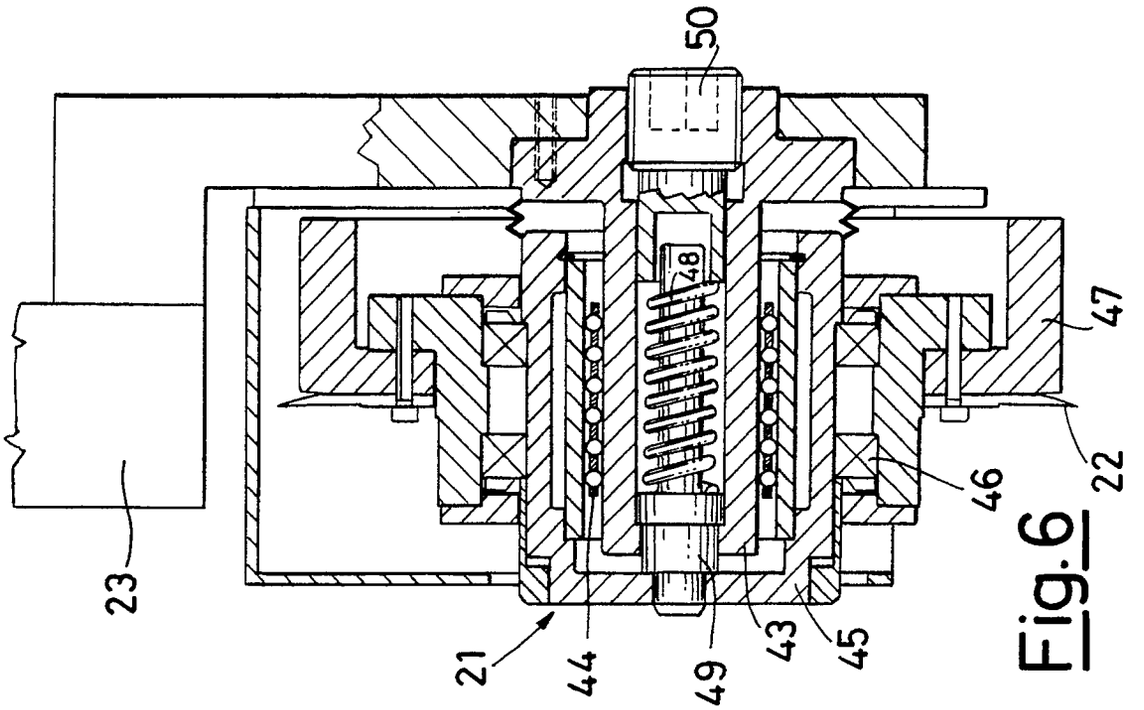

Fig.6

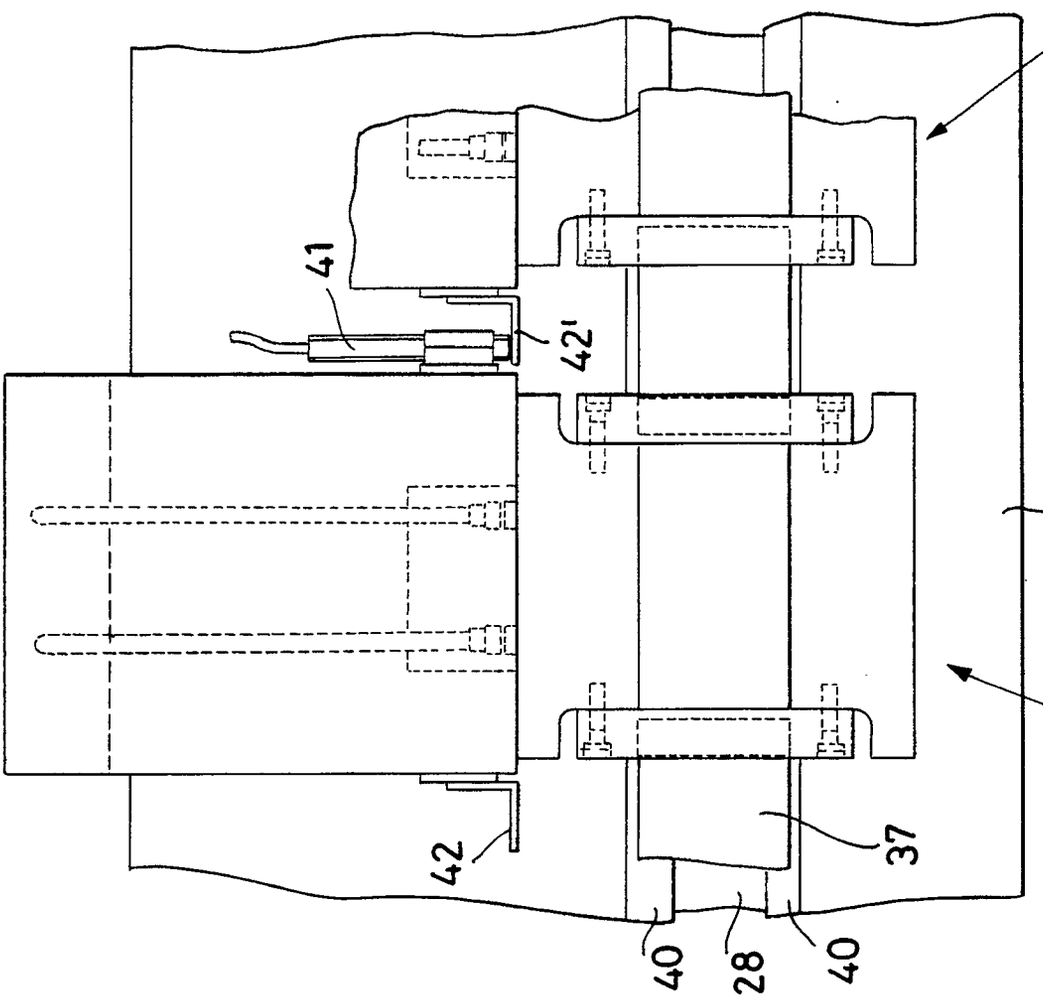

Fig.5

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EUROPEAN SEARCH REPORT

Application Number

EP 91 20 0493

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X,Y	GB-A-2 072 563 (ELIO CAVAGNA) * the whole document *	1,2,4-6,3, 7-15	B 26 D 7/26
Y	DE-A-3 914 184 (EFUESUKEI K.K.) * column 4, lines 13 - 45 *	3,14	
Y	EP-A-0 347 060 (TIDLAND CORPORATION) * column 8, line 33 - column 9, line 36 * * column 10, lines 33 - 35; figures 3-6 *	7-9,15	
Y	DE-A-3 247 711 (GRESSER) * claim 1; figure 1 *	10	
Y	GB-A-2 089 709 (DIENES WERKE FÜR MASCHINEN-TEILE GMBH CO. KG) * page 1, lines 90 - 123; figure 1 *	11-13	
A	DE-A-3 437 995 (ELIO CAVAGNA S.R.L.) * page 8, line 19 - page 12, line 11; figures *	1	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

B 23 D
B 26 D

The present search report has been drawn up for all claims

Place of search	Date of completion of search	Examiner
The Hague	26 July 91	GARELLA M.G.C.D.

CATEGORY OF CITED DOCUMENTS

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