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(54) AUTOMATIC WINDING MACHINE PROVIDED WITH AN ELECTRONIC COMPENSATOR UNIT FOR ADJUSTING THE DISTANCE BETWEEN A SUCTION NOZZLE ON THE REEL SIDE AND THE REEL, AND ASSOCIATED ADJUSTMENT METHOD

(57) An automatic winding machine (4) comprising at least one winding unit (8) for unwinding a yarn from a spool (12) and winding it onto a tube of a reel (16) with an external diameter that varies according to the winding of the yarn unwound from the spool (12), the winding unit (8) being equipped with:
- a gripping arm (20) having a suction nozzle (24) on the reel side, configured to abut in proximity to said reel (16) and aspirate a yarn end on the reel side,
- the gripping arm (20) being connected to suction means to create a vacuum at the suction nozzle (24) and being provided with drive means (28) for the rotation of said gripping arm (20) from a rest position to a working position in which it moves closer to the reel (16) so as to aspirate the yarn end. The automatic winding machine (4) is equipped with a control unit (32) programmed to calculate the working position of the suction nozzle (24) on the reel side according to the contingent outer diameter of the reel (16) being formed, and to control the drive means (28) in order to bring the suction nozzle (24) into said working position.

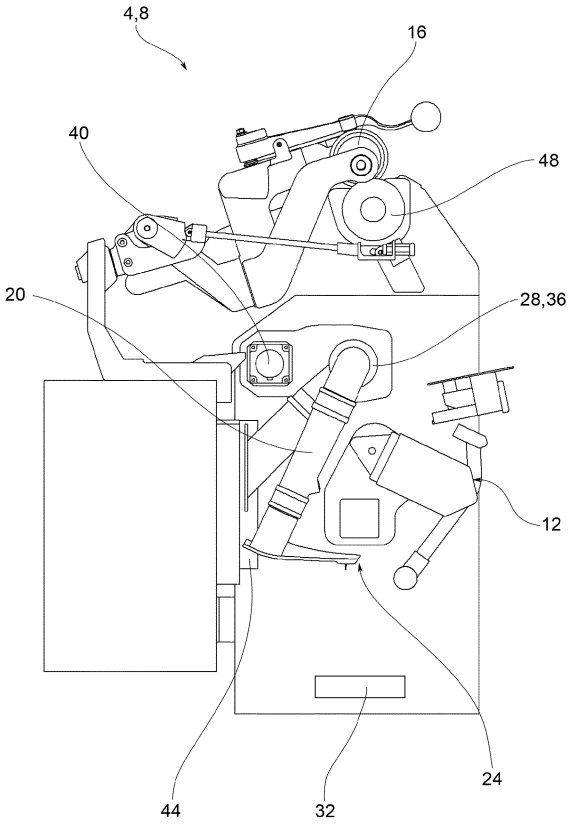

FIG.2

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Description

FIELD OF APPLICATION

[0001] This invention relates to an automatic winding machine provided with an electronic compensator unit for adjusting the distance between a suction nozzle on the reel side and the reel, and the associated adjustment method.

PRIOR ART

[0002] The automatic winding machine is composed of a plurality of independent winding units, the function of which is to unwind the yarn from a spool (input spool) and wind it into a reel (output pack) while continually monitoring the quality of the yarn being processed by means of a sensor (slubcatcher) placed along the path of the yarn unwinding from the spool. When a defect is detected, the sensor immediately interrupts the winding process by cutting the yarn and reporting the type of defect identified and the relative length to the CPU of the winding unit. The yarn is cut, thereby obtaining an end on the spool side and an end on the reel side: these ends then have to be brought together and connected in a specific joining cycle.

[0003] The "joining cycle" includes the following steps:

- braking the reel and the drive cylinder of said reel;
- aspirating the end of the yarn, from the spool side, by means of a suction nozzle on the spool side;
- moving the suction nozzle on the reel side toward the reel in order to find the relevant yarn end on the reel side;
- aspirating the end of the yarn on the reel side and the particular piece comprising the defect from the reel while said reel is rotating in the unwinding direction of the yarn;
- moving the nozzle on the reel side downward in order to introduce the end into the piecing machine;
- moving the suction nozzle on the spool side upward in order to introduce the yarn end on the spool side into the piecing machine;
- producing the join by means of the automatic piecing machine;
- restarting the winding.

[0004] The most critical step of the joining cycle is undoubtedly that of picking up the yarn end of the reel by means of the suction nozzle on the reel side. For this reason, it is fundamentally important to adjust the working distance between the reel and the nozzle itself.

[0005] In the known solutions, the distance between the suction nozzle on the reel side and the reel is adjusted by the operator by mechanically abutting the suction nozzle on the reel side against a detection sensor: this abutment may be adjusted by means of two blocking rings which define the operating distance D with respect to the reference reel diameter of 180 mm. This distance is then maintained at each diameter of the reel being processed by means of a mechanical cam profile C which dynamically changes the end stop position of the sensor as the reel increases in diameter (Fig. 4).

[0006] The correct distance between the suction nozzle for the end and the reel itself determines the picking-up efficiency: in particular, when the distance D is too large, the picking-up efficiency becomes very low and, after a number of unsuccessful pick-up attempts, the winding unit stops and reports the need for the operator to intervene, causing a production loss.

[0007] If the distance D is too small, the excessive vacuum generated by the suction nozzle may cause the surface loops on the reel to become disarrayed, creating problems when subsequently unwinding said reel during the processes downstream of the winding.

[0008] Finally, if the reel nozzle accidentally comes into contact with the reel, there would be a risk of damage to the outer layers of the reel or yarn end falls would be generated in the lateral surfaces of the reel, which are also problematic for subsequent processes downstream of the winding.

[0009] Therefore, up to now, the process for adjusting the distance between the suction nozzle on the reel side and the reel being formed has required human time whenever different specific adjustment is required for the yarn being processed; as this is a manual adjustment, it is liable to adjustment errors between the various winding units of the machine and there is also the possibility that the adjustment may be lost as a result of the impacts of the suction nozzle on the reel side or the vibrations present in the winding unit during its operating cycle.

SUMMARY OF THE INVENTION

[0010] There is therefore a need to resolve the disadvantages and limitations mentioned with reference to the prior art.

[0011] In particular, the aim of this invention is to provide an automatic system that makes it possible to define the distance between the suction nozzle on the reel side and the reel itself and to keep this distance constant.

[0012] This need is satisfied by an automatic winding machine according to claim 1 and by a method according to claim 14.

DESCRIPTION OF THE DRAWINGS

[0013] Further features and advantages of this invention will become clearer from the following detailed description of preferred non-limiting embodiments thereof, in which:

Fig. 1 is a lateral view of a unit of the automatic winding machine according to one solution of the prior art and provided with a mechanical cam C;

Fig. 2 is a lateral view of a unit of the automatic wind-

ing machine according to one embodiment of this invention in a set-up condition;

Fig. 3 is a lateral view of the unit of the automatic winding machine from Fig. 2 in a rest condition.

[0014] Elements or parts of elements common to the embodiments described in the following will be provided with the same reference signs.

DETAILED DESCRIPTION

[0015] With reference to the aforementioned figures, reference sign 4 indicates, as a whole, an automatic winding machine comprising at least one winding unit 8 for unwinding a yarn from a spool 12 (or even a reel or a portion of an input reel) and winding it onto a tube of a reel 16 with an external diameter that varies according to the winding of the yarn unwound from the spool 12. The winding unit 8 is equipped with a gripping arm 20 having a suction nozzle 24 on the reel side, which suction nozzle is configured to abut in proximity to said reel 16 and aspirate a yarn end on the reel side at said outer diameter of the reel 16.

[0016] The gripping arm 20 is connected to suction means (not shown) to create a vacuum at the suction nozzle 24.

[0017] The gripping arm 20 is also provided with drive means 28 for the rotation of said gripping arm 20 from a rest position, in which it does not interface with said reel 16, to a working or suction position in which it moves closer to the reel 16 so as to be able to aspirate the yarn end on the reel side.

[0018] It should be noted that the suction nozzle may move closer to the reel 16 in a number of stages or steps; moving from the rest position to the working position may therefore take place either in a single movement or via a number of steps.

[0019] The automatic winding machine 4 is advantageously provided with a control unit 32 programmed to:

calculate the working position of the suction nozzle 24 on the reel side according to the contingent outer diameter of the reel 24 being formed, in order to guarantee a predetermined distance D between the suction nozzle 24 and the outer diameter of the reel 24 being formed,

control the drive means 28 in order to bring the suction nozzle 24 into said working position.

[0020] The control unit 32 therefore acts as an electronic compensator for the position of the suction nozzle 24, replacing the function which is performed by a mechanical cam in the winding machines of the prior art; in other words, the control unit 32 acts as an electronic cam which guides the working position of the suction nozzle 24.

[0021] According to one possible embodiment, the control unit 32 is programmed to continuously calculate, while winding, the working position of the suction nozzle 24 on the reel side according to the contingent outer diameter of the reel 24 being formed. In other words, the calculation of the working position is updated in real time, even during winding, i.e. when it is not necessary to grip the yarn end on the reel side.

[0022] According to a further possible embodiment, the control unit 32 is programmed to calculate the working position of the suction nozzle 24 on the reel side according to the contingent outer diameter of the reel 24 being formed, in the event of a request for recovery of the yarn end on the reel side. In other words, the working position is only calculated when necessary.

[0023] The control unit 32 is programmed to acquire the contingent diameter of the reel being formed by direct or indirect measurement, and then to use this diameter to calculate the working position of the suction nozzle on the reel side.

[0024] The diameter may be acquired by means of direct measurement of the yarn unwound from the spool 12 and wound onto the reel 16, for example measured directly by the slubcatcher or even, for example, according to the number of turns or rotations carried out by the reel and/or by its relevant drive cylinder.

[0025] The drive means 28 typically comprise an electric motor 36 fitted with a relative angular position detector 40 of the suction nozzle 24 of the gripping arm 20 with respect to the outer diameter of the reel 16 being formed.

[0026] For example, said electric motor 36 is in line with the gripping arm 20 of the suction nozzle 24 on the reel side and with the angular position detector 40.

[0027] The drive means 28 may comprise transmission means which are fitted with a gear reducer and/or a belt pulley mechanism, for the transmission of motion from the electric motor to the gripping arm.

[0028] The electric motor 36 may be a synchronous stepper or brushless type motor.

[0029] According to one embodiment, the electric motor 36 is a stepper motor, and the drive of the motor 36 uses closed loop current. In these conditions, energy is saved during processing and the drive system becomes more efficient since it is robust in the event of temporary obstructions during the movement of the suction nozzle 24.

[0030] The angular position detector 40 is typically an encoder.

[0031] Said encoder 40 may be an absolute type encoder or an incremental encoder.

[0032] The automatic winding machine 4 preferably comprises a plurality of winding units 8, each equipped with its own control unit 32 programmed so as to calculate the working position of the gripping arm of the corresponding winding unit 8 according to a law that maintains a predetermined distance D of the suction nozzle 24 on the reel side from the corresponding reel 16, depending on the diameter of the reel 16 being formed.

[0033] Each winding unit 8 of the automatic winding machine 4 is therefore preferably equipped with its own

independent control unit 32.

[0034] The operation of the automatic winding machine according to this invention will now be described.

[0035] In particular, when the automatic winding machine 4 is switched on or each time the winding unit 8 is supplied with power, the electric motor 36 is controlled by the control unit 32 to bring the suction nozzle 24 on the reel side into abutment against a fixed contact 44 (Fig. 2). In this condition, the control unit 32 becomes aware that it is at its end stop because the angular position detector 40 does not change its angular position despite the movement command from the electric motor 36; the control unit 32 therefore stores this position in a non-volatile memory.

[0036] Subsequently, the gripping arm 20 is controlled to bring the suction nozzle 24 into the rest position (Fig. 3) by rotating in an anti-clockwise direction: this position is the operating position during the winding or local stop phase of the winding unit 8, does not interfere with the path of the yarn and is defined a priori from the end stop position identified previously.

[0037] The control unit 32 provides initial adjustment in which, with the help of the operator, the 0 (zero) point is established: the suction nozzle 24 on the reel side is brought into contact with a sampling tube (the diameter of which is known) that is resting against the reel drive cylinder 48, so as to define the distance D=0 mm; this zero point is saved in the control unit 32 of the winding unit 8 in a non-volatile memory and represents the angular delta between the rest position (Fig. 3) and the position at D=0 in contact with the reel.

[0038] For example, the winding unit 8 is brought into a state of "search for 0", with local or centralized control from the control board of the winding machine 4, and the gripping arm 20 is controlled by the electric motor 36 in order to sample a predefined angular stroke which brings the suction nozzle 32 on the reel side close to the reel 16 (for example 140°) in order to then stop.

[0039] At this point the operator, for example by means of the local control panel, slowly moves the suction nozzle 32 closer until it comes into contact with the sampling tube which has the known diameter, and, once the contact position has been reached, the operator confirms that the zero point is defined and is correlated with the diameter of the sampling tube which is known; this value is saved in the aforesaid non-volatile memory of the control unit 32.

[0040] Each winding unit 8 preferably receives, from the control unit 32, the information on the distance to be maintained with respect to the reel 16 and, on the basis of the information on the contingent diameter of the reel 16 being formed (measured directly or indirectly by means of other sensors), calculates the final angular position to which the gripping arm 20 with the relative suction nozzle 24 has to be brought with respect to the zero position saved in the memory, so as to maintain the desired distance D for each diameter of the reel 16 being formed.

[0041] The procedure described above could also define the desired operating distance, for example 5 mm, with respect to the sampling tube.

[0042] As the reel 16 grows (i.e. as the diameter of the reel 16 increases), the control unit corrects the working angular position, i.e. the target angular position, of the suction nozzle 24 in order to guarantee the constancy of the desired distance D.

[0043] The law of correcting the angular position is correlated with the type of tube being processed, for example a cylindrical tube, a 3°51 conical tube, a 4°20 conical tube, a 5°57 conical tube, and so on.

[0044] This aspect constitutes a considerable improvement with respect to the solution in the prior art, which uses a single cam profile for all types of tube (or a mechanical solution which requires the relevant cam to be replaced from time to time).

[0045] In a system of this kind, it is possible to create a monitoring means which makes it possible to define a law that adjusts the working distance of the suction nozzle 24 on the reel side on the basis of the diameter of the reel 16 in order to increase the efficiency in picking up the end as the reel itself grows: for example, when the reel is small, i.e. has a reduced diameter, it may be kept closer (for example 4 mm) than a larger reel, i.e. which has a greater diameter (6 mm and any diameter greater than 100 mm).

[0046] The working position of the suction nozzle 24 is preferably not calculated continuously but is calculated when needed, i.e. when it is necessary to recover the end on the reel 16 side, for example for a phase of reattaching the yarn.

[0047] According to a further possible embodiment, the automatic winding machine 4, by means of the control unit 32, carries out a cycle for autonomously learning the working position of the suction nozzle 24 via a sampling process.

[0048] For example, said sampling process involves the following steps:

- during the winding of a first reel, the operator interrupts the winding process,
- the operator manually positions the suction nozzle 24 until it comes into contact with the outer lateral surface of the reel 16,
- the operator tells the winding unit 8 to store the position of the suction nozzle 24,
- the operator resumes the winding,
- the preceding operations are repeated for 3 or 4 different winding diameters of the same reel 16,
- once the measurements have been made, the control unit 32 processes the collected data and, by means of interpolation, is able to learn how the outer diameter of the reel 16 evolves over time during winding,
- the control unit 32 stores this information and reuses it for all the similar reels 16.

[0049] This information is then shared with all of the other control units 32 present on the various winding units 8, which will reuse the information in similar reels 16.

[0050] As may be understood from the above, this invention overcomes the disadvantages of the prior art.

[0051] In particular, this invention allows the following aspects to be improved:

- the set-up times for the machine are reduced, thereby simultaneously obtaining adjustment that is reliable and may be repeated for each reel diameter and for each tube type, i.e. with tubes having different geometries and dimensions;
- flexibility and productivity: in fact, with the possibility of varying the working distance of the suction nozzle as the diameter of the reel increases, the invention makes it possible to improve the final quality of the reel and to have fewer winding unit stoppages caused by missed ends;
- energy savings: by driving the motor in a closed current and position loop, the invention makes it possible to actuate the motor using only the current required by the load and not using the nominal current of the motor for the entire actuation period (conventional driving in fact takes place using a stepper motor).

[0052] A person skilled in the art, in order to satisfy contingent and specific needs, may make numerous modifications and variations to the solutions described above, which modifications and variations are all contained within the scope of the invention as defined in the following claims.

Claims

1. Automatic winding machine (4) comprising at least one winding unit (8) for unwinding a yarn from a spool (12) and winding it onto the tube of a reel (16) with an external diameter that varies according to the winding of the yarn unwound from the spool (12), the winding unit (8) being equipped with:

- a gripping arm (20) having a suction nozzle (24) on the reel side, configured to abut in proximity to said reel (16) and aspirate a yarn end on the reel side at said outer diameter of the reel (16),
- the gripping arm (20) being connected to suction means to create a vacuum at the suction nozzle (24) and being provided with drive means (28) for the rotation of said gripping arm (20) from a rest position, in which it does not interface with said reel (16), to a working or suction position in which it moves closer to the reel (16) so as to be able to aspirate the yarn end on the reel side,

wherein the automatic winding machine (4) is equipped with a control unit (32) programmed to:

- calculate the working position of the suction nozzle (24) on the reel side according to the contingent outer diameter of the reel (16) being formed, in order to guarantee a predetermined distance between the suction nozzle (24) and the outer diameter of the reel (16) being formed,
- control the drive means (28) in order to bring the suction nozzle (24) into said working position.

2. The automatic winding machine (4) according to claim 1, wherein the control unit (32) is programmed to continuously calculate, while winding, the working position of the suction nozzle (24) on the reel side according to the contingent outer diameter of the bobbin (16) being formed.

3. The automatic winding machine (4) according to claim 1, wherein the control unit (32) is programmed to calculate the working position of the suction nozzle (24) on the reel side according to the contingent outer diameter of the reel (16) being formed, in case of request for recovery of the yarn end on the reel side.

4. The automatic winding machine (4) according to claim 1, 2, or 3 wherein the drive means (28) comprise an electric motor (36) fitted with a relative angular position detector (44) of the suction nozzle (24) of the gripping arm (20) with respect to the outer diameter of the reel (16) being formed.

5. The automatic winding machine (4) according to claim 4, wherein said electric motor (36) is in line with the gripping arm (20) of the suction nozzle (24) on the reel side and with the angular position detector (44).

6. The automatic winding machine (4) according to claim 4 or 5, wherein the drive means (28) comprise transmission means, fitted with a gear reducer and/or belt pulley mechanism, for the transmission of motion from the electric motor (36) to the gripping arm (20).

7. The automatic winding machine (4) according to any of the claims from 4 to 6, wherein the electric motor (36) is a synchronous stepper or brushless type motor.

8. The automatic winding machine (4) according to any of the claims from 4 to 7, wherein the electric motor (36) is a stepper motor, and the motor drive is closed loop current.

9. The automatic winding machine (4) according to any

of the claims from 4 to 8, wherein said angle position detector (44) is an encoder.

10. The automatic winding machine (4) according to claim 9, wherein said encoder (44) is an absolute type encoder.

11. The automatic winding machine (4) according to claim 9, wherein said encoder (44) is an incremental encoder.

12. The automatic winding machine (4) according to any of the claims from 1 to 11, comprising a plurality of winding units (8), each equipped with its own control unit (32) programmed so as to calculate the working position of the gripping arm (20) of the corresponding winding unit (8) according to a law that maintains a predetermined distance (D) of the suction nozzle (24) on the reel side from the corresponding reel (16), depending on the diameter of the reel (16) being formed.

13. The automatic winding machine (4) according to any of the claims from 1 to 12, wherein the control unit (32) is programmed so as to:

- acquire the contingent diameter of the reel (16) being formed by direct or indirect measurement,
- use this diameter to calculate the working position of the suction nozzle (24) on the reel side.

14. Adjustment method for catching the yarn end on the reel side in an automatic winding machine (4) comprising the steps of:

- providing an automatic winding machine (4) comprising at least one winding unit (8) for unwinding a yarn from a spool (12) and winding it onto the tube of a reel (16) with an external diameter that varies according to the winding of the yarn unwound from the spool (12), the winding unit (8) being equipped with:
- a gripping arm (20) having a suction nozzle (24) on the reel side, configured to abut in proximity to said reel (16) and aspirate a yarn end on the reel side at said outer diameter of the reel (16),
- the gripping arm (20) being connected to suction means to create a vacuum at the suction nozzle (24) and being provided with drive means (28) for the rotation of said gripping arm (20) from a rest position, in which it does not interface with said reel (16), to a working or suction position in which it moves closer to the reel (16) so as to be able to aspirate the yarn end on the reel side,
- calculating the working position of the suction nozzle (24) on the reel side according to the contingent outer diameter of the reel (16) being formed, so as to guarantee a predetermined distance (D) between the suction nozzle (24) and the outer diameter of the reel (16) being formed,
- bringing the suction nozzle (24) into said working position and aspirating said yarn end on the reel side.

15. The method according to claim 14, wherein the step of calculating the working position of the suction nozzle (24) on the reel side according to the contingent outer diameter of the reel (16) being formed, so as to guarantee a predetermined distance (D) between the suction nozzle (24) and the outer diameter of the reel (16) being formed, is carried out continuously during winding.

16. The method according to claim 14, wherein the step of calculating the working position of the suction nozzle (24) on the reel side according to the contingent outer diameter of the reel (16) being formed, so as to guarantee a predetermined distance (D) between the suction nozzle (24) and the outer diameter of the reel (16) being formed, is performed in the case of a yarn end recovery request on the reel side.

17. The method according to any of the claims from 14 to 16, comprising the steps of:

- acquiring the contingent diameter of the reel (16) being formed by direct or indirect measurement,
- using this diameter to calculate the working position of the suction nozzle (24) on the reel side.

18. The method according to any of the claims from 14 to 17, comprising the step of providing an automatic winding machine (4) according to any of the claims from 1 to 12.

19. The method according to any of the claims from 14 to 18, comprising the steps of:

- interrupting the winding process of a first reel (16),
- manually positioning the suction nozzle (24) until it comes into contact with an outer lateral surface of the first reel (16),
- memorising the position of the suction nozzle (24) via the winding unit (8),
- resuming winding of the first reel (16),
- repeating the previous steps for a plurality of different winding diameters of the same first reel (16),
- processing the data collected by means of the control unit (32) and interpolating them so as to learn how the outer diameter of the reel (16)

evolves over time, during winding.

20. The method according to claim 19, comprising the steps of:

- using the control unit (32) to store the law of variation in time of the outer diameter of the reel (16),
- sharing this law for all the reels similar to said first reel (16).

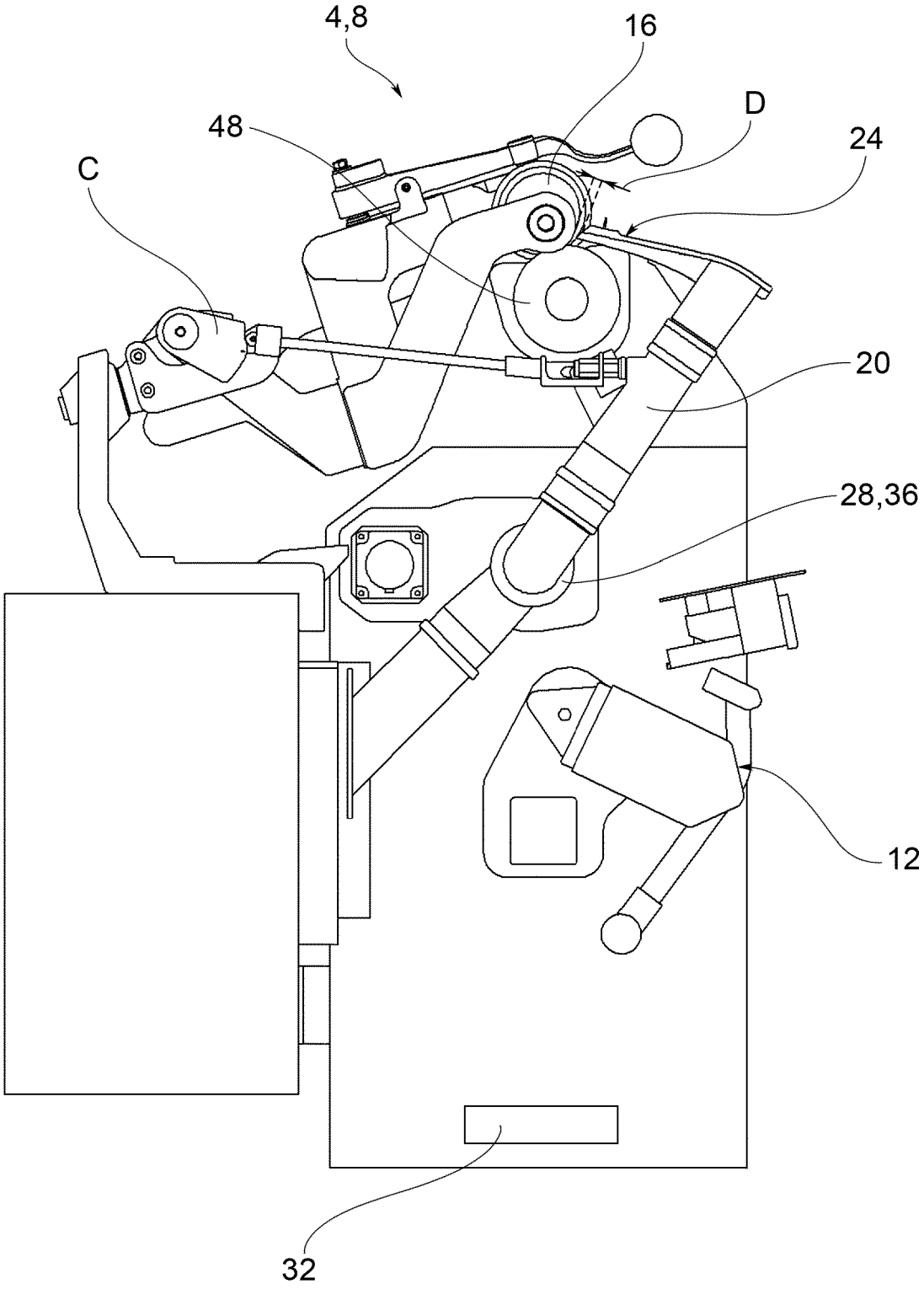

FIG.1

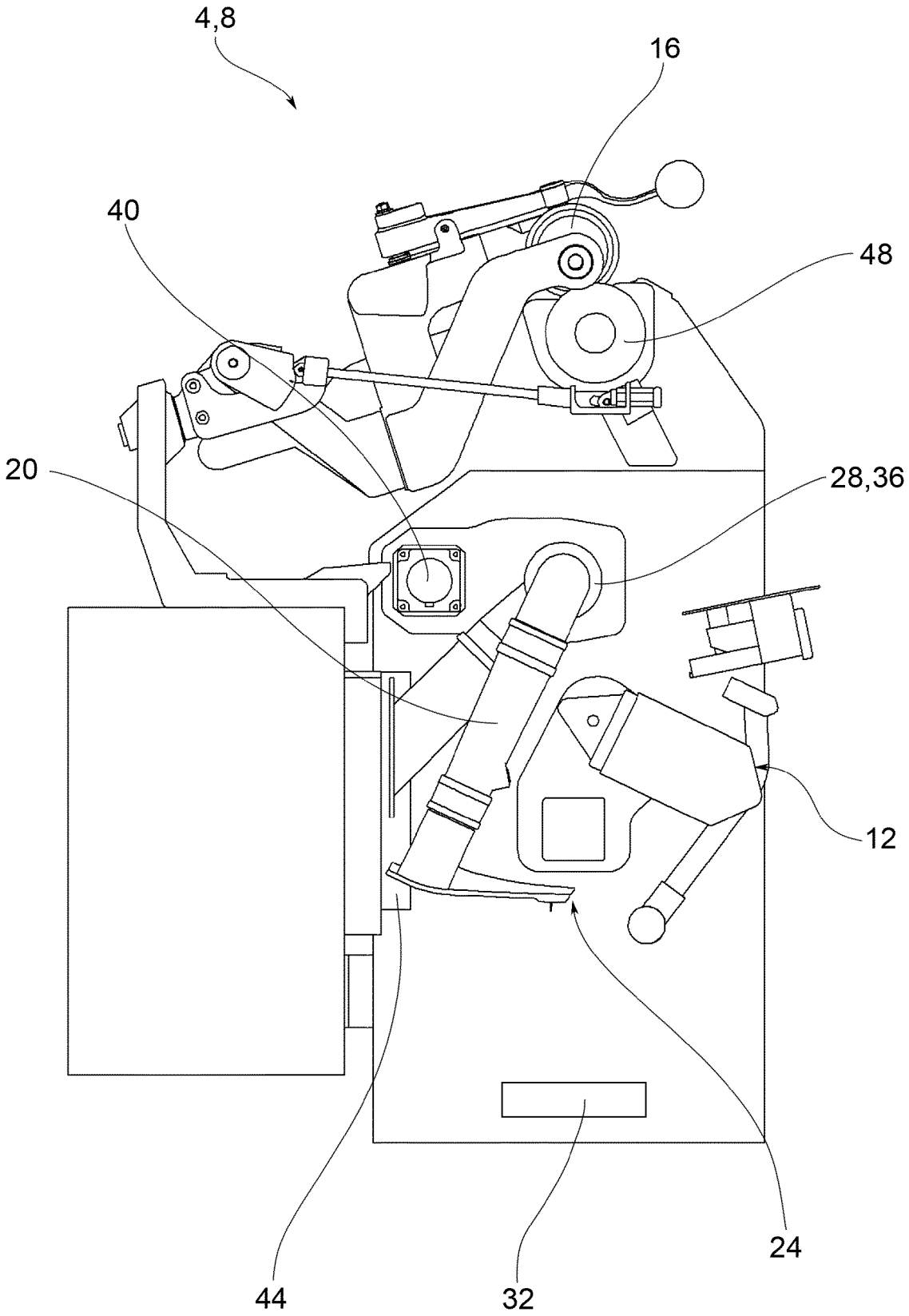

FIG.2

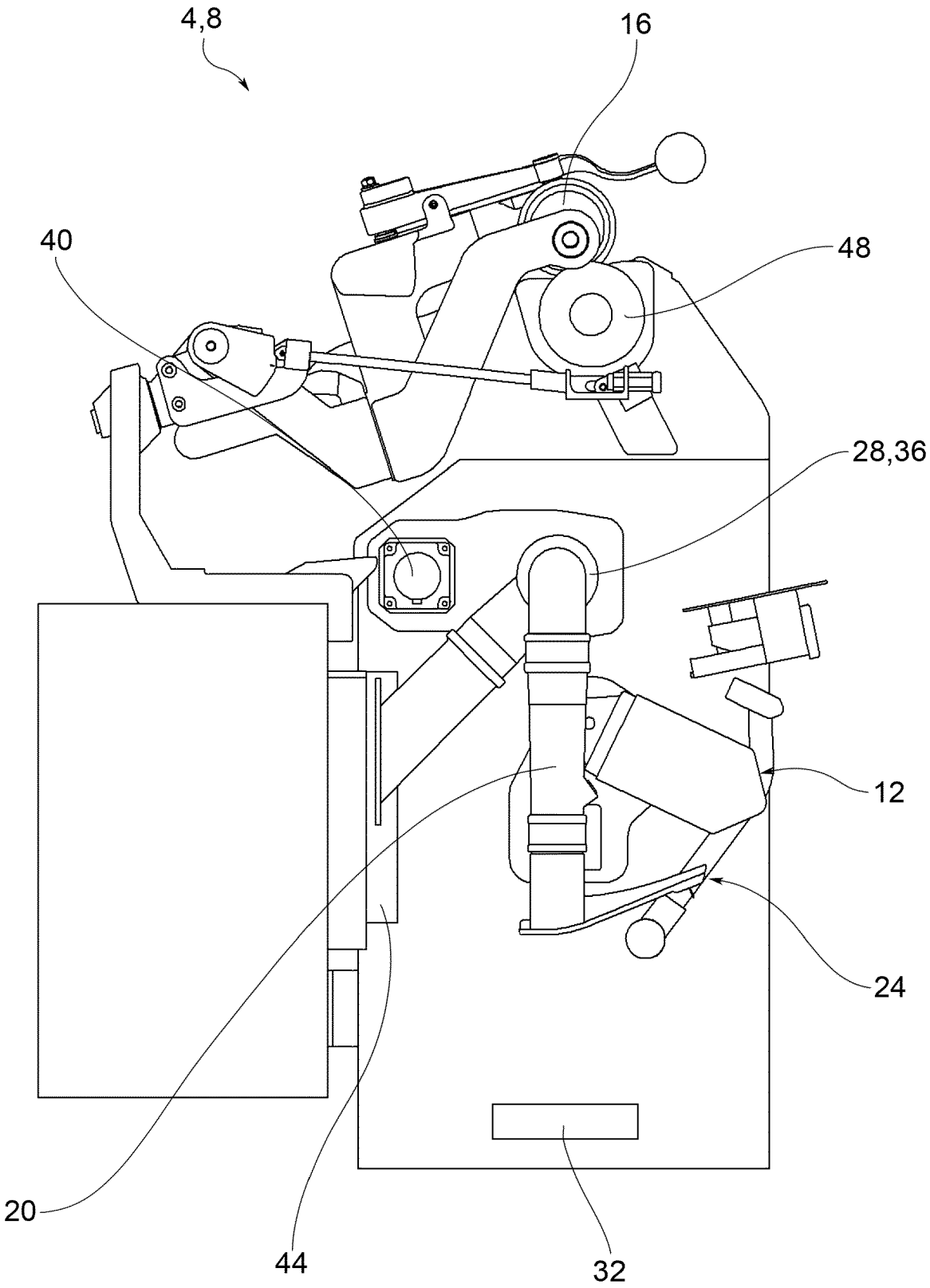

FIG.3

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EUROPEAN SEARCH REPORT

Application Number
EP 21 18 6778

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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Y	DE 10 2013 004053 A1 (SAURER GERMANY GMBH & CO KG [DE]) 11 September 2014 (2014-09-11) * paragraphs [0007], [0021], [0024], [0026] - [0028], [0054], [0058] * -----	13,17	

TECHNICAL FIELDS SEARCHED (IPC)

B65H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	20 November 2021	Lemmen, René

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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E : earlier patent document, but published on, or after the filing date
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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 21 18 6778

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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20-11-2021

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