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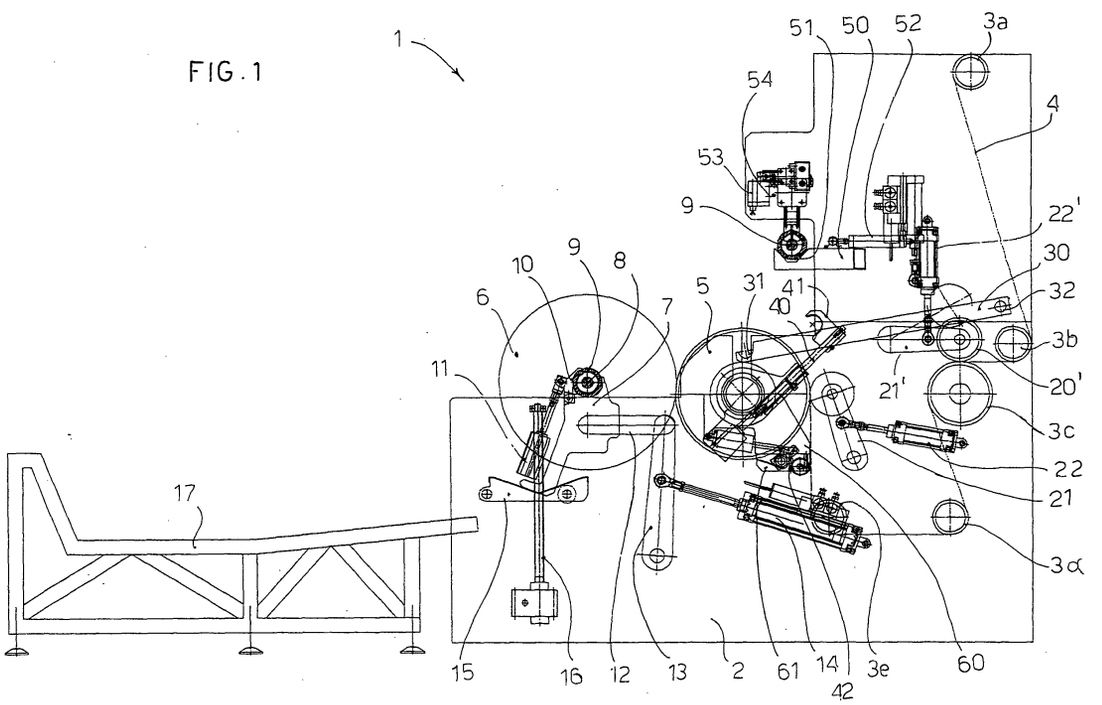
(54) Automatic rewinder particularly for flexible film of plastic material and relative method for producing rolls

(57) An automatic rewinding machine (1), particularly for film of plastic material, comprising film feeding means (3a, 3b, 3c, 3d, 3e, 5) able to feed a film (4) toward at least one core (9) supported by a mandrel (8) rotatably mounted in a winding cradle (7), so as to generate at least one roll (6) of film, roll unloading means (15) able to unload at least one finished roll (6) out of the winding area of the rewinder, core feeding means (110, 111) able to feed cores (9) from a magazine toward a loading support (50) mounted on a frame (2) of the rewinder, a mandrel loading/unloading device (100) able to load a mandrel (8') inside the cores (9) disposed in the loading support (50) and unload the mandrel (8) from the cores (9), and mandrel handling means (30, 40) able to pick up the mandrel (8') from the loading support (50) to carry it toward the winding area.

FIG. 1



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Description

[0001] The present invention refers to an automatic rewinding machine for winding film, in particular a film of flexible plastic material, onto cores supported by a mandrel so as to create rolls of film of plastic material ready to be put on sale. The present invention further refers to a method for automatic production of rolls of film of plastic material.

[0002] Various types of rewinding machines or automatic winders constructed according to different technological and functional schemes are widely available on the market at present. Known to the art are centre drive winders in which rotation of the roll being formed is controlled by the mandrel that supports the cores, surface drive winders in which rotation is imparted to the roll being formed from the outside by means of a drum, and mixed winders provided with both centre and surface drive.

[0003] All rewinding machines, if provided with complete automation, allow a formed roll of a pre-established length to be deposited at the exit, without stopping the production process, precisely re-positioning a new core for winding of a new roll. However, in any case, it is the operator's task to reload the rewinding machine with new cores for winding, each time a roll change is carried out once the pre-established wound length has been reached.

[0004] In some applications, the rewinders are disposed downstream of extruders or calenders and therefore operate as terminal machines in the production process of thermoplastic films. In this case the absolute continuity of the production process must be ensured.

[0005] Consequently, rewinders are provided with magazines consisting of chains with couplers/hooks that support two or more mandrels already coupled to the cores to be wound so as to allow the process a longer autonomy, without the immediate intervention of the operator at each roll change.

[0006] In particularly fast automatic rewinders, dedicated anthropomorphic robots are applied, which in any case are separate and independent from the machine. Said robots carry out the operations that are normally carried out by the operator, that is to say removal of the mandrel from the cores of the formed rolls, reloading of the cores onto the mandrel and re-placing on the feeder of the machine of the mandrel, with the relative cores for winding inserted.

[0007] The use of such dedicated robots considerably increases the level of complexity of the rewinding machine, and also its production cost and operating difficulty.

[0008] The object of the present invention is to overcome the drawbacks of the prior art, providing a rewinding machine for flexible film of plastic material that is fully automatic, able to eliminate the operations of human intervention and able to guarantee a high production cycle speed.

[0009] Another object of the present invention is to provide such a rewinding machine that is economical, of simple construction, and in which the moving parts and dimensions are reduced to a minimum.

[0010] Another object of the present invention is to provide such a rewinding machine that is reliable, functional and versatile.

[0011] These objects are achieved, in accordance with the invention, with the characteristics listed in appended independent claim 1.

[0012] Another object of the present invention is to provide a method of producing rolls of film of plastic material that is fully automatic and able to avoid human intervention.

[0013] This object is achieved in accordance with the invention with the characteristics listed in appended independent claim 14.

[0014] Advantageous embodiments of the invention are apparent from the dependent claims.

[0015] The automatic rewinder comprises:

- film feeding means able to feed the film toward at least one core supported by a mandrel rotatably mounted in a winding cradle, so as to generate at least one roll of film,
- cutting means able to cut the film once the roll has been completed,
- roll unloading means able to unload at least one completed roll out of the winding area of the rewinder,
- core feeding means able to feed cores from a magazine toward a loading support mounted on the frame of the winding machine,
- a mandrel loading/unloading device, able to load a mandrel inside the cores disposed in said loading support and to unload the mandrel from the cores, when formation of the rolls on said cores has been completed, and
- mandrel handling means able to pick up a mandrel with the relative cores inserted from said loading support to carry it toward the winding area in said winding cradle.

[0016] From this brief description it is clear that the rewinder according to the invention can work automatically without human intervention. In fact the mandrel loading/unloading device is responsible for inserting the mandrel into the cores fed from the magazine to the rewinder to be able to begin the winding cycle and for removing the mandrel from the cores of the formed rolls on completion of the winding cycle.

[0017] Further characteristics of the invention will be made clearer by the detailed description that follows, referring to a purely exemplary and therefore non-limiting embodiment thereof illustrated in the appended drawings, in which:

Figure 1 is a side elevation view, schematically il-

lustrating the automatic rewinder according to the invention in the stage wherein a roll of film of flexible plastic material has been completed and wherein a mandrel must be loaded inside the cores for winding;

Figures 2-15 are schematic side elevation views, like Figure 1, illustrating the successive stages of the work cycle of the rewinder according to the invention;

Figure 16 is a schematic front view of the rewinder according to the invention, wherein the mandrel loading and unloading device is shown;

Figure 17 is a top plan view of Figure 16, schematically illustrating the rewinder and the mandrel loading and unloading device of Figure 16;

Figure 18 is a side view taken from the left of Figure 16 illustrating the mandrel loading and unloading system;

Figure 19 is a schematic top plan view of the mandrel loading/unloading device and the core feeding device during feeding of the cores toward the rewinder;

Figure 20 is a schematic front view of the mandrel loading/unloading device in a mandrel loading position;

Figure 21 is a schematic top plan view of the mandrel loading/unloading device during loading of the mandrel;

Figure 22 is a schematic front view of the mandrel loading/unloading device in a mandrel unloading position;

Figure 23 is a schematic top plan view of the mandrel loading/unloading device in a position ready for unloading of the mandrel;

Figure 24 is a schematic top plan view of the mandrel loading/unloading device during unloading of the mandrel.

[0018] The automatic rewinding device according to the invention, denoted as a whole by reference numeral 1, is described with the aid of the figures. Further on, even if some elements of the machine are denoted singly, it is to be understood that they are arranged in pairs, one on each side of the machine.

[0019] With reference for now to Figure 1, the rewinder 1 comprises a main frame 2 whereon idle rollers 3a, 3b, 3c, 3d and 3e are mounted which guide a film of plastic material 4 (shown with a dashed and dotted line) toward a drive drum 5 disposed in a central part of the machine 1. The drive drum 5 is mounted in such a manner that its side surface comes into contact with the side surface of a roll 6 of film being formed, disposed in the front part of the machine.

[0020] To maintain the pull on the film 4, a pressure roller rotatably mounted on an arm 21 hinged to the frame 2 of the machine acts on the drum 5. The arm 21 of the presser roller 20 is driven by a linear actuator 22 the piston of which is hinged in the central part of the arm 21. A pressure roller 20' rotatably mounted on an arm 21' hinged to the frame of the machine and driven by a linear actuator 22' also acts on the idle roller 3c.

[0021] A cutting device 60 provided with a cutting blade 61 for cutting of the film 4 is provided beneath the drum 5. The cutting device 60 is hinged to the frame 2 of the machine to be able to pass from a resting position beneath the drum 5, as shown in Figure 1, wherein it does not interfere with the film 4, to a cutting position, above the drum 5 and near the roll 6, to cut the web 4 once the roll 6 has been completed.

[0022] The roll 6 is formed by the film 4 which winds around a core 9 supported by a mandrel 8 disposed in the winding position. The mandrel 8, when it is in the winding position, is rotatably mounted around its own axis. At each end, the mandrel 8 is supported by a cradle 7. The cradle 7 has a tooth 10 to clamp or release the mandrel 8. The tooth 10 is controlled by a linear actuator 11 mounted on the cradle 7.

[0023] The cradle 7 is driven by means of a lever system comprising two arms 12 and 13 controlled by a linear actuator 14. The first arm 12 has one end hinged to the cradle 7 and the other end hinged to one end of the second arm 13. The other end of the second arm 13 is hinged to the frame 2 of the machine. The piston of the linear actuator 14 is hinged in an intermediate position of the second arm 13. The linear actuator 14 is supported by the machine frame.

[0024] An unloading support 15 which moves vertically along a vertical guide 16 acts beneath the cradle 7. The unloading support 15 serves to receive the formed roll 6 and bring it to the height of a slide 17 for unloading thereof. The unloading support 15 also has the possibility of turning around a pivot axis to tip the roll 6 toward the slide 17. The slide 17 is disposed downstream of the machine frame 2.

[0025] A first lever 30 having a cradle-shaped free end 31 with upward facing concavity is hinged in the rear part of the machine frame 2, at a point of fulcrum 32. The cradle 31 of the lever 30 is situated above the winding drum 5 and the lever 30 is driven in rotation around its fulcrum 32 by actuator means not shown.

[0026] A second lever 40 that has a telescopic coupling controlled by a linear actuator to be able to be adjusted in length is hinged beneath the winding drum 5, in a point of fulcrum 42. The telescopic lever 40 bears at one end a cradle 41 with a downward facing concavity.

[0027] A loading support 50 that protrudes horizontally forward from the upper part of the frame 2 is provided in the upper part of the frame 12 of the machine. The loading support 50 has in its front end a cradle 51 with upward facing concavity, to receive one or more cores 9 intended to be wound by the plastic film to form a roll. The loading support 50 is driven in horizontal translation by a linear actuator 52 acting in a horizontal direction.

[0028] A gluing device 53 which has a glue sprayer and a drive roller 54 is provided in the upper part of the frame 2 above the loading support 50.

[0029] A loading/unloading device for mandrels, denoted as a whole by reference numeral 100, will now be described with reference to Figures 16, 17 and 18.

[0030] The loading/unloading device 100 is disposed alongside a side of the rewinder 1. The loading/unloading device 100 comprises a fixed base frame 101 whereon is mounted a movable frame 102 which can translate horizontally, in a longitudinal direction, from a retracted mandrel loading position to an extended mandrel unloading position. The movable frame 102 is mounted on wheels 103 sliding on respective guides provided in the fixed frame 101.

[0031] A carriage 104 that defines a horizontal plane vertically translatable on a movable frame from a raised mandrel loading position to a lowered mandrel unloading position is mounted on the movable frame 102. Rollers 105 with a longitudinal axis with respect to the rewinding machine are mounted on the carriage 104 to convey the mandrels 8 transversely from the loading/unloading device 100 to the rewinder 1 and from the rewinder 1 to the loading/unloading device 100.

[0032] Chain carriers 110 able to convey the cores 9 from a magazine toward the rewinding machine are provided upstream of the loading/unloading device 100.

[0033] The work cycle of the loading/unloading device 100 will now be described with reference to Figures 19-24.

[0034] As shown in Figure 19, in an initial situation the loading support 50 mounted in the upper part of the frame 2 of the rewinding machine is disposed in its retracted position ready to receive the cores 9 coming from the chain carrier 110. To be precise, a pusher 111 is responsible for pushing the cores 9 into the cradle 51 of the loading support 50. In this situation the movable frame 102 of the loading/unloading device 100 is in its retracted position.

[0035] Once the cores 9 have been loaded into the cradle 51 of the loading support 50, the support 50 is made to advance into its advanced position. As shown in Figure 20, in this situation the carriage 104 of the loading/unloading device is in its raised position and supports on the rollers 105 a mandrel 8' which is coaxial with the cores 9 held in the cradle 51.

[0036] The mandrel 8' comprises an expansion system. That is to say, when pressurized air is blown inside the mandrel 8', it expands increasing in diameter, whereas when the air is let out, the mandrel 8' decreases in diameter, being in its unexpanded state.

[0037] As shown in Figure 21, the mandrel 8' in its unexpanded state is pushed transversally on the carriage 104 so as to enter into the cores 9 disposed in the cradle 51. Once the mandrel 8' is inside the cores 9, pressurized air is blown thereinto so as to cause expansion thereof and thus gripping of the cores which must be sent for winding.

[0038] When already formed rolls 6 are positioned on the unloading support 15, disposed in the front lower part of the rewinder 1, as shown in Figure 22, the carriage 104 of the loading/unloading device is translated downward into its lowered position at the level of the unloading support 15. In this case a mandrel 8 in the expanded state is positioned inside the cores of the rolls 6.

[0039] As shown in Figure 23, at the same time as lowering of the carriage 104, there is a horizontal forward translation of the movable frame 102 of the loading/unloading device which is disposed in its forward position. At this point a depressurising and gripping head 120, mounted on the movable frame 102, intervenes. The head 120 acts on the mandrel 8 which supports the formed rolls 6 and depressurises it, causing it to return to its unexpanded state. After the mandrel 8 has decreased in diameter, the head 120 pulls it axially extracting it from the cores of the formed rolls 6 and carrying it onto the carriage 104, as shown in Figure 24. The movable frame 102 is then retracted and the carriage 104 is raised to carry the mandrel 8 into the loading position to start a new cycle.

[0040] Operation of the rewinding machine 1 will now be described with reference to Figures 1-15.

[0041] As shown in Figure 1, the cores are initially loaded by the chain drive 110 to the loading support 50 which is in its retracted position.

[0042] As shown in figure 2, following operation of the linear actuator 52, the loading support 50 is made to translate horizontally in the direction of the arrow F1 to come into its forward position. In this situation, by means of the loading/unloading device 100, the mandrel 8' is inserted inside the cores 9 supported by the loading support 50 and the mandrel 8' is then inflated to increase in diameter and adhere to the cores 9.

[0043] As shown in Figure 3, the first lever 30 is operated upward in the direction of the arrow F2, rotating around its fulcrum 32. The cradle 31 of the lever 30 goes onto the end of the mandrel 8' and raises it, thus raising the cores 9 from the cradle 51 of the loading support 50. The cores 9 thus arrive beneath the gluing device 53. By means of the roller 54 of the gluing device the mandrel 8' is rotated and glue is thus sprayed evenly with the glue on the surface of the cores 9 to allow the film 4 to adhere.

[0044] As shown in Figure 4, when a roll 6 of the desired diameter has been formed, the linear actuator 22 is operated to move the presser roller 20 away from the drum 5, so as to allow the passage of the cutting device

60. The cutting device 60 is then rotated around its fulcrum to bring it into the cutting position above the drum 5 and near the formed roll 6.

[0045] At this point, as shown in Figure 5, the linear actuator 22 is operated to bring the pressure roller 20 into contact with the drum 5.

[0046] As shown in Figure 6, the first lever 30 is subsequently lowered to bring the mandrel 8' with the cores 9 above the drum 5, the second telescopic lever 40 is rotated counterclockwise to bring its cradle 41 above the mandrel 8' and the loading support 50 is withdrawn to return it to its core loading position.

[0047] As shown in Figure 7, the telescopic lever 40 is subsequently lowered so that the cradle 41 engages above the end of the mandrel 8'.

[0048] As shown in Figure 8, at this point the lever 30 is further lowered to bring the cores 9 into contact with the film above the drum 5 and cutting of the film 4 is done by means of the cutting blade 61 of the cutting device 60.

[0049] As shown in Figure 9, at this point the linear actuator 14 is operated to push, through the lever system 12, 13, the cradle 7 that carries the mandrel 8 of the formed roll 6. In this manner the roll 6 moves horizontally forward in the direction of the arrow F3, moving away from the drum 5. Subsequently the cutting device 60 is rotated counterclockwise to return it to the resting position.

[0050] As shown in Figure 10, at this point the loading support 15 is raised until it comes into contact with the lower surface of the formed roll 6. Subsequently the actuator 11 is operated to open the tooth 10 which retains the mandrel 8 of the roll 6 in the cradle 7. At this point the loading/unloading device 100 intervenes to remove the mandrel 8 from the cores 9 of the rolls 6, as has been described with reference to Figures 22-24.

[0051] As shown in Figure 11, at this point the unloading support 15 is lowered to the level of the slide 17 and then rotated around its fulcrum to tip the formed roll 6 onto the slide 17. At the same time the first lever 30 is further lowered so that the cores 9 supported by the mandrel 8' are supported on the drum 5.

[0052] As shown in Figure 12, at this point the linear actuator 14 is operated to withdraw the cradle 7 in the horizontal direction of the arrow F4 to dispose it in the working position near the drum 5. The second telescopic lever 40 is subsequently rotated to bring the mandrel 8' onto the cradle 7.

[0053] As shown in Figure 13, at this point the linear actuator 11 is operated to close the tooth 10 so as to clamp the mandrel 8' firmly to the cradle 7. At the same time the unloading support 15 is raised to position itself in its position ready to receive a new formed roll.

[0054] As shown in Figure 14, at this point the telescopic lever 40 lengthens telescopically, so that its cradle 41 moves away from the mandrel 8'.

[0055] Lastly, as shown in Figure 15, the telescopic lever 40 is rotated clockwise around its fulcrum to return to the starting position, ready to grip a new mandrel. The mandrel 8' is thus situated in the winding position to allow winding of the film 4 around the cores 9 supported by the mandrel 8'.

[0056] Numerous changes and modifications of detail known to a person skilled in the art can be made to the present embodiment of the invention, without thereby departing from the scope of the invention, as set forth in the appended claims.

Claims

1. Automatic rewinder (1), particularly for film of plastic material, comprising:

   - film feeding means (3a, 3b, 3c, 3d, 3e, 5) able to feed a film (4) toward at least one core (9) supported by a mandrel (8) rotatably mounted in a winding cradle (7), so as to generate at least one roll (6) of film,
   - cutting means (60) able to cut the film (4) once the roll has been completed (6),
   - roll unloading means (15) able to unload said at least one completed roll (6) outside the winding area of the rewinder,
   - core feeding means (110, 111) able to feed cores (9) from a magazine to a loading support (50) mounted on the frame (2) of the rewinder,
   - a mandrel loading/unloading device (100), able to load a mandrel (8') into the cores (9) disposed in said loading support (50) and to unload the mandrel (8) from the cores (9) disposed in said winding cradle (7), when formation of the rolls on said cores has been completed, and
   - mandrel handling means (30, 40), able to take said mandrel (8') with the relative cores (9) inserted from said loading support (50) to bring it to the winding area in said winding cradle (7).

2. A rewinder according to claim 1, **characterised in that** said mandrel loading/unloading device (100) comprises:

   - a fixed base frame (101) mounted at one side of the rewinder (1),
   - a movable frame (102) mounted on the fixed frame that can translate horizontally, longitudinally to the machine, from a retracted position for loading mandrels to the rewinder to a forward position for unloading mandrels from the rewinder, and
   - a carriage (104) mounted on the movable frame (102) that can translate vertically from a raised mandrel loading position for loading mandrels to the rewinder to a lowered mandrel unloading position for unloading mandrels from the re-

winder.

3. A rewinder according to claim 2, **characterised in that** rollers or wheels (105) with a longitudinal axis, able to support a mandrel (8, 8') during translation in a transverse direction, are mounted on said carriage (104).

4. A rewinder according to any one of the preceding claims, **characterised in that** said mandrel loading/unloading device (100) comprises air input means for blowing air into the mandrel (8'), when it is inserted in the cores (9) supported by the loading support (50) so as to increase it in diameter and a gripping head (120) able to cause release of air from the mandrel (8) when it is inserted in cores (9) that support completed rolls (6) to cause it to decrease in diameter and able to pick up said mandrel (8) once it has decreased in diameter.

5. A rewinder according to any one of the preceding claims, **characterised in that** said loading support (50) comprises a cradle (51) to receive said cores (9) and is mounted moveable from a retracted core loading position for loading cores (9) to a forward mandrel loading position for loading the mandrel (8').

6. A rewinder according to claim 5, **characterised in that** said loading support (50) is driven by means of a linear actuator (52) mounted on the rewinder frame.

7. A rewinder according to any one of the preceding claims, **characterised in that** said film feeding meams comprise idle rollers (3a, 3b, 3c, 3e) and a drive drum (5) disposed in the central part of the rewinder, peripherally in contact with the roll (6) to be formed.

8. A rewinder according to claim 7, **characterised in that** said mandrel handling means comprise a first pair of levers (30) hinged to the frame (2) of the rewinder and having one cradle-shaped end (31) to support the ends of the mandrel (8'), each lever (30) being moveable from a raised position for picking up the mandrel (8') from said loading support (50) to a lowered position for depositing the mandrel (8') on said drum (5).

9. A rewinder according to claim 8, **characterised in that** it comprises a gluing device (53) mounted in the frame (2) of the rewinder above the loading support (50) and that said first pair of levers (30) can pass from the position for picking up said mandrel (8') to the position in which they carry said mandrel with the cores (9) under the gluing device (53) which is responsible for depositing a layer of glue on the side surface of the cores (9) supported by the mandrel (8').

10. A rewinder according to claim 8 or 9, **characterised in that** said mandrel handling means comprise a second pair of levers (40) hinged to said frame, telescopically adjustable in length and having one end (41) shaped as a cradle to support the ends of the mandrel (8'), each lever (40) being moveable from a first position for picking up the mandrel (8') above said drum (5) to a second position for depositing the mandrel (8') on said winding cradle (7).

11. A rewinder according to any one of the preceding claims, **characterised in that** said winding cradle (7) is driven by a lever system comprising a first arm (12) hinged to the cradle (7) and to a second arm (13) in turn hinged to the frame (2) of the rewinder and a linear actuator acting on said second arm (13), so that the cradle (7) can pass from a retracted winding position to a forward unloading position.

12. A rewinder according to any one of the preceding claims, **characterised in that** said winding cradle (7) comprises a tooth (10) to clamp the mandrel (8) that supports the cores in the winding area, said tooth being operated by a linear actuator (11) mounted in said cradle (7).

13. A rewinder according to any one of the preceding claims, **characterised in that** said roll unloading means comprise an unloading support (15) mounted vertically slidable and rocking on a vertical guide (16) mounted in said frame, to be able to pass from a raised position for picking up said formed rolls (6) to a lowered position for unloading of said formed rolls toward a slide (17) disposed downstream of the rewinder.

14. A method of producing rolls (6) of film material comprising the following steps:

- feeding a film (4) to a winding area wherein at least one core (9) is supported by a mandrel (8) to form a roll (6),
- feeding cores (9) from a magazine to a loading support (50) of a rewinder (1),
- inserting a mandrel (8') into the cores (9) supported in said loading support (50), by means of a mandrel loading/unloading device (100),
- picking up the mandrel (8') supporting the cores (9) by means of lever means (30, 40) to carry the mandrel (8') toward a drive drum (5) for peripheral winding of the films onto the cores,
- cutting the film (4) by means of cutting means (60), once the roll (6) has been formed,
- moving the formed roll into a position of unloading and removal of the mandrel (8) from the

cores of formed roll, by means of the loading/unloading device (100),

- moving the mandrel (8') with the cores (9) toward the winding area to begin winding of the film (4) onto the cores (9),
- conveying the mandrel (8) removed from the cores by means of the loading/unloading device into the loading area for insertion of the cores (9) that have been loaded again on the loading support (50).

15. A method according to claim 14, **characterised in that** a reciprocating movement of said loading support (50) is provided to pass from a core loading position to a mandrel loading position.

16. A method according to claim 14 or 15, **characterised in that** it further comprises a gluing step wherein glue is deposited on the outer surface of the cores (9) supported by said mandrel (8') when said mandrel is picked up, by means of moving means (30, 40), from said loading support (50).

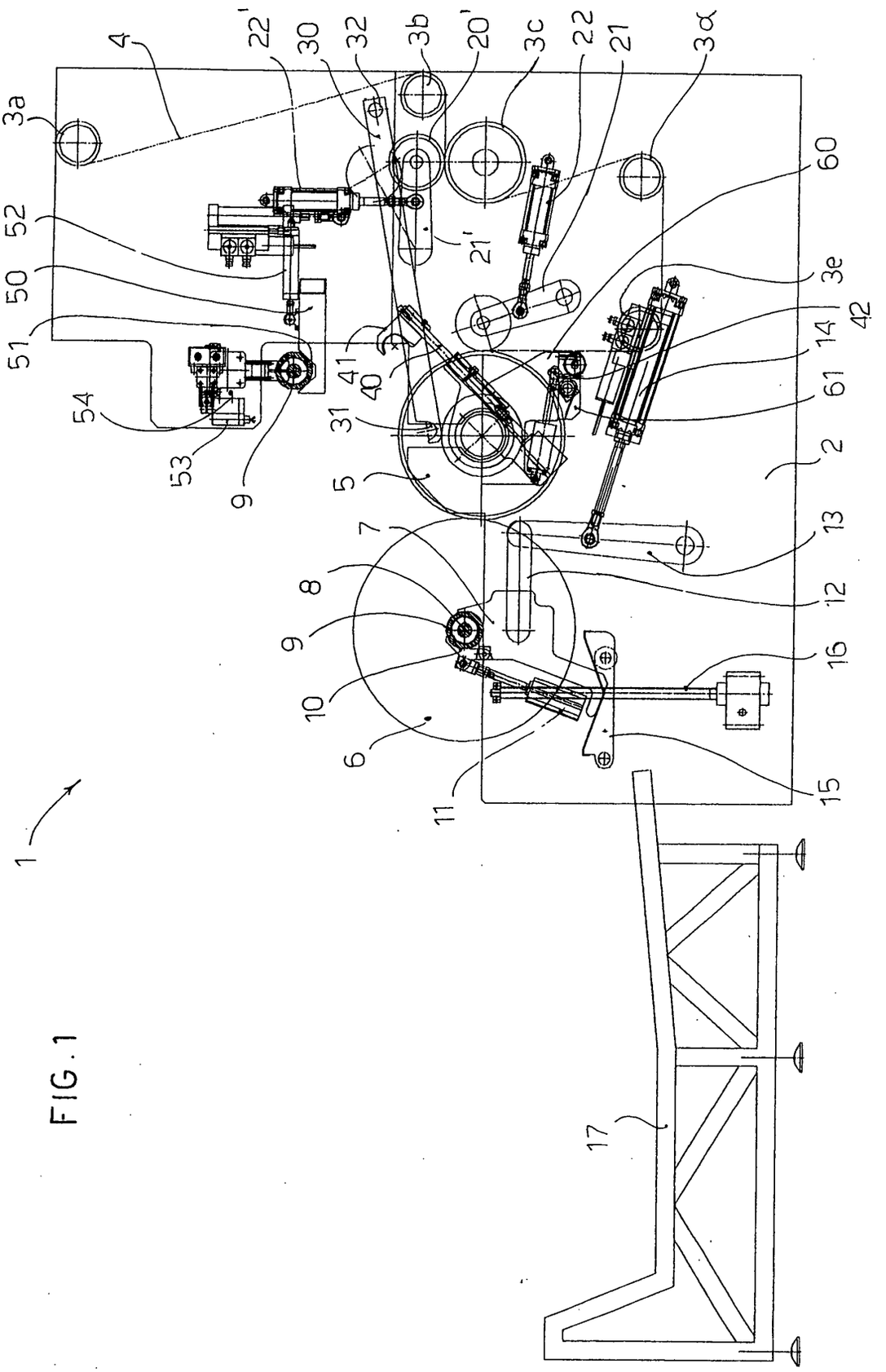
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FIG. 1

FIG. 2

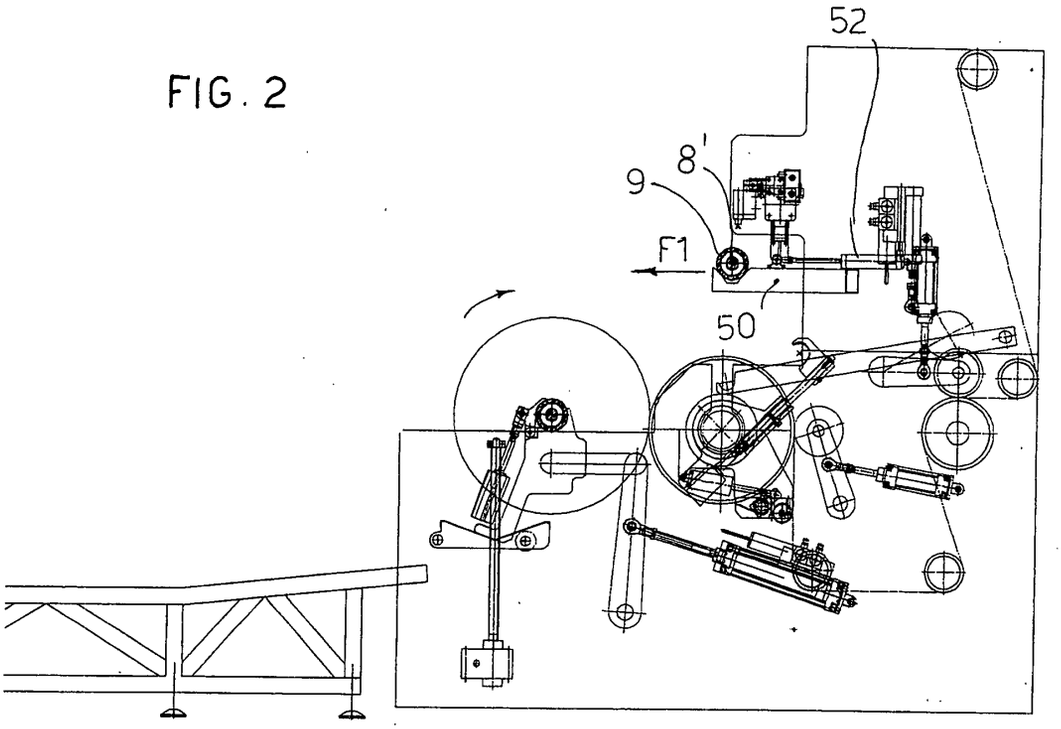


FIG. 3

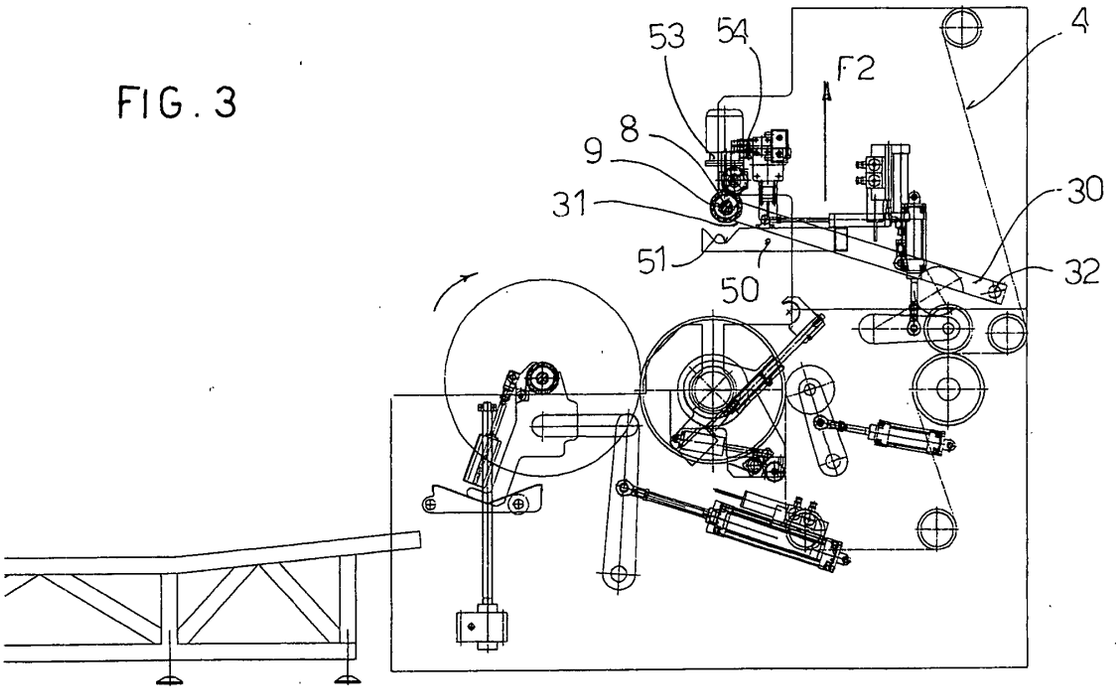


FIG.4

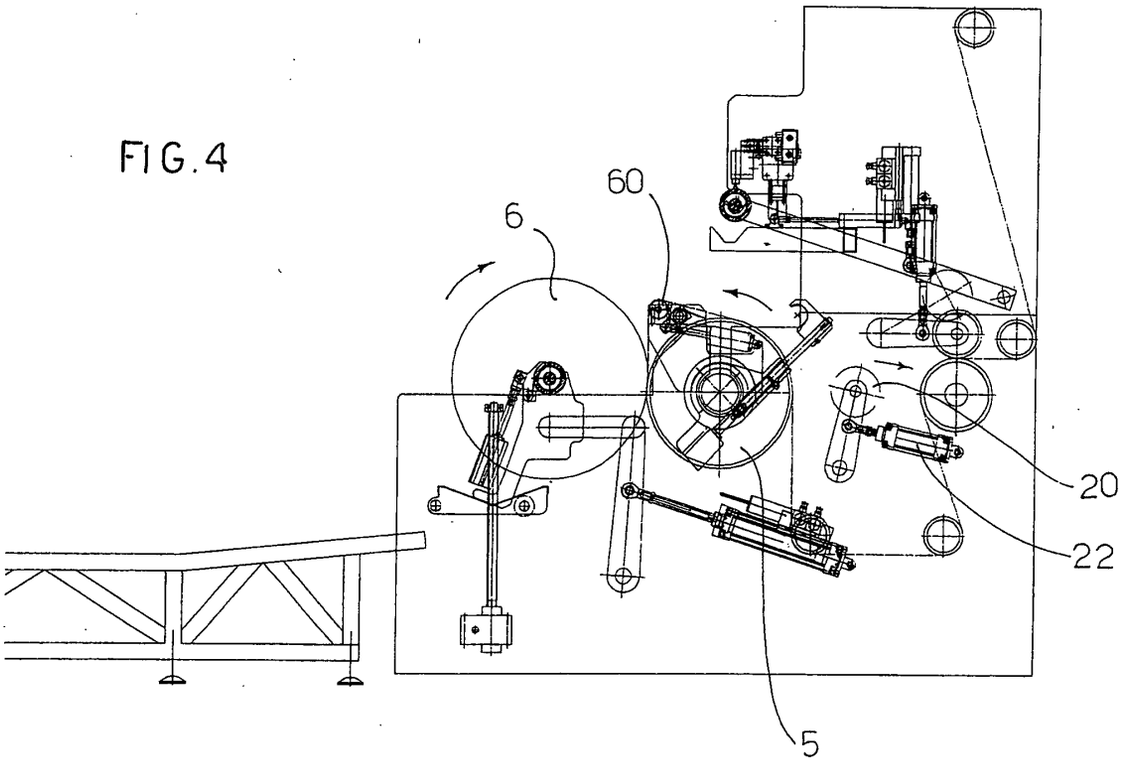


FIG.5

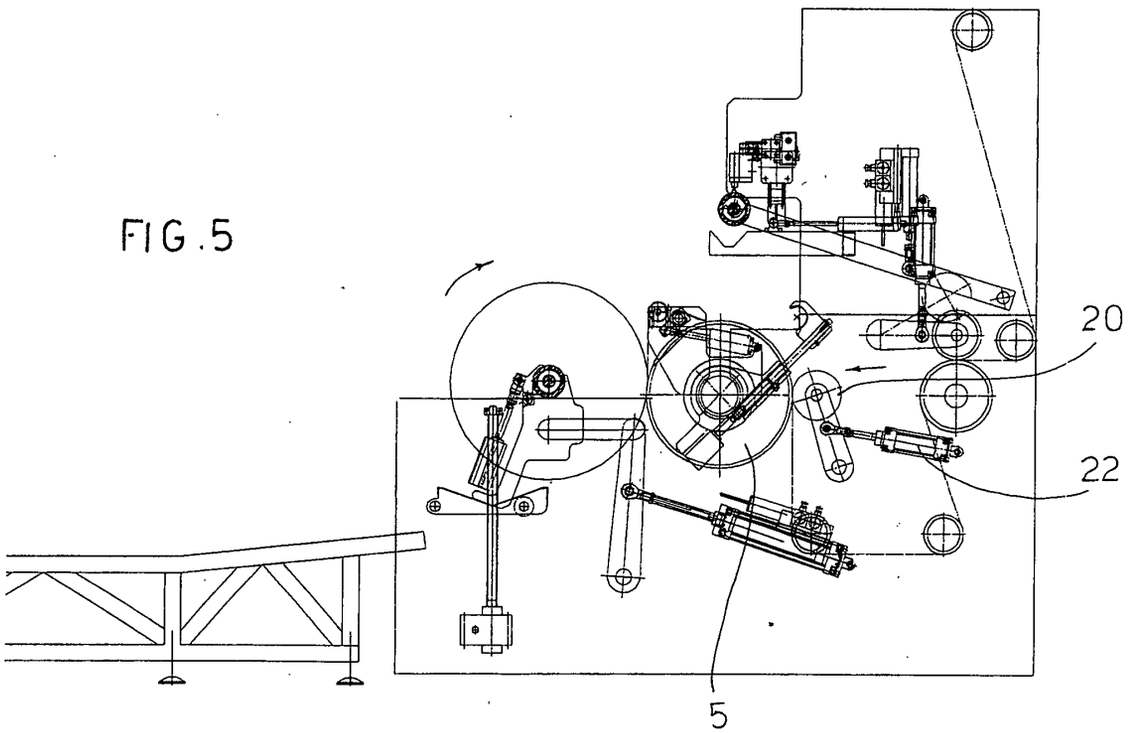


FIG. 6

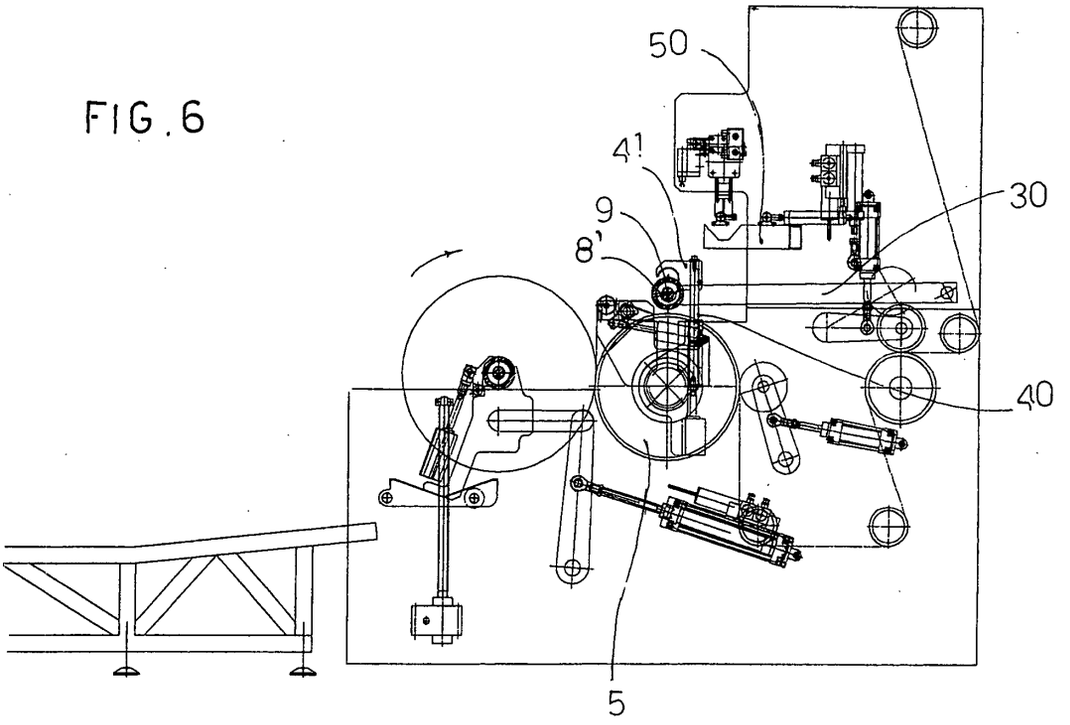


FIG. 7

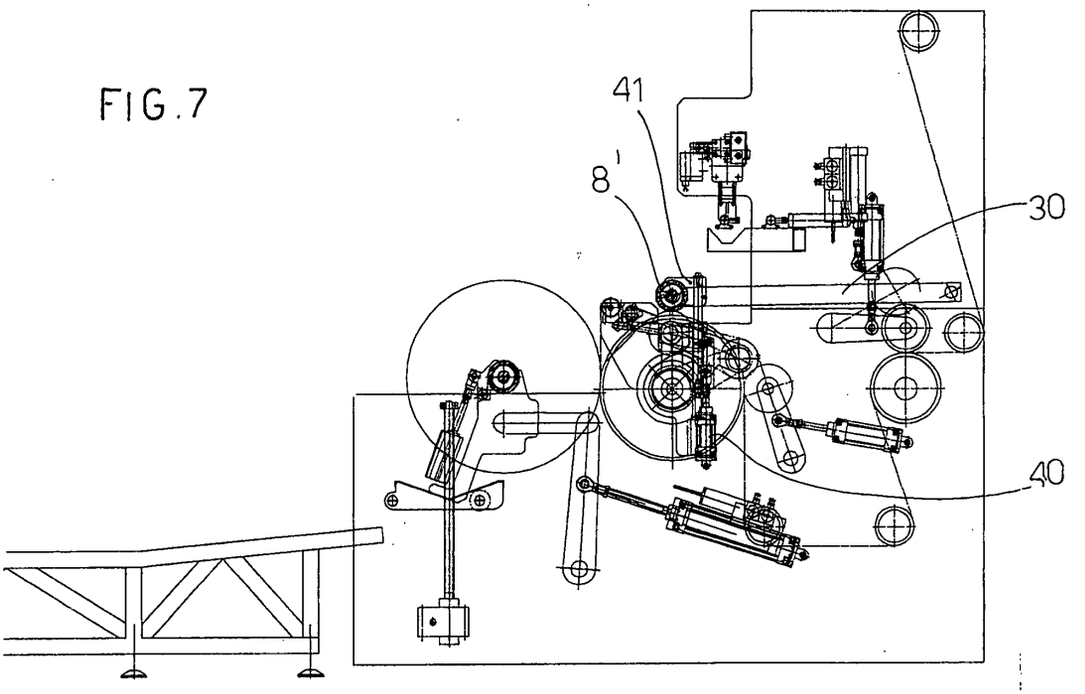


FIG 8

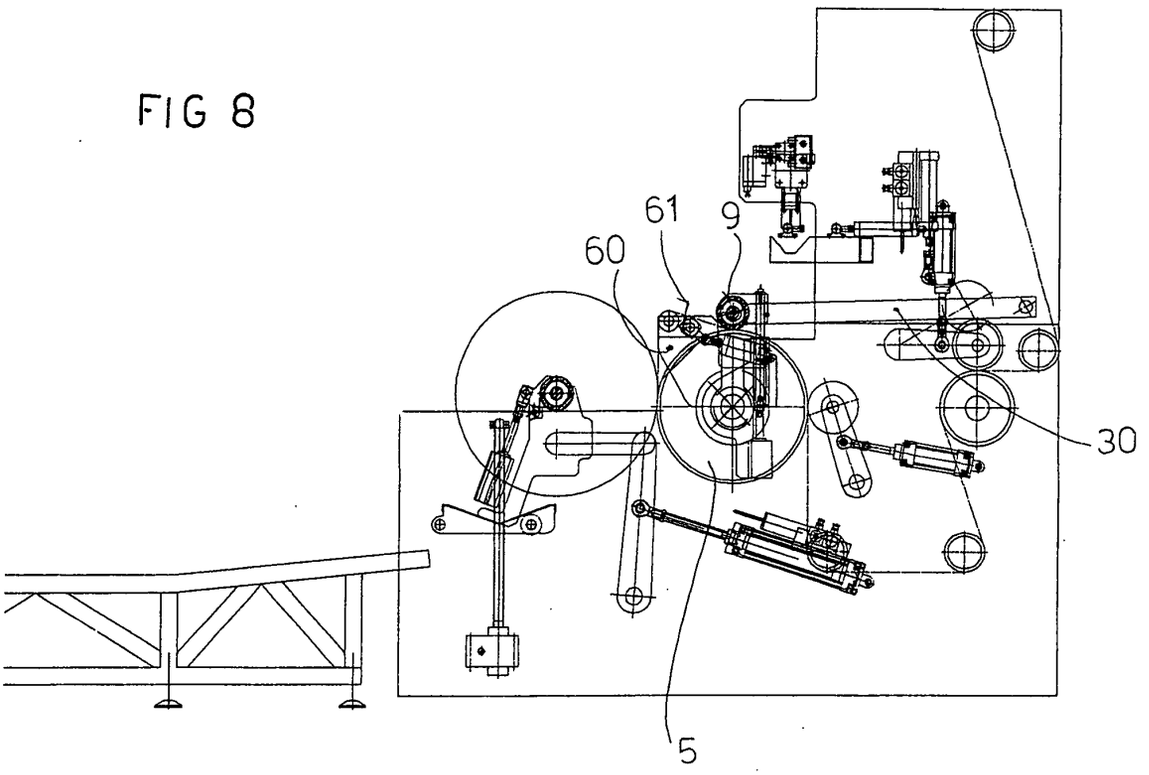


FIG.9

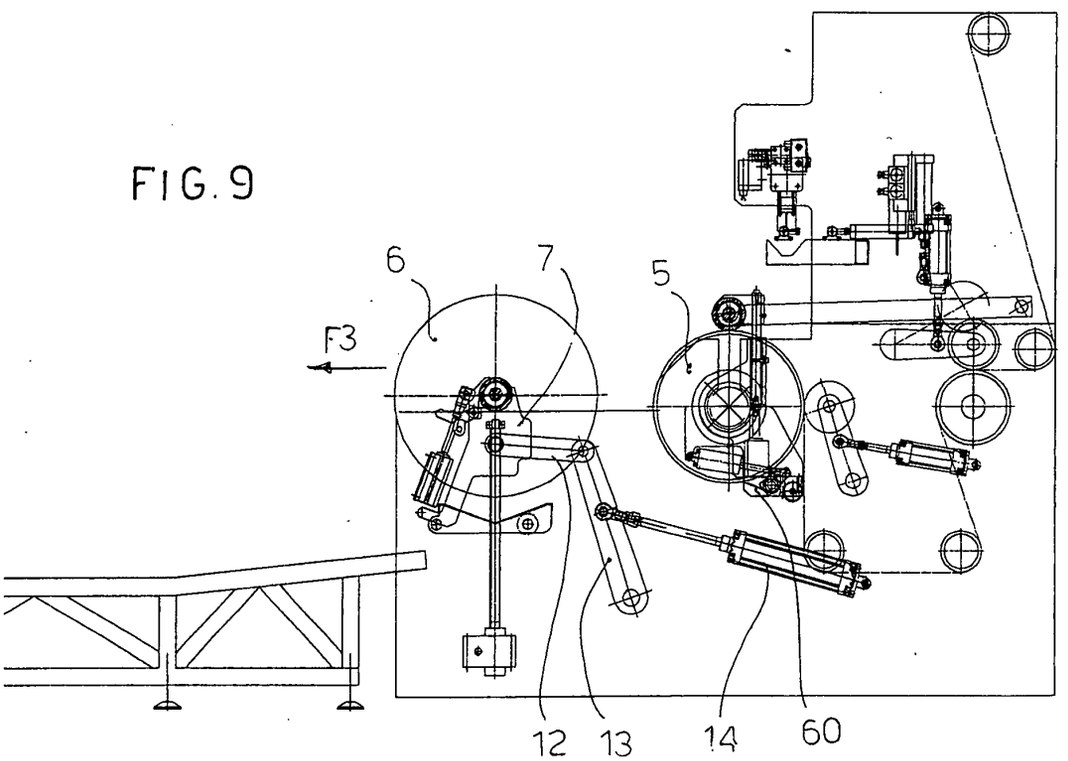


FIG. 10

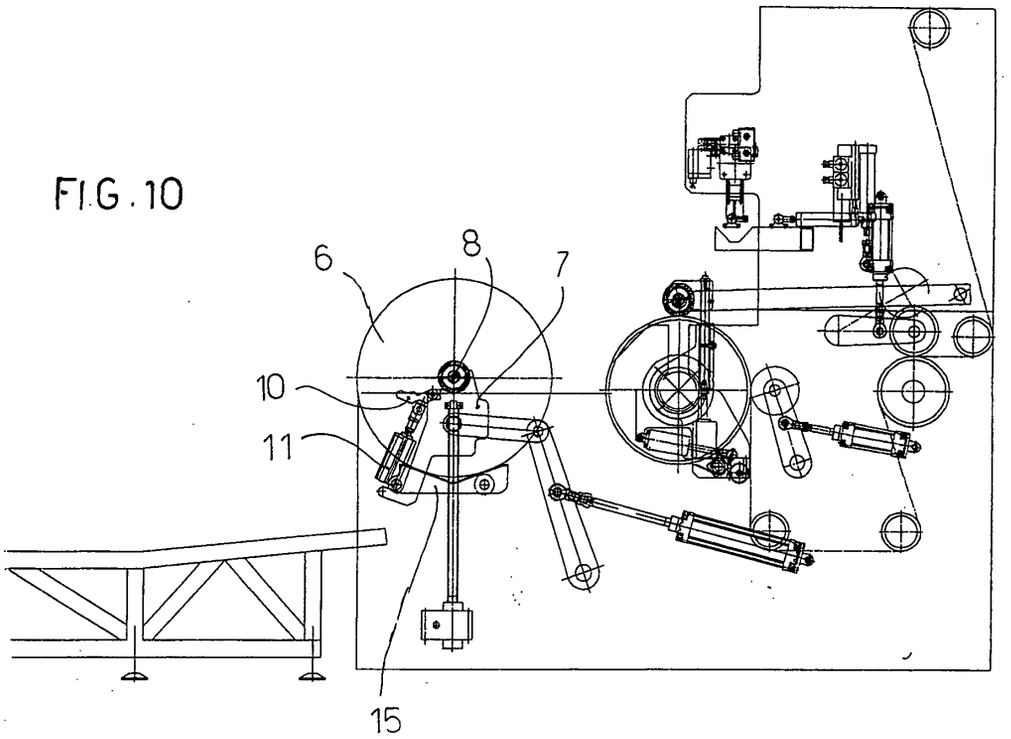


FIG. 11

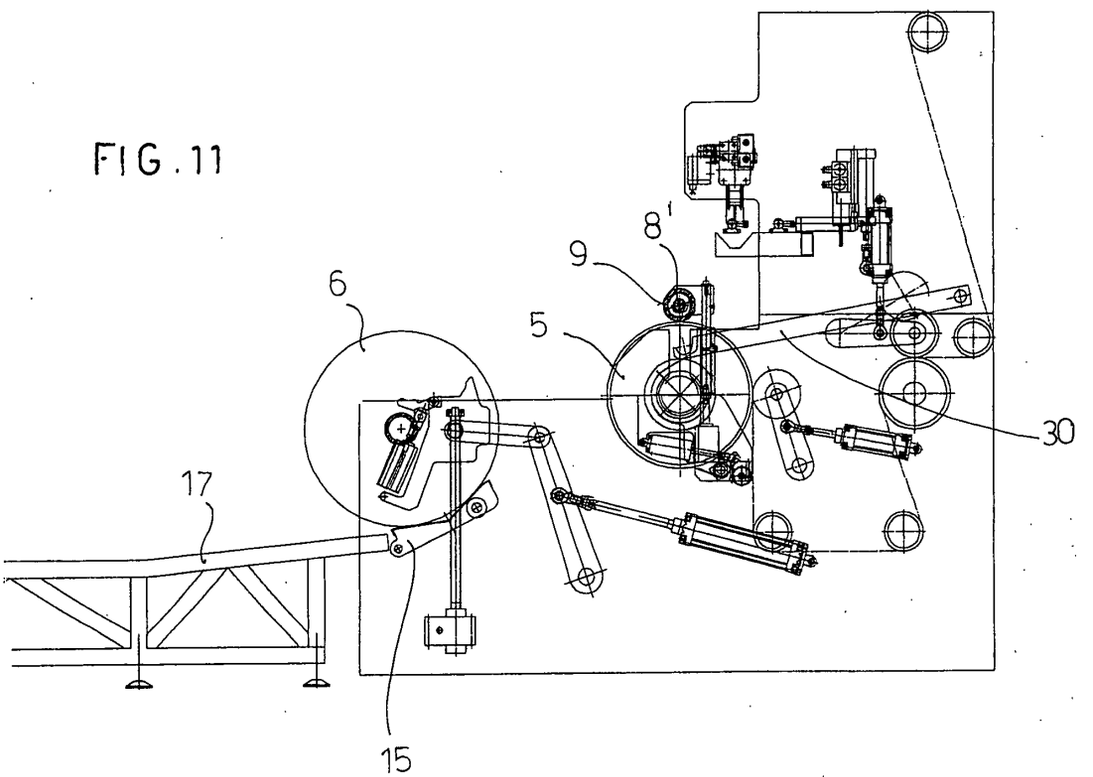


FIG. 12

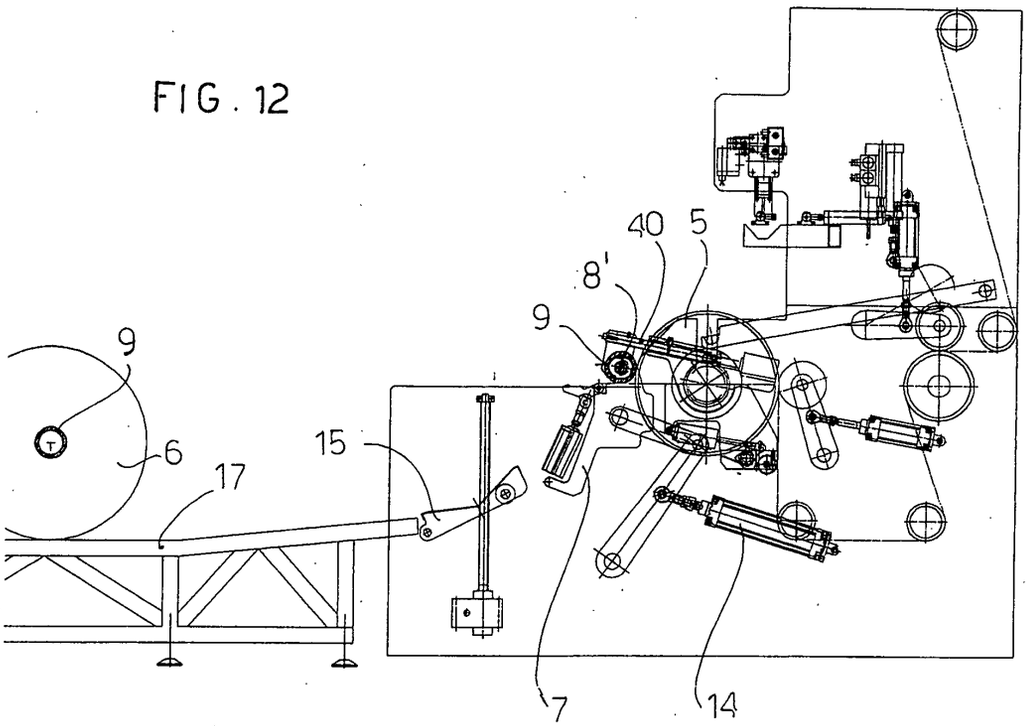


FIG. 13

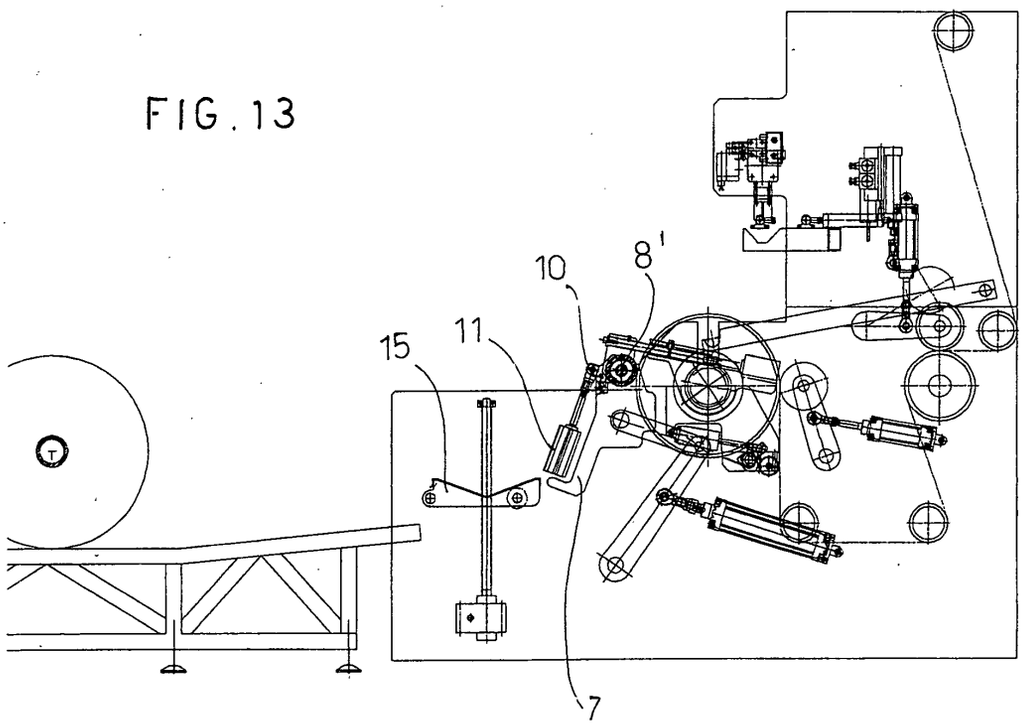


FIG. 14

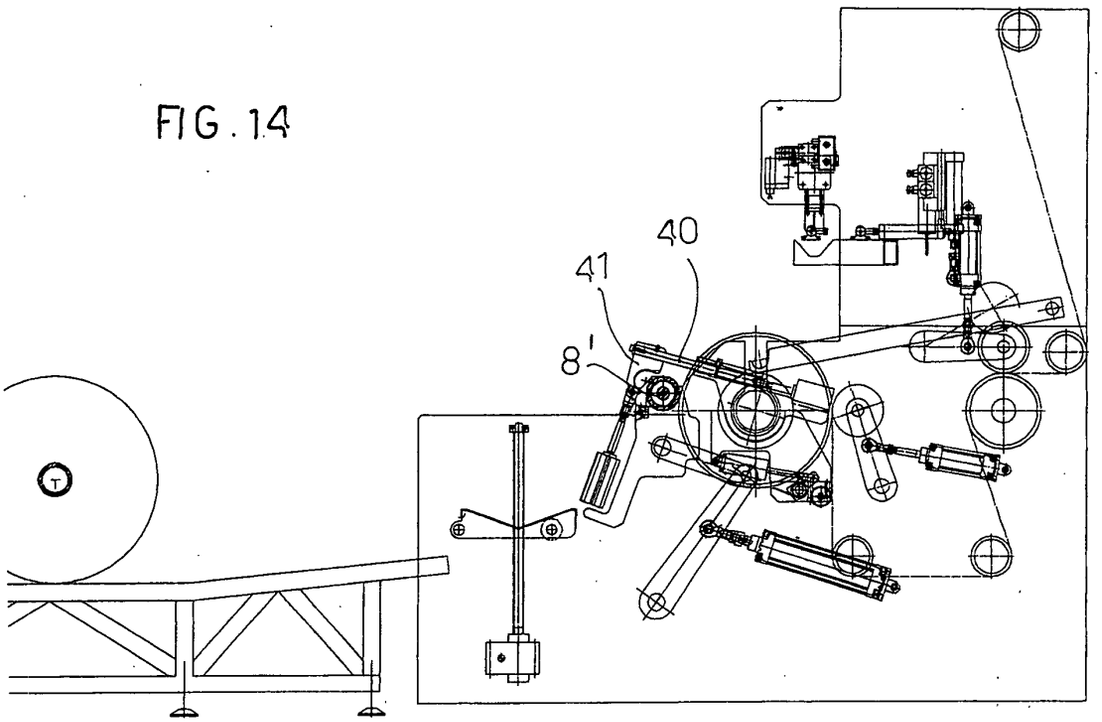


FIG. 15

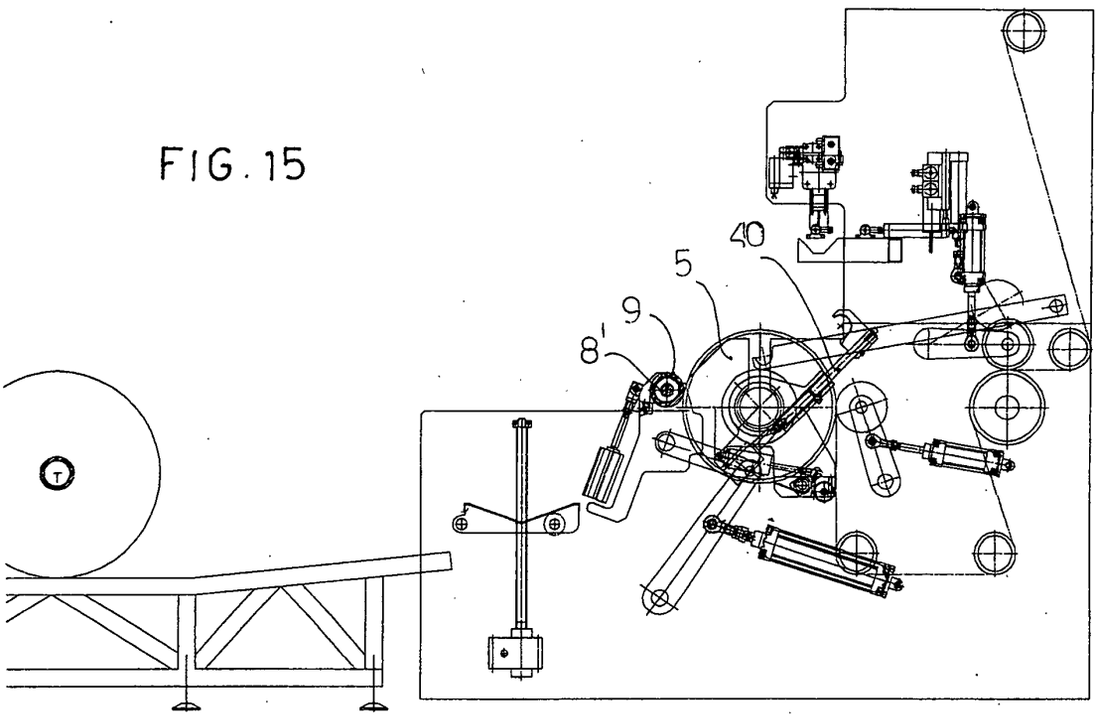


FIG. 16

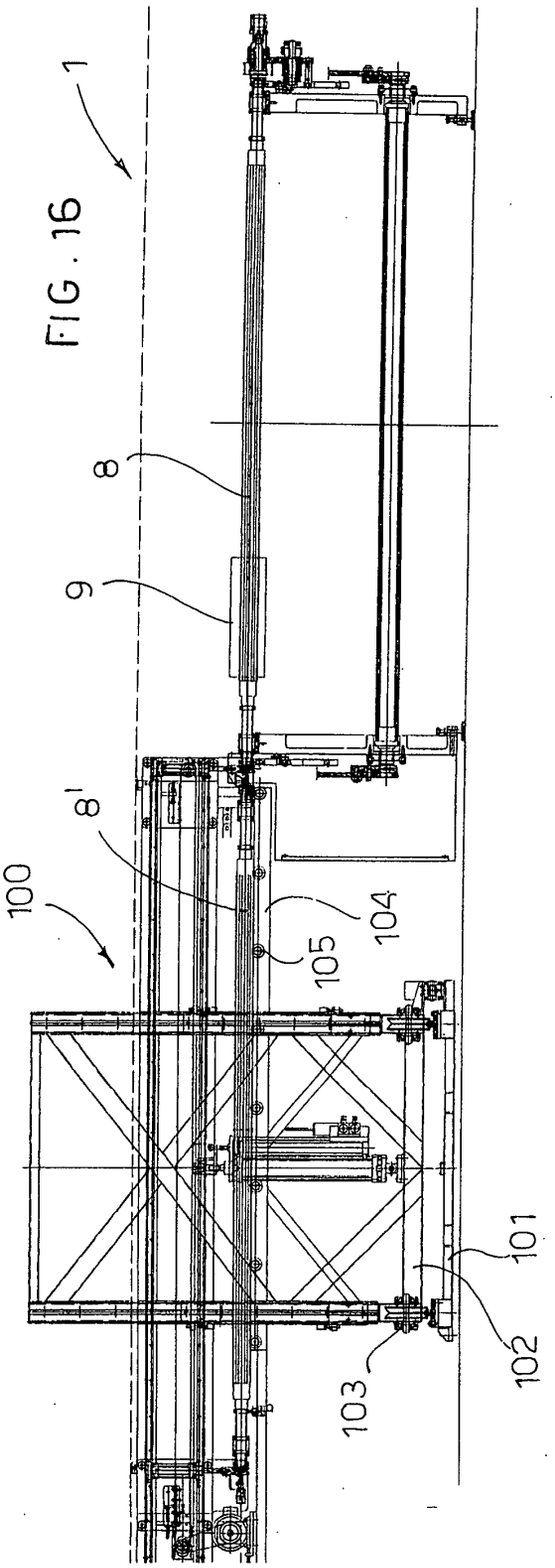
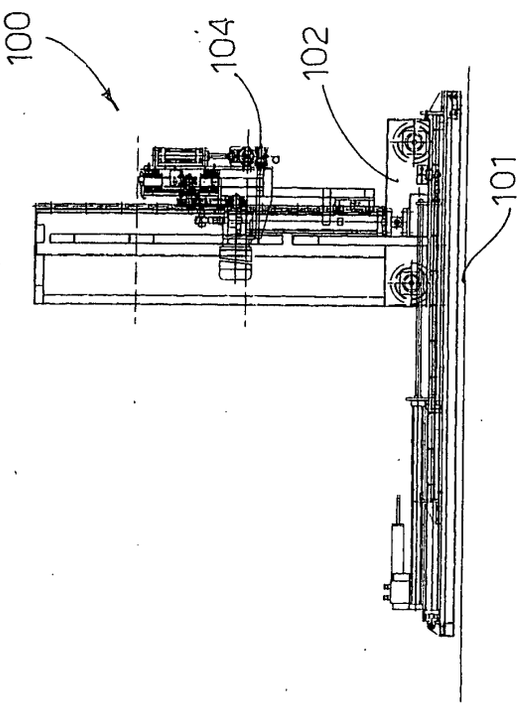


FIG. 18



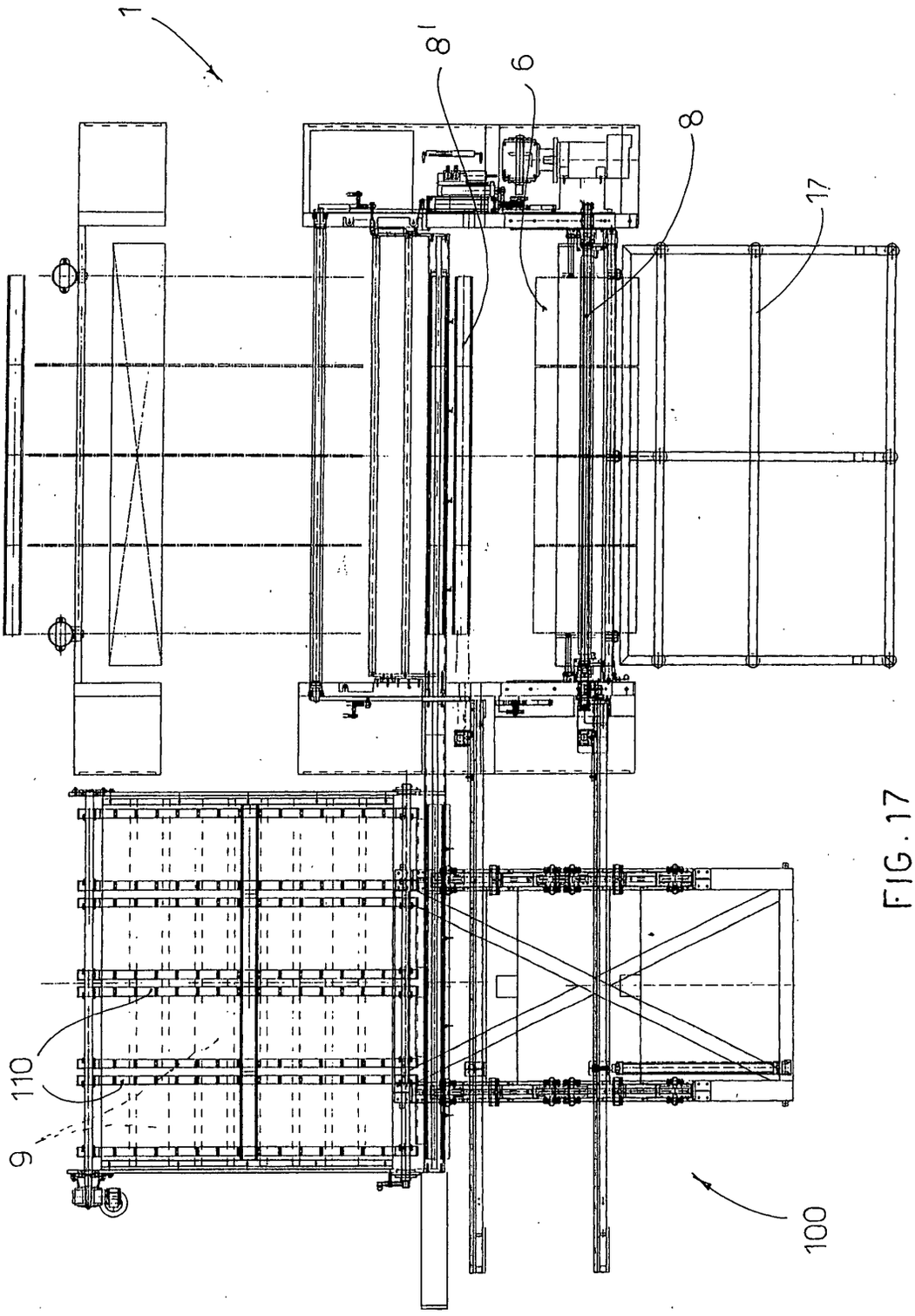


FIG. 17

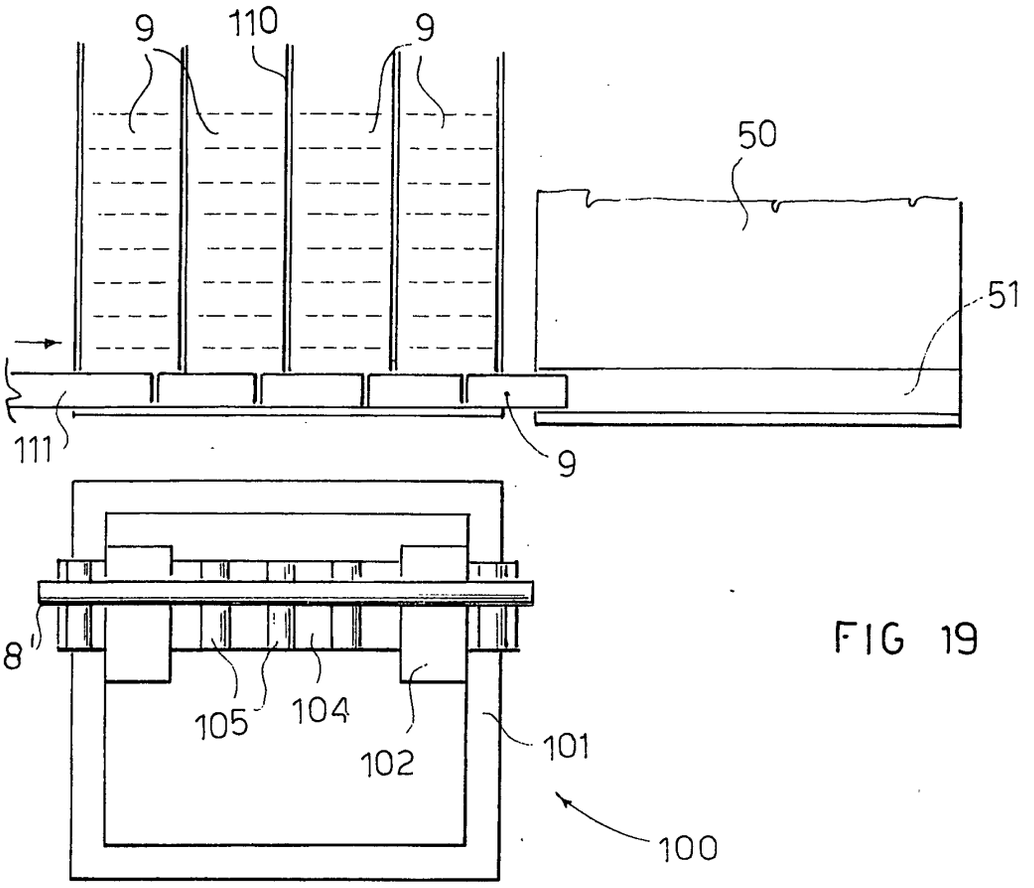

9
110
9
50
51
111
9
8'
105
104
102
101
100

FIG 19

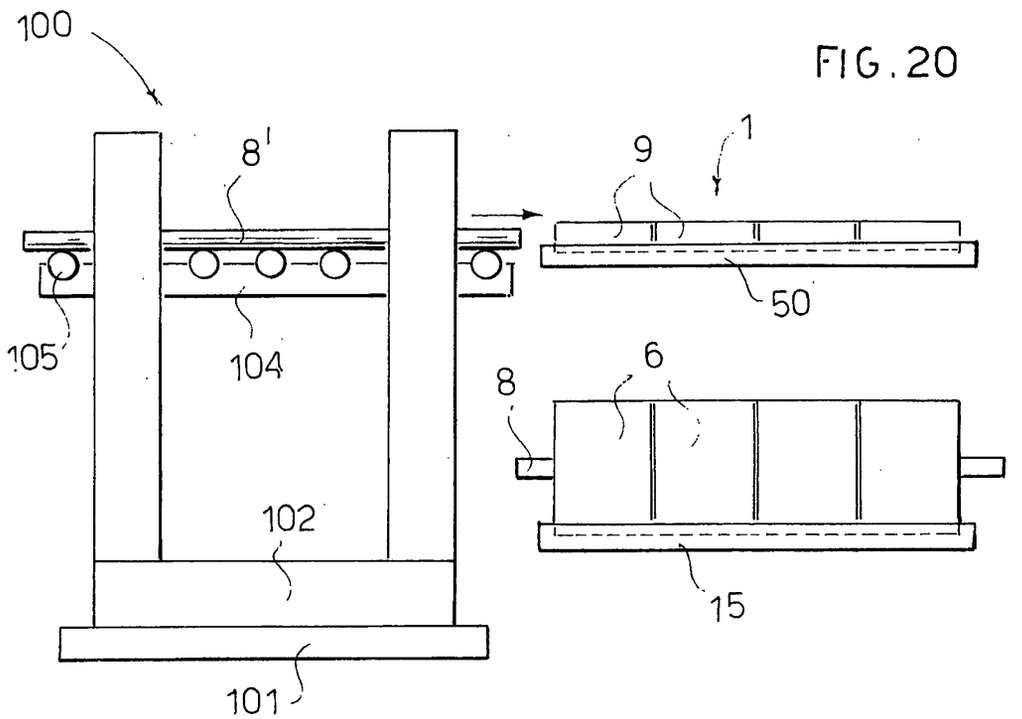

100
8'
9
1
105
104
50
6
8
102
15
101

FIG. 20

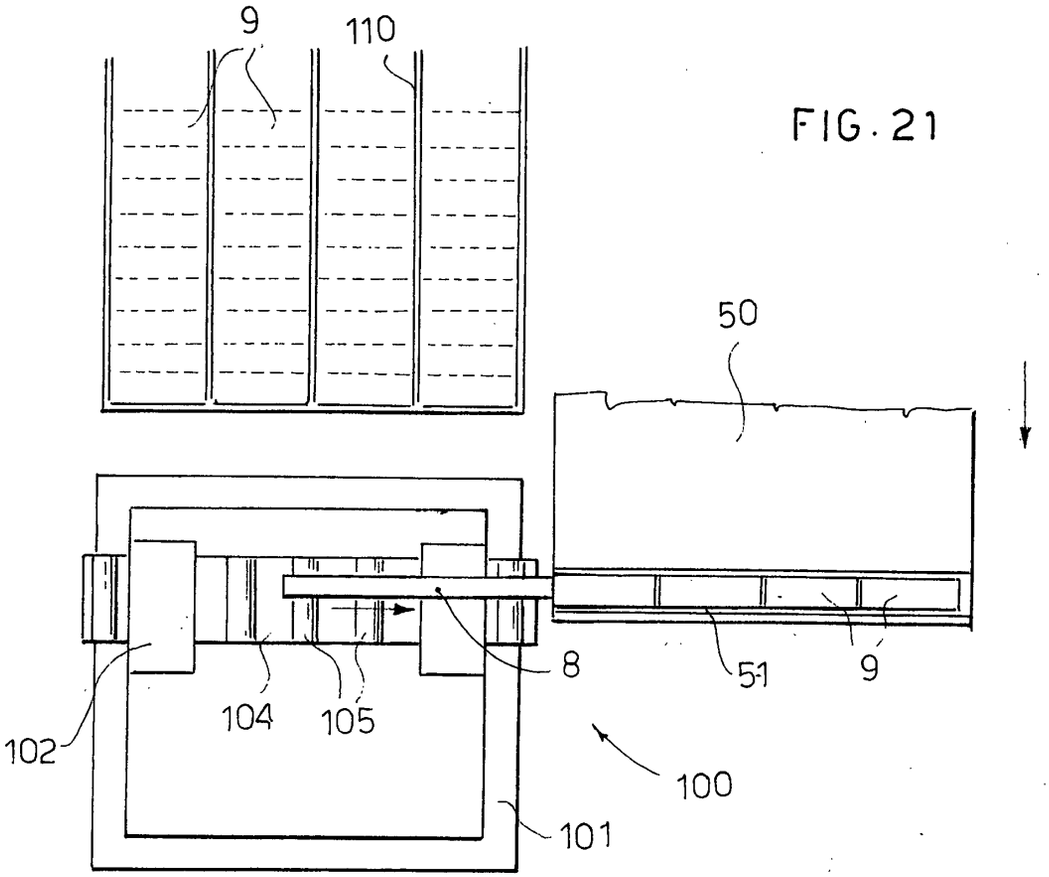

9
110
50
8
51
9
104
105
102
100
101

FIG. 21

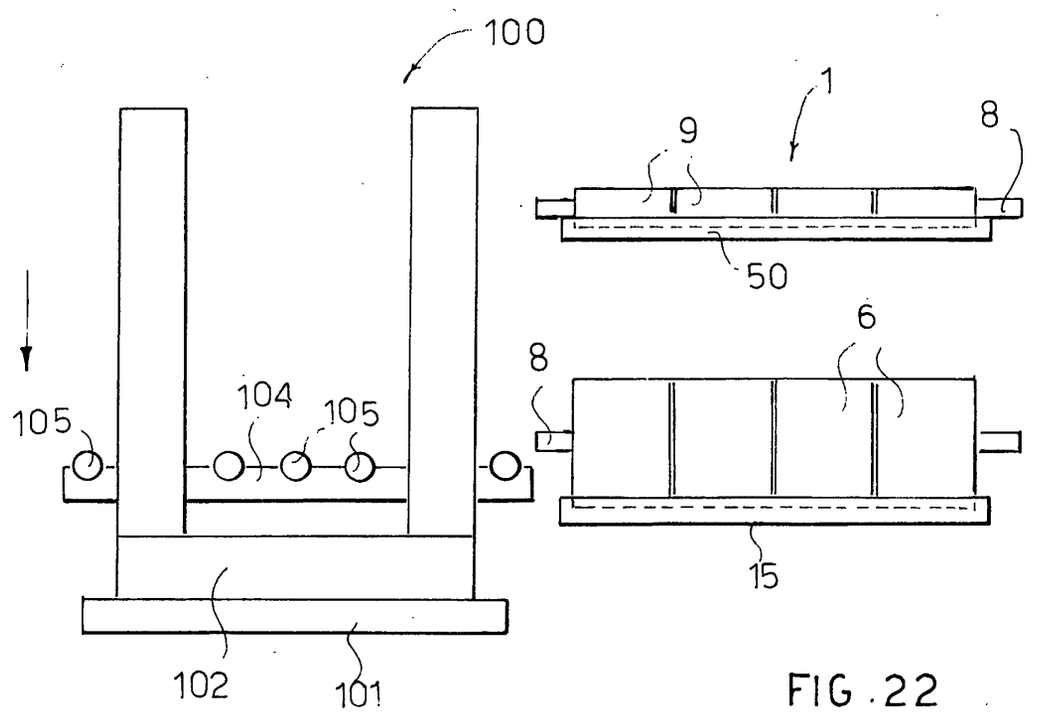

100
1
9
8
50
6
8
104
105
105
15
102
101

FIG. 22

FIG. 23

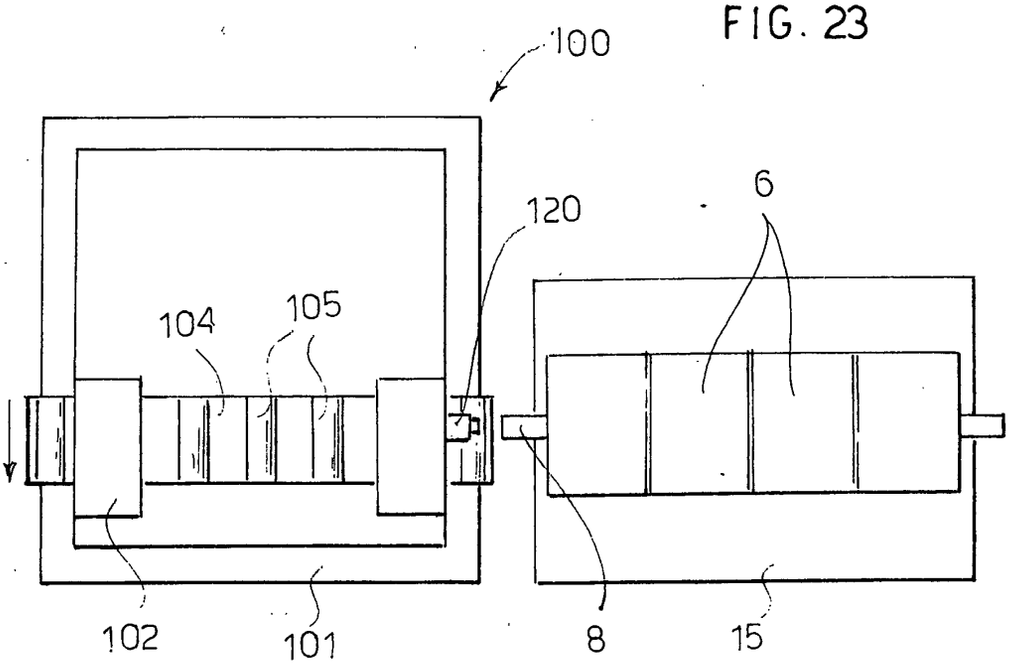


FIG. 24