

(19)



(11)

EP 4 470 951 A2

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:
04.12.2024 Bulletin 2024/49

(51) International Patent Classification (IPC):
B65H 18/16 (2006.01) **B65H 18/26** (2006.01)
B65H 45/08 (2006.01)

(21) Application number: **24172106.7**

(52) Cooperative Patent Classification (CPC):
B65H 45/08; B65H 18/16; B65H 18/26;
B65H 2301/41468; B65H 2511/22; B65H 2553/51;
B65H 2555/10; B65H 2555/11; B65H 2701/1752;
B65H 2701/1944

(22) Date of filing: **24.04.2024**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL
NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA
Designated Validation States:
GE KH MA MD TN

(71) Applicant: **Lpmachinery S.r.l.**
15033 Casale Monferrato (AL) (IT)

(72) Inventor: **PATRUCCO, Luciano**
15033 Casale Monferrato (AL) (IT)

(74) Representative: **Studio Torta S.p.A.**
Via Viotti, 9
10121 Torino (IT)

(30) Priority: **01.06.2023 IT 202300011268**

(54) **WINDING GROUP FOR AN EXTENDIBLE FILM RECOILING MACHINE AND EXTENDIBLE FILM RECOILING MACHINE**

(57) A winding group (3) for a recoiling machine (1) of extendible film (20) is described, comprising an assembly (51) for supporting a core (12) so it can rotate about a first rotational axis (B), a winding roller (50) rotatable about a second rotational axis (A), at least partially wound around by the extendible film (20) and being adapted to wind the core (12) around with the film; and

a control unit (52). The winding group (3) comprises an electrical actuator (53, 54) operatively connected to the assembly (51) and the control unit (52) is programmed to command the electrical actuator (53, 54) to vary the distance of said second rotational axis (B) from the first rotational axis (A).

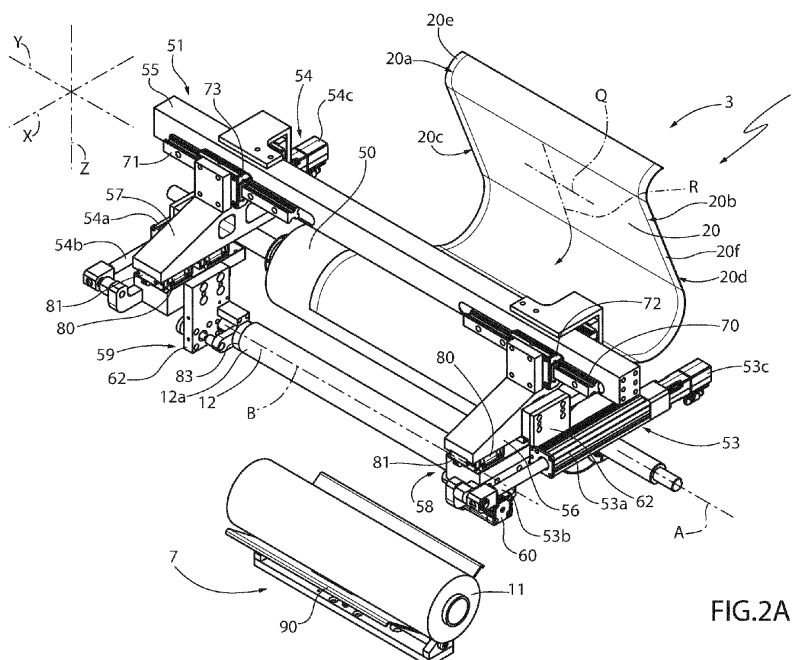


FIG.2A

EP 4 470 951 A2

Description

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This patent application claims priority from Italian patent application no. 102023000011268 filed on June 1st, 2023, the entire disclosure of which is incorporated herein by reference.

TECHNICAL FIELD

[0002] This invention relates to a winding group for an extendible film recoiling machine and to an extendible film recoiling machine.

BACKGROUND

[0003] In general, in production plants for extendible film using extrusion, for example for packaging, the film produced is wound around cardboard cores, creating coils of different sizes, with weight varying from a few kilograms to some tens of kilograms. The coils that weigh more, called "jumbo" coils are characterised by very large diameters and the overall length of the film they are made up of is in the order of thousands of metres.

[0004] These "jumbo" coils are successively processed by recoiling machines, which make it possible to obtain coils of extendible film, which are shorter in length, from the "jumbo" coils.

[0005] The recoiling machines basically comprise:

- an unwinding group, at which a primitive coil is gradually unwound; and
- a winding group, at which the film unwound from the primitive coil is wound on a core until the desired length is reached.

[0006] In particular, known winding groups comprise a winding roller that can be rotated around a mobile rotation axis and that is partially wound around by the film unwound by the primitive coil. The winding roller is placed in contact with the core of the coil to be formed in order to gradually transfer to it, via friction, the same film from which it is wound.

[0007] Known winding groups also comprise:

- at least one pneumatic actuator, which is operationally connected to the winding roller, to adjust the distance of the winding roller itself from the coil being formed and, thus, the pressure exerted by the winding roller on the coil being formed; and
- a mobile mechanical stop, which counterbalances the action exerted by the winding roller against the coil being formed due to the pneumatic actuator.

[0008] In other words, the distance between the winding roller and the coil being formed and the pressure in play are controlled over time by the algebraic sum of two

contributions acting in opposite directions, of which one is provided by the pneumatic actuator and the other by the mobile mechanical stop.

[0009] However, these known winding groups have a large number of components and do not always make it possible to obtain an optimal and accurate control over the winding.

[0010] In detail, due to the compressibility of air, the force exerted by the pneumatic actuator on the winding roller is not constant. This risks significantly worsening the quality of the winding.

[0011] Known recoiling machines are sometimes also provided with a pre-stretch group, which comprises multiple rollers adapted to pre-stretch - i.e. to stretch along the longitudinal direction - the film unwound from the unwinding group, before this is re-wound around a core by the winding group.

[0012] The resulting pre-stretched film is more easily used than film having not undergone this pre-stretching process, since it is not necessary to stretch it during the packaging operations and it can be used, for example, for packaging fragile or deformable goods.

[0013] However, the pre-stretching operation subjects the film to greater stresses, which in the presence of impurities in the film, may cause tears during the operation of the recoiling machines.

[0014] In order to limit the risk of tears in the film, it is known to refold the longitudinal edges of the film one or more times on themselves. This folding actually determines a thickening of the film at the longitudinal edges and acts as a mechanical barrier to tears spreading in the film. In detail, the folded edges prevent the film from tearing completely during the pre-stretching process and during use of the film.

[0015] Especially in the case of edges folded more than once, during the winding of the film around the core, the folding exerts gradually increasing tensions on the core. Specifically, the folding of successive layers of wound film is arranged in the same position along the longitudinal extension of the core. This can significantly affect the quality of the coil produced and/or determine the collapse of the core.

[0016] There is a need, therefore, to provide a winding group that makes it possible to efficiently and accurately wind the film on the coil being formed.

[0017] The purpose of this invention is to produce a winding group allowing to satisfy the above need in a simple and inexpensive manner.

DESCRIPTION OF THE INVENTION

[0018] The above-mentioned purpose is achieved with this invention, as it relates to a winding group according to claim 1.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] Two preferred, non-limiting embodiments of this

invention will be described by way of example with reference to the attached drawings, wherein:

- Figure 1 illustrates a side view of a recoiling machine according to a first embodiment of this invention comprising a winding group with parts removed for clarity;
- Figures 2A, 3B, 4C, and 5D are perspective views of the winding group in Figure 1 in different respective operating positions and with parts removed for clarity;
- Figures 6A, 7B, 8C, and 9D are side views of the winding group in Figure 1 respectively in the operating positions illustrated in Figures 2A, 3B, 4C, and 5D and with parts removed for clarity;
- Figure 10 is a perspective view of the winding group of Figures 1 to 9D comprising an oscillation mechanism;
- Figure 11 is a block diagram of a portion of the winding group in Figures 1 to 10; and
- Figure 12 illustrates a recoiling machine according to a second embodiment of this invention comprising a winding group with parts removed for clarity.

EMBODIMENTS OF THE INVENTION

[0020] With reference to Figure 1, reference number 1 indicates a recoiling machine of extendible film 20. The extendible film 20 is, in particular, a film made of plastic, for example polyester, polyethylene, or polypropylene. The extendible film 20 is preferably made of Linear Low-Density Polyethylene (LLDPE).

[0021] As illustrated in the figures, the extendible film 20 has a longitudinal extension direction R and a transverse direction Q, which is orthogonal to the longitudinal direction R. Specifically, the extendible film 20 comprises longitudinal edges 20a, 20b; 20c, 20d opposite each other along the transverse direction Q and extending along the longitudinal direction R.

[0022] The recoiling machine 1 has the purpose of producing coils 11 of extendible film 20 with the desired length starting from a primitive coil 10. "Length" means the total length of the film 20 forming the coil.

[0023] The recoiling machine 1 basically comprises:

- an unwinding group 2, which is adapted to unwind the extendible film 20 from the primitive coil 10; and
- a winding group 3, which is adapted to wind the extendible film 20 unwound from the unwinding group 2 around a virgin core 12 to form the coil 11.

[0024] According to the embodiment illustrated, the recoiling machine 1 also comprises a pre-stretch group 4, which is adapted to pre-stretch the film 20 unwound from the unwinding group 2 before it is wound by the winding group 3. Specifically, pre-stretching the film 20 means stretching it along the longitudinal direction R. The tension applied to the film 20 along its length determines its

lengthening (for example, in the order of 300%).

[0025] As illustrated in Figure 1, the pre-stretch group 4 is at least partially interposed between the unwinding group 2 and the winding group 3 along a direction X of the machine 1.

[0026] The recoiling machine 1 also comprises a main body 5, to which the unwinding group 2, the winding group 3, and the pre-stretch group 4 are operationally connected.

[0027] The recoiling machine 1 also comprises an electronic control unit 52, which is only illustrated schematically in Figures 1 and 11.

[0028] Specifically, the unwinding group 2 comprises (Figure 1) :

- a first and a second support 30, 33 adapted to support a respective primitive coil 10 relative to the main body 5. The first and the second support 30, 33 support the respective primitive coil 10 rotatably around respective rotation axes I during its unwinding; and
- an unwinder device 35 adapted to rotate the coil 10 mounted on the first support 30 or on the second support 33 around its rotation axis I to unwind it.

[0029] The primitive coils 10 can preferably rotate idly on the supports 30, 33.

[0030] More specifically, the unwinding group 2 comprises a coil change mechanism 31 comprising, in turn:

- an arm 32 hinged to the main body 5 around a rotation axis J;
- the first support 30 adapted to support a first primitive coil 10; and
- the second support 33 adapted to support a second primitive coil 10.

[0031] More specifically, the arm 32 comprises two ends 32a, 32b opposite each other along a longitudinal direction K of the arm 32. The first support 30 is arranged at one (32a) of the two ends 32a, 32b; the second support 33 is arranged at the other (32b) of the two ends 32a, 32b.

[0032] In addition, the arm 32 is rotatable about the rotation axis J between:

- a first position, illustrated in Figure 1, wherein the first support 30 faces the unwinder device 35 and the second support 33 is opposite the unwinder device 35 in relation to the first support 30; and
- a second position, not illustrated, wherein the second support 33 faces the unwinder device 35 and the first support 30 is opposite the unwinder device 35 in relation to the second support 33.

[0033] Specifically, when the arm 32 is in the first position, the second support 33 can be loaded with a new primitive coil 10 while the primitive coil 10 supported by the first support 30 is unwound by the unwinder device 35. Similarly, when the arm 32 is in the second position,

the first support 30 can be loaded with a new primitive coil 10 while the primitive coil 10 supported by the second support 33 is unwound by the unwinder device. More specifically, in the first position, the second support 33 can be accessed from the outside of the machine 1; in the second position, the first support 31 can be accessed from the outside of the machine 1.

[0034] As illustrated in Figure 1, the unwinder device 35 comprises:

- a drive pulley 36 that can rotate around its rotation axis in relation to the main body 5;
- a driven pulley 37 that can rotate around its rotation axis in relation to the main body 5; and
- an unwinder belt 38 wound around the drive pulley 36 and the driven pulley 37 and adapted to be placed in contact with the primitive coil 10.

[0035] In particular, the unwinder belt 38 is adapted to unwind, via friction, the film 20 wound around the primitive coil 10 it is in contact with.

[0036] In addition, the unwinder device 35 comprises a device 39 for adjusting the distance between the unwinder belt 38 and the primitive coil 10 facing it. The device 39 is adapted to move the assembly consisting of the drive pulley 36, driven pulley 37, and unwinder belt 37 between one position wherein the unwinder belt 37 is in contact with the primitive coil 10 facing it and a position wherein the unwinder belt 37 is spaced apart from the primitive coil 10 facing it. More specifically, the device 39 is adapted to vary the position of the unwinder belt 37 in relation to the main body 5, with the purpose of ensuring continuous contact between the unwinder belt 37 and the primitive coil 10 facing it as the diameter of the primitive coil 10 is reduced due to its being unwound. The device 39 preferably comprises one or more pneumatic or electrical actuators.

[0037] The unwinder device 35 is operationally connected to the control unit 52. The control unit 52, in turn, is programmed to command the unwinder device 35 to vary the distance between the unwinder belt 37 and the primitive coil 10 facing it.

[0038] The winding group 3 comprises:

- a winding roller 50 that can rotate around a rotation axis A and adapted to be at least partially wound around by the extendible film 20; and
- an assembly 51 adapted to support the core 12 rotatably around a rotation axis B.

[0039] The rotation axes A and B are parallel to each other and spaced apart from each other along the direction X.

[0040] Advantageously, the winding group 3 comprises two electrical actuators 53, 54 operationally connected to the assembly 51 and the control unit 52 is programmed to command the electrical actuators 53, 54 to vary the distance of the rotation axis B in relation to the rotation

axis A. As a result, the electrical actuators 53, 54 are adapted to adjust the distance of the core 12 from the winding roller 50.

[0041] The core 12 is a tubular, cylindrical body, for example made of cardboard, and comprising two ends 12a, 12b opposite each other parallel to the rotation axis B. The core 12 is adapted to be repeatedly wound around by the extendible film 20, until a coil 11 is formed.

[0042] In the embodiment illustrated, the rotation axis A is fixed in relation to the main body 5, the rotation of the winding roller 50 around the rotation axis A is motorised and the core 12 is idle around the rotation axis B.

[0043] Specifically, the winding group 3 comprises a motor 50a operationally connected to the winding roller 50 and adapted to rotate it around the rotation axis A and a device 50b for measuring the angular position and/or angular velocity of the winding roller 50 in relation to the rotation axis A. The device 50b is operationally connected to the control unit 52 (Figure 11). In the embodiment illustrated, the device 50b comprises an encoder.

[0044] As illustrated in Figures 2A, 3B, 4C, and 5D, the assembly 51 comprises a main body 55, an arm 56 and another arm 57, which are operationally connected to the main body 55 and spaced apart from each other parallel to the rotation axis B.

[0045] The assembly 51 also comprises a gripping unit 58 and another gripping unit 59, which are adapted to grip the core 12, each at a respective end 12a, 12b.

[0046] The gripping units 58 and 59 are connected so as to slide in relation to the arm 56 and to the other arm 57 parallel to the direction X. Specifically, the electrical actuator 53 is operationally connected to the gripping unit 58 to make it slide along the direction X in relation to the respective arm 56 and the electrical actuator 54 is operationally connected to the gripping unit 59 to make it slide along the direction X in relation to the respective arm 57. The gripping units 58 and 59 can preferably move independently of each other.

[0047] Specifically, each gripping unit 58, 59 comprises: a respective coupling element 80 and each arm 56, 57 comprises a respective coupling element 81. Each coupling element 80 is coupled to the respective coupling element 81 to enable the gripping unit 59 to slide in relation to the respective arm 56, 57. In the embodiment illustrated, each coupling element 80 comprises a slide and each coupling element 81 is a direct linear guide parallel to the direction X.

[0048] The gripping units 58, 59 are preferably arranged below the respective arms 56, 57 along a vertical direction Z orthogonal to the direction X, i.e. closer than the arms 56, 57 to the ground S on which the main body 5 rests. In particular, the coupling elements 80 are arranged in a region of the respective gripping units 58, 59 opposite the ground S along the direction Z; the coupling elements 81 are arranged in a region of the respective arms 56, 57 facing the ground S.

[0049] The actuators 53, 54 are linear and each comprises:

- a respective main body 53a, 54a, which is integral with a respective arm 56, 57;
- a respective rod 53b, 54b that can slide in relation to the respective main body 53a, 54a parallel to the direction X and operationally connected to the respective gripping unit 58, 59; and
- a respective electrical motor 53c, 54c adapted to move a respective rod 53b, 54b in relation to the respective main body 53a, 54a.

[0050] Specifically, the rods 53b, 54b are integral with the coupling elements 80 of the respective gripping units 58, 59. More specifically, each rod 53b, 54b comprises a first longitudinal end housed inside the respective main body 53a, 54a and a second longitudinal end opposite the first longitudinal end and connected to the respective gripping unit 58, 59.

[0051] The actuator 53 also comprises a device 53d adapted to detect the amount of sliding of the rod 53b in relation to the main body 53a parallel to the direction X; similarly, the actuator 54 comprises a device 54d adapted to detect how much the rod 54b slides in relation to the main body 54a parallel to the direction X. For example, the devices 53d and 54d are adapted to detect the distance between the second longitudinal ends of the rods 53b, 54b in relation to the respective main bodies 53a, 54a. In other words, the devices 53d, 54d are adapted to detect the distance between the rotation axis A and the rotation axis B parallel to the direction X.

[0052] The devices 53d and 54d are operationally connected to the control unit 52 (Figure 11). In the embodiment illustrated, the devices 53d, 54d each comprise a linear encoder.

[0053] The actuators 53 and 54 are preferably adapted to slide the respective rods 53b, 54b in relation to the respective main bodies 53a, 54a with an average speed equal to the maximum speed that can be obtained. This makes it possible to simplify the control of the movements of the rods 53b and 54b.

[0054] The electrical actuator 53 also comprises a device 53e adapted to detect the amount of electricity E absorbed by the motor 53c and the electrical actuator 54 comprises a device 54e adapted to detect the amount of electricity E absorbed by the motor 54c (Figure 11).

[0055] Each gripping unit 58, 59 comprises a respective grabbing head 83 adapted to engage the tubular cavity of the core 12 respectively at the ends 12a and 12b. The grabbing heads 83 face each other and are coaxial to each other and to the rotation axis B. In detail, the grabbing heads 83 define the rotation axis B.

[0056] In the embodiment illustrated, the grabbing heads 83 are cylindrical bodies having an outer diameter smaller than or the same as the inner diameter of the tubular body of the core 12.

[0057] The grabbing heads 83 are also mobile in relation to the main body 55 parallel to the rotation axis B. Specifically, the grabbing heads 83 are mobile in relation to the coupling elements 80 of the respective gripping

units 58, 59 parallel to the rotation axis B.

[0058] The winding group 3 also comprises two actuators 60, 61, each operationally connected to a respective grabbing head 83. The control unit 52 is programmed to control the actuators 60, 61 to move one or both the grabbing heads 83 in relation to the coupling element 80 of the respective gripping unit 58, 59 parallel to the rotation axis B. The actuators 60, 61 are preferably pneumatic.

[0059] In detail, the control unit 52 is programmed to command the actuators 60, 61 to bring the grabbing heads 83 close to each other in order to grasp a core 12 and move the grabbing heads 83 away from each other in order to release a core 12 or a finished coil 11.

[0060] As illustrated in Figure 2A, each gripping unit 58, 59 comprises a plate 62, which is fixed and/or integral with the coupling element 80 of the respective gripping unit 58, 59. The plates 62 are directed perpendicularly to the rotation axis B and a respective actuator 60, 61 is connected to each of them. In addition, the grabbing heads 83 are mobile in relation to the respective plate 62.

[0061] The arm 56 and another arm 57 are also coupled, so as to slide, to the main body 55 parallel to the rotation axis B. In this way, the distance between the arm 56 and the other arm 57 along the rotation axis B and, as a result, the distance between the gripping unit 58 and the other gripping unit 59 along the rotation axis B can be adjusted, to collect cores 12 of different lengths.

[0062] Specifically, the main body 55 comprises guides 70, 71 arranged parallel to the rotation axis B and the arms 56, 57 comprise respective slide elements 72, 73 respectively coupled to the guides 70 and 71 and able to slide in relation to them. More specifically, the main body 55 comprises two guides 70, 71 mounted on the side opposite the unwinding group 2 along the direction X and two guides 70, 71 (not illustrated) on the side facing the unwinding group 2 along the direction X.

[0063] The control unit 52 is programmed to control the electrical actuators 53, 54 to place the core 12 in contact with the winding roller 50 and to gradually move the rotation axis B away from the rotation axis A when the film 20 is wound around the core 12.

[0064] Specifically, the control unit 52 is programmed to command the electrical actuators 53, 54 to gradually move the gripping units 58, 59 away from the winding roller 50 as a function of the diameter Φ of the coil being formed around the core 12 (i.e. of the overall diameter of the core 12 and of the layers of film 20 gradually wound around the core 12). This diameter Φ can vary over time, in particular increase over time, as the film 20 is gradually wound around the core 12.

[0065] The control unit 52 is programmed to calculate the diameter Φ at successive instants of time (for example, every 100 ms) as a function of the diameter Φ_i of the core 12, of the thickness s of the film 20 and of the length l of the film 20 wound around the core 12 between an initial instant of time and the instant of time when the calculation is made. The formula (I) for the calculation of

the diameter Φ is included below:

$$(I) \quad \Phi = \sqrt{\frac{4 \cdot s \cdot l}{\pi} + \Phi_i^2}$$

[0066] In detail, the diameter Φ_i of the core 12 is the outer diameter measured in relation to the rotation axis B, before the core 12 is wound around by the film 20. The thickness s of the film 20 is the thickness along a direction orthogonal to the longitudinal direction R and to the transverse direction Q. In addition, the thickness of the film 20 to be considered is that of the film 20 immediately upstream of the winding roller 50. The diameter Φ_i and the thickness s of the film 20 are pre-set by the operator.

[0067] The control unit 52 is also programmed to receive a signal from the device 50b that relates to the angular position and/or angular velocity of the winding roller 50 in relation to the rotation axis A (Figure 11) and to calculate the length l of film 20 wound around the core 12 between the initial instant of time and the instant of time when the calculation of the diameter Φ is made based on the signal received by the device 50b.

[0068] Since the winding roller 50 and the coil being formed around the core 12 are in contact during the winding, half of the diameter Φ at a given instant of time corresponds to the distance provided between the rotation axis B and the most radially outer surface of the winding roller 50 parallel to the direction X in that given instant of time.

[0069] The control unit 52 is also programmed to receive from the devices 53d, 54d a signal relating to the actual distance between the rotation axis A and the rotation axis B parallel to the direction X.

[0070] The control unit 52 is also programmed to compare the envisaged distance between the rotation axes A and B (calculated based on the diameter Φ) in a given instant of time with the actual distance in that given instant of time and to command the electrical actuators 53, 54 to move the gripping units 58, 59 in relation to the winding roller 50 so that the actual distance corresponds to the distance envisaged.

[0071] The control unit 52 is also programmed to receive a signal from the devices 53e, 54e relating to the amount of electricity E absorbed respectively by the motors 53c, 53d and to stop the operation of these motors 53c, 53d if the amount of electricity E absorbed is greater than a threshold amount of electricity E_0 .

[0072] According to an alternative operation method, the control unit 52 is programmed to control the electrical actuators 53, 54 to gradually move the gripping units 58, 59 away from the winding roller 50 as a function of a fictitious diameter Φ that can change over time, so as to enable or, in any case, increase the introduction of air between the layers of film 20 gradually wound around

the core 12. The fictitious diameter Φ' in a given instant of time is calculated by multiplying the diameter Φ in the same instant of time by a factor α , which depends on the percentage of air to be introduced:

$$\Phi' = \alpha \cdot \Phi, \quad \alpha > 1$$

[0073] Specifically, for any instant of time, the diameter Φ' is greater than the diameter Φ and the factor α grows as the quantity of air to be introduced between the turns of film 20 wound around the core 12 grows, which is set by the user.

[0074] As illustrated in Figure 1, the machine 1 also comprises an unloading station 7, where the coils 11 are unloaded from the winding group 3. In the embodiment illustrated, the unloading station 7 is opposite the unwinding group 2 along the direction X (Figure 1).

[0075] The unloading station 7 comprises a tray 90 adapted to collect the coils 11 released by the gripping units 58, 59 at the end of their winding. The tray 90 is arranged below the winding group 3 along the direction Z.

[0076] The tray 90 preferably comprises two plates angled between them so as to have concavities facing the winding group 3. As illustrated in Figure 1, the plates form a V on a plane passing through the directions X and Z.

[0077] In addition, the tray 90 is mobile along the direction Z in relation to the main body 5. In addition, the tray 90 is preferably aligned along the direction X to the rotation axis B at the end of the winding of the coil 11 (Figures 5D and 9D).

[0078] The unloading station 7 also comprises an unloading surface 92, for example a conveyor belt, at which the coils 11 collected by the tray 90 are unloaded.

[0079] The unloading surface 92 is preferably tilted. Specifically, proceeding along the direction X in the direction oriented by the unwinding group 2 to the winding group 3, the distance along the direction Z between the unloading surface 92 and the ground S gradually decreases.

[0080] As illustrated in Figure 1, the machine 1 comprises an actuator 91 adapted to move the tray 90 in relation to the main body 5 along the direction Z. The actuator 91 comprises a main body 91a and a rod 91b that can slide in relation to the main body 91a. The rod 91b comprises, in turn, a first longitudinal end housed inside the main body 91a and a second longitudinal end opposite the first longitudinal end fixed to the tray 90.

[0081] The actuator 91 is adapted to move the tray 90 between an unloading station, wherein it is aligned or basically aligned with the unloading surface 92 along the direction Z (Figure 1, Figure 6A) and a raised position, wherein it is raised in relation to the unloading surface 92 along the direction Z (Figure 9D). When the actuator 91 is in the raised position, the tray 90 is near the gripping units 58, 59.

[0082] The control unit 52 is operationally connected to the actuator 91 and is programmed to control its move-

ment between the unloading station and the raised position.

[0083] More specifically, the tray 90 is hinged to the rod 91b and can rotate around an axis L parallel to the rotation axes A and B (Figures 6A, 9D). The unloading station 7 also comprises an actuator 93 cooperating with the tray 90 and adapted to rotate it around the axis L, so as to enable the unloading of the coil 11 from the tray 90 on the unloading surface 92. The actuator 93 is preferably adapted to cooperate with the tray 90 when the actuator 90 is in the unloading station.

[0084] The control unit 52 is operationally connected to the actuator 93 and is programmed to control the rotation of the tray 90 around the axis L.

[0085] The machine 1 also comprises storage 8 adapted to contain one or more cores 12 (Figure 1). In the embodiment illustrated, the storage 8 is arranged above the winding group 3 along the direction Z.

[0086] As illustrated in Figure 1, the pre-stretch group 4 comprises a first pre-stretch roller 40 and a second pre-stretch roller 41 that can rotate around respective rotation axes in relation to the main body 5 and partially wound around by the film 20. The rotation axis of the first pre-stretch roller 40 and the rotation axis of the second pre-stretch roller 41 are parallel to each other.

[0087] The first pre-stretch roller 40 and the second pre-stretch roller 41 rotate at respective, different rotation speeds around the respective rotation axes. Specifically, the rotation speed of the second pre-stretch roller 41 is greater than the rotation speed of the first pre-stretch roller 40, in order to obtain the desired stretching of the film 20.

[0088] The pre-stretch group 4 also comprises an idler roller 42 that can rotate around a rotation axis in relation to the main body 5 and adapted to come into contact with the film 20 in an intermediate position between the first pre-stretch roller 40 and the second pre-stretch roller 41. Specifically, the rotation axis of the idler roller 42 is parallel to the rotation axes of the first pre-stretch roller 40 and the second pre-stretch roller 41.

[0089] As illustrated in Figure 1, proceeding along the path followed by the extendible film 20 from the unwinding group 2 to the winding group 3, the film 20 is wound in succession around an angular sector of the first pre-stretch roller 40 opposite the winding group 3, around an angular sector of the idler roller 42 facing the winding group 3 and around an angular sector of the second pre-stretch roller 41 opposite the winding group 3.

[0090] The pre-stretch group 4 also comprises a pressure roller 44 that can rotate around a rotation axis in relation to the main body 5 and adapted to staple the film 20 against the second pre-stretch roller 41. Specifically, the rotation axis of the pressure roller 44 is also parallel to the rotation axes of the first pre-stretch roller 40 and the second pre-stretch roller 41.

[0091] In addition, the pressure roller 44 can slide along a direction M in relation to the main body 5. In the embodiment illustrated, the direction M is transverse to

the directions X and Z. Specifically, the pre-stretch group 4 comprises an actuator 45 operationally connected to the pressure roller 44 to adjust its distance from the second pre-stretch roller 41 along the direction M.

[0092] The machine 1 also comprises two accompanying rollers 46, 47, which are adapted to guide the film 20 between the second pre-stretch roller 41 and the winder roller 50. The accompanying rollers 46 and 47 can be rotated in relation to the main body 5 around respective rotation axes parallel to the rotation axes of the first pre-stretch roller 40 and the second pre-stretch roller 41.

[0093] The rotation speed of the accompanying roller 46 and the rotation speed of the accompanying roller 47 are preferably equal and the same as the rotation speed of the second pre-stretch roller 41.

[0094] The machine 1 also comprises one or more devices 48 for guiding and passing the film 20 between the primitive coil 10 from which the film 20 is unwound and the pre-stretch group 4. These devices 48 comprise, in a known way, one or more rollers and/or one or more guides.

[0095] In detail, the devices 48 comprise two devices 49a, 49b adapted to refold the longitudinal edges 20a, 20b of the film 20 unwound by the unwinding group 2 on themselves one or more times, preferably twice. In detail, the devices 49a, 49b are adapted to refold each longitudinal edge 20a, 20b of the film 20 towards the respective, opposite longitudinal edge 20b, 20a along the transverse direction Q. As a result of the folding, the film 20 has two new longitudinal edges 20c, 20d, which constitute the more peripheral portions of the film 20 along the transverse direction Q; at the same time, the longitudinal edges 20a, 20b overlap the film 20 to form two respective folds 20e, 20f (only schematically illustrated in the Figures).

[0096] As a result of the refolding carried out by the devices 49a, 49b, the extension of the film 20 along the transverse direction Q is decreased.

[0097] Specifically, the device 49a is preferably adapted to refold the longitudinal edge 20a and the device 49b is adapted to refold the longitudinal edge 20b.

[0098] The winding group 3 also comprises an oscillation mechanism 100, which is only illustrated in Figure 10 for simplicity of representation. The oscillation mechanism 100 is adapted to move, alternatively, the arms 56, 57 in relation to the frame 55 parallel to the rotation axis A between two dead points. Specifically, the frame 55 is fixed in relation to the main body 5. The stroke between the two dead points parallel to the rotation axis A is preferably in the order of tens of mm (for example, 40 mm).

[0099] The oscillation mechanism 100 comprises:

- actuation means adapted to provide the mechanical energy for moving the arms 56, 57 parallel to the rotation axis A;
- motion transmission means for the mechanical energy provided by the actuation means to the arms

56, 57; and

- guiding means adapted to guide the movement of the arms 56, 57 with respect to the frame 55 parallel to the rotation axis A.

[0100] In the embodiment illustrated, the actuation means comprise a rotary electric motor 106. In addition, the motion transmission means comprise:

- a plate 101 that is mobile in relation to the frame 55 and integral with the arms 56 and 57;
- a cam 108 rotatable integrally with the electrical motor 106;
- a rod 107 comprising two ends 107a, 107b opposite each other, whose end 107a is fixed to the cam 108 and the end 107b is fixed to the plate 101.

[0101] The cam 108 and the rod 107 are adapted to transform the rotary motion provided by the electrical motor 106 into reciprocating motion parallel to the rotation axis A.

[0102] The guiding means comprise two linear, direct guides 102, 103 parallel to the rotation axis A and two sliding elements 104, 105 each engaging a respective guide 102, 103. Specifically, the plate 101 comprises the guides 102, 103 and the frame 55 comprises the sliding elements 104, 105.

[0103] The guiding means also comprise the guides 70 and 71.

[0104] The control unit 52 can be operationally connected with a remote control device 600 (Figure 11). For example, the control device 600 is a smartphone or a personal computer.

[0105] The operation of the machine 1 is described below starting from a condition in which no primitive coil 10 is loaded on the machine 1 and no extendible film 20 is passed between the rollers of the pre-stretch group 4 and the winding group 3.

[0106] In use, a primitive coil 10 is mounted on the support 30, 33 accessible from the outside of the machine 1 and the arm 32 is rotated from the first and second position, or vice versa, so as to bring the mounted primitive coil 10 near the unwinder device 35.

[0107] The film 20 unwound from the primitive coil 10 is passed, in succession and preferably manually, between the devices 48, the first pre-stretch roller 40, the idler roller 42, the second pre-stretch roller 41, the accompanying rollers 46 and 47, and the winding roller 50.

[0108] A virgin core 12 is, thus, dropped from the core storage 8 and gripped by the gripping units 58, 59. Specifically, the control unit 52 commands the actuators 60, 61 to move the grabbing heads 83 so as to couple them with the core 12 at the respective ends 12a, 12b.

[0109] At this point, the core 12 is supported by the assembly 51 and can be rotated idly around the rotation axis B (Figures 2A, 6A).

[0110] Subsequently, the control unit 52 commands the actuators 53, 54 to move the gripping units 58, 59 in

relation to the respective arms 56, 57, so as to bring the core 12 in contact with the winding roller 50 (Figures 3B, 7B).

[0111] At this point, the control unit 52 commands the actuator 39 to bring the unwinder belt 37 in contact with the primitive coil 10 and commands the rotation of the drive pulley 36. The friction exerted by the unwinder belt 37 on the extendible film 20 of the primitive coil 10 causes the rotation of the latter around the respective rotation axis I, the forward movement of the film 20 passed along the machine 1, and the gradual unwinding of the primitive coil 10.

[0112] When the unwound film 20 passes between the unwinding group 2 and the pre-stretch group 4, the devices 49a, 49b fold the longitudinal edges 20a, 20b of the film 20, forming the folds 20e, 20f.

[0113] When crossing the pre-stretch group 4, the film 20 is stretched as a result of the jump in rotation speed between the first pre-stretch roller 40 and the second pre-stretch roller 41.

[0114] Once it has crossed the pre-stretch group 4, the film 20 is guided by the accompanying rollers 46, 47 to the accompanying roller 50.

[0115] As a result of contact between the winding roller 50 and the core 12, the core 12 starts to rotate about the rotation axis B and is wound around by the pre-stretched extendible film 20 (Figures 4C, 8C).

[0116] The film 20 is slowly wound around the core 12, the control unit 52 commands the actuators 53, 54 to gradually move the gripping units 58, 59 away from the winding roller 50.

[0117] During winding, the control unit 52 calculates the diameter Φ at successive instants of time and compares the expected distance between the rotation axes A and B of each of these instants of time (calculated based on the diameter Φ) with the actual distance. When the control unit 52 detects a greater difference of a certain threshold between the expected distance and the actual distance, the control unit 52 commands the electrical actuators 53, 54 to move the gripping units 58, 59 in relation to the winding roller 50 so that the actual distance corresponds to the expected distance.

[0118] In addition, if the amount of electricity E absorbed by the motor 53c or the motor 54c is greater than a threshold amount of electricity E0, the control unit 52 stops the operation of the motors 53c, 54c.

[0119] In the operation method in which air is introduced between the turns of wound film 20, the control unit 52 controls the electrical actuators 53, 54 based on the fictitious diameter Φ' .

[0120] In addition, during the winding of the film 20, the oscillation mechanism 100 oscillates the arms 56, 57 in relation to the frame 55 parallel to the rotation axis A between two dead points.

[0121] Once the length of the film 20 around the core 12 reaches the desired length, a coil 11 is obtained. Therefore, the rotation of the winding roller 50 around the rotation axis A is interrupted.

[0122] At this point, the control unit 52 commands the actuator 91 to move the tray 90 into the raised position and the actuators 60, 61 to move the grabbing heads 83 away, so as to cause the coil 11 to fall on the tray 90 (Figures 5D, 9D).

[0123] The control unit 52 thus commands the actuator 91 to move the tray 90 into the unloading station and, subsequently, the actuator 93 to rotate the tray 90 around the axis L, so as to unload the coil 11 on the unloading surface 92.

[0124] During the unwinding of the primitive coil 10, another primitive coil 10 can be loaded on the support 33, 30 accessible from the outside of the machine 1.

[0125] With reference to Figure 10, reference number 1' indicates a recoiling machine according to a second embodiment of the invention. The recoiling machine 1' is similar to the recoiling machine 1 and will be described below only as far as it differs from the latter; the same or equivalent parts of the recoiling machines 1, 1' will be distinguished, where possible, by the same reference numbers. The recoiling machine 1' differs from the recoiling machine 1 due to the fact that it does not comprise the pre-stretch group 4. Therefore, the recoiling machine 1' is specifically for producing coils 11 of film 20 that are not pre-stretched.

[0126] The operation of the machine 1' is similar to the operation of the machine 1 and differs from the latter because the film 20 wound around the core 12 is not pre-stretched and the oscillation mechanism 100 is not activated.

[0127] The advantages that can be achieved with the winding group 3 and recoiling machine 1; 1' produced according to this invention are apparent from an examination of the characteristics thereof. In particular, since the winding group 3 comprises two electrical actuators 53, 54 adapted to vary the distance between the rotation axes A and B, the winding of the film 20 around the core 12 can be controlled efficiently. In fact, the distance between the axes A and B is adjusted instant by instant by just the electrical actuators 53, 54 that push the core 12 in the same direction and not by the algebraic sum of two contributions acting in opposite directions.

[0128] This operation is characterised by high precision and the ability of the movements to be repeated. In particular, the electrical actuators 53, 54 are able to exert a continuous force over time, unlike the pneumatic actuator used in the prior art, ensuring the quality of the winding.

[0129] The electrical actuators 53, 54, in addition, are characterised by the greater efficiency of the movements of the pneumatic actuators used in the prior art, which are instead limited by the filling times of the chambers.

[0130] In addition, the number of components of the winding group 3 is less than the number of components of the winding groups discussed in the introduction to this description. This makes it possible to minimise the space occupied by the winding group 3 compared to the winding groups of the prior art. Moreover, the electrical actuators

53, 54 require little maintenance compared to other types of actuators.

[0131] Since the distance between the rotation axes A and B can be effectively controlled by the fictitious diameter Φ' , it is possible to include a desired quantity of air between the turns of the coil being formed on the core 12 simply by setting the factor α . The introduction of air between the turns by the coil reduces the risk that the edges of the coil 11 get damaged if the coil 11 accidentally falls and increases the ease of unwinding the film 20 during the use of the coil 11.

[0132] Since the winding group 3 comprises the oscillation mechanism 100, the folds 20e, 20f of successive layers of film 20 around the core 12 are distributed across several positions of the core 12 along the rotation axis B. This makes it possible to improve the quality of the coils 11 produced and to minimise the risk of the core 12 collapsing.

[0133] Lastly, it is clear that modifications and variations may be made to the winding group 3 and the recoiling machine 1; 1' without departing from the scope of this invention.

[0134] The control unit 52 could comprise, in turn, multiple control units operationally connected together.

[0135] In particular, the winding group 3 could comprise just one electrical actuator 53, 54 operationally connected to the assembly 51 or more than two electrical actuators 53, 54.

[0136] The winding group 3 could comprise just one actuator 60, 61 operationally connected to the gripping unit 58 and/or to the gripping unit 59.

[0137] The guides 70, 71 could be arranged on a respective arm 56, 57 and the slide elements 72, 73 could be arranged on the main body 5.

[0138] The machine 1 could be used to produce coils 11 of non pre-stretched film. Specifically, in the machine 1, the extendible film 20 could be passed directly from the primitive coil 10 to the winding roller 50 without passing through the pre-stretch group 4. For example, starting from the primitive coil 10 being wound, the extendible film 20 could be wound by one or more devices 48, the accompanying roller 47 and, finally, the winding roller 50.

[0139] The recoiling machine could be adapted to recoil extendible film 20 in parallel starting from more than just one primitive coil 10, for example from two primitive coils 10. Specifically, this recoiling machine would comprise more than one unwinding group 2, more than one pre-stretch group 4, and more than one winding group 3.

Claims

1. A winding group (3) for a recoiling machine (1) of extendible film (20), comprising:

- an assembly (51) defining a first rotational axis (A) and adapted to rotatably support a core (12) about a first rotational axis (B);

- a winding roller (50) rotatable about a second rotational axis (A); said winding roller (50) being at least partially wound, in use, by said extendible film (20) and being adapted to wind said core (12) with said extendible film (20), so as to form a coil of said extendible film (20);
- a control unit (52);
- characterized in that** it comprises at least one electrical actuator (53, 54) operatively connected to said assembly (51);
- said control unit (52) being programmed to command said electrical actuator (53, 54) to vary, in use, the distance of said first rotational axis (B) from said second rotational axis (A).
2. The winding group according to claim 1, **characterized in that** said control unit (52) is programmed to command said at least one electrical actuator (53, 54) to vary the distance over time of said first rotational axis (B) from said second rotational axis (A) as a function of an estimated diameter (Φ) of said coil of said film (20), in use, being formed about said core (12);
- said estimated diameter (Φ) at a specific time instant being a function of the diameter of said core (Φ_i), the thickness (s) of said film (20) and the length (1) of said film (20) which is wound about said core (20) between an initial time instant and said time instant.
3. The winding group according to claim 1, **characterized in that** said control unit (52) is programmed to command said at least one electrical actuator (53, 54) to vary the distance over time of said first rotational axis (B) from said second rotational axis (A) as a function of a fictitious diameter (Φ') of said coil of said film (20), in use, being formed about said core (12);
- said fictitious diameter (Φ') at a specific time instant being calculated, in use, by multiplying an estimated diameter (Φ) of said coil of said film (20) being formed about said core (12) at the same time instant by a factor (α);
- said factor (α) depending on a desired percentage of air to be introduced, in use, between the consecutive turns of said coil of said film (20) being formed about said core (12);
- said estimated diameter (Φ) at a specific time instant being a function of the diameter of said core (Φ_i), the thickness (s) of said film (20) and the length (1) of said film (20) which is wound about said core (20) between an initial time instant and said time instant.
4. The winding group according to any one of the foregoing claims, **characterized in that** said assembly (51) comprises:
- a frame (55);
- a first arm (56) and a second arm (57) operatively connected to said frame (55) and distanced from each other parallel to said second rotational axis (B);
- a first gripping unit (58) and a second gripping unit (59) operatively connected to said first arm (56) and said second arm (57), respectively; said first gripping unit (58) and said second gripping unit (59) being adapted to grip said core (12) at respective ends (12a, 12b) of said core (12) opposite to each other along said second rotational axis(B);
- said winding group (3) comprising a first said electrical actuator (53) operatively connected to said first gripping unit (58) to move it, in use, with respect to said respective first arm (56) orthogonally to said second rotational axis(B);
- said winding group (3) comprising a second said electrical actuator (54) operatively connected to said second gripping unit (59) to move it, in use, with respect to said respective second arm (57) orthogonally to said second rotational axis(B).
5. The winding group according to claim 4, **characterized in that** said first gripping unit (58) and said second gripping unit (59) comprise respectively a first and a second grabbing head (83);
- said first and second grabbing head (83) being adapted to engage said core (12) at said respective opposite ends (12a, 12b) along said second rotational axis(B);
- said first and second grabbing heads (83) being movable with respect to said frame (55) parallel to said second rotational axis(B).
6. The winding group according to claim 5, **characterized in that** it comprises at least one third actuator (60, 61) operatively connected to said first grabbing head and/or said second grabbing head (83);
- said control unit (52) being programmed to command said third actuator (60, 61) to move said first grabbing head and/or said second grabbing head (83) with respect to said frame (55) parallel to said second rotational axis (B).
7. The winding group according to any one of claims 4 to 6, **characterized in that** said first arm (56) and/or said second arm (57) are slidably coupled to said frame (55) parallel to said second rotational axis (B).
8. The winding group according to any one of claims 4 to 7, **characterized in that** it comprises an oscillation mechanism (100), which is adapted to move alternately said first arm (56) and said second arm (57) with respect to said frame (55) parallel to said second rotational axis (A) between two dead points.

9. The winding group according to claim 8, **characterized in that** said oscillation mechanism (100) comprises:

- actuation means to supply mechanical energy to move said first arm (56) and said second arm (57) with respect to said frame (55); 5
- motion transmission means adapted to transmit said mechanical energy supplied, in use, by said actuation means to said first and second arm (56, 57); 10
- guiding means adapted to guide the movement of said first and second arm (56, 57) with respect to said frame (55) parallel to said second rotational axis (A). 15

10. The winding group according to claim 9 when dependent on claim 4, **characterized in that** said actuation means comprise a rotary electrical motor (106) and said motion transmission means comprise: 20

- a cam (108) rotatable integrally with said electrical motor (106);
- a beam (107) comprising a first end (107a) and a second end (107b) opposite to each other; 25

said first end (107a) being fixed to said cam (108) and said second end (107b) being at least indirectly connected to said first and second arm (56, 57). 30

11. The winding group according to any one of the foregoing claims, **characterized in that** said control unit (52) is operatively connectable to a remote control device (600). 35

12. A recoiling machine (1; 1') of extendible film (20) comprising:

- a main body (5); 40
- an unwinding group (2) adapted to unwind, in use, said extendible film (20) from a primitive coil (10);
- a winding group (3) according to any one of the foregoing claims; 45

wherein said frame (55) is fixed to said main body (5) and said second rotational axis (A) is stationary with respect to said main body (5). 50

13. The recoiling machine according to claim 12, comprising a pre-stretch group (4), which is adapted to stretch said extendible film (20) unwound, in use, by said unwinding group (2) before it is wound by said winding group (3). 55

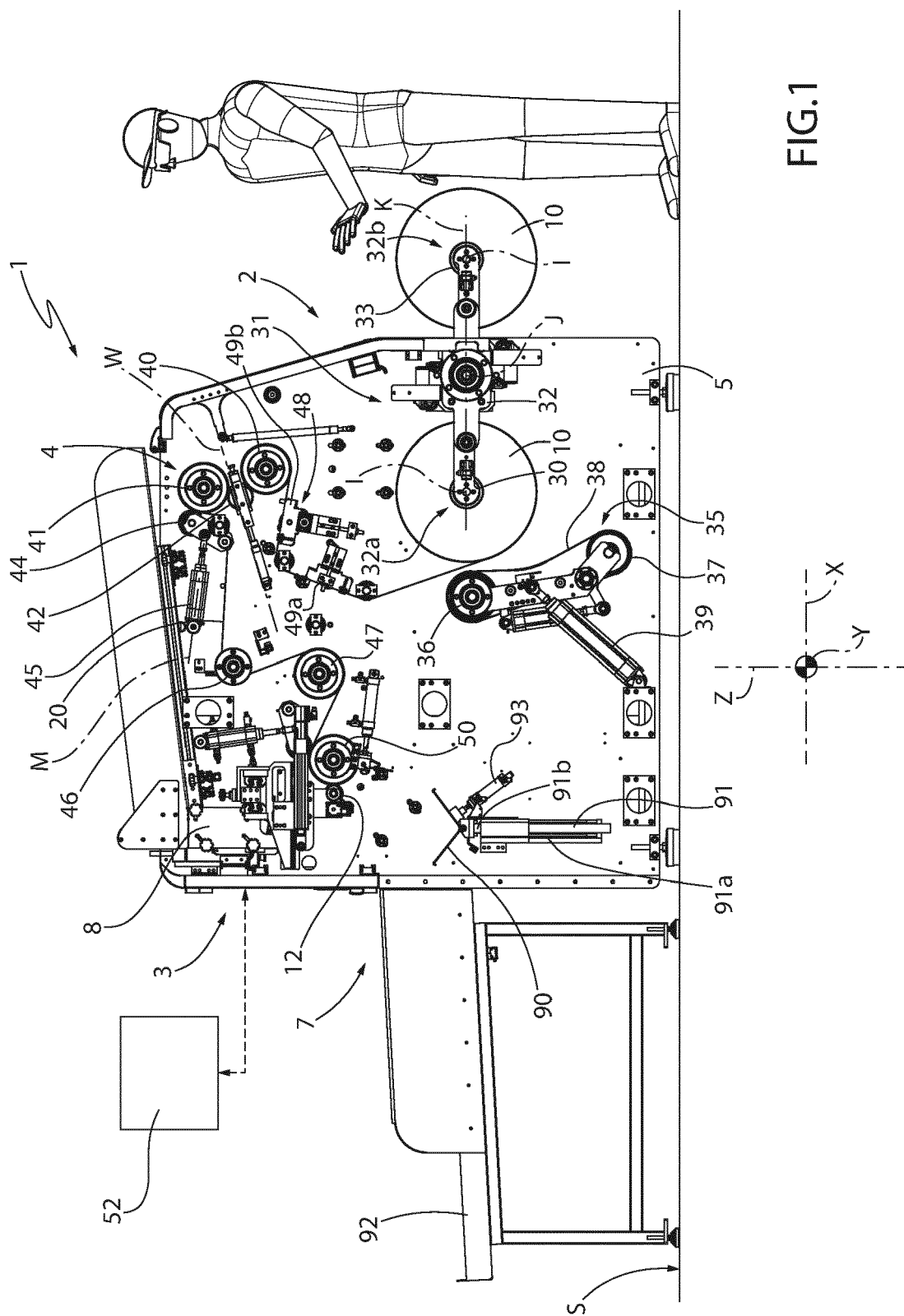


FIG.1

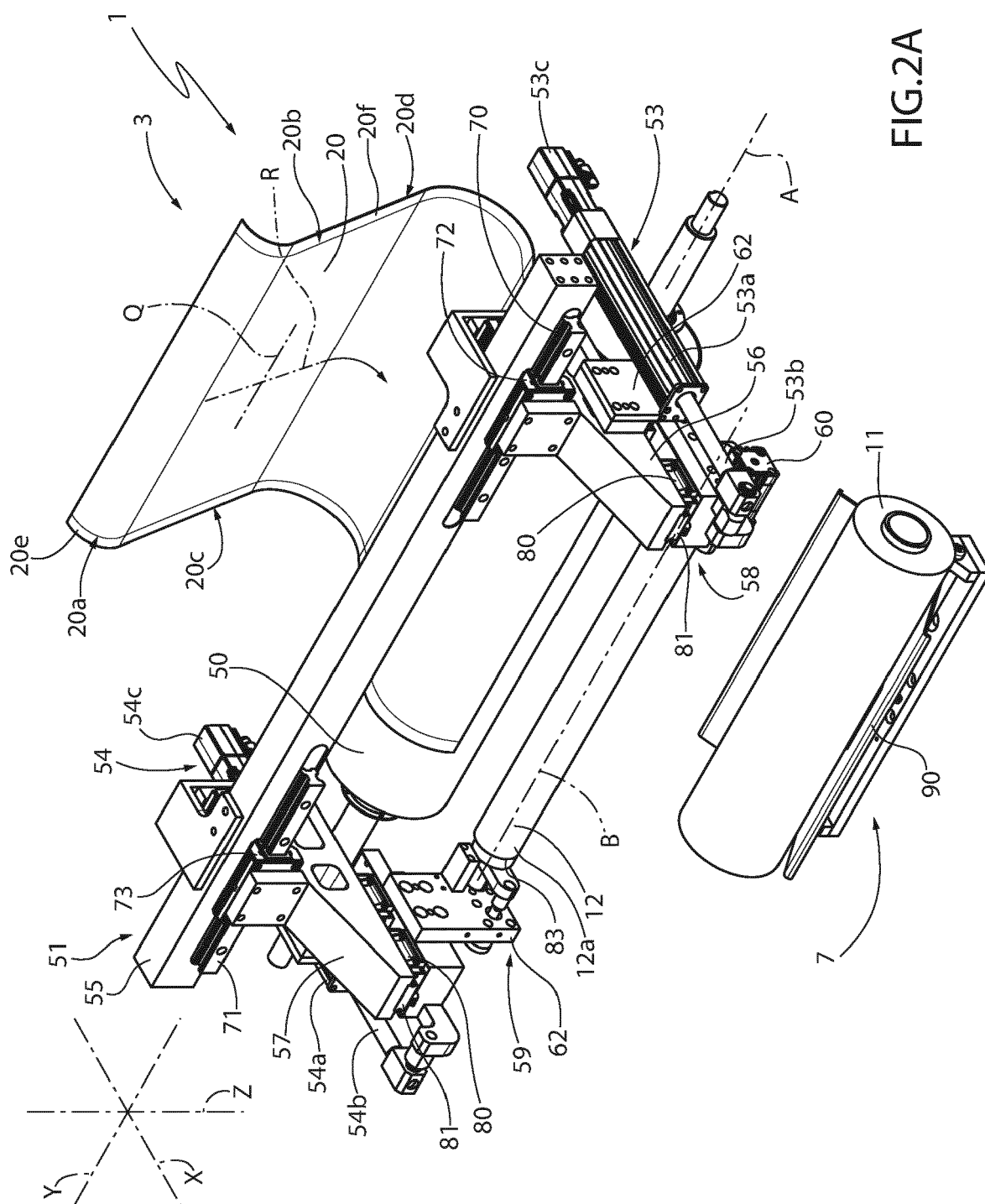


FIG. 2A

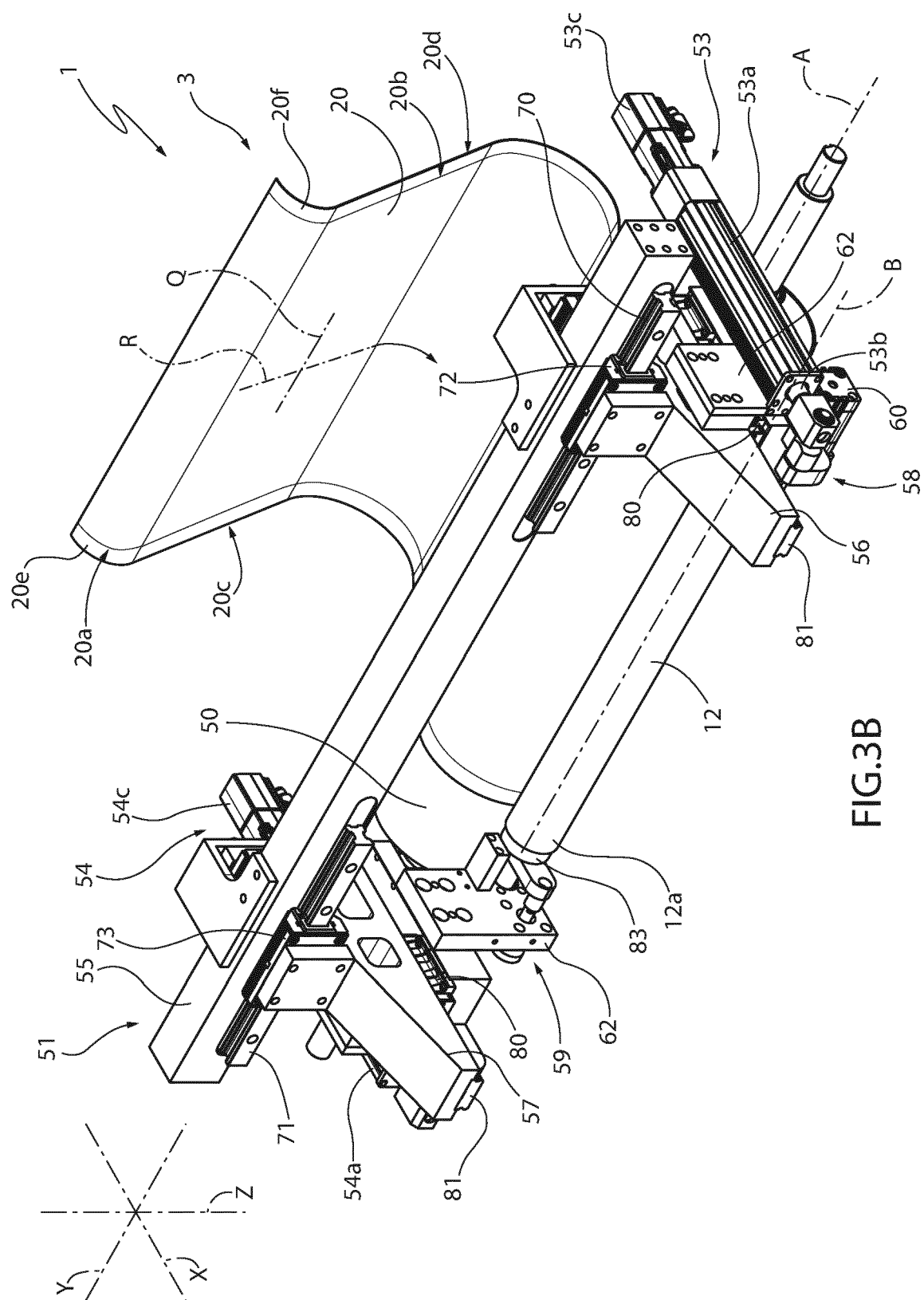


FIG. 3B

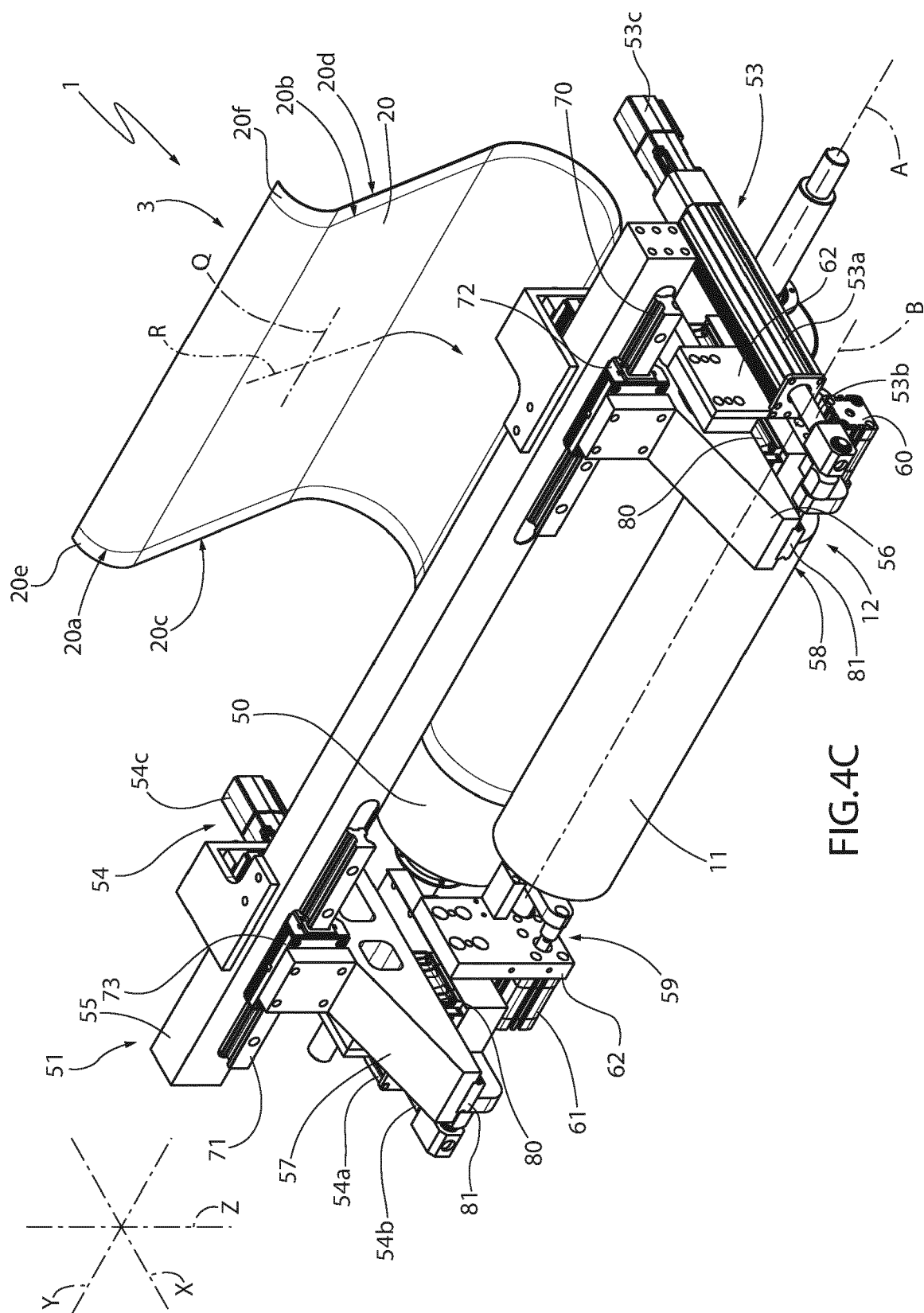


FIG. 4C

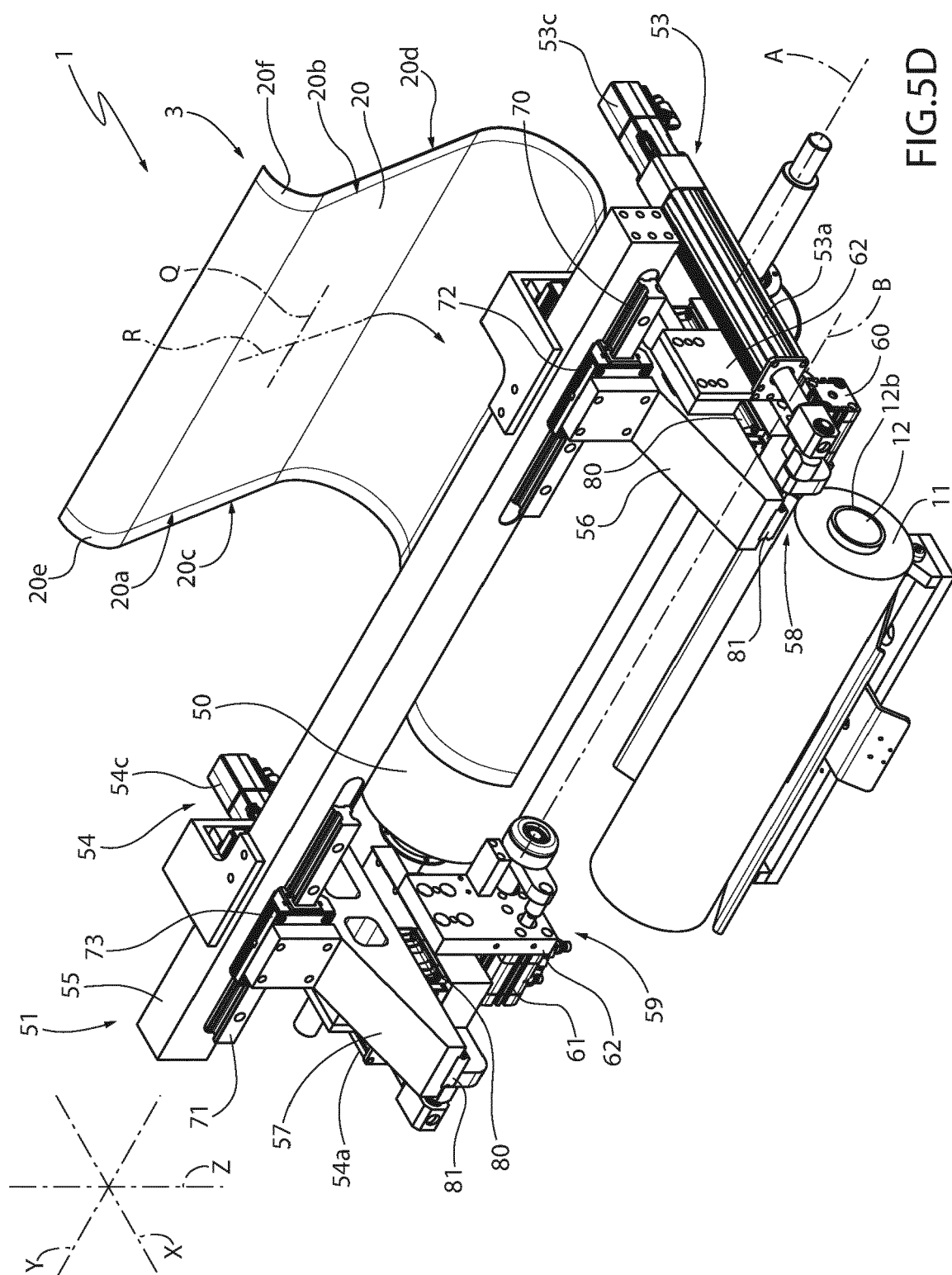
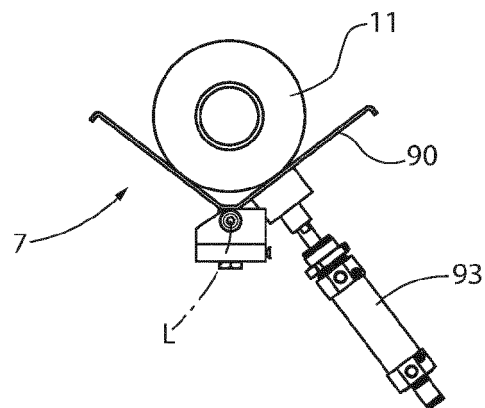
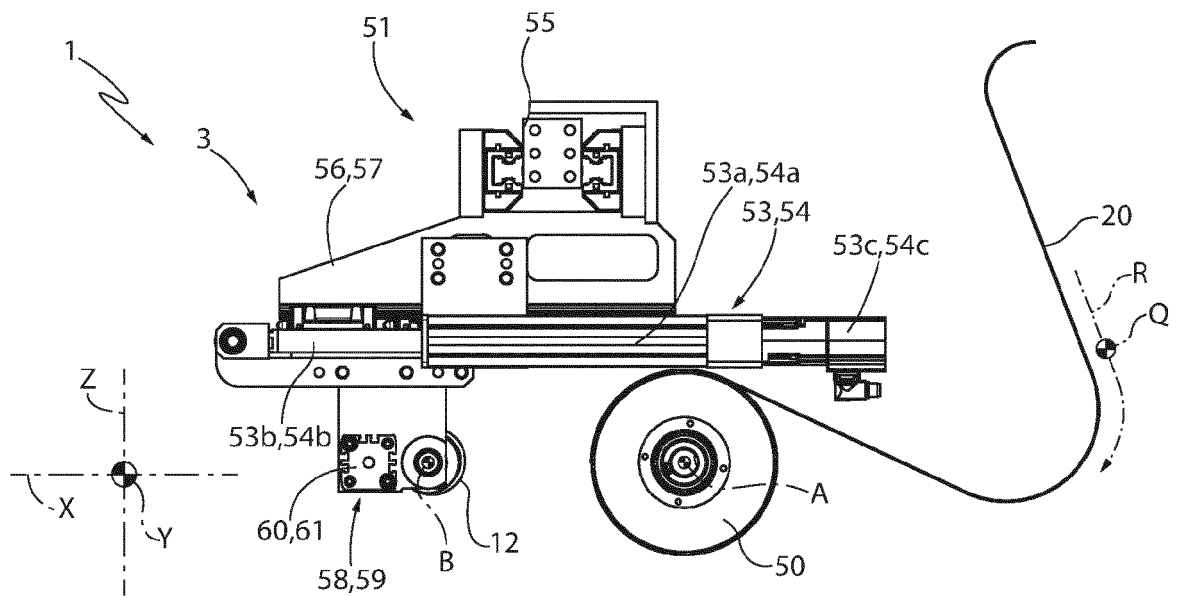
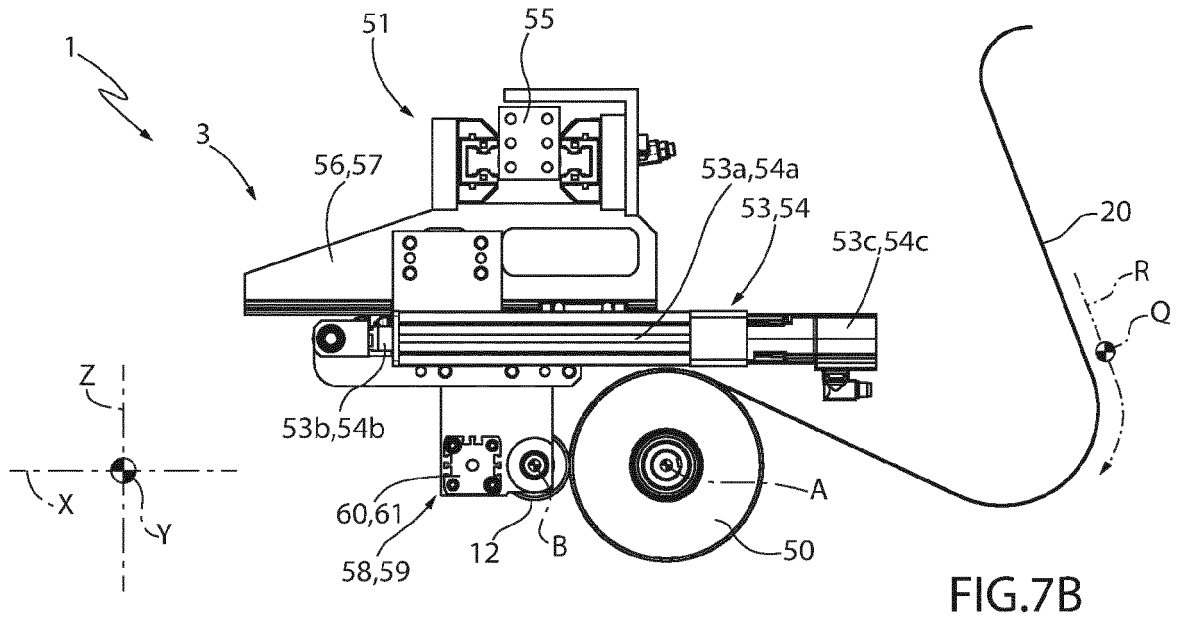
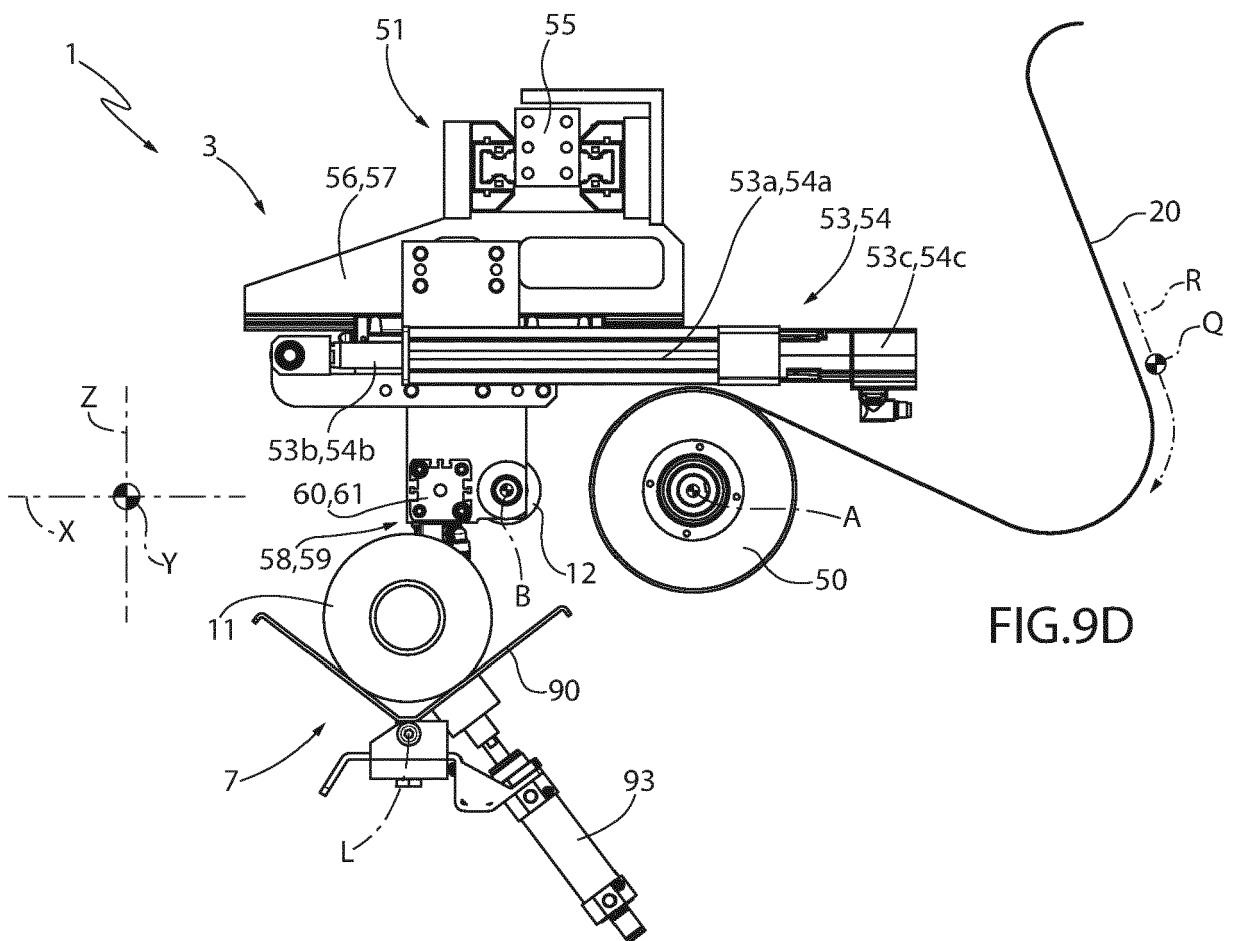
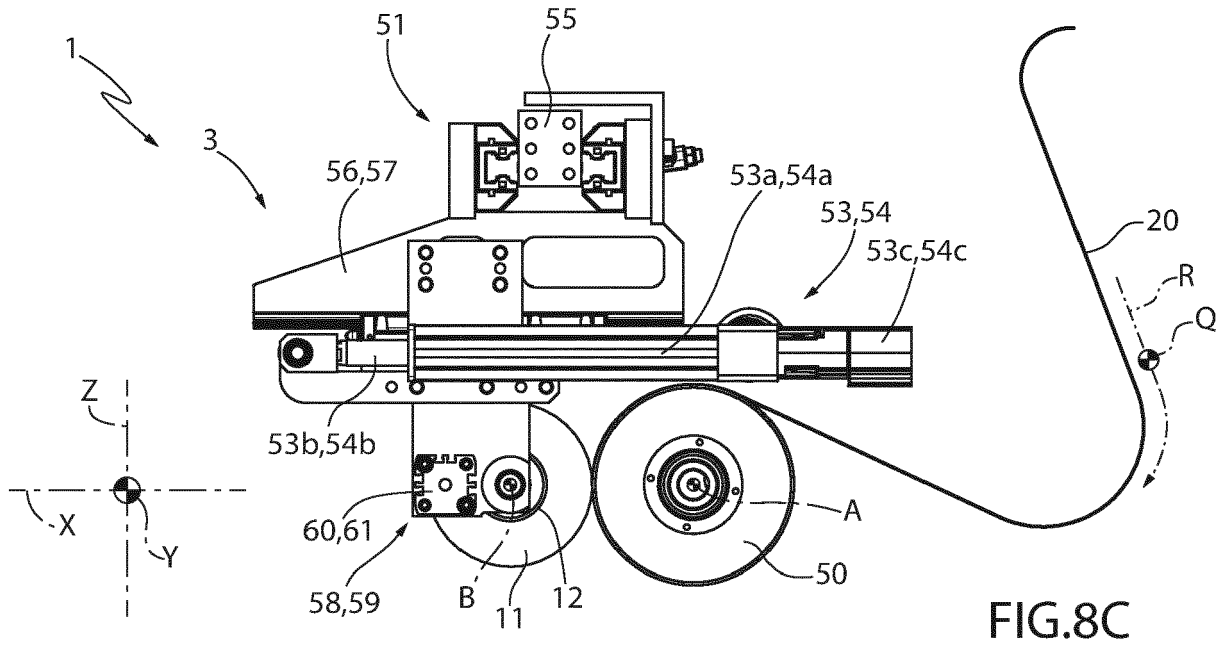


FIG. 5D





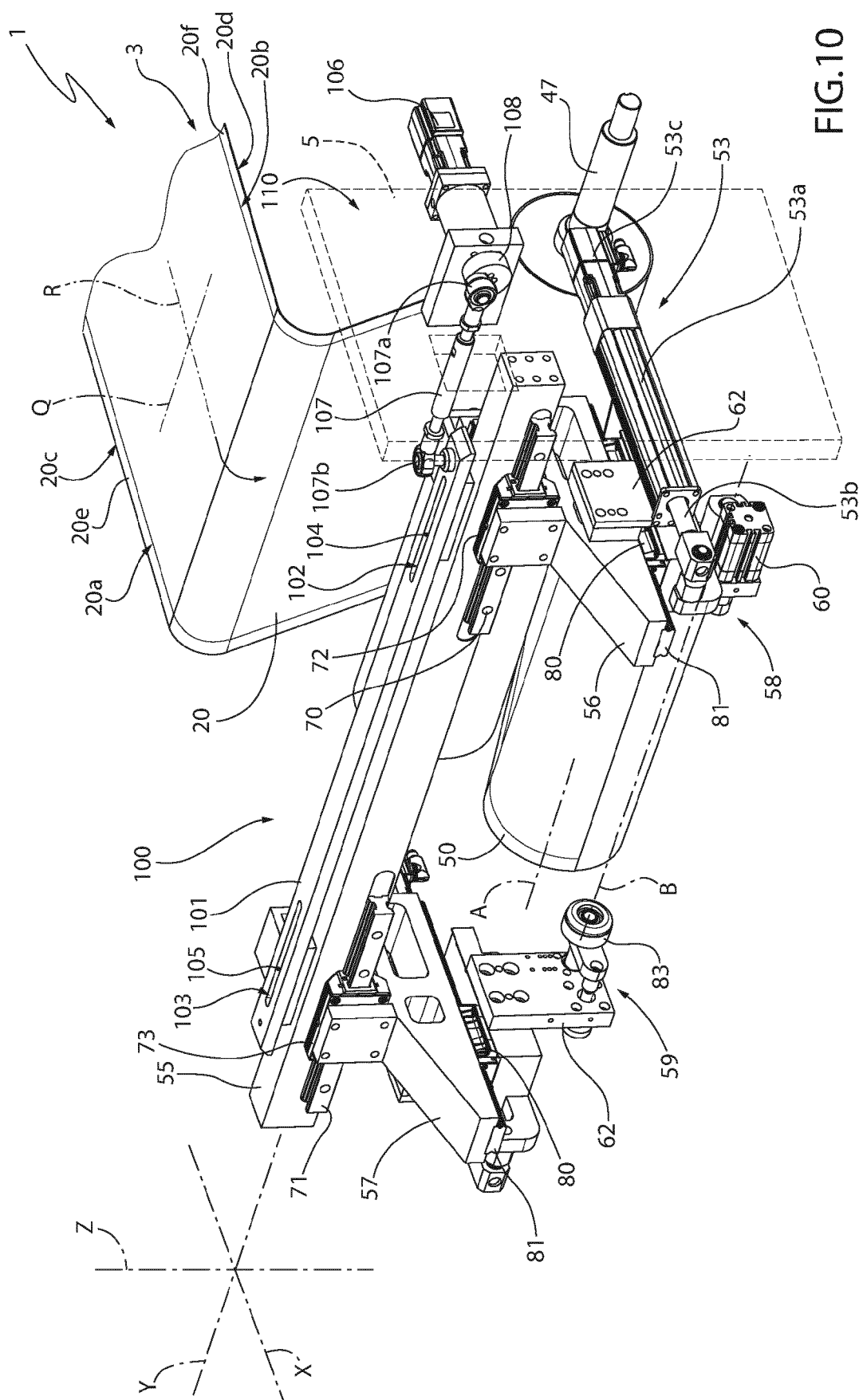


FIG. 10

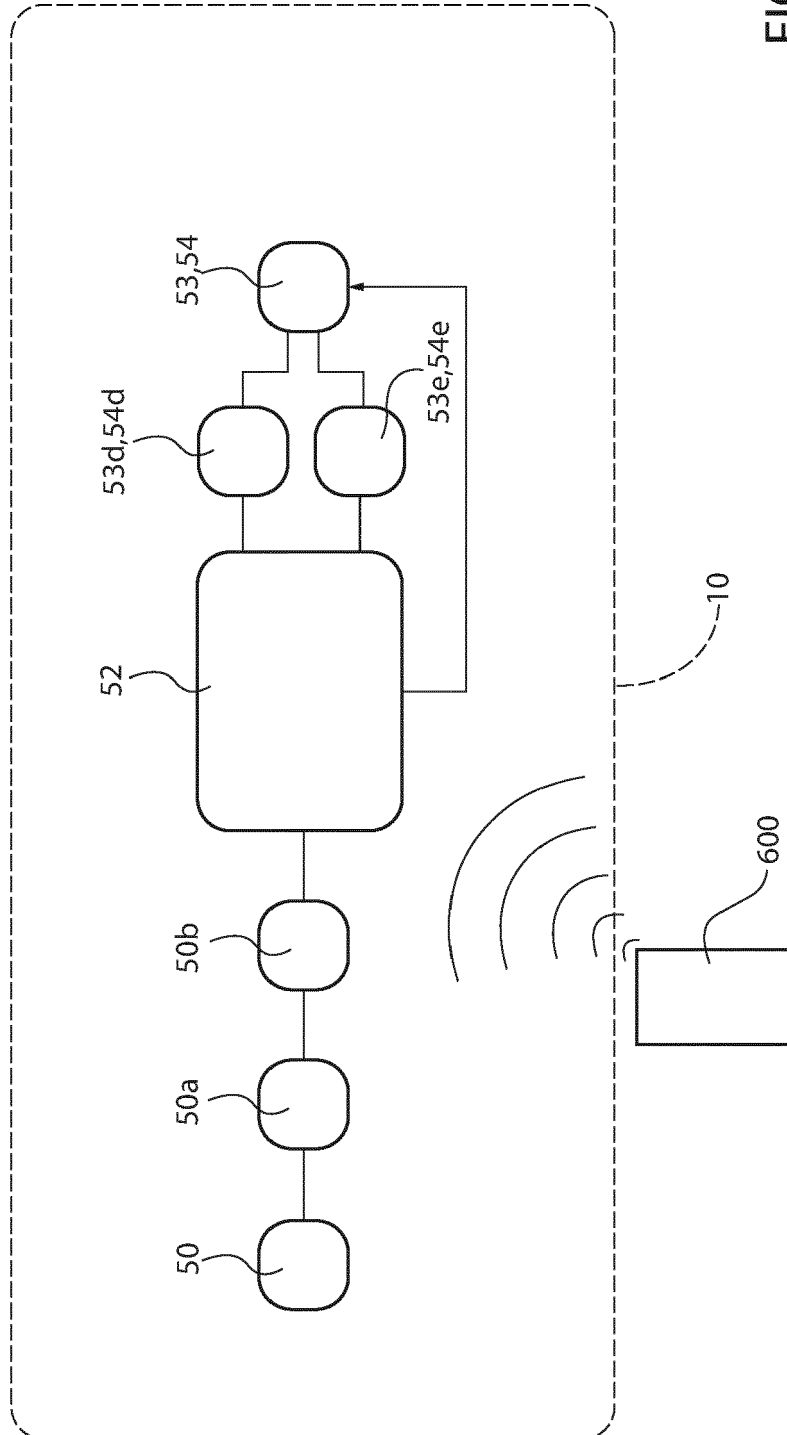


FIG.11

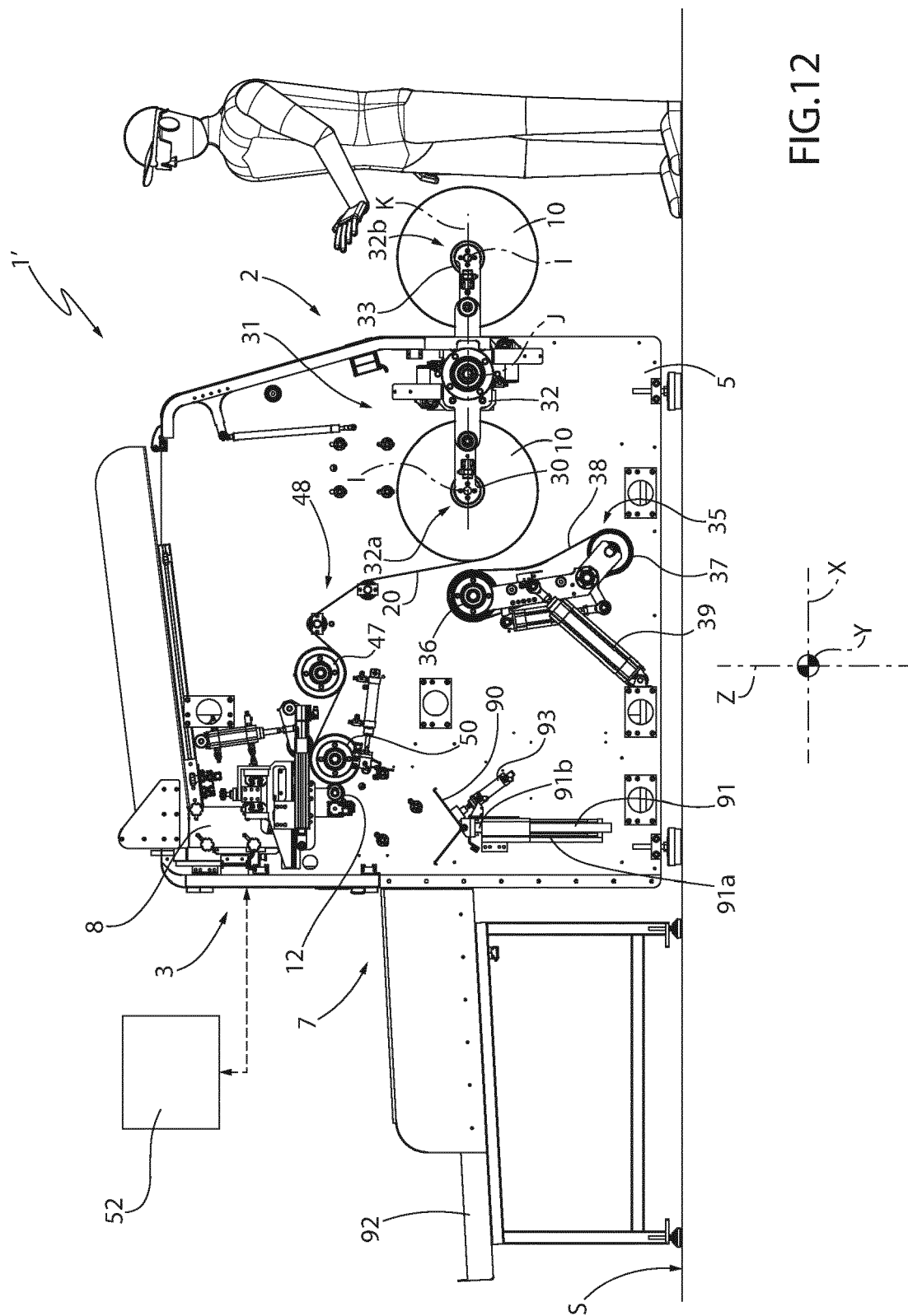


FIG.12

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- IT 102023000011268 [0001]