

(19)



(11)

EP 3 140 446 B1

(12)

EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention
of the grant of the patent:

28.08.2019 Bulletin 2019/35

(21) Application number: **15720022.1**

(22) Date of filing: **23.04.2015**

(51) Int Cl.:

D03D 47/36 (2006.01)

(86) International application number:

PCT/EP2015/058802

(87) International publication number:

WO 2015/169611 (12.11.2015 Gazette 2015/45)

(54) **WEFT FEEDER DEVICE**

SCHUSSFADENZUFÜHRVORRICHTUNG

DISPOSITIF DÉLIVREUR DE TRAME

(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 MK MT NL NO
PL PT RO RS SE SI SK SM TR**

(30) Priority: **09.05.2014 BE 201400335**

09.05.2014 BE 201400334

09.05.2014 BE 201400336

09.05.2014 BE 201400337

09.05.2014 BE 201400338

09.05.2014 BE 201400339

(43) Date of publication of application:

15.03.2017 Bulletin 2017/11

(73) Proprietor: **Picanol**

8900 Ieper (BE)

(72) Inventors:

- **JOSEFSSON, Pär**
S-50765 Borås (SE)

• **HALVARSSON, Björn**

S-52331 Ulricehamn (SE)

• **SVANSTRÖM, Anders**

S-52333 Ulricehamn (SE)

• **DECONINCK, Filip**

B-8630 Veurne (BE)

• **MAERTENS, Koen**

B-8670 Oostduinkerke (BE)

(74) Representative: **Patentanwälte**

**Ruff, Wilhelm, Beier, Dauster & Partner mbB
Kronenstraße 30**

70174 Stuttgart (DE)

(56) References cited:

WO-A1-92/01102 JP-A- H09 170 141

US-A- 4 850 400

EP 3 140 446 B1

Note: Within nine months of the publication of the mention of the grant of the European patent in the European Patent Bulletin, any person may give notice to the European Patent Office of opposition to that patent, in accordance with the Implementing Regulations. Notice of opposition shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

Description

TECHNICAL FIELD

[0001] The invention relates to a weft feeder device, also named prewinder, comprising a winding drum having an adjustable winding circumference. The invention further relates to a method for adjusting a winding circumference of a winding drum of a weft feeder device. The invention further relates to a control device for a weft feeder device. The invention further relates to a method for determining the winding circumference of a winding drum of a weft feeder device. The invention further relates to a wireless power transmission system for use with a weft feeder device. The invention further relates to a weft feeder device comprising a winding drum having an adjustable winding circumference and a wireless power transmission system.

PRIOR ART

[0002] In weaving machines it is known to provide weft feeder devices arranged between a bobbin and the shed. The weft feeder devices generally comprise a winding drum onto which a weft thread is wound that is pulled off from the bobbin. For an insertion of the weft thread, the weft thread is unwound from the winding drum. In known weft feeder devices, the winding drum is arranged stationary and a rotating winding arm is provided for winding weft thread in several windings onto the stationary winding drum. The winding arm separates the winding drum from the main body of the weft feeder device in the area of an air gap.

[0003] It is further known to adjust the desired length of the weft thread stored onto the winding drum to the fabric width of the woven fabric, to the type of fabric and/or to the type of threads used for weaving the fabric. The length of the weft thread stored and subsequently unwound depends on the number of windings and the winding circumference of the winding drum. Consequently, the number of windings and/or the winding circumference can be adjusted to vary the length of the weft thread stored onto the winding drum. An adjustment of the winding circumference is generally carried out manually by a skilled operator.

[0004] The length of the stored weft thread is also referred to as stored length. Because the stored length of weft thread is inserted, the so-called filling length of an inserted weft thread is essentially proportional to the stored length of weft thread. The filling length must be chosen in minimum equal to the fabric width. The difference between the filling length and the fabric width is referred to as waste length. An error in the set winding circumference results in an error of the filling length that is essentially proportional to the error in the set winding circumference multiplied by the number of windings for one filling length. Hence, assuming an error in the set winding circumference is about 1 mm and there are 5

windings for one filling length, this results in an error in the filling length of about 5 mm.

[0005] For example, US 5,046,537 shows a weft feeder device having an adjustable winding circumference formed by a fixed eccentric cylinder and a plurality of moveable rods. The rods are moveable with respect to an axis of the said cylinder and surround a wide portion of the periphery of the cylinder, the distance of said rods to the said cylinder being adjustable for each rod or for groups of rods. For each rod or for groups of rods a control arm is provided, which control arm is slidable in a guide of the weft feeder device. The guide is positioned perpendicularly to the axis of said cylinder, said control arms being movable simultaneously in the respective guides under the control of a single operating member that moves the rods simultaneously toward or away from the cylinder. Means are provided to releasably lock said arms in said guides in any of a plurality of positions. The position of the control arms is manually adjusted.

[0006] For example, JP 09-170141 A discloses a weft feeder device comprising a number of winding surfaces forming a winding drum, which winding surfaces are arranged radially displaceable with respect to a center axis by means of a driving mechanism. The position of the winding surfaces is manually adjusted. A scale is provided for visually observing the position of a winding surface. For example, WO 92/01102 A1 discloses a winding drum according to the preamble of claim 1 with several moveable fingers, wherein each finger comprises a radially extending, central guiding leg. Each finger is assigned a moveable element, which is moveable with respect to the finger for advancing weft threads.

[0007] For example from US 4,850,400 it is known to provide a winding drum having an adjustable winding circumference. In order to adjust the winding circumference it is known to provide an adjustment system including an electric motor driven to rotate forward or backward when activating two switches by a control circuit, whereby control signals are transmitted to the switches. The electric motor is provided at the winding drum. The winding arm separates the winding drum from the main body of the weft feeder device. According to one embodiment, an accumulator and a current generator are provided in order to power the electric motor. According to another embodiment, the electric motor is powered by magnetic induction by transformers supplying a DC current of a required polarity.

SUMMARY OF THE INVENTION

[0008] It is an object of the invention to provide a weft feeder device with a winding drum having an adjustable winding circumference for storing a weft thread allowing for an easy use of operation.

[0009] It is an object of the invention to provide a weft feeder device allowing the winding circumference to be set with high accuracy.

[0010] It is an object of the invention to determine the

winding circumference and in this way also the length of the weft thread to be stored by the weft feeder device.

[0011] It is a further an object of the invention to provide a method for determining and/or varying the winding circumference with high accuracy.

[0012] It is an object of the invention to provide a weft feeder device that is in particular suitable for being used in a textile machine, in particular a weaving machine, in particular an airjet weaving machine.

[0013] These objects are solved by a weft feeder device with a winding drum having an adjustable winding circumference for storing weft thread as claimed in claim 1. In this case in the direction of the center axis, the first leg and the second leg are offset from each other. Preferred embodiments are claimed in the dependent claims.

[0014] According to the invention, a weft feeder device is provided comprising a winding drum having an adjustable winding circumference for storing weft thread and a center axis, the winding drum comprising a base structure and at least one moveable finger, wherein the at least one moveable finger is mounted on the base structure so as to be moveable over the full length of a linear movement path, wherein the at least one moveable finger comprises a first leg, and a second leg extending on opposite sides of the center axis, and further comprises a segment connecting the first leg and the second leg, wherein the first leg and the second leg are extending parallel to the movement path and wherein the first leg and the second leg are offset from each other in the direction of the center axis.

[0015] Such a weft feeder device offers the advantage that a compact and stable arrangement of the moveable fingers is obtained. In other words, this allows to guide and to move the moveable fingers in a stable manner.

[0016] Preferably, the winding drum comprises three moveable fingers that are mounted on the base structure so as to be moveable in radial direction with respect to the center axis and/or the three moveable fingers are successively arranged so as to form an angle of 90° between two successive moveable fingers and/or the weft feeder device comprises a driving system for driving at least the first leg of the at least one moveable finger and/or only the first leg of the at least one moveable finger is driven and/or the driving system comprises a first pinion, wherein at least the first leg of the at least one moveable finger is provided with a rack section drivingly coupled to the first pinion. This allows to use a simple drive system.

[0017] In one example, the weft feeder device is further provided with at least one preload system for applying a preload to the at least one moveable finger in order to compensate play between that moveable finger and the driving system and/or the preload system comprises at least one spring element assigned to the at least one moveable finger, which at least one spring element is acting on that moveable finger and forcing that moveable finger towards the first pinion and/or the preload system

comprises at least one friction element assigned to the at least one moveable finger, by means of which at least one friction element a frictional force opposing a movement of that moveable finger is applied on that moveable finger. Due to this play and backlash can be kept under control. In one example, the preload system is obtained by the first leg and the second leg, wherein the distance between the first leg and the second leg becomes smaller towards the end of the first leg where the first leg comes into contact with the first pinion. This is advantageous as this results in a low friction at the first leg and at the second leg, and thus a low load of the actuator.

[0018] Preferably, the winding drum comprising a number of moveable fingers, wherein the first legs of each moveable finger are arranged in a first plane perpendicular to the center axis and/or the second legs of the moveable fingers are arranged in a second plane perpendicular to the center axis, wherein the second plane is at a distance along the center axis from the first plane. This arrangement offers the advantage that a compact arrangement of the moveable fingers is obtained.

[0019] In an example, the first leg and/or the second leg of the at least one moveable finger are mainly designed as round bars. Such a design is advantageous as the legs can be manufactured precisely.

[0020] In an example, at least the first leg has a length so that the first leg extends past the center axis and/or the second leg has a length so that the second leg extends past the center axis. In an example a guiding system is provided for guiding the first leg and the second leg and/or at least the first leg has a length so that the first leg is guided by the guiding system past the center axis and/or the second leg has a length so that the second leg is guided by the guiding system past the center axis and/or the first leg is guided along its lateral surface in one direction and/or the second leg is guided along its lateral surface in all directions.

[0021] This allows to provide a first leg and a second leg with a great length and allows to guide the first leg and the second leg over a long movement path. Due to this a rotation of the moveable fingers with respect to the first leg and/or the second leg is avoided.

[0022] Preferably, the first leg is arranged near a first lateral side of the segment of the moveable finger, while the second leg is arranged near a second lateral side of the segment of the moveable finger opposite to the first lateral side. This allows to apply a driving system for the moveable fingers with a first pinion having a large diameter.

[0023] In an example, the segment comprises outer edges extending in parallel to the central axis, wherein the outer edges define the winding circumference onto which weft thread is wound. In an example, the driving system comprises a second pinion driven to rotate in opposite direction to the first pinion, wherein the second leg of the at least one moveable finger is provided with a rack section drivingly coupled to the second pinion.

[0024] A weft feeder device can be provided compris-

ing a winding drum having an adjustable winding circumference for storing weft thread and a center axis, the winding drum comprising a base structure, at least one fixed finger and at least one moveable finger, wherein the at least one fixed finger is mounted in a fixed finger position on the base structure and wherein the at least one moveable finger is mounted on the base structure so as to be moveable over the full length of a movement path in a radial direction with respect to the center axis, wherein each fixed finger and each moveable finger are provided with a number of outward facing outer edges extending parallel to the center axis, wherein the outer edges are arranged to define the winding circumference onto which weft thread is wound, so that in each position of each fixed finger and in each position of each moveable finger along the movement path, the weft thread stored on the winding drum makes contact with all the outer edges. Preferably three moveable fingers are provided, wherein the at least one fixed finger and the moveable fingers are evenly distributed about the winding circumference.

[0025] Such a weft feeder device allows to determine a relationship between the positioning of the fingers of the winding drum and the circumferential length of the winding drum with high accuracy, so that the stored length of weft thread can be determined with high accuracy. In other words, the length of weft thread stored on the winding drum can be calculated with high accuracy. This is possible because the weft thread wound onto the winding drum remains in contact with the outer edges of the fingers.

[0026] Preferably, all moveable fingers are arranged for conjoint movement with respect to the center axis of the weft feeder device, for enabling a symmetric winding circumference in each position of each moveable finger along the movement path.

[0027] Such a weft feeder device also allows arranging a so-called balloon breaker along the center axis in front of the weft feeder device. This is possible because as the center axis is fixed and is independent of the position of the moveable fingers. Further, the moveable fingers move over the same distance with respect to the center axis, so that the section of the winding circumference determined by the moveable fingers remains rather circular.

[0028] In an example, the at least one fixed finger and/or the at least one moveable finger is provided with four outward facing outer edges. Preferably, two side outer edges are arranged near a lateral side of the at least one fixed finger and/or of the at least one moveable finger and two middle outer edges are arranged between the two side outer edges, wherein the distance along the winding circumference of the winding drum between the middle outer edges is less than the distance between each middle outer edge and each side outer edge. Hereby, the outer edges are arranged for enabling a rather circular winding circumference.

[0029] The arrangement of four outward facing outer edges allows to obtain a winding circumference with a

rather circular shape. The outer edges allow to determine the winding circumference with high accuracy and in this way also the position where a weft thread is wound on the winding drum.

[0030] In an example, the outer edges each comprise two rib parts that are arranged parallel to each other and/or the rib parts end at a front arc of the respective fixed or moveable finger and/or a transition is provided between the rib parts and the front arc. In an example, the outward facing outer edges are arranged on a segment. Such a shape of the outer edges is advantageous for the contact between the weft thread and the outer edges.

[0031] Preferably, the at least one moveable finger is mounted on the base structure so as to be essentially continuously moveable, wherein a desired position is determined as a distance of the respective moveable finger to the center axis and/or the fixed finger is mounted in at least one repeatable fixed finger position and the at least one moveable finger is mounted on the base structure so as to be moveable into a number of desired positions and so as to be releasably securable in each of said desired positions for an adjustment of the winding circumference. The positioning of the at least one fixed finger is pre-determined and in this way well-known in advance.

[0032] In an example, the weft feeder device comprises a driving system for moving the at least one moveable finger into a respective desired position and/or a mounting device for the fixed finger is provided for enabling a clamping of the fixed finger in each one of the number of repeatable fixed finger positions. The fixed finger allows to arrange the magnet pin for holding a weft thread in a fixed position in front of the fixed finger.

[0033] Preferably, the winding drum comprises one fixed finger and three moveable fingers mounted on the base structure so as to be moveable conjointly in a radial direction with respect to the center axis, which fingers are successively arranged so as to form an angle of 90° between each of the successive fingers.

[0034] A weft feeder device can be provided comprising a winding drum having an adjustable winding circumference for storing weft thread, the winding drum comprising a base structure, at least one moveable finger, and a driving system comprising a first pinion, wherein the at least one moveable finger is mounted on the base structure so as to be moveable over the full length of a linear movement path and is provided with a first leg having a rack section drivingly coupled to the first pinion, wherein the driving system comprises a gear system for driving the first pinion continuously, which gear system is self-locking for securing the first pinion, so that the first pinion is held in position in any position reached along the movement path. Preferably, the driving system further comprises an actuator for driving the first pinion via the gear system.

[0035] The fact that the gear system is self-locking offers the advantage that the fingers can remain held in a position reached even during weaving, for example when

the actuator is not activated, or even in idle times. This further allows to drive the first pinion continuously with a high accuracy over a small angle of rotation, while the first pinion keeps his position when the drive system is not activated. This is in particular advantageous in case of a power fail.

[0036] In an example, the driving system comprises a gear system with a reduction ratio of at least one over fifty and/or the gear system of the driving system comprises a self-locking worm drive. In an example, the worm drive comprises a worm wheel and the gear system comprises a reduction gear with a gear wheel, which worm wheel and gear wheel are arranged in one piece that can rotate around an axle. In an example, the actuator drives an integrated gearbox with a reduction ratio of at least one over hundred.

[0037] In an example, the weft feeder device is further provided with at least one preload system for applying a preload to the at least one moveable finger in order to compensate play between the at least one moveable finger and the driving system and/or the preload system comprises at least one spring element assigned to the at least one moveable finger, which at least one spring element is acting on that moveable finger and is forcing that moveable finger towards the first pinion and/or the preload system comprises at least one friction element assigned to the at least one moveable finger, by means of which at least one friction element a frictional force opposing a movement of that moveable finger is applied on that moveable finger. In alternative, the gear system comprises at least one preloaded gear wheel in order to compensate play in the gear system. These arrangements all enhance the self-locking effect of the weft feeder device and are compact.

[0038] Preferably, a sensor device is provided for determining the position of the at least one moveable finger by measurement of the position of at least one element of the weft feeder device and/or a sensor device is provided for determining the position of the at least one moveable finger by measurement of the position of at least one element of the driving system.

[0039] Preferably, the driving system further comprises a drive part for driving the first pinion via the gear system. Due to the self-locking gear system, the actuator can be relieved from any control when the first pinion and the fingers should not be moved. This is advantageous for the life-time of the actuator.

[0040] In an example, the actuator is separable from the first pinion for allowing a manual movement of the at least one moveable finger. The self-locking is advantageous and allows to provide a driving system with a drive part that is driven manually.

[0041] Preferably, the driving system comprises an axle driven by the actuator or by means of the drive part, which axle is arranged perpendicular to the center axis and is offset to a plane along the center axis, in which plane the first leg lies. This allows a compact arrangement.

[0042] In alternative, the driving system comprises a second pinion driven to rotate in opposite direction to the first pinion, wherein the at least one moveable finger is provided with a second leg having a rack section drivingly coupled to the second pinion.

[0043] A weft feeder device can be provided comprising a winding drum having an adjustable winding circumference for storing weft thread, the winding drum comprising a base structure and at least one moveable finger, wherein the at least one moveable finger is mounted on the base structure so as to be moveable over the full length of a movement path, wherein the weft feeder device comprises a sensor device arranged for determining the actual position of the at least one moveable finger, wherein the sensor device comprises a first sensor system for measuring a relative movement of at least one moving element of the weft feeder device and the sensor device comprises a second sensor system for determining a first reference position of at least one moving element of the weft feeder device.

[0044] In the context of the application a "moving element" is defined as an element moving together with a moveable finger. In one example, the moveable finger itself functions as the "moving element". Preferably, the moving element is mechanically coupled with the moveable finger. In the context of the application, "measuring a relative movement" is to be construed as meaning determining a relative travel distance. By measuring a relative movement with respect to a reference position, an accurate absolute position can be determined. This allows to determine very accurately the position of the fingers and hence the length of the winding circumference, by properly measuring a relative movement using a simple first sensor system with respect to a reference position, which reference position is determined using a simple second sensor system.

[0045] In an example, the weft feeder device further comprises a driving system drivingly coupled to the at least one moveable finger, wherein the sensor device comprises a first sensor system for measuring the relative movement of at least one moving element of the driving system and comprises a second sensor system for determining a first reference position of at least one moving element of the driving system.

[0046] Preferably, the moving element of the driving system captured by the first sensor system and/or the second sensor system is a first pinion, wherein the at least one moveable finger is drivingly coupled to the first pinion.

[0047] In an example, the first sensor system comprises an incremental rotary encoder system and/or the first sensor system comprises a rotary encoder system with at least one encoder disc drivingly coupled for movement with a moving element of the weft feeder device, in particular of the driving system, for measurement of an incremental movement of that moving element.

[0048] In an example, the second sensor system comprises a signal source and a receiver, wherein either the

signal source or the receiver is mounted on a moving element of the weft feeder device, in particular of the driving system, and the other one of the signal source and the receiver is mounted stationary on the base structure, and wherein the signal source and/or the receiver are arranged so that when moving the at least one moveable finger within its movement path a signal is received by the receiver, and wherein a position of the moving element of the weft feeder device, in particular of the driving system, corresponding to a predetermined value of the signal serves as the first reference position for the driving system. Hereby, the signal source and/or the receiver are arranged so that when moving the at least one moveable finger within its movement path a signal with a changing sign is received by the receiver, and wherein a position of the moving element of the weft feeder device, in particular of the driving system, corresponding to the zero crossing position of the signal serves as the first reference position for the driving system.

[0049] In an example the second sensor system comprises a magnetic sensor system drivingly coupled for movement with a moving element of the driving system and/or the second sensor system comprises a magnetic sensor system drivingly coupled for movement with the first pinion and/or the magnetic sensor system comprises one Hall sensor and at least one magnet. In an example the receiver comprises one Hall sensor and the signal source comprises a first magnet, which first magnet is arranged so that the magnetic field is directed perpendicular to the axis of the first pinion and/or the receiver comprises a Hall sensor and the signal source comprises a second magnet, which second magnet is arranged so that the magnetic field is directed in parallel to the axis of the first pinion.

[0050] Such a first sensor system and such a second sensor system are of simple design and are in particularly suitable to be used in a weft feeder device.

[0051] In an example, the sensor device is further arranged for detecting a second reference position of at least one moving element of the weft feeder device, in particular of the driving system, wherein a value measured by the first sensor system for a travel distance between the first reference position and the second reference position, serves as a calibration value for the driving system and/or the second reference position corresponds to a position of the at least one moveable finger for a predefined winding circumference.

[0052] The predefined winding circumference is for example the maximum winding circumference or a winding circumference that can be determined easily.

[0053] A method for determining a winding circumference of a winding drum of a weft feeder device with a winding drum having an adjustable winding circumference for storing weft thread can be provided, the winding drum comprising a base structure and at least one moveable finger, wherein the at least one moveable finger is mounted on the base structure so as to be moveable over the full length of a movement path, wherein the rel-

ative movement of at least one moving element of the weft feeder device is measured by means of a first sensor system, in that a first reference position of at least one moving element of the weft feeder device is determined by means of a second sensor system, and in that an actual position of the moveable finger is determined based on the determined first reference position and the measured relative movement.

[0054] In an example, the weft feeder device comprises a driving system drivingly coupled to the at least one moveable finger, wherein the relative movement of at least one moving element of the driving system is measured by means of a first sensor system, a first reference position of at least one moving element of the driving system is determined by means of a second sensor system, and an actual position of the moveable finger is determined based on the determined first reference position and the measured relative movement and/or a movement of the at least one moving element of the weft feeder device, in particular of the driving system, into the first reference position is detected by means of the second sensor system comprising a signal source and a receiver, wherein upon movement of the at least one moving element of the weft feeder device, in particular of the driving system, into the first reference position a signal received by the receiver from the signal source has a zero crossing.

[0055] A zero crossing offers the advantage that such a crossing is very accurate and enables to obtain one well defined position using a rather low accurate sensor system.

[0056] In an example, a second reference position of at least one moving element of the weft feeder device, in particular of the driving system, is determined and a value measured by the first sensor system for a travel distance between the first reference position and the second reference position is stored as a calibration value for the driving system. Preferably, for a calibration the moveable finger is moved into a position corresponding to a predefined winding circumference, wherein that position serves as second reference position. The second reference position can also be named calibration position.

[0057] In an example, upon moving the at least one moveable finger into a desired position, an expected signal coming from the signal source and received by the receiver is compared to an actual signal received by the receiver for supervising the movement. Although using a sensor system that is rather low accurate, such a sensor system allows to obtain a signal that has approximately the expected value and allows to apply that signal as signal for supervising.

[0058] Preferably, in an example, at a reset of the weft feeder device, the at least one moving element of the weft feeder device, in particular of the driving system, firstly is moved from the actual position to the first reference position and then is moved back to the desired position. In an example, at a start-up of the weft feeder device or after a power fail, the at least one moving ele-

ment of the weft feeder device, in particular of the driving system, is moved to the first reference position and then is moved back to the desired position. Preferably, the position of the at least one moving element of the weft feeder device, in particular of the driving system, is stored in a non-volatile memory at each moment, in particular after a power fail.

[0059] A weft feeder device can be provided comprising a winding drum having an adjustable winding circumference for storing weft thread, the winding drum comprising a base structure and at least one moveable finger, wherein the at least one moveable finger is mounted on the base structure so as to be moveable over the full length of a movement path into a number of positions, and preferably is releasably securable in each of said number of positions, wherein the winding circumference depends on the position of the at least one moveable finger, and wherein a control device is associated to the weft feeder device for determining a relationship between an actual position of the at least one moveable finger and a filling length of a weft thread.

[0060] Such a control device allows to "translate" a desired filling length, in other words a set filling length, into a corresponding position of each moveable finger determining the length of the winding circumference. Conversely, such a control device allows to "translate" a position of each moveable finger determining the length of the winding circumference, into a filling length.

[0061] An advantage is that a weaving machine can be started with an initial set filling length, in other words the filling length is sufficiently long for weaving but not too long. After starting the weaving machine one can adjust the filling length if necessary.

[0062] This further allows to compare the actual filling length determined based on the stored length belonging to the actual position of the moveable fingers with the desired filling length of a weft thread. This allows setting the desired filling length easily and to display the actual filling length for the actual position of the fingers.

[0063] Preferably, the control device is arranged for determining a desired winding circumference based on the number of windings to be stored on the winding drum for one filling length of a weft thread and/or the control device has an interface for manually setting the desired filling length of a weft thread to be stored on the winding drum and/or the control device has a processing unit for determining the desired filling length of a weft thread to be stored on the winding drum and/or the control device is further arranged for providing a control signal for an adjustment of the position of the at least one moveable finger based on the desired filling length.

[0064] In an example, three moveable fingers are mounted on the base structure so as to be moveable into in a radial direction with respect to a center axis of the weft feeder device, and a desired position of each moveable finger is defined as the distance of the moveable finger to the center axis.

[0065] In an example, the winding drum comprises at

least one fixed finger mounted on the base structure in at least one repeatable fixed finger position and the control device is arranged for determining the desired position of the at least one moveable finger as a function of the actual one of that number of repeatable fixed finger positions.

[0066] In an example, the weft feeder device comprises a driving system for moving the at least one moveable finger into a desired position, which driving system is controlled by the control device.

[0067] Preferably, a sensor device is provided for determining the position of the at least one moveable finger by measurement of the position of one moving element of the weft feeder device, which sensor device cooperates with the control device and/or the sensor device is provided for determining the position of the at least one moveable finger by measurement of the position of at least one moving element of the driving system, which sensor device cooperates with the control device.

[0068] In an example, an output device is associated to the control device, which output device is arranged to display the actual filling length corresponding to the actual positions of the fingers and the desired filling length.

[0069] A method for setting a winding circumference of a winding drum of a weft feeder device can be provided, the winding drum comprising a base structure and at least one moveable finger, wherein the at least one moveable finger is mounted on the base structure so as to be moveable over the full length of a movement path into a plurality of positions, and preferably is releasably secureable in the number of positions, and wherein the winding circumference depends on the position of the at least one moveable finger, the method comprising determining a desired filling length of a weft thread to be stored on the winding drum, determining a desired position of the at least one moveable finger based on that desired filling length, and moving the at least one moveable finger into the respective desired position.

[0070] Preferably, the winding drum comprises at least one fixed finger mounted on the base structure in one of a number of repeatable fixed finger positions, wherein the actual one of that number of repeatable fixed finger positions is determined and the desired position of the at least one moveable finger is defined based on the desired filling length of the weft thread to be stored on the winding drum and the determined fixed finger position.

[0071] In an example, an actual position of at least one moveable finger is determined and a feedback signal is provided, which feedback signal is used for moving the at least one moveable finger into the respective desired position and/or the desired filling length of the weft thread to be stored is determined using a weaving factor, which weaving factor is defined in dependency of at least one weaving parameter and/or the desired filling length of the weft thread to be stored is determined by the winding circumference multiplied by the number of windings for the filling length and/or the desired filling length is specified as an absolute desired filling length or as a relative

desired filling length.

[0072] A weft feeder device can be provided comprising a winding drum with an adjustable winding circumference and a wireless power transmission system, the wireless power transmission system comprises a primary side system comprising a signal generator and a secondary side system comprising an actuator driver for driving an actuator and a secondary control unit, wherein the secondary side system is arranged for an inductive coupling across an air gap with the primary side system, wherein the power transmission system is arranged for generating by means of the signal generator, at least during an operation time of the actuator, a signal with a first frequency matched to the resonant frequency of the secondary side system and in that the power transmission system is arranged for transmitting a first power across the air gap from the primary side system to the actuator driver for driving the actuator of the secondary side system.

[0073] Matching the frequency of the signal to the resonant frequency of the secondary side system offers the advantage that the frequency of that signal can easily be matched without the need to adjust the resonant frequency of the secondary side system, in particular during operation of the weft feeder device. The frequency of the signal generated by the primary side system can easily be set as the primary side system is well accessible to an operator during operation of the weft feeder device.

[0074] Preferably, the secondary side system comprises an evaluation device for evaluating a power received, wherein an output from the evaluation device is used for tuning the first frequency to match the first frequency to the resonant frequency of the secondary side system.

[0075] In an example, the primary side system is adapted for selectively transmitting across the air gap the first power used for powering the actuator driver for driving the actuator or a second power used for powering the secondary control unit.

[0076] Preferably, the first power is transmitted in slots followed by slots during which the second power is transmitted. Transmitting the power used for powering the actuator driver in slots, preferably in short slots, offers the advantage that heat generation can be avoided.

[0077] In an example, the wireless power transmission system is arranged for transmitting the second power used for powering the control unit by controlling the signal generator to generate a signal with a second frequency, which is different from the resonant frequency of the secondary side system.

[0078] Further, the inductive coupling provides a communication link for a bidirectional data communication between the primary side system and the secondary side system. In an example, the signal generator comprises a pulse-width modulation generator. In an example, the actuator driver is a motor driver, for example the motor driver is a four-quadrant motor driver.

[0079] In an example, the secondary side system comprises at least one secondary inductor and at least one

secondary capacitance and/or the at least one secondary capacitance and the at least one secondary inductor are arranged in parallel and/or the secondary inductor of the secondary side system is a secondary coil provided on a shield-shaped insulating support element and/or the secondary coil is wound on the support element so that the coil is wound at least essentially rectangular at a first section and at least essentially triangular at a second section and/or the primary inductor of the primary side system is a primary coil provided on a shield-shaped insulating support element and/or the primary coil is wound on the support element so that the coil is wound at least essentially rectangular at a first section and at least essentially triangular at a second section and/or the primary coil and the secondary coil are shaped equal and/or the wireless power transmission system is arranged at least partly near to a fixed finger of the winding drum.

[0080] A method for a wireless power transmission across an air gap of a weft feeder device can be provided using a power transmission system with a primary side system with a signal generator, and a secondary side system with an actuator driver for driving an actuator and a secondary control unit, wherein the secondary side system is arranged for an inductive coupling across the air gap with the primary side system, wherein at least during an operation time of the actuator, the signal generator generates a signal with a first frequency matched to the resonant frequency of the secondary side system and the power transmission system transmits a first power across the air gap from the primary side system to the actuator driver for driving the actuator of the secondary side system.

[0081] Preferably, at the secondary side system a power received is evaluated using an evaluation device, wherein an output from the evaluation device is used for tuning the first frequency to match the first frequency to the resonant frequency of the secondary side system.

[0082] In an example, for transmitting the power used for powering the secondary control unit the frequency of the signal from the signal generator is tuned to a second frequency, which is different from the resonant frequency of the secondary side system.

[0083] Preferably, the resonant frequency is situated between 50 kHz and 500 kHz, and for example is about 160 kHz.

[0084] In an example, during the operation time of the actuator and/or for powering at least one other active element provided at the secondary side system, the first power is transmitted to the secondary side system.

[0085] Hereafter exemplary embodiments of the invention will be described in detail, based on different schematic drawings, wherein

- Fig. 1 is a side view of a weft feeder device according to the invention;
- Fig. 2 is a front view of the weft feeder device of Fig. 1;
- Fig. 3 is a perspective view of a fixed finger;

- Fig. 4 is an enlarged view of a part of Fig. 3;
 Fig. 5 is a perspective view of a moveable finger and a drive system;
 Fig. 6 is a detailed view of the moveable finger of Fig. 5;
 Fig. 7 is a perspective view of a part of a drive system and three moveable fingers;
 Fig. 8 is a perspective view of a part of a drive system and three moveable fingers;
 Fig. 9 is a side view of the moveable fingers of Fig. 1;
 Fig. 10 is a perspective view of a part of a drive system and one moveable finger;
 Fig. 11 is a top view of the moveable finger of Fig. 5;
 Fig. 12 is a front view of a part of a drive system without an actuator and three moveable fingers;
 Fig. 13 is a front view of a part of a drive system with an actuator and three moveable fingers;
 Fig. 14 is a perspective view of a part of a drive system with an actuator;
 Fig. 15 is a perspective view of a part of a drive system without an actuator;
 Fig. 16 shows a course of the signal of a second sensor system in relation to the position of the first pinion of the weft feeder device;
 Fig. 17 is a perspective view of a part of an alternative drive system and one moveable finger;
 Fig. 18 is a perspective view in more detail of a part of an alternative drive system;
 Fig. 19 is a front view of an alternative of Fig. 12;
 Fig. 20 is a detailed view of an alternative of Fig. 6;
 Fig. 21 is a side view similar to the side view of Fig. 1;
 Fig. 22 shows a circuit for a power transmission system;
 Fig. 23 is a perspective view of a base structure of a winding drum of the weft feeder device of Fig. 1;
 Fig. 24 is a perspective view of a main body of the weft feeder device of Fig. 1;
 Fig. 25 is a front view similar as Fig. 2;
 Fig. 26 is a simplified front view of Fig. 25;
 Fig. 27 is a further simplified front view of Fig. 26;
 Fig. 28 shows an interactive device for a weft feeder device according to the invention.

DETAILED DESCRIPTION

[0086] In Fig. 1 and 2 a weft feeder device 1 is shown comprising a winding drum 2 for storing a weft thread 10 and a winding arm 3 arranged to rotate with respect to a center axis 4 of the weft feeder device 1 in order to wind weft thread 10 onto the winding drum 2. Weft thread 10 coming from a bobbin (not shown) is wound onto the winding drum 2. The winding drum 2 has an adjustable winding circumference for storing weft thread 10. The winding drum 2 is arranged stationary and comprises a base structure 5, one fixed finger 6 mounted in a fixed finger position on the base structure 5 and three moveable fingers 7, 8 and 9 that are evenly distributed about

the winding circumference. Each moveable finger 7, 8, 9 is mounted on the base structure 5 and is moveable into a plurality of positions, in particular is moveable in an associated radial direction R7, R8 or R9 with respect to the center axis 4 into a number of positions. The three moveable fingers 7, 8, 9 are successively arranged so as to form an angle of 90° between two successive moveable fingers, in other words an angle of 90° between the moveable fingers 7 and 8 and an angle of 90° between the moveable fingers 8 and 9. Each moveable finger 7, 8, 9 is essentially continuously moveable along a linear movement path in relation to the center axis 4. Furthermore, each moveable finger 7, 8, 9 is releasably securable in a desired position along the movement path, in other words can be held in a number of positions. The fixed finger 6 and the moveable fingers 7, 8, 9 determine the winding circumference of the winding drum 2. In other words, the winding circumference depends on the position of the fingers 6, 7, 8, 9.

[0087] The fixed finger 6 is mounted in a fixed finger position, in other words the fixed finger 6 can be set in a predefined fixed finger position. In this case, the predefined fixed finger position is a repeatable and settable fixed finger position. The predefined fixed finger position can also be named as pre set fixed finger position. The fixed finger 6 is arranged in front of a magnet pin 11 for holding a weft thread 10 with respect to the winding drum 2. As the fixed finger 6 is mounted in a predefined fixed finger position, a simple arrangement for the magnet pin 11 is possible. The fixed finger position may be set or adjusted, so that the winding circumference has a rather circular shape or the winding circumference at least does not substantially deviate from a circular shape.

[0088] As shown in Fig. 2, the fixed finger 6 and the three moveable fingers 7, 8, 9 form a noncontinuous winding circumference onto which the weft thread 10 is wound. For varying the winding circumference, at least one of the moveable fingers 7, 8, 9 is displaced with respect to the center axis 4. In case a resulting winding circumference deviates substantially from a circular shape, the fixed finger 6 may be moved into an adjusted fixed finger position.

[0089] For weaving machines in which a fabric width can be considerably varied, for example weaving machines allowing for fabric widths differing by more than about 500 mm, arranging the fixed finger 6 in one fixed finger position may result in a winding circumference that substantially deviates from a circular shape. Such a shape may bring about tension peaks in the weft thread 10 at the entry of a weft feeder device 1 and may result in weft thread breakages. To avoid this, the fixed finger 6 may be positioned in a number of predefined fixed finger positions.

[0090] As shown in Fig. 3 and 4, a mounting device 60 for the fixed finger 6 is provided for clamping the fixed finger 6 in the predefined fixed finger position. The mounting device 60 for the fixed finger 6 comprises a clamping element 61 and a guiding arm 62 cooperating with the

clamping element 61 for enabling a clamping of the fixed finger 6 in at least one predefined fixed finger positions, for example three fixed finger positions A, B and C or only one fixed finger position A. The guiding arm 62 is moveably, in particular slidably mounted in a guiding element 63 on the base structure 5. The guiding arm 62 is provided with a number of grooves 64, which can be arranged in line with a groove 65 provided on the base structure 5, wherein for mounting the guiding arm 62 on the base structure 5, a clamping element 61 with a protrusion 66 engaging with one of the grooves 64 and the groove 65 is provided. The positioning of the fixed finger 6 is for example carried out manually. As shown in Fig. 4, the clamping element 61 is L-shaped with a protrusion 66 and can be mounted on the base structure 5 by means of a bolt 67. As shown in Fig. 3 the fixed finger 6 is mounted in the fixed finger position A. If required, the fixed finger 6 can be mounted in the fixed finger positions B or C, instead.

[0091] In alternative, in order to ensure a precise positioning of the fixed finger 6 in predefined fixed finger positions, the guiding arm may be provided with a plurality of protrusions cooperating in alternative with a groove provided on the clamping element. Other alternatives are possible, for example using a different clamping element for each predefined fixed finger position.

[0092] The fixed finger 6 and the moveable fingers 7, 8, 9 are arranged and shaped in order to provide a winding circumference having a rather circular shape, in particular a winding circumference having a shape close to the circular shape. To this end, the fingers are shaped with a particular periphery allowing to obtain a rather circular winding circumference with the fingers 6, 7, 8, 9 independent of the position of the fixed finger 6 and the position of the moveable fingers 7, 8, 9. As shown in Figs. 3, 5 and 6, the periphery of the fixed finger 6 and the periphery of the moveable fingers 7, 8, 9 is provided with four outward facing outer edges 30, 31, 32, 33, for example outer edges 30, 31, 32, 33 that are designed as ribs. The four outer edges 30, 31, 32, 33 are extending parallel to the center axis 4 in the area in which weft thread 10 is wound onto the outer edges 30, 31, 32, 33. The fact that the outer edges 30, 31, 32, 33 are extending parallel to the center axis 4 offers the advantage that the length of the winding circumference of the winding drum 2 does not change for each plane perpendicular to the direction the center axis 4, so that the length of stored weft thread can be determined with high accuracy, for example an accuracy of about 0,2mm for the length of the winding circumference. Each finger comprises four outward facing outer edges 30, 31, 32, 33, preferably two side outer edges 30, 31 arranged near the lateral sides 34, 35 of the respective finger 6 to 9 and two middle outer edges 32, 33 arranged between the two side outer edges 30, 31. The distance along the winding circumference of the winding drum 2 between the middle outer edges 32, 33 is less than each of the distance between the middle outer edge 32 and the side outer edge 30 and the distance

between the middle outer edge 33 and the side outer edge 31.

[0093] As shown in detail in Fig. 5 and 6 for the finger 7, each outer edge 30, 31, 32, 33 comprises ribs having two rib parts 36, 37 that are arranged parallel to each other. The rib parts 36, 37 end at a front arc 38 of the finger 7, which front arc 38 is curved or in the shape of a composed line. A smooth transition 84 is provided between the front end of each of the rib parts 36, 37 and the curved front arc 38. Further, as shown in Fig. 6, the finger 7 comprises a first leg 50, a second leg 51 and a segment 52 connecting the first leg 50 and the second leg 51. The first leg 50 is arranged near the first lateral side 34 and the second leg 51 is arranged near the second lateral side 35. This allows to support the moveable fingers 7, 8, 9 in a stable manner. The segment 52 comprises the number of outward facing outer edges 30 to 33, in particular the outer edges 30 to 33 are arranged at an outer side of the segment 52 facing the weft thread 10 and opposite to the inner side of the segment 52 at which the first leg 50 and the second leg 51 are arranged on the segment 52. The outer edges 30 to 33 arranged on the fixed finger 6 and the outer edges 30 to 33 arranged on the segment 52 of the moveable fingers 7, 8, 9 define the rather circular winding circumference onto which the weft thread 10 is wound. In particular, the outer edges 30, 31, 32, 33 are arranged for enabling a rather circular winding circumference independent of the position of the moveable fingers 7, 8, 9 along their movement path. In the context of the application, the movement path is defined as the distance extending between the extreme positions of the moveable fingers 7, 8, 9, in other words between the minimum distance of the moveable fingers 7, 8, 9 from the center axis 4 and the maximum distance of the moveable fingers 7, 8, 9 from the center axis 4. In other words, due to the arrangement of the outer edges 30 to 33, the weft thread 10 wound onto the winding drum 2 makes contact with each of the outer edges 30 to 33 of each finger 6 to 9 independent of the position of each of the moveable fingers 7, 8, 9. In other words, the outer edges 30, 31, 32, 33 of each finger 6, 7, 8, 9 are arranged so that in each position of the fingers 6, 7, 8, 9 during winding of the weft thread 10 onto the winding drum 2, the weft thread 10 is always in contact with all the outer edges 30, 31, 32, 33 of each finger 6, 7, 8, 9. Due to the contact of the weft thread 10 with all the outer edges 30, 31, 32, 33 of each finger 6, 7, 8, 9 during winding, the length of the winding circumference is determined with high accuracy, so that an accurate stored length can be obtained.

[0094] The first leg 50 and the second leg 51 are arranged parallel to each other and at distance to each other. This is advantageous for the stability of the moveable fingers 7, 8, 9 themselves and for the stability of the positioning of the fingers 7, 8, 9, in particular for the movement of the moveable fingers 7, 8, 9. The front arc 38 is a portion of the segment 52. As shown, the segment 52 comprises a number of flat plates 39 arranged, respec-

tively, between the outer edges 30 and 32, the outer edges 31 and 33 and the outer edges 32 and 33. The fingers 8 and 9 can be designed similar to the finger 7. The part of the fixed finger 6 that cooperates with the weft thread 10 can be designed similar to the corresponding part of the finger 7. Preferably the arrangement of and the dimensions of all outer edges 30, 31, 32 and 33, that make contact with the weft thread 10, are identical for all fingers 6, 7, 8 and 9 of the weft feeder device 1.

[0095] The weft feeder device 1 further comprises a driving system 20 for moving each moveable finger 7, 8, 9 into a respective desired position. The desired position is defined as a distance of the respective moveable finger 7, 8, 9 to the center axis 4. The driving system 20 as shown in Fig. 8 allows to move all moveable fingers 7, 8, 9 conjointly, in other words the moveable fingers 7, 8, 9 are arranged for conjoint movement. In this way, all the moveable fingers 7, 8, 9 are moved by means of a common driving system 20. As will be explained in more detail below, the driving system 20 of the weft feeder device 1 is designed to set the winding circumference with high accuracy. Thereby, a simple mechanical structure for the movement of the moveable fingers 7, 8, 9 is provided allowing for a reliable positioning of moveable fingers 7, 8, 9.

[0096] As shown in Fig. 7 and 8, the driving system 20 is drivingly coupled to each moveable finger 7, 8, 9. To this end, the driving system 20 is arranged for driving the first leg 50 of each of the moveable fingers 7, 8 and 9. The driving system 20 comprises a first pinion 21 for driving the moveable fingers 7, 8, 9. The first leg 50 of each moveable finger 7, 8, 9 is provided with a rack section 53 that can be drivingly coupled to the first pinion 21. In this way each moveable finger 7, 8, 9 comprises a first leg 50 by means of which the moveable finger 7, 8, 9 is mounted on the base structure 5, so as to be moveable along a linear movement path. As shown in Fig. 8, only the first leg 50 of each moveable finger 7, 8, 9 is driven. The driving system 20 is arranged for moving the first pinion 21 continuously with a high accuracy over a small angle of rotation.

[0097] An accuracy of the positioning of the moveable fingers 7, 8, 9 depends on the characteristics of the driving system 20. In particular, two mechanical phenomena may occur that can cause a position uncertainty of the moveable fingers 7, 8, 9, namely play and backlash. In the context of the application, a "play" is defined as a free movement between a driving element and a driven element, which cannot be controlled and depends not only on a variable external load, but also on tolerances of the components of the driving system 20. When the driving system 20 is subjected to vibrations or when the external load is varying, the amount of play is generally unknown unless defined by means of an appropriate measuring system. To the contrary, a "backlash" is defined in the context of the application as the amount of controllable movement between a driving element and a driven element, which is controllable and, hence, different from a

"play". The controllable movement between a driven element and a driving element will not change due to vibrations or external loads and will only be affected by the movement of the driving element. Backlash can be compensated without a measuring system by using appropriate control strategies.

[0098] The weft feeder device 1 is provided with a preload system 54 for directly applying a preload to the moveable finger 7, 8, 9 in order to compensate play between the moveable finger 7, 8, 9 and the driving system 20. The preload system 54 comprises a spring element 55 assigned to a moveable finger 7, 8, 9, which spring element 55 is acting on the first leg 50 of the moveable finger 7, 8, 9 and is forcing that moveable finger 7, 8, 9 towards the first pinion 21. The preload system 54 is further provided with a friction element 56, which friction element 56 is assigned to a moveable finger 7, 8, 9, in particular to the first leg 50 of each moveable finger 7, 8, 9. By means of the friction exerted by the friction element 56 a frictional force opposing a movement of the moveable finger 7, 8, 9 is acting on the first leg 50 of the respective moveable finger 7, 8, 9.

[0099] When providing at least one preload system 54 for directly applying a preload to the moveable fingers 7, 8, 9, a play between the moveable fingers 7, 8, 9 and the driving system 20 can be reduced or the uncontrollable play can be transformed into a backlash, which is controllable without an extra measuring system.

[0100] As shown in Fig. 8, the preload system 54 is directly applying a preload to the moveable fingers 7, 8, 9. In other words, the preload is exerted to the coupling between the moveable fingers 7, 8, 9 and the first pinion 21 via the moveable fingers 7, 8, 9 and not via the first pinion 21. Thereby it is ensured that the position of the moveable fingers 7, 8, 9 is not affected by changing external loads, for example due to a changing of the weft thread tension acting on the moveable fingers 7, 8, 9 and/or due to vibrations of the moveable fingers 7, 8, 9.

[0101] In an alternative not shown, a spring element is acting on the segment 52 connecting the first leg 50 and the second leg 51 and forces the moveable finger 7, 8, 9 in radial direction towards the center axis 4. In another example (not shown), two spring elements are provided acting respectively on the first leg and the second leg in the movement direction of the legs. In still another example (not shown), two spring elements are provided acting on the first leg and the second leg in a direction perpendicular to the movement direction. When providing spring elements on the legs, an equal number of spring elements may be provided, which spring elements are arranged for avoiding forces or torques tilting the moveable fingers. In another alternative, the preload system 54 comprises only one of a spring element 55 and a friction element 56.

[0102] As shown in Fig. 9, the first legs 50 of each moveable finger 7, 8, 9 are arranged in a first plane 40 perpendicular to the center axis 4. Preferably, the second legs 51 of each moveable finger 7, 8, 9 are arranged in

a second plane 41 perpendicular to the center axis 4. The second plane 41 is arranged at a distance along the center axis 4 from the first plane 40. In other words, the first plane 40 is offset to the second plane 41 with respect to the center axis 4. As indicated in dotted lines, the first pinion 21 is located in the first plane 40. As can be seen in Fig. 10, the first leg 50 and the second leg 51 of each moveable finger 7, 8, 9 extend parallel to the associated radial direction R7, R8, R9 with respect to the center axis 4, extend on opposite sides of the center axis 4 and extend offset from each other in the direction of the center axis 4. The length of the first leg 50 and the length of the rack section 53 of the first leg 50 are chosen sufficiently large in order to ensure a long movement path of the moveable fingers 7, 8, 9, in other words for enabling an adjustment over a wide range. The length of the first leg 50 is chosen, so that at least the first leg 50 extends past the center axis 4. As shown in Figs. 7 and 10, also the length of the second leg 51 is chosen, so that also the second leg 51 extends past the center axis 4. Preferably, the movement path of the moveable fingers 7, 8, 9 has a length in the order of magnitude of the diameter of the first pinion 21.

[0103] When arranging all first legs 50 in a first plane 40, an axial length of the first pinion 21, as shown in dotted lines in Fig. 9, can be chosen small. Providing the first legs 50 and the second legs 51 in two planes 40, 41 offset to each other allows providing both legs 50, 51 with a sufficient length to ensure a reliable guidance. In addition, the legs 50, 51 can be arranged at a large distance in a direction perpendicular to the center axis 4, thereby ensuring a reliable guidance. To this end the legs 50, 51 are arranged near the lateral sides 34, 35 of the moveable fingers 7, 8, 9.

[0104] As shown in Fig. 11, a guiding system 68 is provided for guiding the first leg 50 and the second leg 51. The guiding system 68 comprises a first guide 69, by means of which the first leg 50 is guided in its length direction and past the center axis 4. The first leg 50 is guided along its lateral surface in one direction. Hereby, the first leg 50 is guided so that the first leg 50 can be driven by the first pinion 21. The first legs 50 are guided in a plane 40 perpendicular to the center axis 4 for avoiding rotation. The guiding system 68 comprises a second guide 70, by means of which the second leg 51 is guided in its length direction and past the center axis 4. The second leg 51 is guided along its lateral surface in all directions. The second guide 70 has a round cross section, while the second leg 51 has a cylindrical shape. In other words, the second leg 51 has a circular cylindrical section guided in a circular hole of the second guide 70. Driving only the first legs 50 also provides a simple and cost efficient solution. When driving only the first leg 50, a jamming can be avoided by an appropriate guiding system 68. The guiding system 68 that guides the first leg 50 and the second leg 51 allows to avoid rotation of a moveable finger 7, 8, 9 with respect to the first leg 50 and in this way also with respect to the second leg 51.

[0105] As shown in Fig. 11, the guiding system 68 comprises guides 69 and 70 to guide the legs 50 and 51 of, for example, the moveable finger 7. The guiding system 68 as shown in Fig. 11, also comprises another first guide 120 and another second guide 121 that are intended to guide the legs 50 and 51 of, for example, the moveable finger 9, that respectively are shaped similarly as the guides 69, 70. The guides 69 and 70 and the guides 120 and 121 are arranged in a mirror symmetrical way with respect to the axis 108.

[0106] As shown in Fig. 1, the weft feeder device 1 further comprises a control device 12, in other words the control device 12 is a part of the weft feeder device 1, in particular the control device 12 is a separate unit that is located inside the weft feeder device 1. The control device 12 is arranged for controlling a desired position of each moveable finger 7, 8, 9 in order to obtain a desired winding circumference of the winding drum 2. A desired position of each moveable finger 7, 8, 9 is defined as the distance of the moveable finger 7, 8, 9 to the center axis 4. The control device 12 is further arranged for providing a control signal for adjusting the position of each moveable finger 7, 8, 9 to the respective desired position. The control device 12 is arranged for controlling the desired position of each moveable finger 7, 8, 9 as a function of one of the number, in the shown example three predefined or set positions A, B, C of the fixed finger 6. The control device 12 is arranged to control the driving system 20 in order to move at least one moveable finger 7, 8, 9 into a desired position. The movement of the at least one moveable finger 7, 8, 9 can be carried out automatically, semi-automatically or manually and will be explained in more detail below.

[0107] In alternative, the control device 12 is assigned to the weft feeder device 1. To this end, for example, the control device 12 is integrated into a central control device 12 of a weaving machine. In another alternative, the control device 12 is arranged apart from the weft feeder device 1, wherein in particular a plurality of weft feeder devices 1 can be assigned to one common control device 12.

[0108] A method for adjusting a winding circumference of a winding drum 2 for a weft feeder device 1 comprises setting a desired length of the weft thread 10 to be stored on the winding drum 2, determining a desired position of each moveable finger 7, 8, 9 based on that desired length, and moving each moveable finger 7, 8, 9 into the respective desired position. Further, a predefined fixed finger position is determined and the desired position of each moveable finger 7, 8, 9 is determined based on the desired length of the weft thread 10 to be stored on the winding drum 2 and the predefined fixed finger position. Preferably, an actual position of at least one moveable finger 7, 8, 9 is determined and a feedback signal is provided, which feedback signal is used for moving at least one moveable finger 7, 8, 9 into the respective desired position. The desired length of the weft thread to be stored is set, for example using a weaving factor, which

weaving factor is defined in dependency of at least one weaving parameter, for example a weaving factor taken from the group comprising: weaving styles, bobbin characteristics, weft thread characteristics, characteristics of the stretching device and characteristics of other insertion components. The desired filling length is proportional to the desired stored length. The stored length is defined by the winding circumference multiplied by the number of windings for one filling length.

[0109] A weaving factor can be set and/or determined by a skilled operator using his experience and/or using tables for mapping weaving parameters to recommended weaving factors. The mapping can be performed using printed tables and/or by electronic means.

[0110] Hereby, the control device 12 is arranged for determining the desired length of the weft thread 10 to be stored on the winding drum 2 by the weft feeder device 1 using the weaving factor. In other words, the control device 12 is arranged for adjusting the winding circumference of the winding drum 2. The winding circumference defines a desired length of the stored weft thread. A desired filling length can be defined by a width of the fabric to be woven and a waste length. In order to minimize a waste length, while still ensuring a sufficient filling length, a weaving factor is used, wherein the filling length is calculated based on a fabric width and a minimal required waste length. Hereby the filling length is proportional to the stored length, in other words is approximately equal to the stored length multiplied with that weaving factor. Preferably, the weaving factor ranges from about 0.9 to about 1.1.

[0111] This allows setting a desired filling length and/or a desired length of the weft thread 10 to be stored by the weft feeder device 1, by defining a desired position of each moveable finger 7, 8, 9 based on that desired filling length and/or the desired stored length of weft thread 10, and by moving each moveable finger 7, 8, 9 into the respective desired positions.

[0112] Preferably, the desired length of the weft thread 10 to be stored on the winding drum 2 is defined. To this end, the control device 12 is arranged for determining a desired winding circumference based on the number of windings to be stored on the winding drum 2 for a respective filling length of a weft thread 10. For example, the control device 12 has an interface for manually setting the desired filling length of a weft thread 10 to be stored on the winding drum 2. In alternative or in addition, the control device 12 has a processing unit for determining the desired length of a weft thread 10 to be stored on the winding drum 2. Further, the control device 12 is arranged for adjusting the position of the at least one moveable finger 7, 8, 9 based on the desired filling length. For example, the control device 12 is arranged for providing a control signal for an adjustment of the position of the moveable fingers 7, 8, 9 into the desired position. For example, this control signal allows to automatically or semi-automatically move each moveable finger 7, 8, 9 into the respective desired position. In another example,

this control signal is used for displaying a respective desired position of each moveable finger 7, 8, 9 and for manually moving each moveable finger 7, 8, 9 into the respective desired position. An adjustment in one example is carried out manually by applying a torque to the first pinion 21, for example by means of an Allen key or a screwdriver.

[0113] Using the weft feeder device 1 it is possible for an operator to set a desired filling length of weft thread 10, and by means of the control device 12 a desired position of each moveable finger 7, 8, 9 is determined allowing a length of the weft thread to be stored in order to obtain a filling length as close as possible to the desired filling length. In addition, a control signal for moving the moveable finger 7, 8, 9 into the respective desired positions is provided. For example, a control signal is sent to an output device 13 (shown in Figs. 1, 14 and 22) and the operator manually adjusts the position of the moveable fingers 7, 8, 9 in accordance with the signal optically and/or acoustically provided on the output device 13. In other examples, the operator is assisted by an actuator 14 in the adjustment of the position. The actuator 14 will be explained in more detail below. The output device 13 is for example a display controlled by the control unit 12 of the weaving machine.

[0114] Preferably, at least one driving system 20 is provided for moving each moveable finger 7, 8, 9 into the respective desired position according to the control signal. For example, the driving system 20 is in direct communication with the control device 12 by means of a wired or wireless communication link. In alternative, the control signal is generated by the control device 12 and the control signal is transferred via a data network to the driving system 20 of the winding drum 2.

[0115] Using a data network enables to determine a common setting for a plurality of winding drums having an identical design and to subsequently adjust the winding circumference for each of the winding drums. For example, a desired filling length of the weft thread to be stored is determined and optimized by means of experiments, wherein based on the optimized desired filling length a winding circumference for each one or a number of winding drums is set.

[0116] For this purpose, the movement of the moveable fingers 7, 8, 9 is carried out automatically, semi-automatically or manually. The step of moving the moveable fingers 7, 8, 9 into desired positions may be carried out repeatedly for a number of winding drums 2 on the same or on different weaving machines. To this end data from a control device 12 associated to one weaving machine may be transferred to a control device 12 associated to another weaving machine, for example via an USB output apparatus.

[0117] For example, an actual fixed finger position is determined and the desired position of each moveable finger 7, 8, 9 is based on the desired length of the weft thread 10 to be stored on the winding drum 2 and the actual fixed finger position.

[0118] As explained above, in case the desired position of the moveable fingers 7, 8, 9 cannot be reached or leads to a winding surface deviating too much from a circular shape, in addition a control signal for assisting a setting of the fixed finger 6 into another of the number of repeatable fixed finger positions is provided. Such a control signal may assist an operator in a manual adjustment of the position of the fixed finger 6, for example a control signal is sent to an output device 13 and the operator manually adjusts the position of the fixed finger 6 in accordance with the signal optically and/or acoustically provided on the output device 13.

[0119] In alternative, an actual position of at least one moveable finger 7, 8, 9 and/or the fixed finger 6 is determined and a feedback signal is provided, which feedback signal is used for moving the at least one moveable finger 7, 8, 9 into the respective desired position. A movement of the moveable fingers 7, 8, 9 is then carried out manually, semi-automatically or automatically based on the feedback signal. The feedback signal can be displayed on the output device 13.

[0120] As shown in more detail in Figs. 12 to 13, a driving system 20 comprises a first pinion 21, wherein at least the first leg 50 of each moveable finger 7, 8, 9 is provided with a rack section 53 drivingly coupled to the first pinion 21, and wherein the driving system 20, in particular the gear system 23 of the driving system 20 is self-locking for securing the first pinion 21 in position during weaving, in particular when the driving system 20 is subjected to vibrations of the weaving machine, and in idle times. As described in respect with Fig. 8, for example at least one preload system 54, and preferably three preload systems 54, are provided for directly applying a preload to the moveable fingers 7, 8, 9 in order to compensate play between the moveable fingers 7, 8, 9 and the driving system 20, in particular the first pinion 21 of the driving system 20.

[0121] As shown in Fig. 12 to 14, the driving system 20 comprises a gear system 23 for driving the first pinion 21. The gear system 23 comprises a worm drive 24 and a reduction gear 25. The worm drive 24 comprises a worm wheel 26 cooperating with a worm 27. The worm drive 24 of the gear system 23 is self-locking. The reduction gear 25 comprises a gear wheel 28 cooperating with the first pinion 21. As shown in more detail in Fig. 14, the worm wheel 26 and the gear wheel 28 are arranged in one piece 19 that can rotate around an axle 29 and is forced towards the first pinion 21 by means of a spring 17. The piece 19 is advantageous for obtaining a compact arrangement and allows to arrange an axle 15 of the worm 27 at a distance of the first pinion 21 in the direction of the center axis 4. The worm 27 is arranged on the axle 15 that comprises a drive part 16, which drive part 16 can cooperate with a tool, for example an Allen key or a screwdriver, enabling to turn the worm 27 and in this way also the first pinion 21 via the gear system 23. This allows to manually adjust the winding circumference. Preferably, at least the gear wheel 28 of the gear system 23 is

preloaded and tapered in order to compensate play in the gear system 23. In alternative a gear wheel 28 with straight teeth co operating with teeth of the first pinion 21 is provided.

[0122] As shown in Fig. 13 and 14, the driving system 20 comprises the gear system 23 and the actuator 14 for driving the first pinion 21, which actuator 14 is preferably separable from the gear system 23. In normal use, the actuator 14 drives the first pinion 21 via the gear system 23. Preferably, a DC motor or a stepper motor is provided as the actuator 14. The actuator 14 allows for a semi-automatic or automatic adjustment of the winding circumference via the driving system 20. Preferably, the actuator 14 is separable from the gear system 23, in order to allow a manual adjustment when required, for example for maintenance work. To this end a releasable part 18 is provided to separate the axle 15 from the actuator 14. The actuator 14 is arranged in line with a drive part 16, but opposite to the drive part 16 with respect to the worm 27, as shown in Fig. 14. The axle 15, driven by the actuator 14 or by means of the drive part 16, is arranged in a plane perpendicular to the center axis 4, which plane is offset to the planes 40 and 41 along the center axis 4. This allows to arrange the actuator 14 and/or to reach the drive part 16 with a tool. In this example, the actuator 14 is controlled by the control device 12 for adjusting the winding circumference of the winding drum 2.

[0123] For example, the gear system 23 comprises a self locking worm drive 24. This allows the actuator 14 to be separated from the gear system 23 while the first pinion 21 remains held in a position reached without the necessity of any additional means for securing the first pinion 21 in the position reached. Nevertheless, additional securing elements could be provided. This is also advantageous for securing the first pinion 21 in idle times.

[0124] In addition, the driving system 20 preferably comprises a gear system 23 arranged between an integrated gearbox 22 associated to the actuator 14 and the first pinion 21 with a reduction ratio of at least one over fifty. To this end, the gear system 23, for example, comprises a gear wheel 28 arranged between the worm drive 24 and the first pinion 21 with a reduction ratio between the gear wheel 28 and the first pinion 21 of about one over ten. This allows to drive the first pinion 21 continuously and with a high accuracy over a small angle of rotation, for example an angle of rotation allowing to obtain a length of the winding circumference with an accuracy of about 0,2mm. As shown in Fig. 13 and 14, a preloaded gear wheel 28 is provided, for example using the spring 17 that forces the piece 19 comprising the worm wheel 26 and the gear wheel 28 with a force F towards the first pinion 21. The preloaded gear wheel 28 is arranged in order to compensate play in the gear system 23. The gear wheel 28 further enhances a self locking effect. By providing a preloaded gear wheel 28, an introduction of play is avoided. To this end, the gear wheel 28 is provided with tapered teeth that engage with teeth of the first pinion 21 and the gear wheel 28 is forced in

axial direction towards the teeth of the first pinion 21, for example by a force exerted by the spring 17. The gear wheel 28 is separable from the first pinion 21 and in this way also the actuator 14 is separable from the first pinion 21, by shifting the gear wheel 28 in the direction of the axle 29 against the force of the spring 17 for allowing an independent or free movement of the at least one moveable finger 7, 8, 9.

[0125] For example, the actuator 14 drives an integrated gearbox 22 with a reduction ratio of at least one over hundred. This allows the actuator 14, in particular in case of a DC motor, to be operated at a recommended speed. On the other hand, after removing the actuator 14 with the integrated gearbox 22 from the gear system 23 of the driving system 20, as shown in Fig. 12, the reduction ratio of the gear system 23 still present allows for manual adjustments of the moveable fingers 7, 8, 9 by rotating the first pinion 21 via the drive part 16.

[0126] As described above, by means of the driving system 20, the moveable fingers 7, 8, 9 are moved into respective desired positions, wherein the movement is carried out automatically, semi-automatically or manually. For example, a control device 12 is provided. In an example, the control device 12 assists an operator in a manual adjustment, for example a control signal is sent to an output device 13 and the operator manually adjusts the position of the moveable fingers 7, 8, 9 in accordance with the signal optically and/or acoustically provided on the output device 13, so that a manual adjustment is obtained. In other examples, the operator is assisted in the adjustment of the position by a signal of the control device 12 sent to the output device 13 and hereby further assisted by an actuator 14, so that a semi-automatic adjustment is obtained. Preferably, the control device 12 controls the driving system 20 to move the moveable fingers 7, 8, 9 into desired positions, so that an automatic adjustment is obtained. For example, a feed-forward control device 12 is provided.

[0127] As shown amongst others in Fig. 14, a sensor device 42 is provided for determining the position of at least one moveable finger 7, 8, 9 by measurement of the position of one element of the weft feeder device 1, in particular by measurement of the position of at least one element of the driving system 20. The sensor device 42 cooperates with the control device 12. The sensor device 42 of the weft feeder device 1 is adapted for determining the actual position of the moveable fingers 7, 8, 9. To this end, in an example, a sensor device (not shown), for example a proximity sensor device fixedly arranged on the base structure 5, is provided for determining the position of that at least one moveable finger 7, 8, 9 by measurement of the position of that at least one moveable finger 7, 8, 9 itself. However, as shown in Fig. 14 and 15, in the example shown to this end the sensor device 42 is provided for determining the position of at least one element of the driving system 20. When determining the position, the actual position can be used as a feedback signal in the control device 12. In alternative, an operator

is assisted in the manual adjustment by displaying both a desired and an actual position of the moveable fingers. Generally, the sensor device may be arranged for measuring the position of any element of the driving system 20, wherein the position of the moveable fingers is calculated in function of the characteristics of the driving system 20. For example, the sensor device is provided at the worm drive 24. This position allows for an easy integration of the sensor device. Preferably, the sensor device is however arranged as close as possible to the moveable fingers 7, 8, 9 in order to ensure that the measured signal is not deteriorated by play in the driving system 20. In view of design constraints, the sensor device 42 of the example shown is arranged to measure the rotation of the first pinion 21. In case a play between the moveable fingers 7, 8, 9 and the first pinion 21 is avoided or at least reduced to a minimum, for example by means of the preload system 54 shown in Fig. 8, measuring the rotation of the first pinion 21 allows for a reliable determination of the position of the moveable fingers 7, 8, 9. Due to the size and the associated low rotational speed of the first pinion 21, according to the invention a sensor device 42 is provided to detect the movement of the first pinion 21 with high resolution and sufficient accuracy.

[0128] As shown in Fig. 14, preferably, in order to determine the position of the first pinion 21 with sufficient accuracy, the sensor device 42 comprises a first sensor system 43 and a second sensor system 44. The first sensor system 43 is adapted for measuring the relative movement of a moving element of the weft feeder device, in particular for measuring the relative movement of at least one moving element of the driving system 20, and in the example shown, for measuring the relative movement of the first pinion 21 of the driving system 20, in particular the incremental movement of the first pinion 21. The second sensor system 44 is adapted for determining at least a first reference position of a moving element of the weft feeder device 1, in particular for determining at least a first reference position of at least one moving element of the driving system 20, more in particular for detecting a first reference position of the first pinion 21 of the driving system 20. Due to the arrangement of the first pinion 21, the first pinion 21 is particularly suitable to function as the captured moving element of the driving system 20 of the weft feeder device 1, in other words the relative movement of the moving element is measured and/or the reference position of the moving element is determined.

[0129] The first sensor system 43 comprises a rotary encoder system 77, in particular an incremental rotary encoder system 77 is provided for measuring a relative movement of the first pinion 21 in each direction. The incremental rotary encoder system 77 can be a mechanical encoder system. Preferably, the incremental rotary encoder system 77 is an optical encoder system. The incremental rotary encoder system 77 can be mounted directly to the first pinion 21, wherein an encoder disc 45 as part of the incremental rotary encoder system 77 is

arranged on the first pinion 21 and cooperates with a sensor 46 for measuring the rotational movement of the first pinion 21. However, due to the size and the associated low rotational speed of the first pinion 21, the movement of the first pinion 21 is not easy to detect with high resolution and sufficient accuracy when the encoder disc 45 is arranged on the first pinion 21. Therefore, preferably, additional gear wheels are provided for the first sensor system 43. The additional gear wheels can be preloaded to avoid play. Preferably, the sensor system 43 comprises a rotary encoder system 77 with at least one encoder disc 45 drivingly coupled for movement with the first pinion 21 and with an associated sensor 46. The first sensor system 43 is of the type adapted to allow to measure not only a relative movement but also the direction of the relative movement, in other words allowing adding or subtracting the counts.

[0130] For example a rotary encoder system 77 is provided, that comprises an encoder disc 45 that is drivingly coupled for movement with the first pinion 21 and a sensor 46 cooperating with the encoder disc 45 for measuring the incremental rotational movement of the first pinion 21 via the encoder disc 45. The value measured by the first sensor system 43 is a resulting number of encoder counts. The encoder disc 45 is driven by the first pinion 21 via an additional gear system 47. The additional gear system 47 comprises gear teeth 48 that are provided on the first pinion 21, for example on a lateral wall mounted on the first pinion 21, which lateral wall is arranged perpendicular to the center axis 4. The additional gear system 47 further comprises a gear wheel 49 that rotates with the encoder disc 45 and that cooperates with the gear teeth 48. The gear wheel 49 is a small gear wheel. The encoder disc 45 is arranged on the axle 85 of the gear wheel 49. The additional gear system 47, for example, is preloaded to avoid play. The sensor 46 is arranged to generate signals and/or pulses due to the rotation and the direction of rotation of the encoder disc 45 with respect to the sensor 46. The sensor 46 can be an optical fork sensor that cooperates with elements of the encoder disc 45 in order to detect the rotation and the direction of rotation of the encoder disc 45. With such a design it is possible, for example, to generate more than about 200 pulses when moving the moveable fingers over the full length of the movement path. This allows for a sufficient resolution and a high accuracy for determining the position of the first pinion 21, and also of the moveable fingers 7, 8, 9. The number of pulses in this case depends on the reduction ratio between the gear teeth 48 and the gear wheel 49 and on the design of the encoder disc 45.

[0131] According to an alternative (not shown), the additional gear system 47 coupling the first sensor system 43 to the first pinion 21 comprises a gearbox having a number of gear wheels, wherein for example gear teeth are arranged at the inner diameter of the first pinion 21. This gearbox may comprise a first additional small gear wheel that meshes with teeth at the inner diameter of the first pinion 21. This gearbox may further comprise a sec-

ond additional gear wheel, which is larger than the first gear wheel and is arranged on the same axle as the first gear wheel. This second additional gear wheel drives a third additional gear wheel, which is smaller than the second gear wheel and which rotates with the encoder disc. With such a design it is possible, for example to generate more than about 300 pulses when moving the moveable fingers over the full length of the movement path.

[0132] As shown in Figs. 14 and 15, the sensor device 42 further comprises a second sensor system 44. For example, the second sensor system 44 comprises a magnetic sensor system drivingly coupled for movement with the first pinion 21. For example, the second sensor system 44 comprises at least one Hall sensor and at least one magnet. For example, the second sensor system 44 for determining a reference position of the at least one moveable finger 7, 8, 9, in particular a reference position of the first pinion 21, comprises a signal source 57 and a receiver 58, wherein one of the signal source 57 and the receiver 58 is mounted on a moving element of the drive system 20, for example on the first pinion 21, and the other one of the signal source 57 and the receiver 58 is mounted stationary on the base structure 5 (shown in Fig. 1), in particular on a support 59 that is fixed to the base structure 5. For example, the signal source 57 comprises at least one magnet, while the receiver 58 comprises at least one magnet sensor, such as a Hall sensor. Preferably, the signal source 57 and/or the receiver 58 are arranged so that when moving the moveable fingers 7, 8, 9 within their movement path a signal is received by the receiver 58, and a position of the moving element of the driving system 20 corresponding to a predetermined value of the signal serves as the first reference position for the driving system 20. For example, when driving or rotating the first pinion 21 in order to drive or move the at least one moveable finger 7, 8, 9 within the movement path a signal with a changing sign or changing polarity is received by the receiver 58, and wherein a position of the moving element of the driving system 20 or a position of the at least one moveable finger 7, 8, 9 corresponding to the zero crossing of the signal serves as a first reference position for the driving system 20, in particular for the first pinion 21.

[0133] As shown in Fig. 15, the second sensor system 44 comprises a magnetic sensor system, wherein the signal source 57 comprises two magnets 71 and 72 drivingly coupled for movement with a moving element of the driving system 20, such as the first pinion 21, while the receiver 58 comprises one Hall sensor 73 mounted on the support 59. The use of such a magnetic sensor system allows to obtain a signal 75 by means of the receiver 58 as shown in Fig. 16, wherein as explained more in detail below, a zero crossing point 76 can be determined. Further a value 74 is shown corresponding to the maximum position wherein the moveable fingers 7, 8, 9 can be moved.

[0134] For example, the analogue signal sensed by the Hall sensor 73 of the second sensor system 44 is

quantitatively evaluated for determining the position of the moveable finger over the full length of the movement path. For example, the sensor device 42 further comprises a first sensor system 43 for measuring a position of the moveable finger relative to the first reference position.

[0135] As shown in Fig. 14, the receiver 58 of the second sensor system 44 comprises a Hall sensor 73 and the signal source 57 of the second sensor system 44 comprises a first magnet 71, which first magnet 71 is arranged so that the magnetic field is directed perpendicular to the axis of the first pinion 21, in particular to the center axis 4 of the weft feeder device 1, preferably at least essentially in parallel to a tangential direction of the first pinion 21. A sensor device using a Hall effect is simple in design and very reliable even in conditions such as prevailing in a weaving mill, in which the sensor device 42 may be exposed to weaving dust, vibrations, and noise. When arranging the first magnet 71 with the magnetic field directed at least essentially in parallel to a tangential direction of the first pinion 21 the signal sensed is at least essentially point symmetric with respect to the zero crossing position 76, as shown in Fig. 16. In order to provide a more significant analogue sensor signal, the signal source 57 further comprises a second magnet 72, which second magnet 72 is arranged so that the magnetic field is directed in parallel to the axis of the first pinion 21, in particular to the center axis 4 of the weft feeder device 1.

[0136] In Fig. 16 a signal 75 obtained by means of the receiver 58 caused by the signal source 57 comprising two magnets 71 and 72 is shown in relation to the position P of a moving element of the weft feeder device 1. With a signal 75 as shown in Fig. 16, a zero crossing point 76 can be detected very reliably and the respective first reference position can be determined with high accuracy in positioning. When the first reference position is reached, the software used in the second sensor system 44 can be aligned with or linked to the hardware of the driving system 20. Subsequently to this alignment, a position of the at least one moveable finger 7, 8, 9 can be determined with high accuracy and the at least one moveable finger 7, 8, 9 can very accurately and repeatedly be moved into any desired position for an adjustment of the winding circumference by the aid of the first sensor system 43.

[0137] The procedure of finding the first reference position, linking in this position of software and hardware and subsequently moving the moveable finger into a defined reference position, also named "homing" position, is referred to as "homing" procedure. A "homing" procedure can be performed when first starting the sensor device 42 and/or the driving system 20. A "homing" procedure can also be performed in case there are reasons to believe that a position determined by the sensor device 42 does not correspond to the real world.

[0138] For a manual adjustment of the position of the at least one moveable finger, an actual position determined by means of the sensor device 42 is optically and/or acoustically provided to an operator carrying out

the manual adjustment for supporting the operator in moving the at least one moveable finger into the desired position. In alternative, the operator is assisted by an actuator 14 in the adjustment of the position while the actual position determined by means of the sensor device 42 is optically and/or acoustically provided to an operator for semi automatically moving the at least one moveable finger into a desired position. Preferably, the driving system 20 comprises an actuator 14 controlled by the control device 12 for automatically moving the at least one moveable finger into a desired position.

[0139] For example, the sensor device 42 is further adapted for detecting a second reference position of at least one moving element of the driving system 20, wherein a value measured by the first sensor system 43 for a travel distance between the first reference position and the second reference position, serves as a calibration value for the driving system 20, in particular is stored as a calibration value for the driving system 20. For example, a difference in encoder counts between the first reference position of the at least one moveable finger and a second reference position of the at least one moveable finger serves as a calibration value for the driving system 20. This difference in encoder counts determines the travel distance between the first reference position and the second reference position. The calibration value is stored in a non-volatile memory of the weft thread feeding device 1, for example of a control device 12 of the driving system 20. A position of the at least one moveable finger 7, 8, 9 for a predefined winding circumference corresponds to the second reference position. Preferably, a position of the at least one moveable finger 7, 8, 9 corresponding to a maximum desired winding circumference serves as the second reference position.

[0140] As the distance of all the moveable fingers 7, 8, 9 to the center axis 4 is the same and the position of the fixed finger 6 is known, the enveloping distance D between the moveable fingers 7 and 9, as shown in Fig. 13, is related to the length of the winding circumference, in other words the length of the winding circumference can be calculated based on the enveloping distance D. For this purpose, a caliber having legs arranged parallel at a predefined distance can be used to set the fingers 7 and 9 in a desired enveloping distance D in order to obtain a predefined winding circumference associated to the desired enveloping distance D. The corresponding position of the fingers 7, 8, 9 can be used as a second reference position associated to the predefined winding circumference.

[0141] In alternative, the driving system 20 is arranged that upon driving the first pinion 21 to move the at least one moveable finger 7, 8, 9 into a desired position, and an expected signal of the signal source 57 and received by the receiver 58 is compared to an actual signal received by the receiver 58 for supervising the movement. Even when using a second sensor system 44 as shown that is less accurate, it is possible to obtain a signal by means of the second sensor system 44 that has approx-

imately the expected value and can be used as a signal for supervising. In other words, the actual signal of the analogue signal source 57 is used as a safety feature in order to verify for example whether at an assumed position as measured by means of the rotary encoder system 77 a corresponding signal is generated by the analogue signal source 57, in particular measured by the receiver 58. In particular, it can be verified whether a zero crossing is detected at the position where according to the sensor device 42 the first reference position is reached. If the values do not match, then the sensor device 42 can send a warning to the control device 12 of the weaving machine or a request that a homing procedure is initiated for re-adjusting the sensor device 42.

[0142] In an alternative a sensor device is provided for determining the position of the at least one moveable finger 7, 8, 9 by directly measuring the position of the at least one moveable finger 7, 8, 9. Such a sensor device needs to be rather accurate in order to obtain an accuracy as a sensor device 42 as shown with a first sensor system 43 and a second sensor system 44.

[0143] Further, a method for determining and/or varying a winding circumference of a winding drum 2 for storing a weft thread 10 in a weft feeder device 1 is provided. The method comprises determining a zero crossing position 76 of the signal 75 of the receiver 58 as a first reference position and moving the first pinion 21 into the first reference position for aligning the sensor device 42 with the driving system 20.

[0144] In other words, a method is provided, wherein the moveable finger 7, 8, 9 is moved in order to find the first reference position based on the signal from the signal source 57. Preferably, the driving system 20 comprises an actuator 14 for driving the first pinion 21 based on some heuristic rules to follow a certain procedure for finding the first reference position. After the first reference position is found, the sensor device 42 is aligned with the real world. In alternative, the first reference position as identified in the described method is compared with an expected reference position and in the event of a discrepancy the method as described above is repeated. This allows to move the moveable finger 7, 8, 9 to a defined homing position.

[0145] For example, the sensor device 42 further comprises an incremental rotary encoder system 77 for measuring a relative movement of the first pinion 21. A difference in encoder positions between the first reference position of the at least one moveable finger and a second reference position of the at least one moveable finger serves as a calibration value for the driving system 20. A second reference position can be defined, for example the maximum position wherein the moveable fingers 7, 8, 9 can be moved. By means of the incremental rotary encoder system 77 a relative movement of the first pinion 21 and in this way of the moveable fingers 7, 8, 9 is measured. Based on the difference in encoder position between the first reference position and the second reference position, and based on the known winding cir-

cumference of the winding drum 2 when the first pinion 21 is positioned in the second reference position, the exact length of the winding circumference of the winding drum 2 when the first pinion 21 is positioned in the first reference position can be determined.

[0146] In alternative, a calibration procedure is provided, wherein for a calibration the at least one moveable finger is moved into a position corresponding to a maximum desired winding circumference, wherein that position serves as second reference position. This desired winding circumference can be measured or determined by arranging a ring shaped calibration element (not shown) around the winding circumference determined by the fixed finger 6 and the moveable fingers 7, 8, 9. This ring shaped calibration element has a known circumferential length and is suitable to be arranged around the winding circumference in order to provide a calibration length. Otherwise, a measuring apparatus can be used to this end in order to exactly measure the length of the winding circumference. Preferably, the number of encoder counts of the rotary encoder system 77 when moving the moveable finger from the first reference position into the second reference position is measured and stored in a non-volatile memory. The value is used to compare in subsequent movements the number of encoder counts to a relative movement of the moveable finger. The calibration procedure is preferably only carried out when initializing the weft feeder device 1 by an authorized person. Of course, it is also possible to carry out a calibration procedure from time to time.

[0147] For example, upon driving the first pinion 21 to move the moveable finger into a desired position, an expected signal of the signal source 57 is compared to an actual signal for supervising the movement. The comparison is used as a safety feature for identifying when the moveable finger reaches its extreme positions. For example, the second sensor system 44 is arranged so that if the position of the moveable finger as identified by the incremental rotary encoder system 77 is at or close to the maximum position of the movement path, the signal of a Hall sensor 73 used should be negative, and if the position of the moveable finger as identified by the incremental rotary encoder system 77 is at or close to the minimum position of the movement path, the signal of the Hall sensor 73 should be positive. In case the second sensor system 44 comprises also a second magnet 72, than additional provisions can be made so that if the position of the moveable finger as identified by the incremental rotary encoder system 77 is at or close to the minimum position, the signal of the Hall sensor 73 should be positive and above a peak value of the signal caused by the first magnet 71. In the event of a discrepancy, a warning signal may be provided and/or a movement may be stopped. In alternative or in addition, the actuator 14 is controlled to switch from full speed to a step by step movement when approaching the extreme positions. Thereby, the risk that the moveable finger runs into a mechanical end of stroke position in full speed and/or

that any of the gear wheels run into a mechanical end of stroke position in full torque, potentially breaking the mechanics is avoided, in case the system is, for some reason, out of synchronization.

[0148] In an alternative, a sensor device only based on the principle of the second sensor system 44 could be provided. Nevertheless, in order to obtain a sufficient accuracy a rather complicated and expensive device is to be provided that is able to determine each position of the fingers with sufficient accuracy. A sensor device 42 with an incremental encoder 77 and with a Hall sensor 73 assigned to a magnet 71 that determines only a value for one angle accurately, is less complicated and expensive.

[0149] Based on the known winding circumference of the winding drum 2 in the second reference position and the angle of rotation of the first pinion 21 when moving between the second reference position and the first reference position, the winding circumference can be easily calculated taking into account the position of the fixed finger 6 and the position of the moveable fingers 7, 8, 9 and taking into account geometrical values of the weft feeder device 1. In this way the winding circumference of the winding drum 2 can be easily determined for an actual position of the first pinion 21. To this end, the control device 12 is arranged for determining the winding circumference for any position of the first pinion 21. Also the control device 12 allows to determine the desired length of the weft thread 10 to be stored by the weft feeder 1 based on the actual fixed finger position.

[0150] For example, a sensor device 42 is used for determining an actual position of the first pinion 21 and in this way also the actual position of at least one moveable finger 7, 8, 9. This allows to generate a feedback signal to be used in the control device 12 when moving the at least one moveable finger 7, 8, 9 into the respective desired position. The feedback signal in one example is provided to assist an operator in a manual or semi-automatic adjustment. In other examples, the feedback signal is used to control an automated adjustment.

[0151] In alternative to the driving system 20 shown in Figs. 1 to 16, a driving system 20 for driving both legs 50 and 51 of a moveable finger as shown in Fig. 17 and 18 is provided. When driving both legs 50 and 51, a risk of jamming due to frictional forces or the like acting on a drawn second leg 51 is avoided. The first leg 50 and the second leg 51 are arranged on opposite sides of the center axis 4. Therefore, a second pinion 79 is required for driving the second leg 51, which second pinion 79 rotates in opposite direction to the first pinion 21. The two legs 50 and 51 of the moveable finger 7 are provided with a rack section 53 and 78, drivingly coupled to the first pinion 21 and to the second pinion 79, respectively. The first pinion 21 and the second pinion 79 are arranged offset in the direction of the center axis 4 in order to respectively engage with the first leg 50 and the second leg 51. In order to ensure a good synchronization between the first pinion 21 and the second pinion 79, the first pinion 21

and the second pinion 79 are drivingly coupled by planet gear wheels 80 with axles 81 arranged between the pinions 21 and 79, as shown in Fig. 18. The alternative shown in Figs. 17 and 18 can also be provided for the moveable fingers 8 and 9. In alternative, the first pinion 21 and the second pinion 79 are each independently driven by an associated motor, wherein both motors are synchronized by means of a control device 12.

[0152] In alternative to the preload system 54 shown in Fig. 8, in order to avoid play between the first pinion 21 and the section racks 53 of the moveable fingers 7, 8, 9, as shown in Fig. 19, a spring 82 can be provided that forces the first pinion 21 in one direction. The direction in which the first pinion 21 is forced by the spring 82 is preferably the same as the force exerted by weft thread on the moveable fingers 7, 8, 9.

[0153] In a further alternative, in order to avoid play between the first pinion 21 and the section racks 53 of the moveable fingers 7, 8, 9, a preload system 54 is obtained by the first leg 50 and the second leg 51, wherein the distance between the first leg 50 and the second leg 51 becomes smaller towards the end of the first leg 50 where the first leg 50 comes into contact with the first pinion 21. As shown in Fig. 20, at least the end of the first leg 50 and the end of the second leg 51 are bend or inclined with respect to each other, in particular the first leg 50 is arranged at a small angle with respect to the second leg 51, in other words the first leg 50 and the second leg 51 are not parallel to each other. Due to this, in use the first leg 50 always presses with a force against the first pinion 21, while the second leg 51 is guided in a straight second guide 70. This force is caused by a spring force mainly be formed by the segment 52.

[0154] The weft feeder device 1 is particularly suitable for carrying out a method for adjusting a winding circumference of a winding drum 2 of a weft feeder device 1, which method comprises determining a desired length of a weft thread 10 to be stored on the winding drum 2, defining a desired position of the at least one moveable finger 7, 8, 9 based on that desired length, and moving the at least one moveable finger 7, 8, 9 into the respective desired position.

[0155] The weft feeder device 1 is further particularly suitable for carrying out a method wherein an actual preset finger position of a fixed finger 6 is determined and the desired position of the at least one moveable finger 7, 8, 9 is determined based on the desired length of the weft thread 10 to be stored on the winding drum 2 and the determined fixed finger position. The weft feeder device 1 is further particularly suitable for carrying out a method wherein an actual position of at least one moveable finger 7, 8, 9 is determined and a feedback signal is provided, which feedback signal is used for moving the at least one moveable finger 7, 8, 9 into the respective desired position. The weft feeder device 1 is further particularly suitable for carrying out a method wherein the desired length of the weft thread 10 to be stored is determined using a weaving factor, which weaving factor

is defined in dependency of at least one weaving parameter.

[0156] The weft feeder device 1 is further particularly suitable for carrying out a method wherein the desired filling length of weft thread 10 is determined based on the winding circumference multiplied by the number of windings for one filling length. As explained above, the desired filling length is proportional to the desired length of weft thread 10 to be stored that is defined as the winding circumference multiplied by the number of windings for one filling length. The weft feeder device 1 is further particularly suitable for carrying out a method wherein the desired filling length is specified as an absolute desired filling length or as a relative desired filling length. An absolute desired filling length is related to the weaving width. A desired difference in the filling length is referred to as relative desired filling length. The relative desired filling length may be related to the actual filling length that is used for weaving, wherein the relative desired filling length is determined as a difference in length in respect to the actual filling length, in other words a difference in length less or more than the actual filling length.

[0157] At each moment the position of the at least one moving element of the driving system 20, in particular the position of the first pinion 21 and/or the position of the moveable fingers 7, 8, 9 is stored in a non-volatile memory. This is particularly relevant when starting the weft feeding device 1 after a power fail as then the length of the winding circumference remains known.

[0158] In an example, it is possible to reset the weft feeder device 1, wherein the at least one moving element of the weft feeder device 1, such as the first pinion 21 of the driving system 20, firstly is moved from the actual position to the first reference position and then is moved back to the desired position. In this way, it is assured that the moveable fingers 7, 8, 9 are in their actual position as known by the control device 12. A reset is preferably carried out at a start-up of the weft feeder device 1 or after a power fail, wherein the at least one moving element of the weft feeder device 1 is moved to the first reference position and then is moved back to the desired position.

[0159] Preferably, a wireless power transmission system 90 for use with a weft feeder device 1 is provided, allowing a transmission of at least one Watt, preferably approximately two Watt across an air gap 83 of approximately 15 mm, wherein a winding arm 3 moves along the air gap 83. In this way a weft feeder device 1 comprising a winding drum 2 with an adjustable winding circumference and a wireless power transmission system 90 is provided. The power transmission system 90 can also be named energy transfer system.

[0160] In Figs. 21 to 24 a wireless power transmission system 90 is shown for use with a weft feeder device 1 for a textile machine, such as a weaving machine, in particular an airjet weaving machine. The power transmission system 90 of the weft feeder device 1 is arranged for generating by means of the signal generator 92, at

least during an operation time of the actuator 14, a signal with a frequency matched to the resonant frequency of the secondary side system 95. The power transmission system 90 is further arranged for transmitting a first power across the air gap 83 from the primary side system 91 to the actuator driver 96 for driving the actuator 14 of the secondary side system 95. To this end, the power transmission system 90 of the weft feeder device 1 comprises a primary side system 91 with a signal generator 92 generating a signal, also referred to as carrier wave. The primary side system 91 preferably also cooperates with a primary control unit 93, also named primary side control unit. The primary control unit 93 for example is designed as an integrated circuit. The power transmission system 90 further comprises a secondary side system 95 with an actuator driver 96, in particular a motor driver, and a secondary control unit 97, also named secondary side control unit. The secondary control unit 97 for example is designed as an integrated circuit. The secondary side system 95 is arranged for an inductive coupling 100 across an air gap 83 with the primary side system 91. The power transmission system 90 is arranged for adapting either or both of the primary side system 91 and the secondary side system 95 for selectively transmitting, in particular wireless transmitting across the air gap 83, from the primary side system 91 to the secondary side system 95, a first power, which first power is a high power used for powering the actuator driver 96, or a second power, which second power is a low power used for powering the secondary control unit 97. Preferably, only the primary side system 91 is adapted for selectively transmitting across the air gap 83 a high power used for powering the actuator driver 96 or a low power used for powering the secondary control unit 97. For example, the secondary control unit 97 comprises a non-volatile memory for storing the calibration value, the position of the fingers 6, 7, 8 or 9, the position of the first pinion 21 and other relevant values. In the context of the application the operation time of the actuator 14 means the time when the actuator 14 is driven.

[0161] The wireless power transmission system 90 is in particular advantageous when provided in a weft feeder device 1 as mentioned above, in particular for controlling the filling length of weft threads and/or the length of weft thread 10 to be stored on the winding drum 2. The actuator driver 96 is adapted to drive at least the actuator 14 (shown in Fig. 13). This actuator 14 is to be driven via the power transmission system 90. As explained above, the actuator 14 comprises a motor. For example, the actuator driver 96 is a four-quadrant actuator driver. For example, the actuator driver 96 further comprises a rectifier for providing a DC current to the actuator 14.

[0162] As shown in the circuit of Fig. 22, at least for transmitting the high power used for driving the actuator 14 across the air gap 83 an inductive coupling 100 is provided for transmitting the high power at a first frequency which corresponds at least approximately to the resonant frequency of the secondary side system 95, where-

in the secondary side system 95 comprises at least one secondary inductor 101, for example a secondary coil, and at least one secondary capacitance 102. Preferably, the at least one capacitance 102 and the at least one secondary inductor 101 are arranged in parallel. The primary side system 91 comprises a primary inductor 103, for example a primary coil, and for example also a primary capacitance 104 that is arranged in series with the primary inductor 103. Between the primary inductor 103 and the primary capacitance 104, preferably, there is arranged an additional inductor 105 of which the inductance can be adjusted by means of an additional control unit 107. As shown in Fig. 22, the additional control unit 107 is controlled via the control device 12 of the weft feeder device 1, in order to adapt, in particular to match, the resonant frequency of the primary side system 91 to the resonant frequency of the secondary side system 95. The output device 13 is associated to the control device 12, and an input device 122 is associated to the control device 12. As shown in Fig. 22 the resonant frequency of the secondary side system 95 cannot be set and is mainly determined by the characteristics of the secondary inductor 101 and the secondary capacitance 102. The terms "primary" and "secondary" are only used to distinguish between different elements and in the context of the application have no other meaning. The resonant frequency may be between 50 kHz and 500 kHz, and is for example about 160 kHz.

[0163] For example, the wireless power transmission system 90 is arranged for tuning the frequency of the carrier wave from the signal generator 92, wherein for transmitting the high power used for driving the actuator driver 96 the frequency of the carrier wave from the signal generator 92 is tuned to a first frequency which corresponds at least approximately to the resonant frequency of the secondary side system 95, and for transmitting the low power used for powering the secondary control unit 97 the frequency of the power signal is tuned to a second frequency, which is different from the resonant frequency of the secondary side system 95 and different from the first resonant frequency.

[0164] Preferably, the secondary side system 95 comprises an evaluation device 98 for evaluating a power received at the secondary side system 95 from the primary side system 91. An output from the evaluation device 98 is returned to the additional control unit 107 by means of an additional communication link or via the wireless power transmission system 90, and the output is used for tuning the first frequency to match the first frequency to the resonant frequency of the secondary side system 95.

[0165] For example, the signal generator 92 is controlled in order to generate a signal with a certain frequency, for example a sinusoidal shaped power signal that is advantageous to reduce power losses. By tuning the frequency of the carrier wave generated by the signal generator 92 to the first frequency, a-priori knowledge of the resonant frequency of the secondary side system 95 is

not required. In addition to the tuning of the frequency of the carrier wave from the signal generator 92, the resonant frequency of the primary side system 91 may be adjusted. Therefore, specific characteristics of a specific secondary side system 95 due to tolerances and the like can be compensated. Thereby, a reliable transmission of sufficient energy to drive the actuator driver 96 is provided. The tuning of the frequency can be carried out automatically, wherein the frequency is automatically adapted until the highest power transfer occurs. This automatically tuning is also advantageous, when actual elements of the power transmission system 90 are exchanged by spare elements.

[0166] Preferably, the signal generator 92 is able to generate a high power signal or a low power signal. The frequency of the high power signal for driving the actuator driver 96 and the frequency of the low power signal for driving the secondary control unit 97 is tuned to a first frequency which corresponds at least approximately to the resonant frequency of the secondary side system 95. For this purpose, the signal generator 92 comprises a pulse-width modulation generator 106 that provides a block pulse shaped carrier wave wherein the pulse-width of the block pulse determines the amount of energy to be transmitted by the carrier wave. The high power signal is obtained by a power signal with a wide pulse width, while the low power signal is obtained a power signal with a narrow pulse-width. This allows to transmit power across the air gap 83 using a signal from the signal generator 92 with a frequency that is always matched to the resonant frequency of the second side system 95. In this case, the power signal can also comprise a data communication signal, in other words a data communication signal can be added to the power signal to provide a communication link between the primary side system 91 and the secondary side system 95.

[0167] As shown in Fig. 21 to 24, the power transmission system 90 comprises an inductive coupling 100 comprising the primary inductor 103 and the secondary inductor 101. The air gap 83 extends between the main body 86 of the weft feeder device 1 and the base structure 5 of the winding drum 2. The winding arm 3 rotates along the air gap 83 with respect to the main body 86 and the base structure 5 of the winding drum 2. Permanent magnets 87 are provided on the main body 86, which permanent magnets 87 can cooperate with permanent magnets 88 on the base structure 5 of the winding drum 2 in order to keep the winding drum 2 in a fixed position with respect to the main body 86. The drive system 20 as shown in Fig. 13 is mounted on the base structure 5 of the winding drum 2. The winding arm 3 is driven in a known manner by means of a main drive motor 89.

[0168] The inductive coupling 100 of the power transmission system 90 also provides a communication link for a bidirectional data communication between the primary side system 91 and the secondary side system 95. For example, a transistor is arranged in parallel with a rectifier at the secondary side system 95 in order to mod-

ulate a communication signal and to facilitate bidirectional communication. Further, a capacitance is arranged between the rectifier and the actuator driver 96 for the actuator 14 to enable communication from the secondary side system 95 to the primary side system 91. The same capacitance is preferably also used to buffer the energy to the actuator driver 96 for the actuator 14. Preferably, a bidirectional communication protocol via the communication link is provided to manage and to monitor the power transmission. Data sent from the secondary side system 95 to the primary side system 91 comprises for example a control signal indicating the functioning of the secondary side system 95, and a high power demand from the secondary side system 95 to the primary side system 91, for example when a motor needs to be driven. In addition, the communication link is used to monitor a power transmission and/or to tune the carrier wave frequency of the transmitted signal. For example, a data communication is only provided when transmitting a low power. This offers the advantage that communication signals are not disturbed by high power signals.

[0169] The power transmission system 90 is controlled, for example, by the control device 12. With the power transmission system 90, control signals can be sent to the primary side system 91 and control signals can be received from the primary side system 91. With the power transmission system 90 control signals can also be sent to the secondary side system 95 and can be received from the secondary side system 95. In other words, control signals can be transmitted wireless by means of the power transmission system 90, in particular by means of the inductive coupling 100.

[0170] To this end, the power transmission system 90 comprises a communication control unit arranged for communication with the primary control unit 93 and/or with the secondary control unit 97. As shown in Fig. 22, the communication control unit is integrated in the additional control unit 107. In an alternative the communication control unit is integrated in the primary side system 91 or in the secondary side system 95. For example, the control units each comprise a processing unit, more particular a micro control unit (MCU) or a digital signal processor (DSP). Preferably, the communication control unit communicates with the secondary control unit 97 via the inductive coupling 100. In alternative, a separate communication link may be provided between the communication control unit and the secondary control unit 97.

[0171] The wireless power transmission system 90 is not only suitable for being used in combination with a control device 12 arranged for adjusting the winding circumference of a winding drum 2 of a weft feeder device 1, but is also suitable for other applications, for example for powering or controlling other active elements provided at the secondary side system 95, such as a magnet pin 11, sensors mounted on the winding drum 2, such as thread sensors, or other active elements used in a weft feeder device 1, in particular at the height of a winding drum 2 of a weft feeder device 1. For example, the first

power is not only transmitted to the secondary side system 95 during the operation time of the actuator 14, but can also be transmitted for powering at least one other active element provided at the secondary side system 95.

[0172] The power transmission system 90 is advantageous in that excessive energy at the secondary side system 95 that is not required for powering the actuator driver 96 or for powering the secondary control unit 97 and needs to be "burned away", is avoided. In order to avoid this, sufficient energy for driving the actuator driver 96 is only provided when driving the actuator driver 96. The power required for driving the actuator driver 96 is referred to as high power. Preferably, the high power is between approximately one Watt and approximately three Watt. In use of the weaving machine, at idle times of the actuator driver 96, a low power used for powering the secondary control unit 97 is transmitted to the secondary side system 95. The power required for powering the secondary control unit 97, and if applicable further control elements provided at the secondary side system 95, is referred to as low power. The low power is substantially lower than the high power, for example less than 0,5 Watt, and preferably is about 0,1 Watt. The low power is also referred to as stand-by power of the secondary side system 95. For example, the low power is also transmitted intermittent. In alternative, a battery is used for the low power.

[0173] For example, when the actuator 14 is driven to brake in order to decelerate the driving system 20, excessive energy has to be removed to avoid high voltages. In order to avoid high voltages, for example, a dump resistor is provided based on a Zener diode and a resistor at the secondary side system 95. For example, the secondary side system 95 will communicate to the primary side system 91 that there will be a reduced power requirement. In alternative, a data communication is not evaluated during high power transmission and when the excessive energy is burned away.

[0174] Preferably, the first or high power is transmitted in slots followed by slots during which the second or low power is transmitted. For example, the motor of the actuator 14 is a stepper motor, wherein the high power to drive the stepper motor is transmitted in slots followed by slots during which the low power is transmitted. In alternative, the motor of the actuator 14 is a brushed DC motor. As mentioned above, preferably the actuator 14 is used to adjust the effective winding circumference of a winding drum 2. In this case, the response characteristics of the secondary side system 95 depend among others on the type of motor, the mechanics, the friction and the load of the weft threads on the winding drum 2. When the motor is fast enough and position information or winding circumference information is available, the system reaction can be kept constant by making small, rapid steps in adjusting the winding circumference, followed by a comparatively long waiting period, for example 5 times the period of one step. The slots during which the low power is transmitted are, for example, also used

for a data communication.

[0175] The control device 12 is used to control the size of the winding circumference of the winding drum 2. To this end, the primary control unit 93 and the secondary control unit 97 exchange signals provoking a reduction or an enlargement of the effective winding circumference. In addition, a sensor device 42 is provided for observing an actual effective winding circumference and/or sensors may be provided to monitor a power received by the secondary side system 95.

[0176] As shown in Fig. 23, the secondary inductor 101 of the secondary side system 95 is a secondary coil provided on a shield shaped insulating support element 109. The support element 109, for example, is a flat plastic support element. The shield-shaped support element 109 allows integrating the secondary coil on the base structure 5 of the winding drum 2, without interfering too much with the existing elements of the weft feeder device 1. As shown in Fig. 24, the primary inductor 103 of the primary side system 91 is a primary coil provided on a shield-shaped insulating support element 110, for example a flat plastic support element. The shield-shaped support element 110 allows integrating the secondary coil on the main body 86 of the winding drum 2, without interfering too much with the existing elements of the weft feeder device 1. A flat support element 109, 110 is also advantageous for winding the coils in an easy way. As shown in Fig. 23 and 24, both flat support elements 109 and 110 have a same design.

[0177] The secondary coil is wound on the associated support element 109 and preferably also the primary coil is wound on the associated support element 110, in a manner that the respective primary or secondary coil each is wound at least essentially rectangular at a first section 94 or 111 and at least essentially triangular at a second section 99 or 112. This shape is advantageous for arranging the primary coil and the secondary coil with respect to the air gap 83 when a flat support element 109, 110 is used. Further the secondary inductor 101 of the wireless power transmission system 90 is arranged at least partly in front of a fixed finger 6 of the winding drum 2, because due to the provision of a fixed finger 6, in the area of the fixed finger 6 there is sufficient space available to arrange an inductor 101 shaped as a coil having large dimensions. In other words, the wireless power transmission system 90 is positioned at least partly at the top side of the winding drum 2. This positioning is also advantageous to make a cabling at the primary side system 91 as short as possible, to reduce dust problems, and to avoid electromagnetic compatibility (EMC) problems to the greatest extent as possible.

[0178] Although, the power transmission system 90 is adapted for changing the characteristics of the primary side system 91 in order to provide a first frequency, for example by adding or removing capacitances and/or inductors to the primary side system 91, in an alternative the secondary side system 95 may be adapted for changing the characteristics of the secondary side system 95,

in particular for selectively adding or removing capacitances and/or inductors to the secondary side system 95.

[0179] In a weft feeder device 1 according to the invention, in the area where weft thread 10 is wound onto the stationary arranged winding drum 2, the winding drum 2 has an rather circular winding circumference and due to the fact that the outer edges 30, 31, 32, 33 extend parallel to the center axis 4 of the winding drum 2, the winding drum 2 also has an almost cylindrical shape. In order to move the windings wound on the winding drum 2 in a direction away from the winding arm 3 a so called wobbling disc 113 may be provided, as shown in Figs. 1 and 25. Such a wobbling disc 113 is driven to wobble together with the winding arm 3 and pushes the windings of weft thread 10 in a direction away from the winding arm 3 along the cylindrical shaped winding drum 2. A wobbling disc is known from US 4,280,668. According to an alternative the wobbling disc 113 may be replaced by elements that are arranged inside the winding drum 2 and that are able to shift windings along the winding drum 2, which elements are known from WO 92/01102 A1. In the area where no weft thread is wound by the winding arm 3 onto the winding drum 2, the winding drum 2 may be more cone shaped.

[0180] As shown in Fig. 3 the fixed finger 6 comprises an opening 114 arranged to cooperate with the magnet pin 11, in other words the magnet pin 11 can enter into the opening 114 of the fixed finger 6. The opening 114 is arranged between the middle outer edges 32 and 33 of the fixed finger 6. Hereby, support structures 115 are provided on the fixed finger 6 for mounting for example a mirror cooperating with a weft sensor mounted in the area of the magnet pin 11 or for mounting any other element on the fixed finger 6. Such a weft sensor may be arranged at the height of an opening 116 in the wobbling disc 113 as shown in Fig. 25. As shown in Fig. 25 openings 117 are provided in the wobbling disc 113 into which the outer edges 30, 31, 32, 33 can enter. This avoids that weft thread 10 can reach and can being caught behind the fingers 6, 7, 8, 9.

[0181] As shown in Fig. 26 and 27 the movement path of the moveable fingers 7, 8 and 9 is limited and related to the fixed finger positions of the fixed finger 6, so that in each position of all the fingers 6 to 9, weft thread 10 is always in contact with all the outer edges 30 to 33 of each finger 6 to 9. To this end, the weft thread 10 has to be always in contact with the side outer edges 30 and 31 of each finger 6 to 9. In a first extreme situation as shown in Fig. 26, this is achieved when the virtual lines 118 extend in radial direction further than the middle outer edges 32 and 33. In a second extreme situation as shown in Fig. 27, this is achieved when the virtual lines 119 extend in radial direction further than the middle outer edges 32 and 33. It is clear that the transition between the fixed finger 6 and each of the moveable fingers 7 and 9 is most critical in this respect, while the transition between the moveable finger 8 and each of the moveable fingers 7 and 9 is less critical. In this way, the weft thread

10 is always in contact with each of the outer edges 30 to 33 and the circumferential length can be determined, in particular calculated by geometrical formulae based on the radial position of the fingers 6 to 9. As the position of the fixed finger 6 is predetermined and the position of each moveable fingers 7 to 9 can be determined based on the position of the driving system 20 that is determined by the sensor device 42, the circumferential length of the winding drum 2 can be determined with high accuracy. The weft feeder device 1 allows to determine the circumferential length of the winding drum 2 with high accuracy. The weft feeder device 1 is also able to adjust the circumferential length of the winding drum 2 using the driving system 20 or even manually. The weft feeder device 1 further has a sensor device 42 in order to determine the position of the moveable fingers 7 to 9 so that the circumferential length of the winding drum 2 can be determined, in particular calculated with high accuracy, for example with an accuracy of about 0,2mm for the length of the winding circumference.

[0182] The fact that the weft thread is always in contact with all the outer edges 30 to 33 of each finger 6 to 9 is also advantageous to keep the tension during insertion of the weft thread 10 into the shed almost constant, so that a weft thread can be inserted into a shed of a weaving machine in stable conditions. Also the friction of this weft thread 10 with respect to the fingers 6 to 9 remains almost constant.

[0183] The fact that the moveable fingers 7 to 9 move in radial direction with respect to the center axis 4 also offers the advantage that a so called balloon breaker can be arranged centrally with respect to the central axis 4, which is also advantageous for limiting the tension in the weft thread 10 during the insertion of a weft thread 10 into the shed.

[0184] As described above, preferably an interactive device 123 is provided functioning as a man-machine-interface. Hereby the output device 13 and the input device 122, as shown in Fig. 22, are integrated in the interactive device 123. An example of such an interactive device 123 is shown in Fig. 28. The interactive device 123 comprises a first framework 124 displaying the number of windings to be stored on the winding drum 2 for one filling length, a second framework 125 displaying a weaving width, a third framework 126 displaying the chosen weaving factor and a fourth framework 127 displaying the desired filling length. In an example, the interactive device 123 is designed to allow an operator to enter new data at the first framework 124 and/or at the second framework 125 and/or at the third framework 126 and/or at the fourth framework 127.

[0185] The interactive device 123 further comprises a fifth framework 128 displaying the actual filling length as calculated by the control device 12 based on the number of windings stored on the winding drum 2 for one filling length and the determined length of the winding circumference. Preferably, the control device 12 determines the length of the winding circumference based on the position

determined by the sensor device 42, the number of winding for one filling length and the weaving factor. Based on this data, an actual filling length is calculated by the control device 12. As mentioned above, the filling length equals the weaving width plus a waste length.

[0186] In use the control device 12 in one example is operated as follows. A weaving width or the desired filling length is entered to the control device 12 by an operator, for example via at least one of the frameworks 125 and 127 that are acting as input device 122, shown in Fig. 22. The number of windings can be entered by an operator via the first framework 124 or the control device 12 can determine this number automatically. Also the weaving factor can be entered by an operator via the third framework 126.

[0187] Further, a push button field 129 is provided on the interactive device 123 for initiating an automatic adjustment of the actual filling length to the desired filling length. The interactive device 123 further comprises three signal elements 130, 131 and 132, which are actuated, respectively, in case the actual filling length corresponds to the desired filling length, the actual filling length is too short, or the actual filling length is too long.

[0188] If the actual filling length corresponds to the desired filling length, the signal element 130 is activated, for example a green light. If the actual filling length does not correspond to the desired filling length, in case of a too short filling length the signal element 131 is activated, for example a red light, and in case of a too long filling length the signal element 132 is activated, for example a yellow light. In this case the operator can choose to initiate an automatic adjustment of the filling length by pushing the push button field 129 or to carry out a manual adjustment or a semi automatic adjustment.

[0189] For carrying out a semi automatic adjustment two push button fields 133 and 134 are provided on the interactive device 123. By pushing the push button field 133 the actuator 14, as described above, is activated to move the moveable fingers 7, 8 or 9 in order to increase the stored length of weft thread and thus the filling length, while by pushing the push button field 134 the actuator 14, as described above, is activated to move the moveable fingers 7, 8 or 9 in order to decrease the stored length of weft thread and thus the filling length.

[0190] Preferably, the interactive device 123 further comprises a sixth framework 135 for entering the used type of stretching device. This is advantageous, as the stretching device is rather important for the relation between the stored length of weft thread and the resulting filling length, which relation determines the waste length and/or the correction factor.

[0191] The interactive device 123, for example, can be formed by a tablet, a smartphone or any other commercial available similar device that is programmed to carry out the function of the interactive device 123 as described above. Hereby the control device 12 is adapted to communicate with the interactive device 123, preferably wirelessly, in particular with the tablet or the smartphone. For

example, the control device 12 is provided to this end with a GSM, a WIFI, a Bluetooth or any other commercial available connection.

[0192] In the context of the application, the driving system 20 is self-locking means that the driving system 20 is approximately perfectly self-locking. When the driving system 20 is not full perfectly self-locking, then a closed loop system can be provided wherein based on signals from the sensor device 42, in particular the first sensor system 43, the actuator 14 is driven from time to time, for example in between periods of a few minutes, to bring or keep the first pinion 21 of the driving system 20 in a predetermined position. In alternative, a brake can be provided to keep the driving system 20 in position.

[0193] In alternative, instead of one fixed finger 6, a number of fixed fingers can be provided. Although as shown in the drawings there is at least one moveable finger and preferably there are three moveable fingers 7, 8, 9, the invention can also be carried out with another number of moveable fingers, for example more than three moveable fingers can be provided. A weft feeder device 1 as shown in the drawings with one fixed finger 6 and three moveable fingers 7, 8 and 9 is advantageous as this allows to obtain a rather circular winding circumference with a limited number of fingers and further allows a simple drive system 20.

[0194] Of course the weft feeding device 1 may comprise a number of diagnostic devices, for example devices to measure the current fed to the actuator 14, the current fed to the magnet pin 11 and to other elements of the weft feeding device 1. Also diagnostic devices for other elements of the weft feeding device 1 may be provided.

[0195] Although the weft feeding device 1 may set the accuracy of the length of the winding circumference, for example, with an accuracy of about 0,2mm, it is possible for an operator to adjust the filling length, for example, only in steps of about 5mm, while the control device 12 may adjust the filling length in steps of 1 mm.

[0196] The weft feeding device 1 according to the invention also offers the advantage that during winding off a bobbin, the length of the stored weft thread 10 can be continuously adjusted to the remaining diameter of the bobbin, while at a bobbin change, the length of the stored weft thread 10 can be reset for the new bobbin. Also in case of switching over from a number of weft feeding devices 1 to another number of weft feeding devices 1, as known from EP 195 469 A1, the length of the stored weft thread can also be adjusted suitable. It is known that the tension for pulling off a weft thread 10 from a bobbin varies with the bobbin diameter and with the speed of pulling off, so that the relationship between the filling length and the length of weft thread stored on the winding drum 2 varies in function of this tension, as such a tension causes an elongation of the weft thread 10.

[0197] The weft feeding device and the methods according to the invention are not limited to the embodiments shown and described as example, but may com-

prise variants and combinations of all these embodiments that fall under the claims.

5 Claims

1. Weft feeder device with a winding drum (2) having an adjustable winding circumference for storing weft thread (10) and a center axis (4), the winding drum (2) comprising a base structure (5) and at least one moveable finger (7, 8, 9), wherein the at least one moveable finger (7, 8, 9) is mounted on the base structure (5) so as to be moveable over the full length of a linear movement path, **characterized in that** the at least one moveable finger (7, 8, 9) comprises a first leg (50) and a second leg (51) extending on opposite sides of the center axis (4), and further comprises a segment (52) connecting the first leg (50) and the second leg (51), wherein the first leg (50) and the second leg (51) are extending parallel to the movement path and wherein the first leg (50) and the second leg (51) are offset from each other in the direction of the center axis (4).
2. Weft feeder device according to claim 1, **characterized in that** the winding drum (2) comprises three moveable fingers (7, 8, 9) that are mounted on the base structure (5) so as to be moveable in radial direction (R7, R8, R9) with respect to the center axis (4), wherein the three moveable fingers (7, 8, 9) are successively arranged so as to form an angle of 90° between two successive moveable fingers (7, 8; 8, 9).
3. Weft feeder device according to claim 1 or 2, **characterized in that** the weft feeder device (1) comprises a driving system (20) for driving at least the first leg (50) of the at least one moveable finger (7, 8, 9).
4. Weft feeder device according to claim 3, **characterized in that** only the first leg (50) of the at least one moveable finger (7, 8, 9) is driven.
5. Weft feeder device according to claim 3 or 4, **characterized in that** the driving system (20) comprises a first pinion (21), wherein at least the first leg (50) of the at least one moveable finger (7, 8, 9) is provided with a rack section (53) drivingly coupled to the first pinion (21).
6. Weft feeder device according to any one of claims 3 to 5, **characterized in that** the weft feeder device (1) is further provided with at least one preload system (54) for applying a preload to the at least one moveable finger (7, 8, 9) in order to compensate play between that moveable finger (7, 8, 9) and the driving system (20).

7. Weft feeder device according to claim 6, **characterized in that** the preload system (54) comprises at least one spring element (55) assigned to the at least one moveable finger (7, 8, 9), which at least one spring element (55) is acting on that moveable finger (7, 8, 9) and forcing that moveable finger (7, 8, 9) towards the first pinion (21).
8. Weft feeder device according to claim 6 or 7, **characterized in that** the preload system (54) comprises at least one friction element (56) assigned to the at least one moveable finger (7, 8, 9), by means of which at least one friction element (56) a frictional force opposing a movement of that moveable finger (7, 8, 9) is applied on that moveable finger (7, 8, 9).
9. Weft feeder device according to claim 8, **characterized in that** the preload system (54) is obtained by the first leg (50) and the second leg (51), wherein the distance between the first leg (50) and the second leg (51) becomes smaller towards the end of the first leg (50) where the first leg (50) comes into contact with the first pinion (21).
10. Weft feeder device according to any one of claims 1 to 9, **characterized in that** the winding drum (2) comprising a number of moveable fingers (7, 8, 9), wherein the first legs (50) of each moveable finger (7, 8, 9) are arranged in a first plane (40) perpendicular to the center axis (4), and the second legs (51) of the moveable fingers (7, 8, 9) are arranged in a second plane (41) perpendicular to the center axis (4), wherein the second plane (41) is at a distance along the center axis (4) from the first plane (40).
11. Weft feeder device according to any one of claims 1 to 10, **characterized in that** the first leg (50) and/or the second leg (51) of the at least one moveable finger (7, 8, 9) are mainly designed as round bars.
12. Weft feeder device according to any one of claims 1. to 11, **characterized in that** at least the first leg (50) has a length so that the first leg (50) extends past the center axis (4).
13. Weft feeder device according to any one of claims 1 to 12, **characterized in that** the second leg (51) has a length so that the second leg (51) extends past the center axis (4).
14. Weft feeder device according to any one of claims 1 to 13, **characterized in that** a guiding system (68) is provided for guiding the first leg (50) and the second leg (51), wherein at least the first leg (50) has a length so that the first leg (50) is guided by the guiding system (68) past the center axis (4).
15. Weft feeder device according to claim 14, **charac-**

terized in that the second leg (51) has a length so that the second leg (51) is guided by the guiding system (68) past the center axis (4).

16. Weft feeder device according to any one of claims 13 to 15, **characterized in that** the first leg (50) is guided along its lateral surface in one direction, and the second leg (51) is guided along its lateral surface in all directions.
17. Weft feeder device according to any one of claims 1 to 16, **characterized in that** the first leg (50) is arranged near a first lateral side (34) of the segment (52) of the moveable finger (7, 8, 9), while the second leg (51) is arranged near a second lateral side (35) of the segment (52) of the moveable finger (7, 8, 9) opposite to the first lateral side (34).

20 Patentansprüche

1. Schussfadenzuführvorrichtung mit einer Wickeltrommel (2) mit einem einstellbaren Wickelumfang zum Speichern von Schussfaden (10) und einer Mittelachse (4), die Wickeltrommel (2) umfassend eine Grundstruktur (5) und mindestens einen beweglichen Finger (7, 8, 9), wobei der mindestens eine bewegliche Finger (7, 8, 9) an der Grundstruktur (5) montiert ist, um über die gesamte Länge einer linearen Bewegungsbahn bewegbar zu sein, **dadurch gekennzeichnet, dass** der mindestens eine bewegliche Finger (7, 8, 9) einen ersten Schenkel (50) und einen zweiten Schenkel (51) umfasst, die sich auf gegenüberliegenden Seiten der Mittelachse (4) erstrecken, und weiter ein Segment (52) umfasst, das den ersten Schenkel (50) und den zweiten Schenkel (51) verbindet, wobei sich der erste Schenkel (50) und der zweite Schenkel (51) parallel zur Bewegungsbahn erstrecken, und wobei der erste Schenkel (50) und der zweite Schenkel (51) in Richtung der Mittelachse (4) zueinander versetzt sind.
2. Schussfadenzuführvorrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** die Wickeltrommel (2) drei bewegliche Finger (7, 8, 9) umfasst, die an der Grundstruktur (5) montiert sind, um in radialer Richtung (R7, R8, R9) bezüglich der Mittelachse (4) bewegbar zu sein, wobei die drei beweglichen Finger (7, 8, 9) aufeinanderfolgend angeordnet sind, um einen Winkel von 90° zwischen zwei aufeinanderfolgenden beweglichen Fingern (7, 8; 8, 9) zu bilden.
3. Schussfadenzuführvorrichtung nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** die Schussfadenzuführvorrichtung (1) ein Antriebssystem (20) zum Antreiben mindestens des ersten Schenkels (50) des mindestens einen beweglichen Fingers (7, 8, 9) umfasst.

4. Schussfadenzuführvorrichtung nach Anspruch 3, **dadurch gekennzeichnet, dass** nur der erste Schenkel (50) des mindestens einen beweglichen Fingers (7, 8, 9) angetrieben wird.
5. Schussfadenzuführvorrichtung nach Anspruch 3 oder 4, **dadurch gekennzeichnet, dass** das Antriebssystem (20) ein erstes Ritzel (21) umfasst, wobei mindestens der erste Schenkel (50) des mindestens einen beweglichen Fingers (7, 8, 9) mit einem Zahnstangenabschnitt (53) versehen ist, der antriebsmässig mit dem ersten Ritzel (21) verbunden ist.
6. Schussfadenzuführvorrichtung nach einem der Ansprüche 3 bis 5, **dadurch gekennzeichnet, dass** die Schussfadenzuführvorrichtung (1) weiter mit mindestens einem Vorspannungssystem (54) zum Aufbringen einer Vorspannung auf den mindestens einen beweglichen Finger (7, 8, 9) versehen ist, um ein Spiel zwischen diesem beweglichen Finger (7, 8, 9) und dem Antriebssystem (20) zu kompensieren.
7. Schussfadenzuführvorrichtung nach Anspruch 6, **dadurch gekennzeichnet, dass** das Vorspannungssystem (54) mindestens ein Federelement (55) umfasst, das dem mindestens einen beweglichen Finger (7, 8, 9) zugeordnet ist, welches mindestens eine Federelement (55) auf diesen beweglichen Finger (7, 8, 9) einwirkt und diesen beweglichen Finger (7, 8, 9) in Richtung des ersten Ritzels (21) zwingt.
8. Schussfadenzuführvorrichtung nach Anspruch 6 oder 7, **dadurch gekennzeichnet, dass** das Vorspannungssystem (54) mindestens ein Reibungselement (56) umfasst, das dem mindestens einen beweglichen Finger (7, 8, 9) zugeordnet ist, mittels welchem mindestens ein Reibungselement (56) auf diesen beweglichen Finger (7, 8, 9) eine Reibungskraft, die einer Bewegung dieses beweglichen Fingers (7, 8, 9) entgegenwirkt, ausgeübt wird.
9. Schussfadenzuführvorrichtung nach Anspruch 8, **dadurch gekennzeichnet, dass** das Vorspannungssystem (54) durch den ersten Schenkel (50) und den zweiten Schenkel (51) erhalten wird, wobei der Abstand zwischen dem ersten Schenkel (50) und dem zweiten Schenkel (51) zum Ende des ersten Schenkels (50) hin kleiner wird, wo der erste Schenkel (50) mit dem ersten Ritzel (21) in Kontakt kommt.
10. Schussfadenzuführvorrichtung nach einem der Ansprüche 1 bis 9, **dadurch gekennzeichnet, dass** die Wickeltrommel (2) eine Anzahl von beweglichen Fingern (7, 8, 9) umfasst, wobei die ersten Schenkel (50) jedes beweglichen Fingers (7, 8, 9) in einer ersten Ebene (40) senkrecht zur Mittelachse (4) angeordnet sind, und die zweiten Schenkel (51) der beweglichen Finger (7, 8, 9) in einer zweiten Ebene (41) senkrecht zur Mittelachse (4) angeordnet sind, wobei die zweite Ebene (41) entlang der Mittelachse (4) von der ersten Ebene (40) beabstandet ist.
11. Schussfadenzuführvorrichtung nach einem der Ansprüche 1 bis 10, **dadurch gekennzeichnet, dass** der erste Schenkel (50) und/oder der zweite Schenkel (51) des mindestens einen beweglichen Fingers (7, 8, 9) hauptsächlich als Rundstangen ausgebildet sind.
12. Schussfadenzuführvorrichtung nach einem der Ansprüche 1 bis 11, **dadurch gekennzeichnet, dass** zumindest der erste Schenkel (50) eine Länge aufweist, so dass der erste Schenkel (50) sich an der Mittelachse (4) vorbei erstreckt.
13. Schussfadenzuführvorrichtung nach einem der Ansprüche 1 bis 12, **dadurch gekennzeichnet, dass** der zweite Schenkel (51) eine Länge aufweist, so dass der zweite Schenkel (51) sich an der Mittelachse (4) vorbei erstreckt.
14. Schussfadenzuführvorrichtung nach einem der Ansprüche 1 bis 13, **dadurch gekennzeichnet, dass** ein Führungssystem (68) zum Führen des ersten Schenkels (50) und des zweiten Schenkels (51) vorgesehen ist, wobei zumindest der erste Schenkel (50) eine Länge aufweist, so dass der erste Schenkel (50) durch das Führungssystem (68) an der Mittelachse (4) vorbei geführt wird.
15. Schussfadenzuführvorrichtung nach Anspruch 14, **dadurch gekennzeichnet, dass** der zweite Schenkel (51) eine Länge aufweist, so dass der zweite Schenkel (51) durch das Führungssystem (68) an der Mittelachse (4) vorbei geführt wird.
16. Schussfadenzuführvorrichtung nach einem der Ansprüche 13 bis 15, **dadurch gekennzeichnet, dass** der erste Schenkel (50) in einer Richtung entlang seiner Seitenfläche geführt wird, und der zweite Schenkel (51) in alle Richtungen entlang seiner Seitenfläche geführt wird.
17. Schussfadenzuführvorrichtung nach einem der Ansprüche 1 bis 16, **dadurch gekennzeichnet, dass** der erste Schenkel (50) in der Nähe einer ersten lateralen Seite (34) des Segments (52) des beweglichen Fingers (7, 8, 9) angeordnet ist, während der zweite Schenkel (51) in der Nähe einer zweiten lateralen Seite (35) des Segments (52) des beweglichen Fingers (7, 8, 9) gegenüber der ersten lateralen Seite (34) angeordnet ist.

Revendications

1. Dispositif délivreur de trame avec un tambour d'enroulement (2) ayant une circonférence d'enroulement réglable pour stocker fil de trame (10) et un axe central (4), le tambour d'enroulement (2) comprenant une structure de base (5) et au moins un doigt mobile (7, 8, 9), dans lequel l'au moins un doigt mobile (7, 8, 9) est monté sur la structure de base (5) de manière à être déplaçable sur toute la longueur d'une voie de déplacement linéaire, **caractérisé en ce que** l'au moins un doigt mobile (7, 8, 9) comprend une première branche (50) et une deuxième branche (51) s'étendant sur des côtés opposés de l'axe central (4), et comprend en outre un segment (52) reliant la première branche (50) et la deuxième branche (51), dans lequel la première branche (50) et la deuxième branche (51) sont étendues parallèlement à la voie de déplacement et dans lequel la première branche (50) et la deuxième branche (51) sont décalées les unes des autres dans la direction de l'axe central (4).
2. Dispositif délivreur de trame selon la revendication 1, **caractérisé en ce que** le tambour d'enroulement (2) comprend trois doigts mobiles (7, 8, 9) qui sont montés sur la structure de base (5) de manière à être déplaçable dans la direction radiale (R7, R8, R9) par rapport à l'axe central (4), dans lequel les trois doigts mobiles (7, 8, 9) sont disposés successivement de manière à former un angle de 90° entre deux doigts mobiles successifs (7, 8; 8, 9).
3. Dispositif délivreur de trame selon la revendication 1 ou 2, **caractérisé en ce que** le dispositif délivreur de trame (1) comprend un système d'entraînement (20) pour entraîner au moins la première branche (50) de l'au moins un doigt mobile (7, 8, 9).
4. Dispositif délivreur de trame selon la revendication 3, **caractérisé en ce que** seulement la première branche (50) de l'au moins un doigt mobile (7, 8, 9) est entraînée.
5. Dispositif délivreur de trame selon la revendication 3 ou 4, **caractérisé en ce que** le système d'entraînement (20) comprend un premier pignon (21), dans lequel au moins la première branche (50) de l'au moins un doigt mobile (7, 8, 9) est prévue d'une section de crémaillère (53) couplée par entraînement au premier pignon (21).
6. Dispositif délivreur de trame selon l'une quelconque des revendications 3 à 5, **caractérisé en ce que** le dispositif délivreur de trame (1) est en outre prévu d'au moins un système de précharge (54) pour appliquer une précharge sur l'au moins un doigt mobile (7, 8, 9) afin de compenser le jeu entre ce doigt mo-
7. Dispositif délivreur de trame selon la revendication 6, **caractérisé en ce que** le système de précharge (54) comprend au moins un élément à ressort (55) associé à l'au moins un doigt mobile (7, 8, 9), lequel au moins un élément à ressort (55) agit sur ce doigt mobile (7, 8, 9) et force ce doigt mobile (7, 8, 9) vers le premier pignon (21).
8. Dispositif délivreur de trame selon la revendication 6 ou 7, **caractérisé en ce que** le système de précharge (54) comprend au moins un élément de friction (56) associé à l'au moins un doigt mobile (7, 8, 9), au moyen duquel au moins un élément de friction (56) une force de friction s'opposant au déplacement de ce doigt mobile (7, 8, 9) est appliquée sur ce doigt mobile (7, 8, 9).
9. Dispositif délivreur de trame selon la revendication 8, **caractérisé en ce que** le système de précharge (54) est obtenu par la première branche (50) et la deuxième branche (51), dans lequel la distance entre la première branche (50) et la deuxième branche (51) devient plus petite vers l'extrémité de la première branche (50) où la première branche (50) entre en contact avec le premier pignon (21).
10. Dispositif délivreur de trame selon l'une quelconque des revendications 1 à 9, **caractérisé en ce que** le tambour d'enroulement (2) comprenant un nombre de doigts mobiles (7, 8, 9), dans lequel les premières branches (50) de chaque doigt mobile (7, 8, 9) sont disposées dans un premier plan (40) perpendiculaire à l'axe central (4), et les deuxièmes branches (51) des doigts mobiles (7, 8, 9) sont disposées dans un deuxième plan (41) perpendiculaire à l'axe central (4), dans lequel le deuxième plan (41) est à une distance du premier plan (40) le long de l'axe central (4).
11. Dispositif délivreur de trame selon l'une quelconque des revendications 1 à 10, **caractérisé en ce que** la première branche (50) et/ou la deuxième branche (51) de l'au moins un doigt mobile (7, 8, 9) sont principalement conçues comme des barres rondes.
12. Dispositif délivreur de trame selon l'une quelconque des revendications 1 à 11, **caractérisé en ce qu'**au moins la première branche (50) a une longueur de telle sorte que la première branche (50) s'étend au-delà de l'axe central (4).
13. Dispositif délivreur de trame selon l'une quelconque des revendications 1 à 12, **caractérisé en ce que** la deuxième branche (51) a une longueur de telle sorte que la deuxième branche (51) s'étend au-delà de l'axe central (4).

14. Dispositif délivreur de trame selon l'une quelconque des revendications 1 à 13, **caractérisé en ce qu'un** système de guidage (68) est prévu pour guider la première branche (50) et la deuxième branche (51), dans lequel au moins la première branche (50) a une longueur de telle sorte que la première branche (50) est guidée par le système de guidage (68) au-delà de l'axe central (4). 5
15. Dispositif délivreur de trame selon la revendication 14, **caractérisé en ce que** la deuxième branche (51) a une longueur de telle sorte que la deuxième branche (51) est guidée par le système de guidage (68) au-delà de l'axe central (4). 10 15
16. Dispositif délivreur de trame selon l'une quelconque des revendications 13 à 15, **caractérisé en ce que** la première branche (50) est guidée le long de sa surface latérale dans une direction, et la deuxième branche (51) est guidée le long de sa surface latérale dans toutes les directions. 20
17. Dispositif délivreur de trame selon l'une quelconque des revendications 1 à 16, **caractérisé en ce que** la première branche (50) est disposée près d'un premier côté latéral (34) du segment (52) du doigt mobile (7, 8, 9), tandis que la deuxième branche (51) est disposée près d'un deuxième côté latéral (35) du segment (52) du doigt mobile (7, 8, 9) opposé au premier côté latéral (34). 25 30

35

40

45

50

55

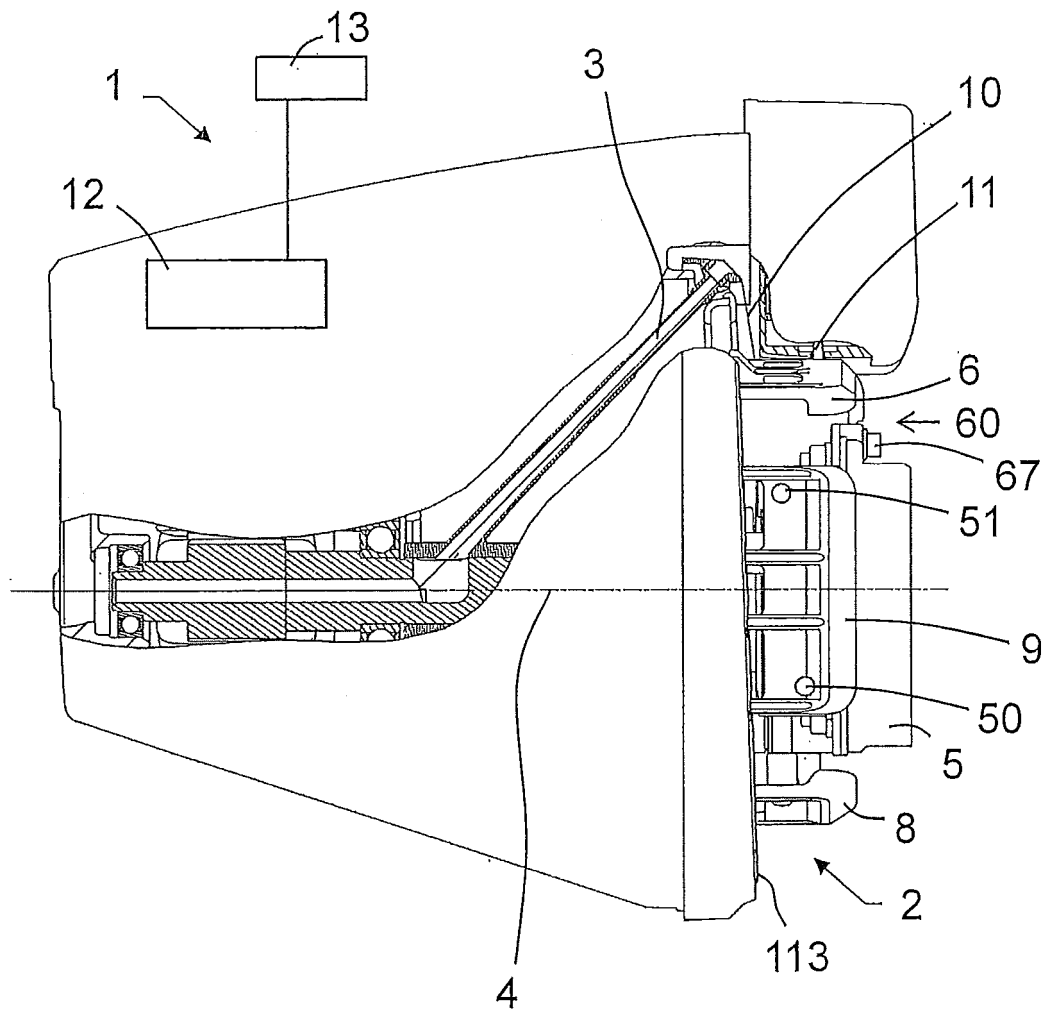


Fig. 1

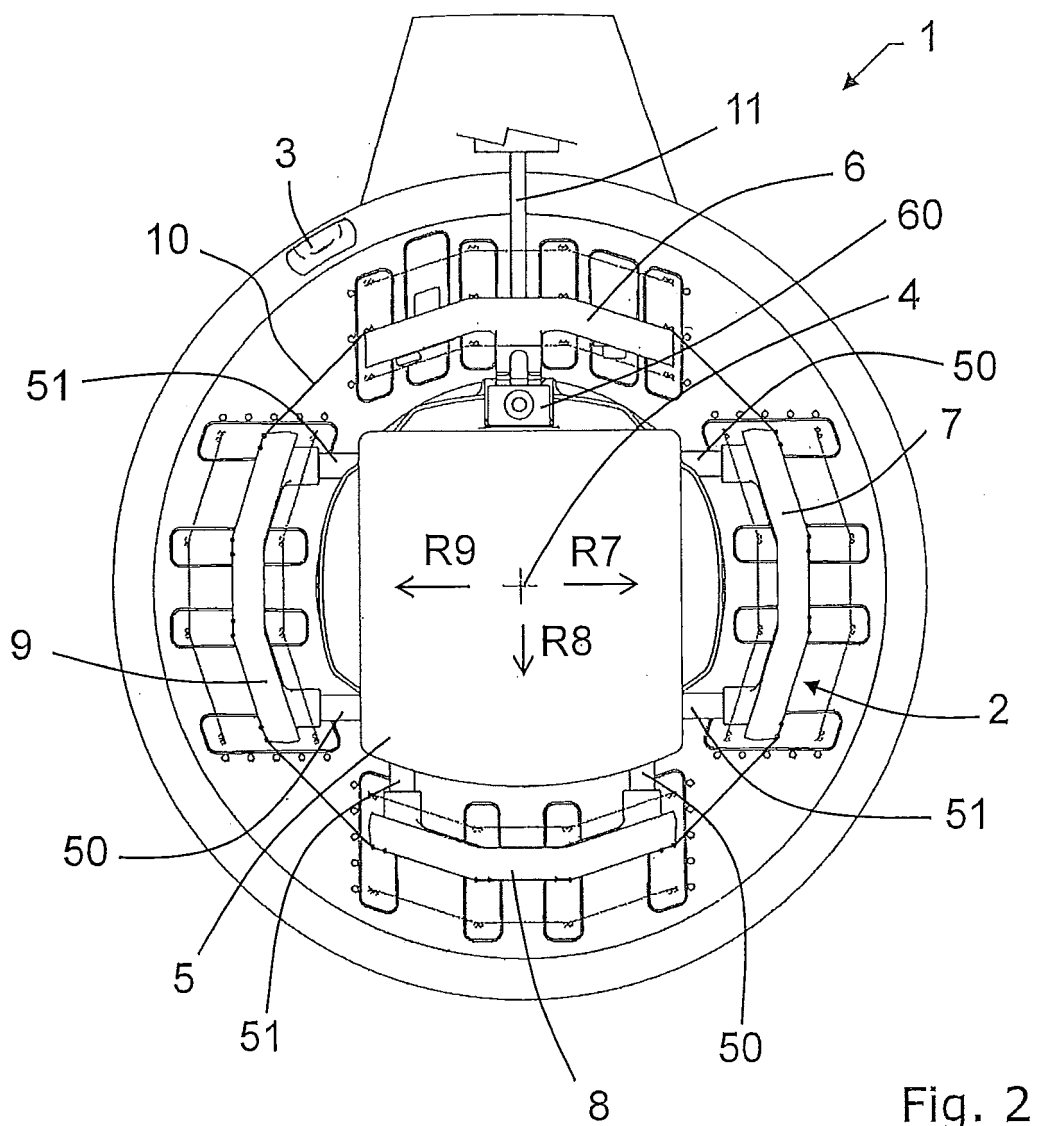
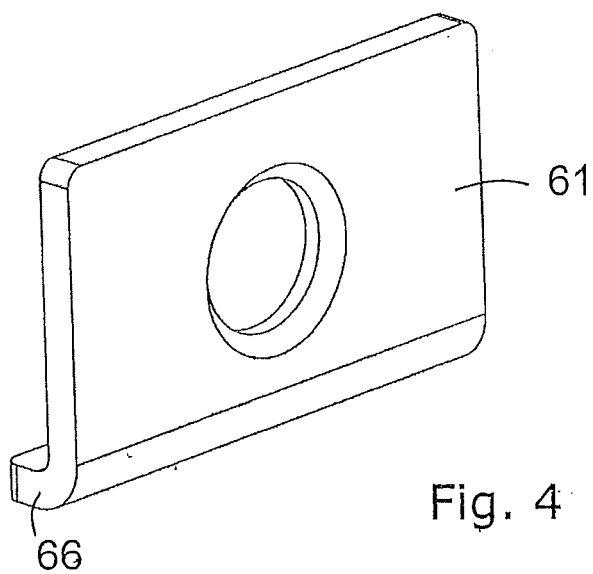
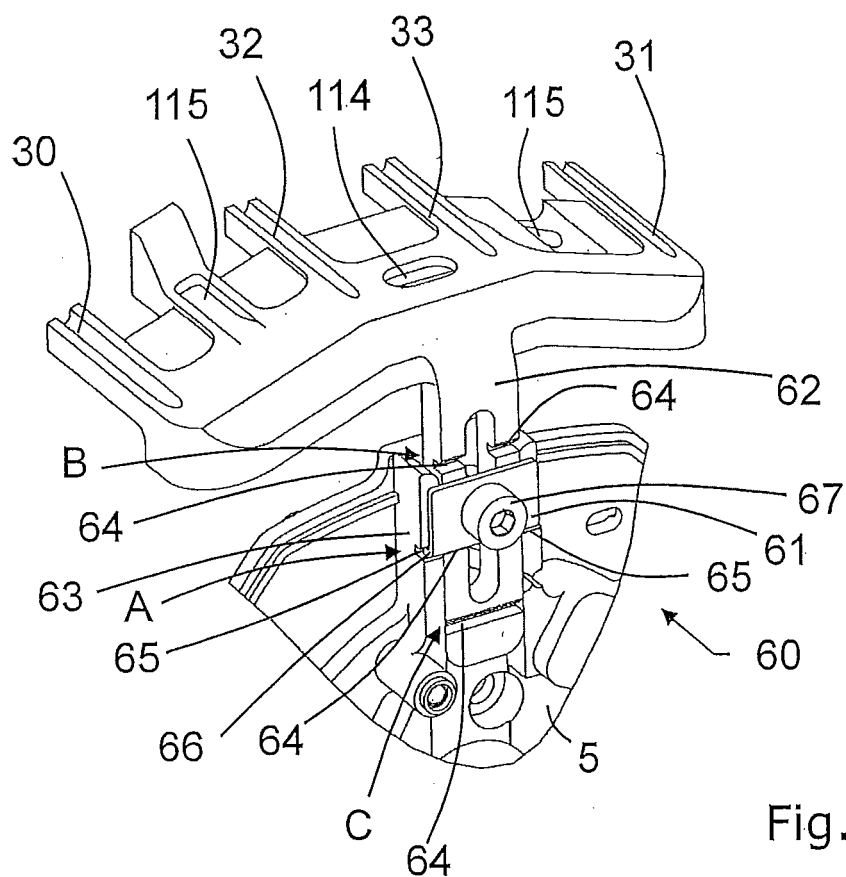


Fig. 2



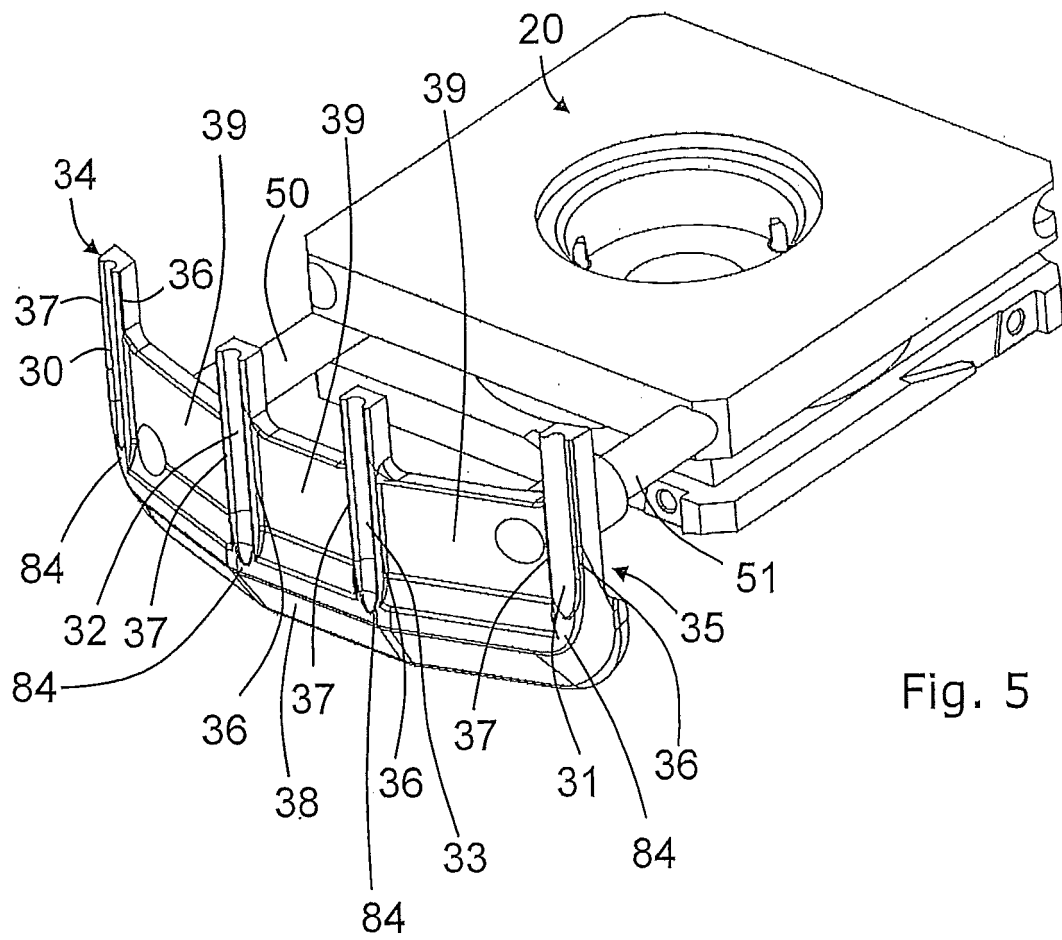
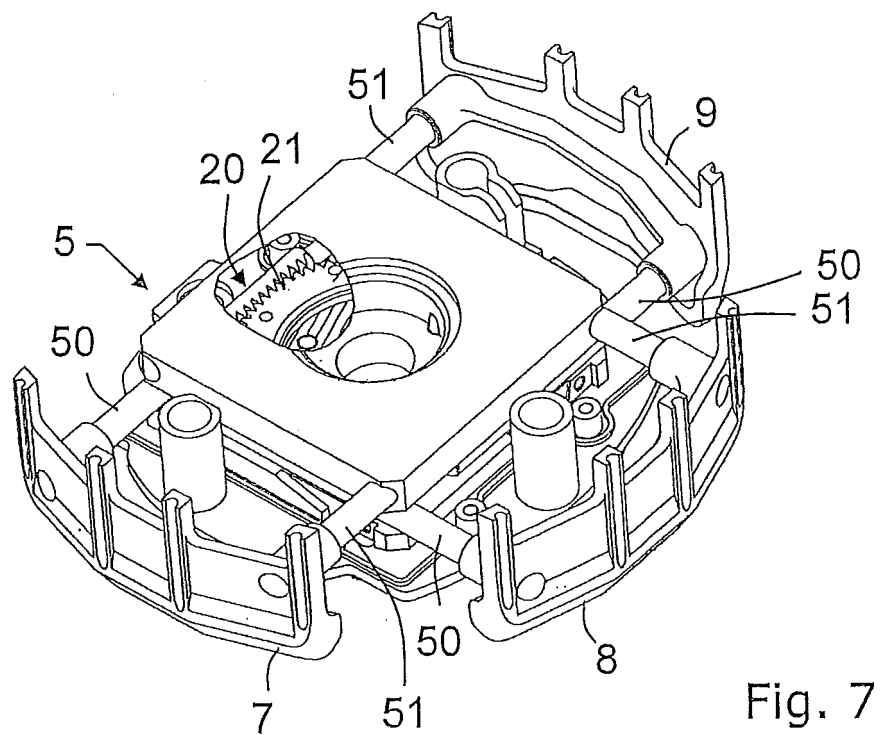
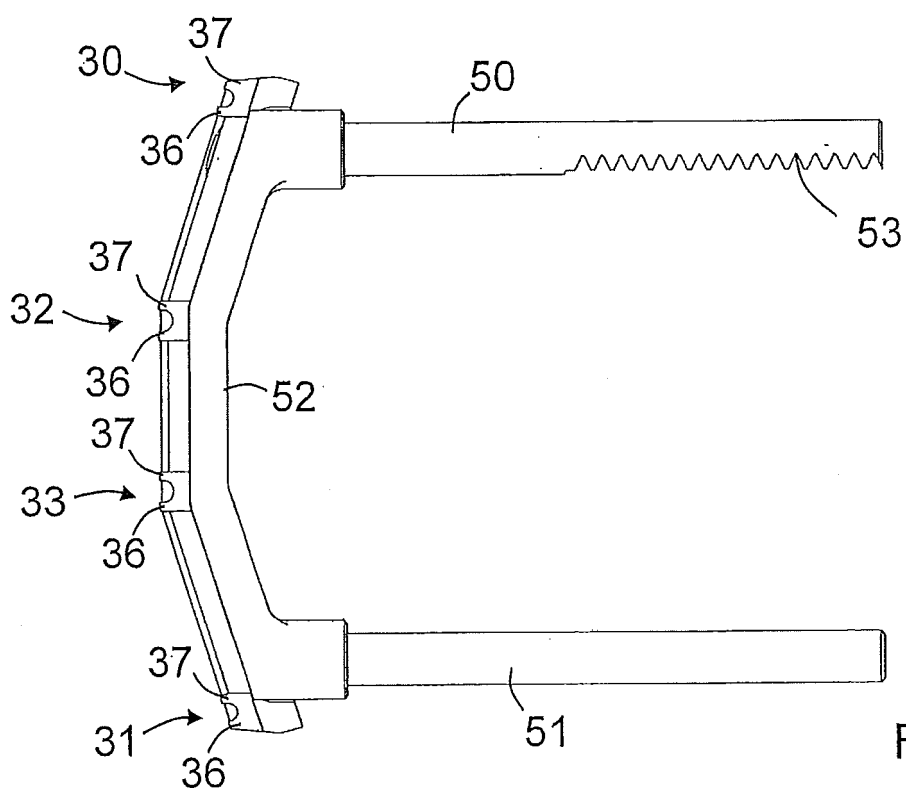
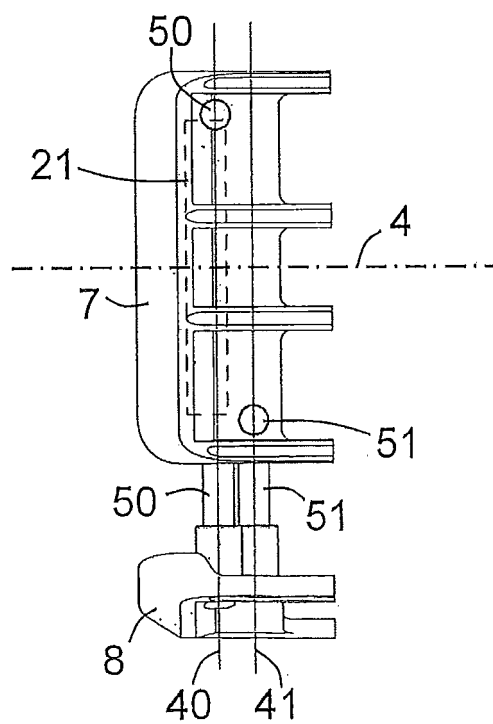
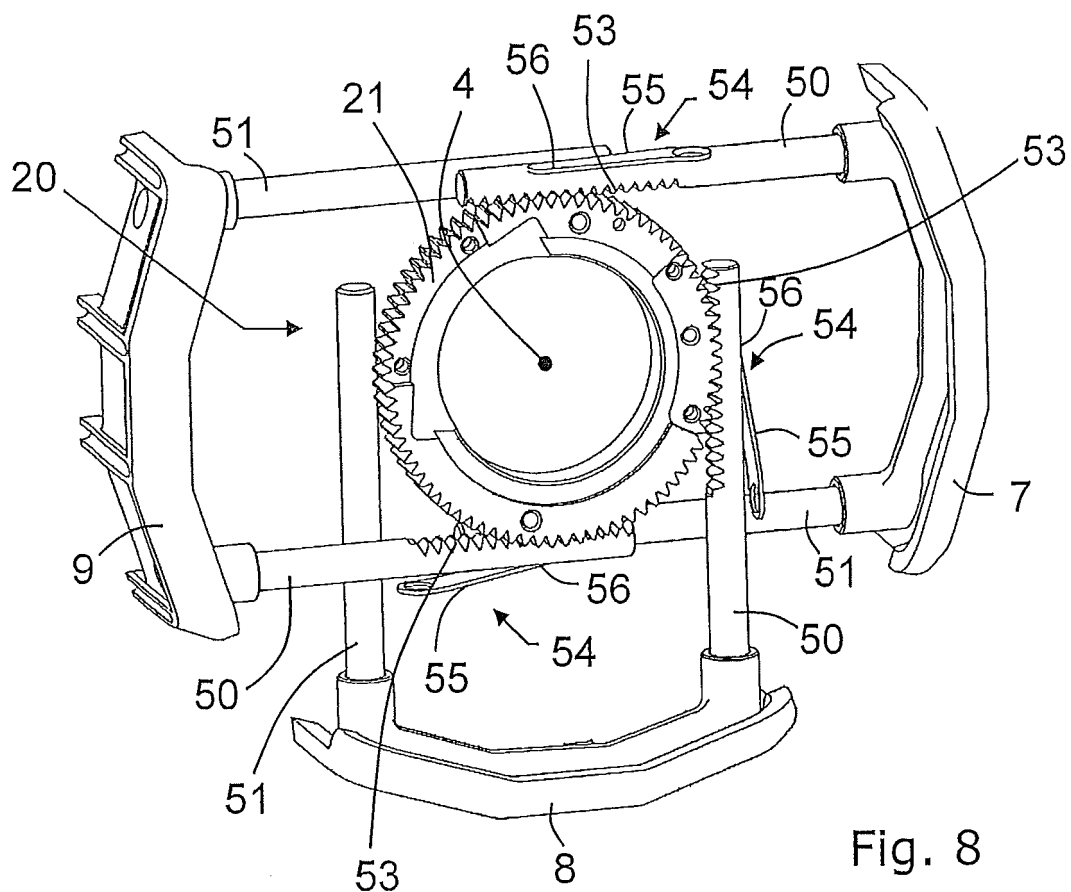
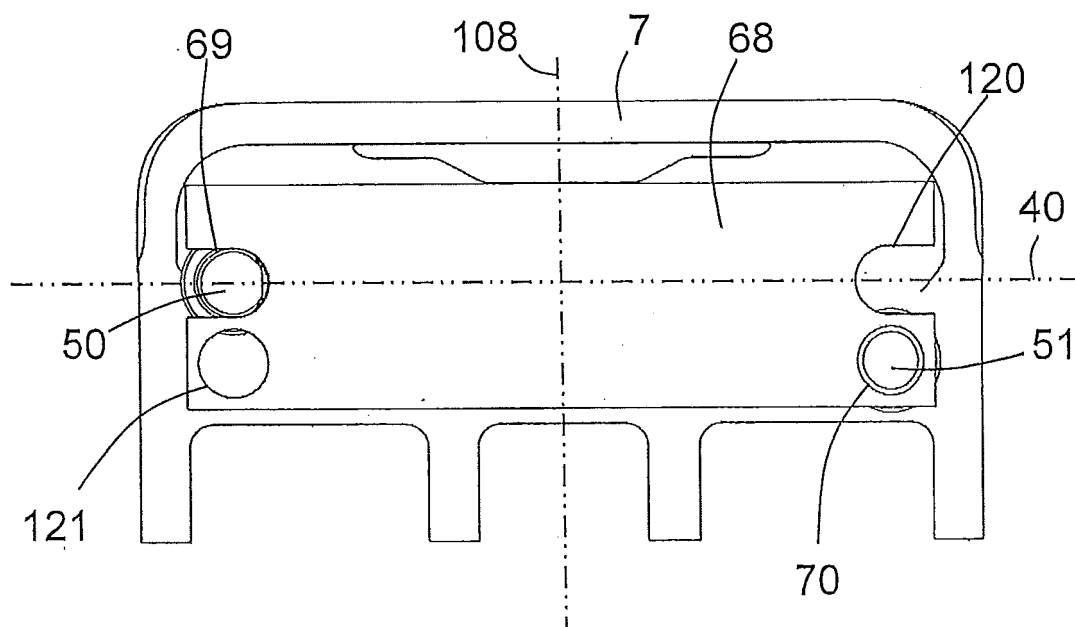
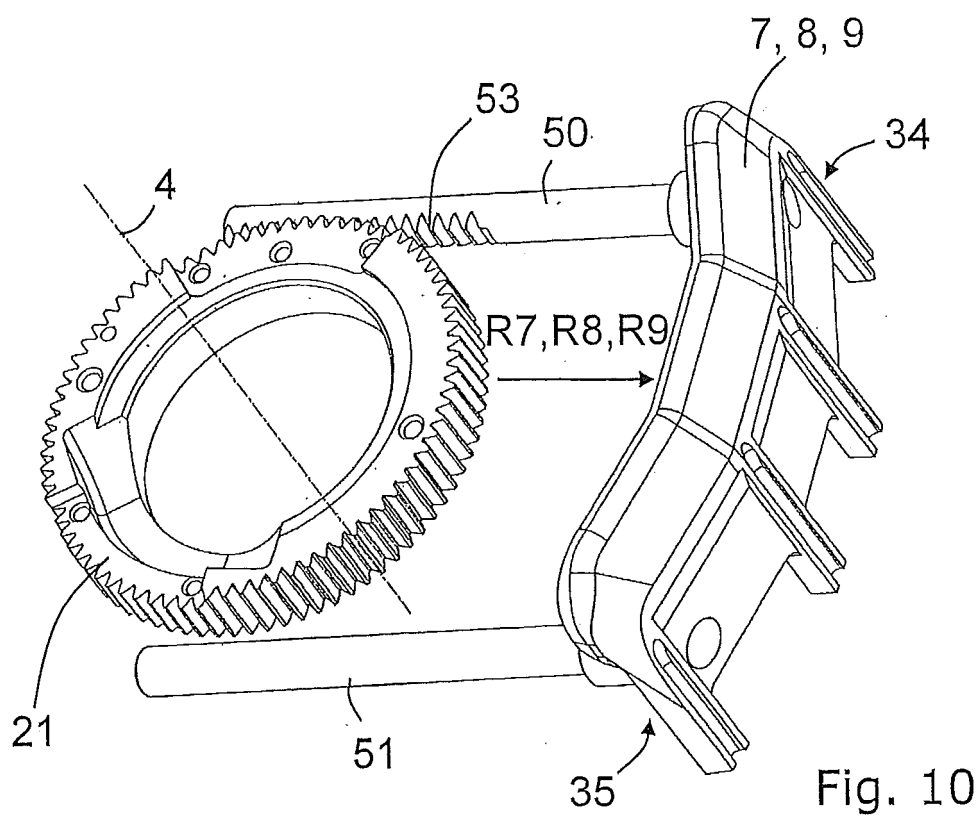


Fig. 5







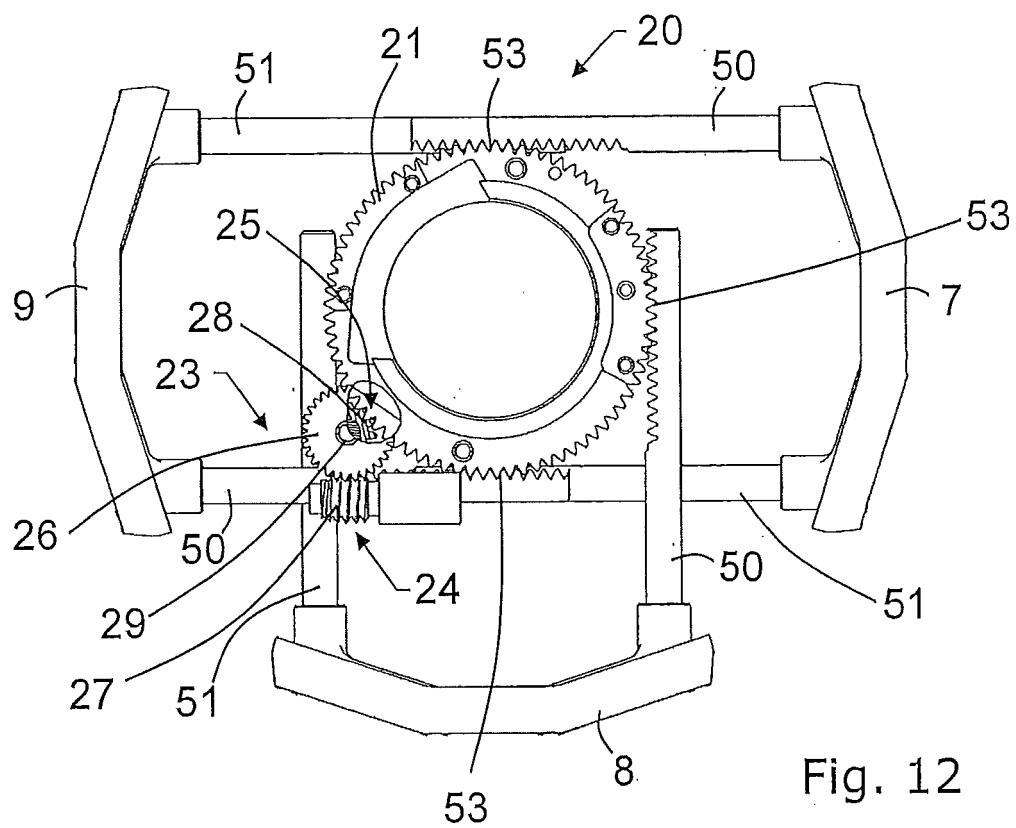


Fig. 12

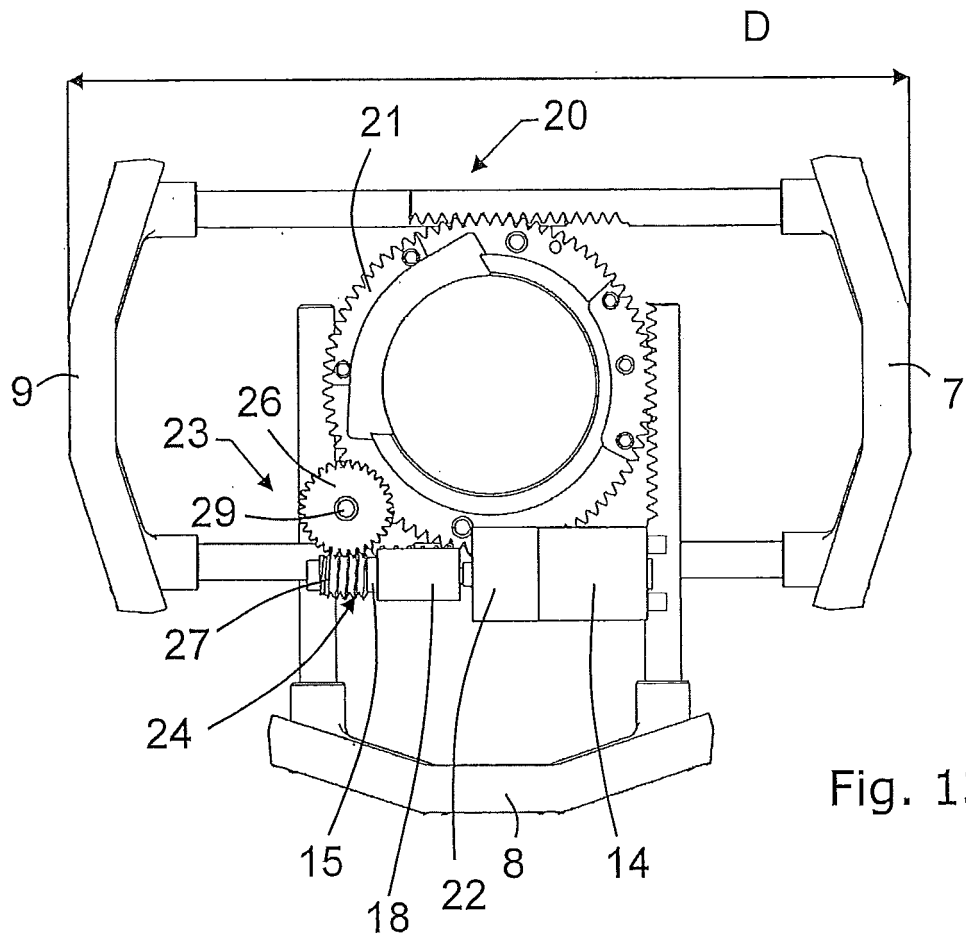
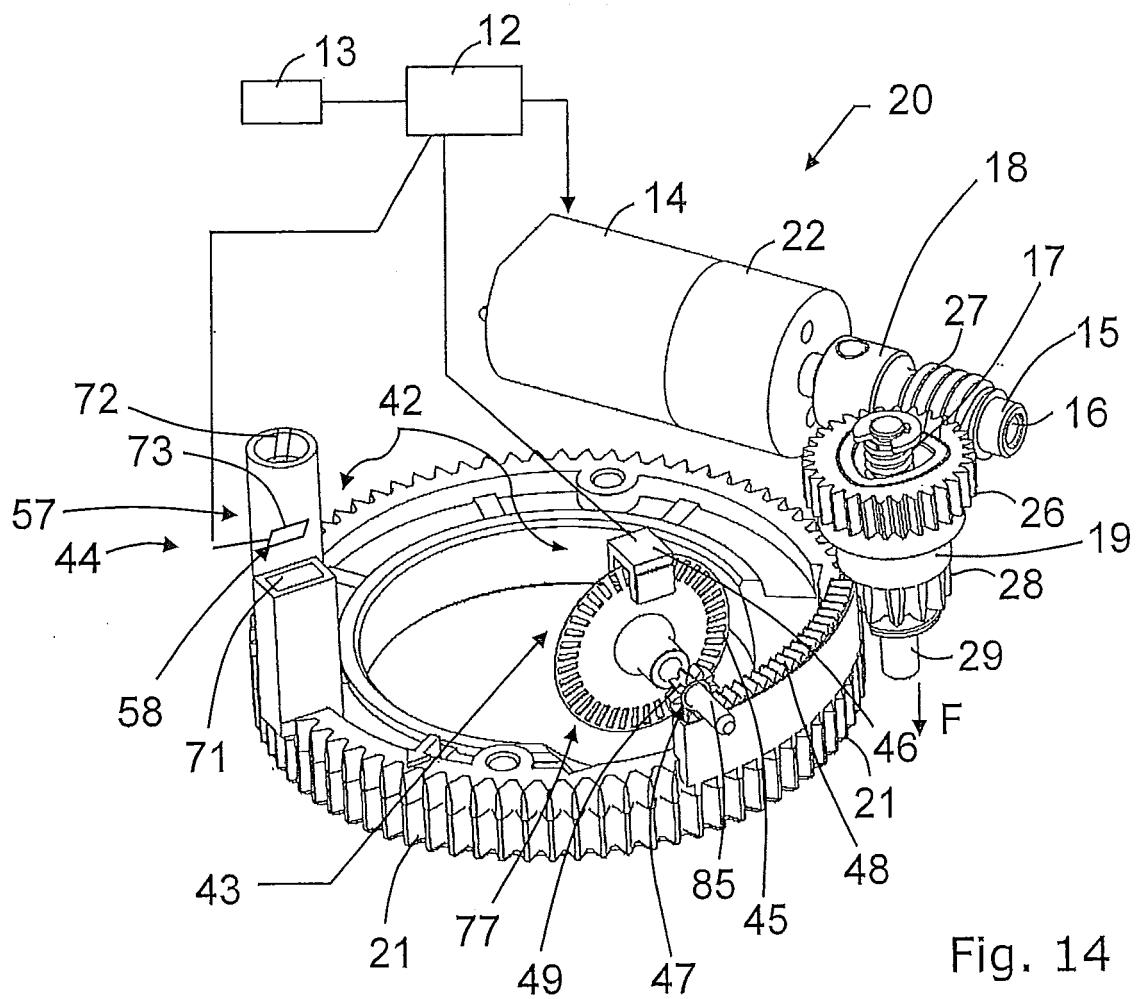


Fig. 13



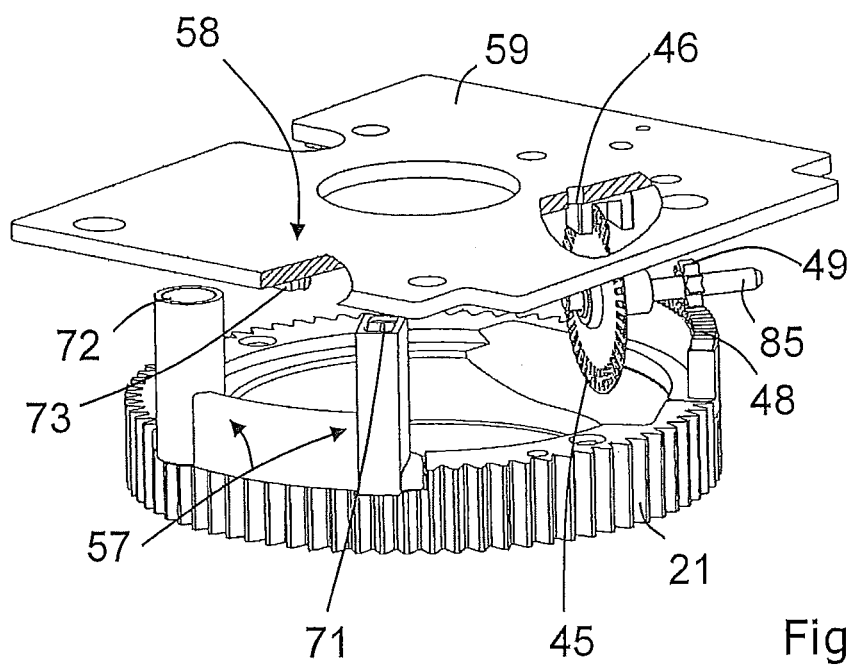
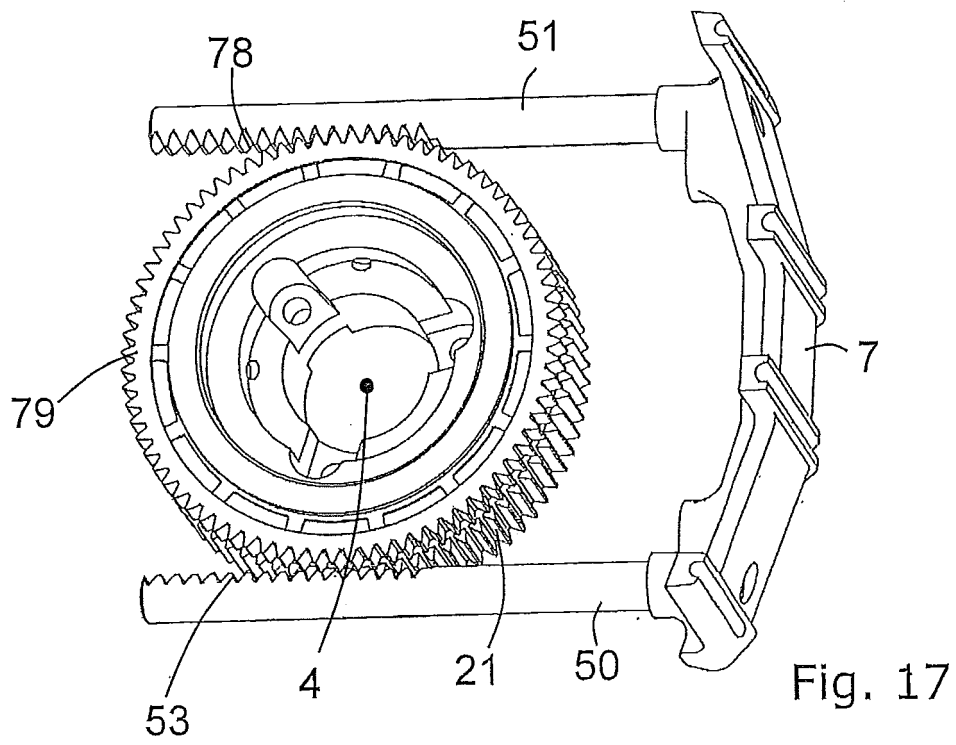
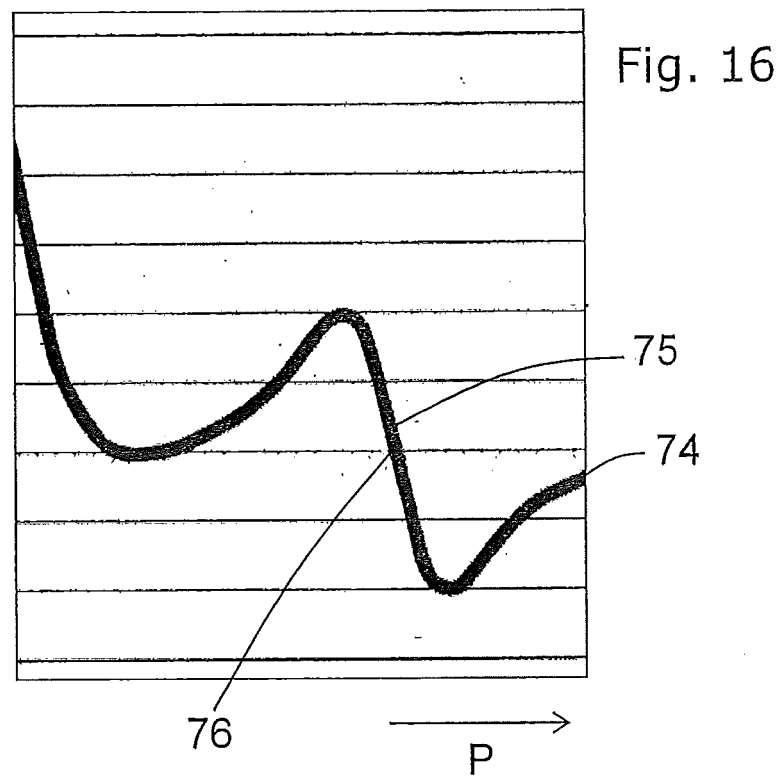


Fig. 15



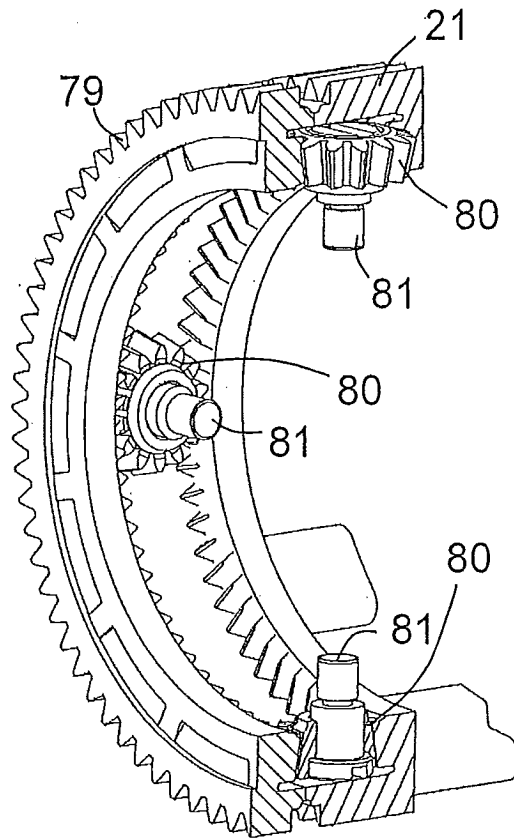


Fig. 18

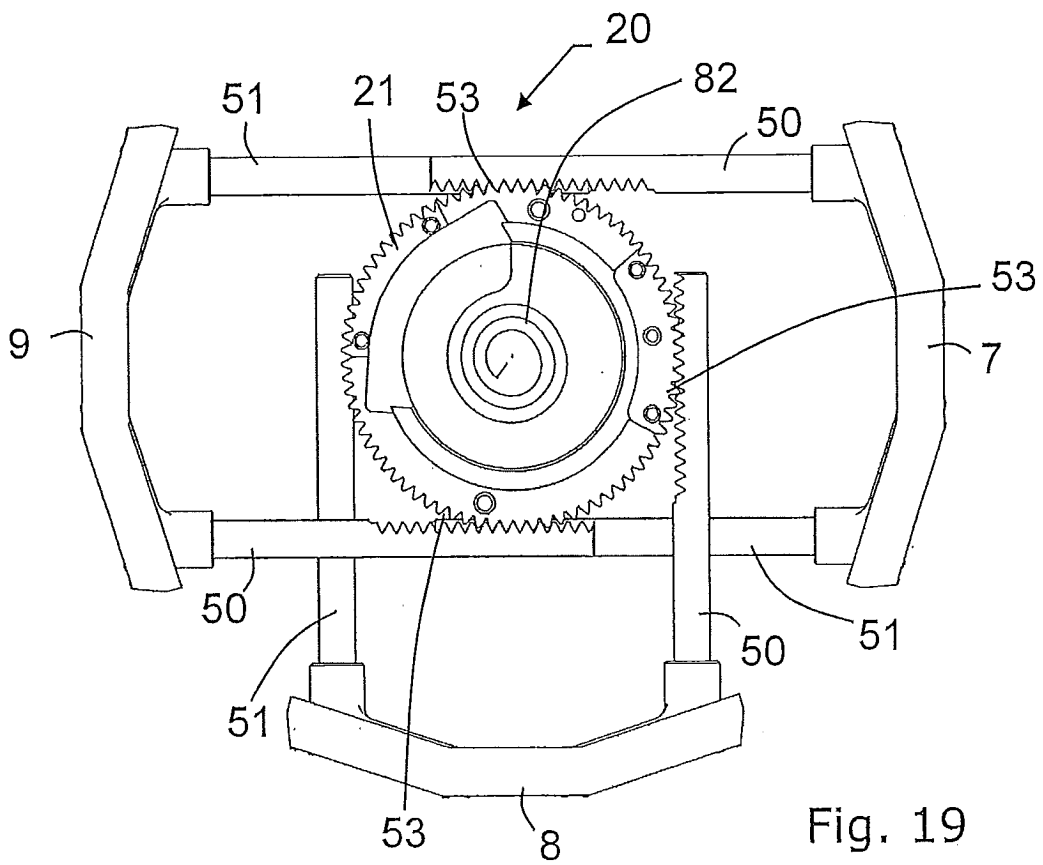


Fig. 19

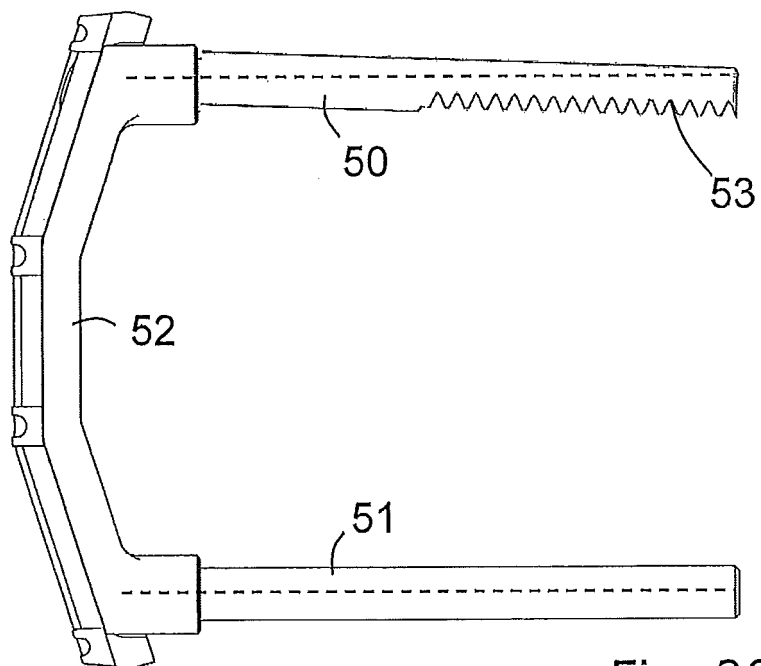


Fig. 20

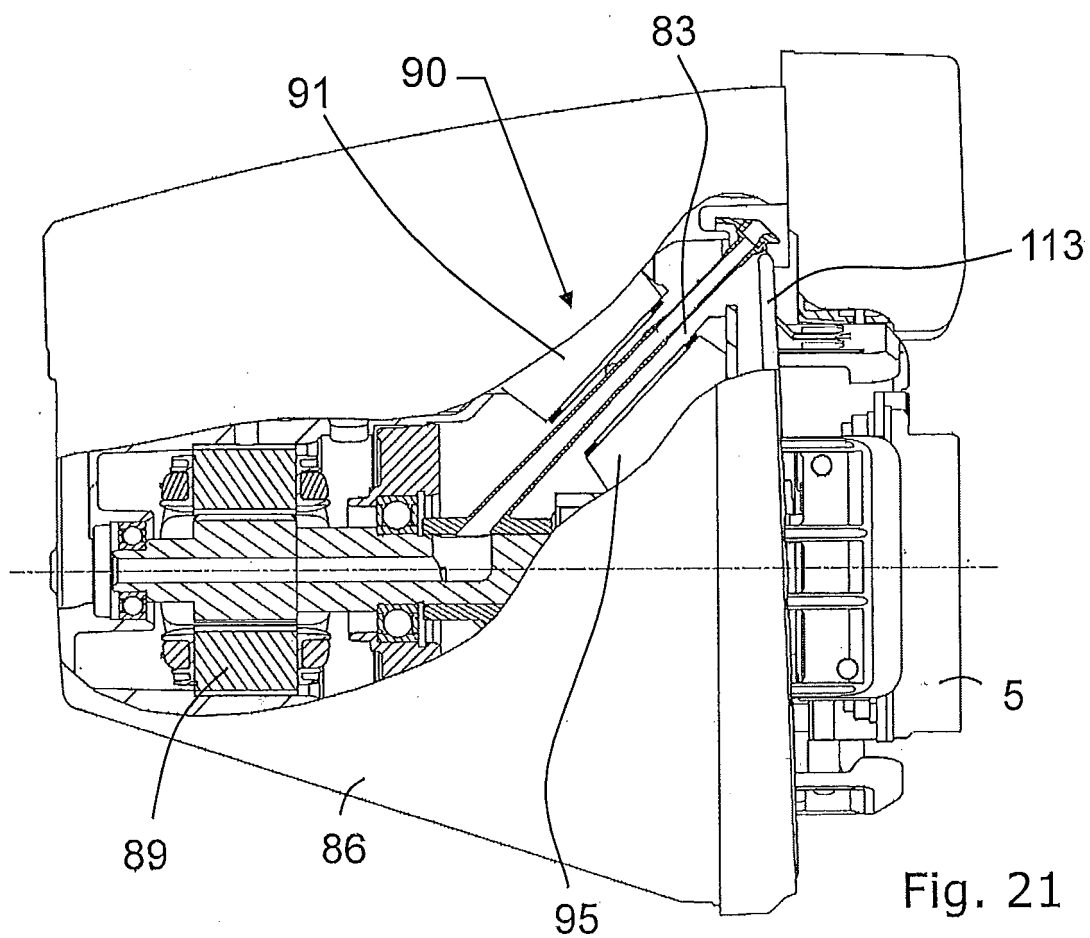
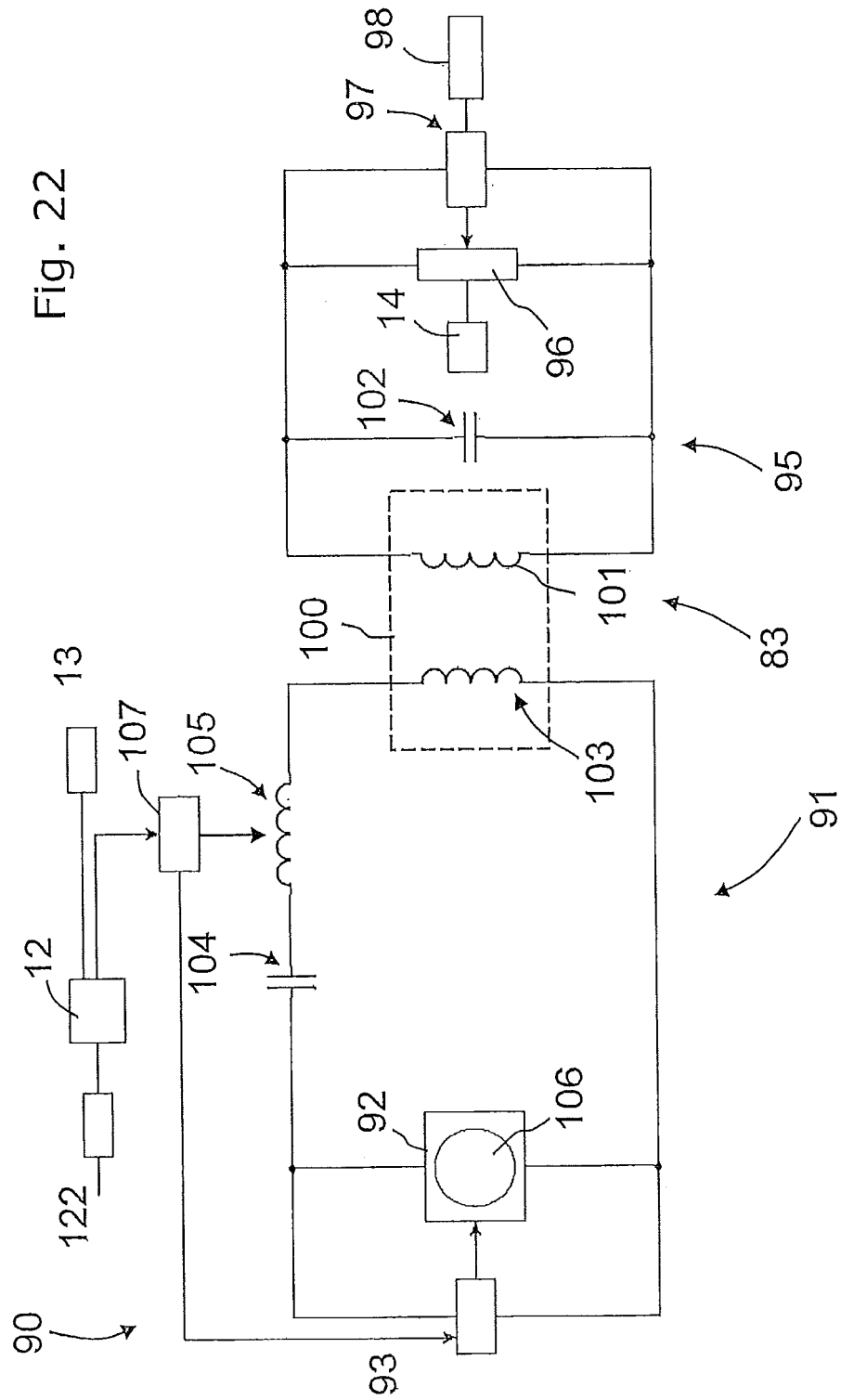
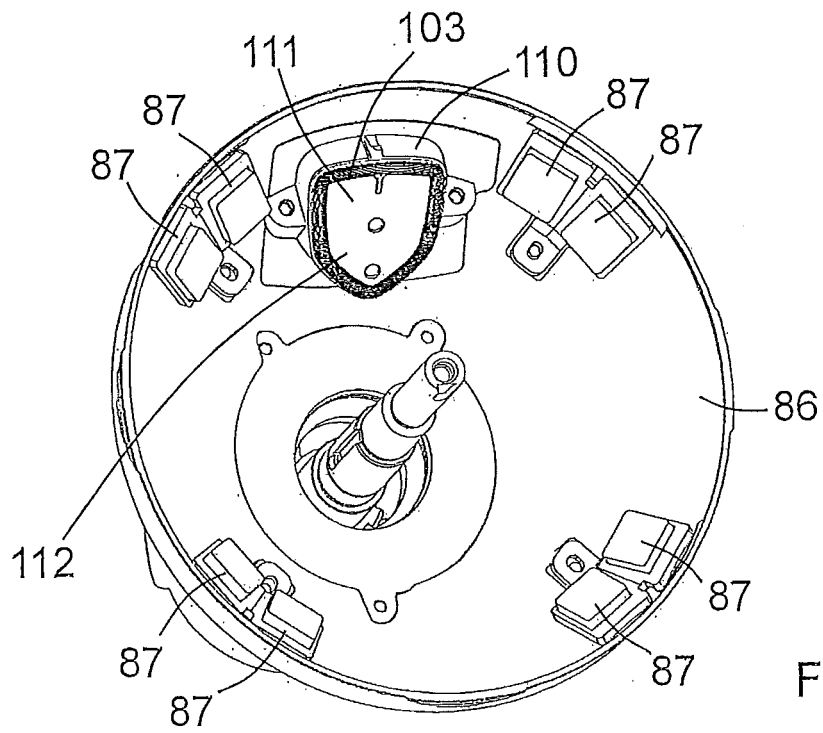
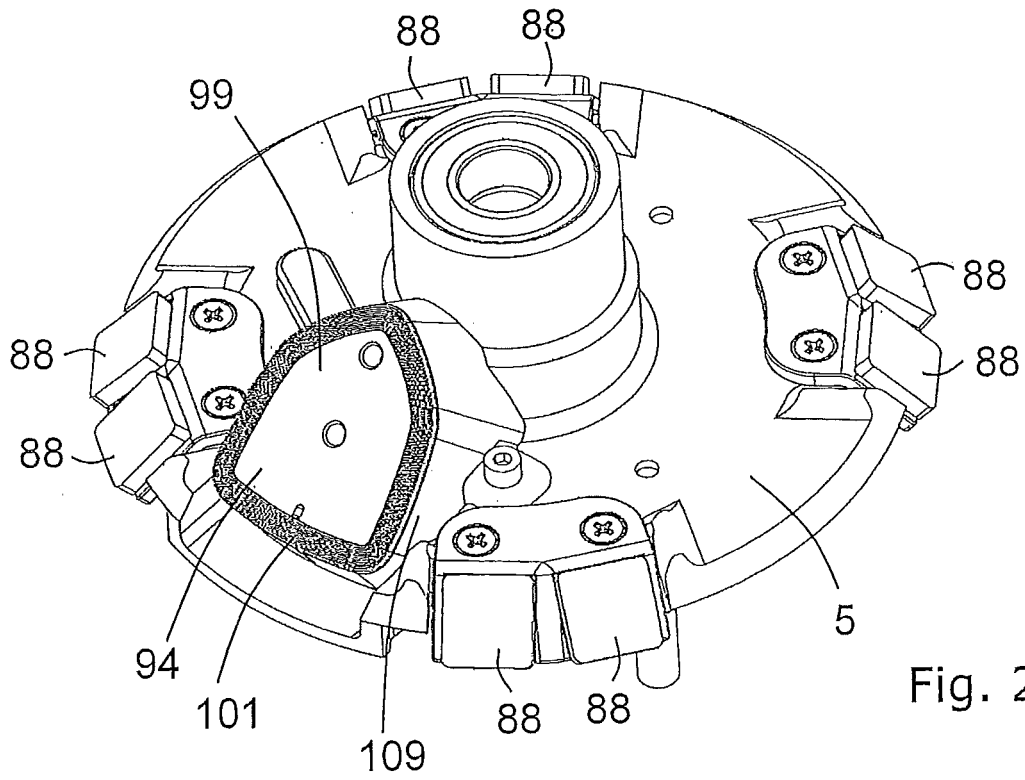


Fig. 21





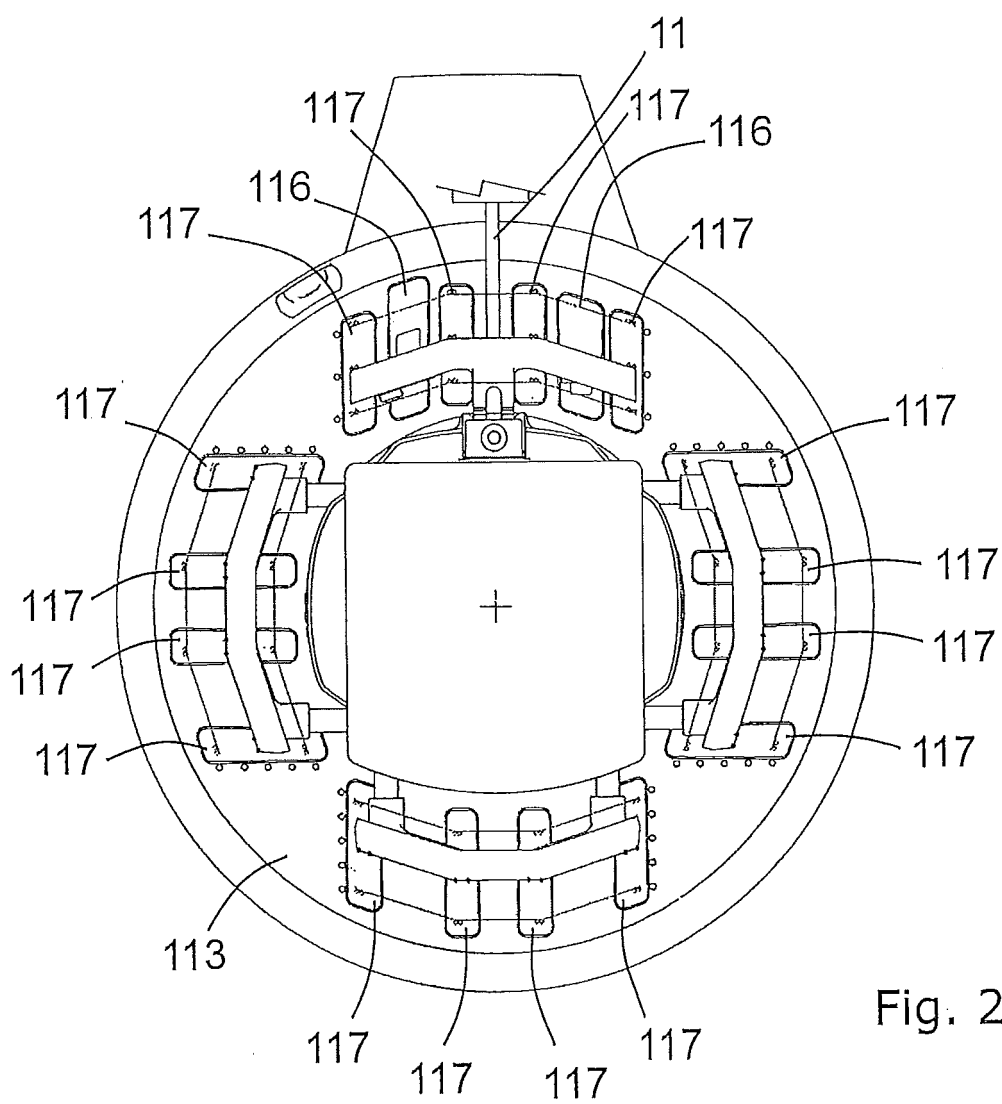
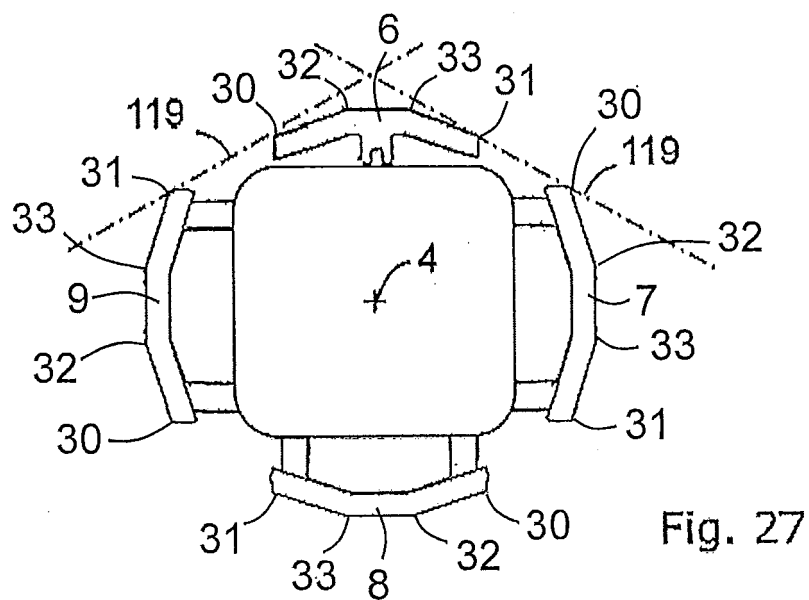
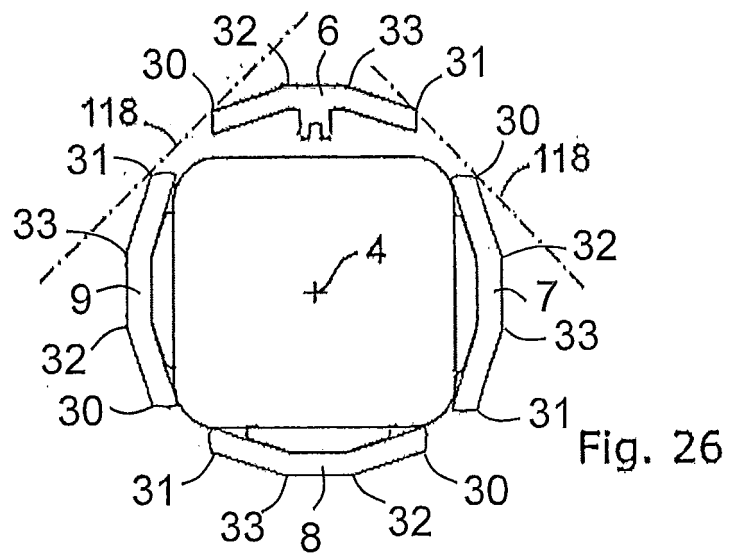


Fig. 25



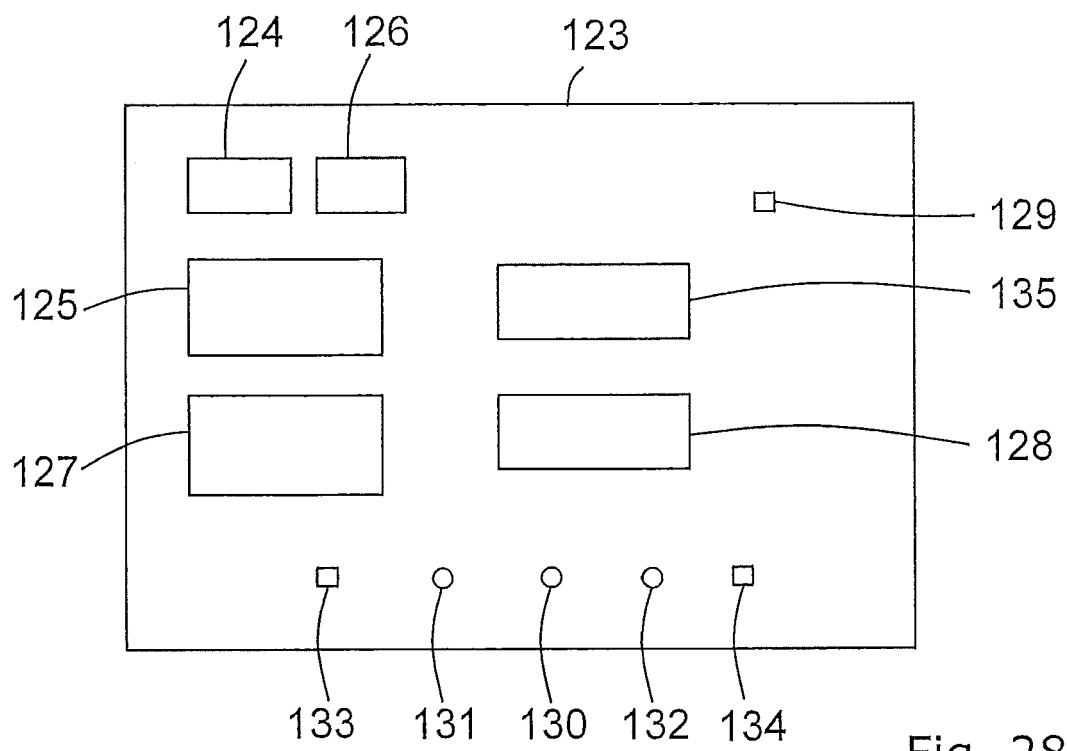


Fig. 28

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

- US 5046537 A [0005]
- JP 9170141 A [0006]
- WO 9201102 A1 [0006] [0179]
- US 4850400 A [0007]
- US 4280668 A [0179]
- EP 195469 A1 [0196]