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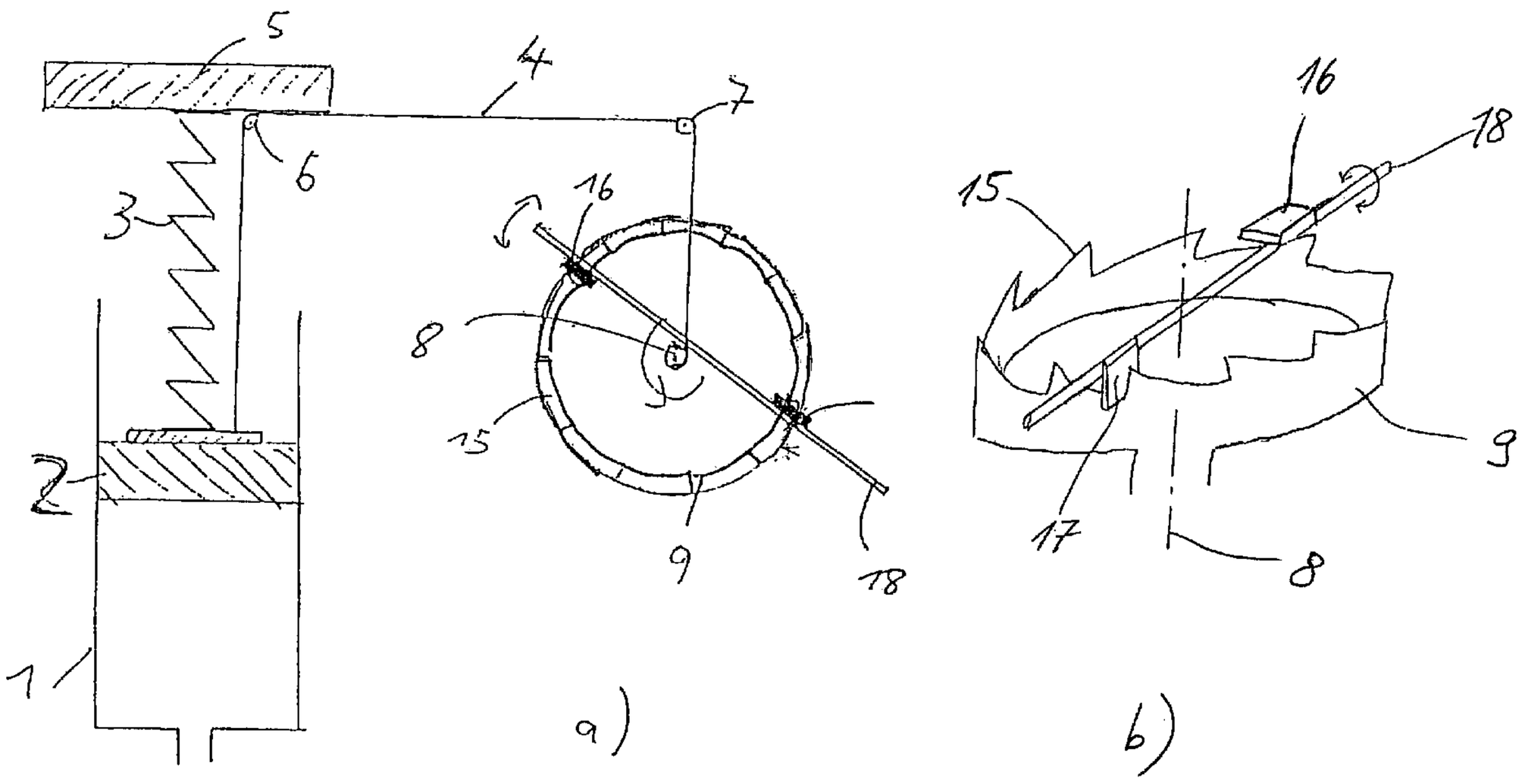


(57) Abrégé/Abstract:
The invention relates to a device for the dosed discharge of a liquid agent, in particular for an infusion pump, comprising a reservoir (1), for storing the liquid agent and a drive mechanism, for propelling a piston (2) towards an outlet from the container in order to discharge the agent. The above is characterised in that the drive mechanism permanently forces the piston forwards, whereby a locking mechanism (9, 11; 9, 16) is provided for permanent locking of the progress of the piston and which is released for discharge of the agent. The invention further relates to an infusion pump for the long-term release of an agent, comprising a device as above and a controller which repeatedly releases the locking mechanism for the discharge of the agent.

abstract

The invention relates to a device for the dosed expelling of a liquid agent, especially for an infusion pump, comprising a receptacle (1) for the storing of the liquid agent and a propulsion mechanism for the propelling of a piston (2) toward an outlet of the receptacle in order to expel the agent, characterized in that the propulsion mechanism permanently acts on the piston with a propulsive force, a blocking mechanism (9, 11; 9, 16) being provided whereby a piston advance is permanently blocked and, in order to expel the agent, released; the invention also relates to an infusion pump for the long-term release of an agent, including a device according to one of the previous claims and a control apparatus that repeatedly releases the blocking mechanism in order to expel the agent.

(Fig. 2)

Device for the dosed discharging of a liquid agent and infusion pump

The present invention relates to a device for the dosed discharging of a liquid agent according to claim 1 as well as an infusion pump for the long-term releasing of an agent according to claim 21 with said device. An especially preferred application relates to the repeated releasing of comparatively small doses of a medical agent over a comparatively long period of time in order to achieve an administration of the agent that is as uniform as possible.

In the medicating of patients, it is often advantageous to provide the patients with small doses of a medical agent over a comparatively long period of time instead of injecting the patients with comparatively large doses of a medicine at relatively few time points. For example, in the treatment of diabetes, it is advantageous to supply the required agent, namely insulin, in microdoses in a quasi-continuous manner over a longer period of time. This opens up the possibility of optimally adjusting the blood sugar of the patient. Recent years have seen the increasing development of diagnostic systems that make possible a quasi-continuous monitoring of medically relevant parameters, for example blood sugar. In cooperation with a quasi-continuous microdosing, an optimal medicating can thus be achieved.

Available for this purpose are infusion pumps that include a reservoir for the liquid agent to be administered and an administration mechanism, for example a microdosing pump. In order that the infusion pumps may be carried on the patients, these pumps have their own energy supply. Usually the reservoir is designed as an ampoule having a piston or plug that is propelled in the direction of an ampoule opening in order to expel the agent. The service life of the energy supply here depends mainly on the frictional forces prevalent in the reservoir. However, the goal is that the energy supply be as long-lived as possible, so that at any time the patient can depend on the fact that the agent so important to him will actually be administered. As is well known, the recharging of storage batteries is complicated, time consuming, and can be forgotten. If disposable batteries are used as the energy supply, the replacement of the batteries usually requires an opening of the infusion pump. However, for hygienic reasons the pump should be hermetically sealed to the degree possible, so that a battery replacement is disadvantageous.

The object of the present invention is thus to create a device for the dosed discharging of a liquid agent, which device is operable in an energy-saving manner and is simple and reliable to operate. In addition, an infusion pump with such a device is to be created.

The object is achieved through a device with the features of patent claim 1 as well as through an infusion pump with the features of patent claim 21. Advantageous further developments are the object of the back-referenced, dependent claims.

A device according to the present invention includes a receptacle for the storage of a liquid agent and a propulsion mechanism for propelling a piston toward an outlet of the receptacle in order to

expel the agent, wherein the propulsion mechanism acts permanently on the piston with a propulsion force and a blocking mechanism is provided, by means of which a piston advance is permanently blocked and, in order to expel the agent, released in a controlled manner. Advantageously, in order to expel the agent, energy is consumed only to activate the blocking mechanism and not to propel the piston of the receptacle, since, according to the invention, the propulsion mechanism can be prestressed prior to the placing into operation of the device in such a way that doses of the agent can be repeatedly expelled without renewed prestressing of the propulsion mechanism. The energy for the prestressing of the propulsion mechanism can thus be provided prior to the placing into operation of the device through, for example, an external energy source, an external mechanism, or manual means. Thus, comparatively little energy is required for the operation of the device itself.

At the same time, the present invention makes allowances for safety considerations, since the blocking mechanism is designed such that the piston advance is permanently blocked, so that an overdosing is effectively excluded, for example in the case of a failure of the device electronics, etc. According to the invention, the blocking mechanism is released only at the point in time of the expelling of the agent. Preferably, the blocking mechanism is designed in such a way that upon the unblocking of the piston propulsion the piston is driven forward only by a predetermined stroke length and that the blocking mechanism automatically reblocks after the driving of the piston by the predetermined stroke length. The predetermined stroke length appropriately corresponds to a minimally presettable dose. Thus, in this preferred embodiment form a long-term release of the agent can be controlled in a simple manner. This is by virtue of the fact that, instead of requiring a presetting each time of a target value for the adjustment of the piston to achieve a desired dosing, according to this embodiment form an electronic control need simply perform a count of how often the blocking mechanism has released the propulsion of the piston. With knowledge of the agent dose that is expelled with a single release of the blocking mechanism, in a simple manner the total dose expelled can be calculated through multiplication of the single dose by the number of releases of the blocking mechanism. Thus, according to the preferred embodiment form, a simple temporal control can be used to control the long-tem dosing.

Also advantageous is the fact that the dosing mechanism is virtually always at rest, since it must be activated only at the comparatively few points in time of an expelling of the agent. This helps to save energy.

According to a preferred embodiment form, the propulsion mechanism prestresses the piston relative to a reference point that is kept fixed in relation to the blocking mechanism. This reference point can therefore be, for example, a housing or a wall of the agent receptacle.

According to the present invention, applicable as the propulsion mechanism are all mechanisms known from the prior art that can be prestressed for the repeated displacement of a piston. For

example, the propulsion mechanism can include a compression spring, one end of which acts on the piston and the other end of which is held fixed, for example relative to the housing of the infusion pump. According to the invention, the compression spring is prestressed prior to the placing into operation of the device. Upon the release of the blocking mechanism, the compression spring can dissipate the prestress in a step by step manner, until a relaxed end position is reached. According to another embodiment form, the propulsion mechanism can be a torsion spring, as the latter is known from other mechanical devices, for example mechanical clocks. For example, the torsion spring can be a wound spiral spring or coil spring of round or rectangular cross section, which spring is accepted in a housing, one end of the torsion spring producing a rotary movement in the propulsion mechanism, which movement is converted in a known manner into a propulsive force for the piston, for example with the aid of gears or through thread engagement of a rotatable, driven threaded bar.

According to a further embodiment form, the propulsion mechanism can include a pressurized chamber in which a gas is stored under pressure and which displays a flexible chamber wall, so that the gas can expand in order to propel the piston when the blocking mechanism is released. Thus, in this embodiment form, prior to the placing into operation of the device the pressurized chamber is pumped up or, as the case may be, a suitable pressurized-gas reservoir is installed in the device, for example a pressurized-gas bottle such as are economically available on the market. It goes without saying that, according to the present invention magnetic forces can also in principle be used for propelling the piston. To this end, sufficiently strong permanent magnets can be provided on the housing of the device and on the piston of the receptacle, such magnets being available economically on the market.

Preferably, the blocking mechanism includes a blocking means and a catch that works together with the latter, which catch is movable and in a first position blocks the piston advance and in a second position releases the piston advance in order to bring about the expelling of the agent. Appropriately, the displacement of the catch requires comparatively little energy, so that the expelling of the agent can be effected in an energy-saving manner. Appropriately, the displacement movement is designed as a simple back-and-forth movement, for example as the tipping movement or swinging movement of a lever.

Preferably, the displacement of the catch is coordinately with a displacement of another catch such that at all times one catch prevents an uncontrolled advance of the piston beyond the preset stroke length.

According to a preferred embodiment form, the blocking mechanism is designed in a manner comparable to an escapement of a mechanical clock movement, which includes a blocking means, for example a ratchet wheel provided with toothing or a piston rod provided with toothing, and a

catch that works together with the blocking means in order to block and unblock in a controlled manner a displacement of the blocking means.

Appropriately, the catch is formed as a swingable anchor escape lever with two pawls that engage the toothing of the corresponding blocking means. In this way, through a simple and energy-saving back-and-forth movement of the anchor escape lever, the blocking means is moved along in each case by one tooth of the toothing. In this, according to the invention the movement of the blocking means is converted into an advance of the piston, the propulsive force being applied by the propulsion mechanism and not by the blocking means. Preferably, the piston is here fixedly connected to the blocking means, so that the piston, due to the permanent application of force, permanently exerts a tractive force on the blocking means, which force is released through a disengagement of a pawl from the toothing, so that the blocking means is displaced until the toothing becomes engaged with the other pawl, which automatically stops the advance of the piston. Thus, the dose to be expelled is definitely predetermined through the toothing, namely through a whole-number multiple of the tooth spacing, in particular one times the tooth spacing of the toothing. Through a moving back of the catch or of the anchor escape lever, as the case may be, the blocking mechanism is moved back into its initial position, in which the piston advance is permanently blocked.

Appropriately, the anchor escape lever of the catch is formed such that during engagement of one catch with the toothing of the blocking means, the other catch is positioned centrally between two teeth of the toothing. If the anchor escape lever is now swung, then the above-described course of movement is triggered.

The toothing that works together with the catch can be provided at an appropriate location in the mechanism, as known from the prior art. According to an embodiment form, the toothing is provided on the outer circumference of a ratchet wheel. In this case, a rotary motion of the ratchet wheel is transferred to the propulsion of the piston. Appropriately, in this embodiment form, a holding means, for example a cable or band, is wound around a rotational axis or an outer circumference of the ratchet wheel and this holding means is unwound upon the advance of the piston.

According to another embodiment form, the toothing is applied to a toothed rack, the displacement of which is transferred directly or indirectly to the piston advance. Advantageous in this embodiment form is the fact that a holding means can be done without, so that a potential source of failure of the device is eliminated.

According to another embodiment form, the blocking mechanism is designed as a spindle blocking, comparable to a spindle escapement known from clock construction. In this embodiment form, the catch includes a rotationally-movable shaft that carries two blocking projections that work together

with a toothing on the top side on opposite sides of the rotary axis of the ratchet wheel, wherein a rotation of the shaft releases the engagement of a blocking projection with the toothing and thus triggers a further turning of the ratchet wheel, until another tooth of the toothing of the ratchet wheel reaches a stopping position with the opposing blocking projection, which automatically ends the piston advance. The blocking toothing can here be provided on a top side of a separate ratchet wheel, in which case a holding means, for example a band or cable, is appropriately wound around the rotary axis or an outer circumference of the ratchet wheel, which holding means restrains the piston. For the piston advance, the holding means is unwound in a controlled manner. Alternatively, the blocking toothing can also be applied to a top side of a separate ratchet wheel, the rotational movement of which is transferred by means of a gearing mechanism to a piston rod or threaded bar or another advancing means. Finally, the blocking toothing can also be arranged directly on a front side of the piston rod or threaded bar, which serves directly or indirectly the advancing of the piston.

Appropriately, the blocking projections of the spindle blocking are arranged in a staggered manner on the rotationally-movable shaft, so that at all times one of the blocking projections blocks an uncontrolled rotation of the ratchet wheel, wherein in first angular position of the shaft a first blocking projection engages a toothing of the blocking means and the second blocking projection is positioned centrally between two teeth of the toothing, and in a second angular position of the shaft the second, opposite blocking projection engages the toothing of the blocking means and the first blocking projection is positioned between two teeth of the toothing. Thus, through a simple back-and-forth swinging of the rotationally-movable shaft, the ratchet wheel can be rotated forward by one tooth, the propulsion force being provided through the propulsion mechanism and not through the blocking mechanism.

Preferably, for the triggering of the expelling of the agent the catch is displaced against a restoring force of a restoring means that attempts to put the catch back into a resting or initial position. Thus, the blocking mechanism automatically returns into a resting or initial position and the only energy required in order to trigger the expelling of the agent is that needed to displace the catch against the restoring force. The releasing of the blocking mechanism can be initiated here through mechanics, for example the pressing of a button, if the device is manually operable, or through an actuation means that is triggered by an electronic control of the device.

Preferably, the propulsion mechanism can be prestressed over the entire stroke of the piston, so that the piston can be advanced until the agent has been completely expelled from the receptacle without requiring the propulsion mechanism to be prestressed again. It is advantageous that the prestressing work required for this can be performed manually or by an external energy source before the placing into operation of the device, so that the energy source of the device can be completely spared.

According to another embodiment form, however, the propulsion mechanism can be prestressed over a portion of the maximal piston stroke, so that the propulsion mechanism must be prestressed again one or several times up to the complete expelling of the agent. Appropriately provided for this purpose is an indicator device that indicates to the user that the propulsion force provided by the propulsion mechanism has fallen under a presettable or preset threshold value. This indicator device can operate mechanically, for example through a mechanical activation of a color field as the indication, or can be triggered electronically, for example in the form of a warning on an LCD display or the like, if necessary aided by an acoustic warning signal, as an indication that the device must be prestressed again.

In principle, the mechanical work required for the prestressing of the propulsion mechanism can also be performed manually by the user of the device, or through connection to an external energy source. If, however, the propulsion mechanism is not prestressed even after several warnings to the user, then the necessary energy is appropriately provided by the energy source of the device, so that it is ensured that the device is ready for operation at all times.

According to another embodiment form, the blocking mechanism can also be designed as a band block, wherein the band block clamps a band that restrains the piston against the permanently active propulsion force of the propulsion mechanism and wherein upon the release of the band block the slipping through of the band is converted into the piston advance. Appropriately, the band block is here formed such that this permanently clamps the band, for which purpose suitable measures from the prior art are known to the specialist in this field.

In principle, the band-blocking mechanism can be combined with the above-mentioned anchor escape lever or blocking spindle. In this embodiment form, the displacement of the band block and of the anchor escape lever or blocking spindle are appropriately coordinated such that first the anchor escape lever or, as the case may be, the rotationally-movable shaft with the blocking projections is swung from one end position to the other end position. In this, a turning of the ratchet wheel is still blocked by the band block. Through the release of the band block, the ratchet wheel can then be rotated until one tooth of its toothing meets the pawl or the blocking projection. After this, the band block again permanently blocks. For a renewed expelling of the agent, the anchor escape lever or, as the case may be, the shaft with the blocking projections is swung back into the other end position. Thus, the catch need be displaced only once for an expelling of the agent.

In the following, preferred embodiment forms of the invention are described in an exemplary manner and with reference to the accompanying figures, in which:

Fig. 1: represents an expelling device according to a first embodiment form of the present invention with an anchor escape lever blocking,

Fig. 2: represents a variant of the first embodiment form with a blocking spindle,

Fig. 3: represents a second embodiment form of the expelling device according to the present invention, wherein a ratchet wheel is attached to an end side of a toothed rack or threaded bar, which ratchet wheel works together with a blocking spindle,

Fig. 4: represents a variant of the embodiment form according to Fig. 4, wherein an anchor escape lever is provided, which works together with the toothing of a toothed rack,

Fig. 5: represents schematically an expelling device according to a third embodiment form of the present invention, wherein the piston advance is produced through expansion of a gas reservoir that is pressurized, and

Fig. 6: represents a fourth embodiment form of the expelling device according to the present invention.

In the figures, identical reference numerals indicate identical or functionally similar components or component groups.

Fig. 1 shows schematically a first embodiment form of an expelling device according to the present invention. This is preferably part of an infusion or injection device, for example an infusion pump for long-term medicating of patients or animals, for example for blood-sugar adjustment. As is shown in Fig. 1, the device includes a reservoir 1, in which a liquid containing the agent is stored. The receptacle 1 displays at its front end an opening through which the agent is expelled, for example to a hollow cannula. Situated opposite the expelling opening is the axially displaceable piston 2, the axial adjustment of which in the direction of the expelling opening causes the expelling of the agent. The piston 2 is permanently prestressed by means of the compression spring 8 against a fixed reference point 5, which is stationary in relation to the blocking mechanism in the right side of the image and/or in relation to the receptacle 1. Attached to the back side of the piston 2 is a holding means, for example a cable or band, which restrains the piston against the restoring force of the spring 3. The holding means 4 is deflected at the deflection points 6 and 7, for example at deflection rollers or deflection pins. The other end of the holding means is connected to the blocking mechanism represented in the right-hand portion of the image.

For this purpose, as shown in Fig. 1, the other end of the holding means 4 is wound onto the ratchet wheel 9, whether this is directly in a circumferential channel of the ratchet wheel 9 or onto a pin arranged on the rotary axis 8 of the ratchet wheel 9. According to Fig. 1, the ratchet wheel 9 displays on its outer circumference a preferably circular ratchet toothing 10 extending in the rotational direction, the teeth of which toothing work together with the pawls 13, 14 of the anchor escape lever 11. The blocking mechanism according to Fig. 1 is overall comparable to an anchor escapement as this is known from clock construction. Thus, the anchor escape lever 11 can be swung back and forth around the axis 12 between a first end position, in which the pawl 14 rests against a tooth of the toothing 10, and a second end position, in which the pawl 13 rests against a tooth of the toothing 10. The anchor escape lever 11 can be restored to one of the end positions by

a restoring means (not shown). It is thus ensured that the ratchet wheel 9 cannot rotate forward in an uncontrolled manner.

As is schematically represented in Fig. 1, the anchor escape lever 11 is designed in such a way that when the pawl 14 is engaged with the ratchet toothing 10, the other pawl 13 is positioned centrally between two teeth of the toothing. Upon further rotation of the ratchet wheel 9, the pawl 13 is consequently carried along by a toothing surface and thus the anchor escape lever is tipped back into the other end position.

In order to place the device into operation, the compression spring 3 is prestressed, for example through introduction of a new receptacle with the piston 2 maximally pushed back. In this, the ratchet wheel 9 is turned back until the holding means 4 is tensioned. In order to turn back the ratchet wheel 9, a restoring means (not shown), for example a torsion spring or an electric restoring mechanism, can be provided. For the expelling of the agent, the anchor escape lever 11 is swung from a first end position to the second end position. Thereby, due to the prestressing through the compression spring 3, the piston 2 is propelled and an expelling of the agent effected. Simultaneously, the holding means 4 deflected around the deflection grooves 6 and 7 turns the ratchet wheel 9 ahead until one of the pawls 13, 14 of the anchor escape lever comes to rest against a tooth of the ratchet toothing 10. A forward turning of the ratchet wheel 9 is then excluded. The ratchet wheel can be turned forward only after a swinging back of the anchor escape lever 11 into the other end position. Thus, the expelled dose of the agent is preset in a one-to-one manner through the ratchet toothing 10 of the ratchet wheel 9. The angular displacement of the ratchet wheel 9 by one tooth is converted one-to-one into a predefined stroke of the piston 2.

Fig. 2 shows a variant of the first embodiment form in which the blocking mechanism has a design comparable to a blocking spindle known from clock construction. In this variant, a toothing 15 is provided on a top side of the ratchet wheel 9, which works together with the two blocking projections 16, 17 of a shaft 18. The shaft 18 is supported such that it is rotatable, around a rotary axis, in a radial manner with respect to the rotary axis 8 of the ratchet wheel 9. The shaft 18 is rotatably supported such that it can be rotated back and forth only between a first end position, wherein the blocking projection 17 lies against one of the teeth of the ratchet toothing 15, and a second end position, wherein the other blocking projection 16 lies against one of the teeth of the ratchet toothing 15, so that one of the two blocking projections 16 and 17 accordingly swings into engagement and the other out of engagement. Thus, it is ensured that the ratchet wheel 9 cannot turn forward in an uncontrolled manner. Rather, the ratchet wheel can always be turned forward by only one tooth, which is brought about by the rotation of the shaft 18 from one end position into the other. In this embodiment form too, the other end of the holding means 4 is wound either into a circumferential channel of the ratchet wheel 9 or around a pin placed onto the rotary axis 8 of the ratchet wheel 9 and is unwound upon the advancing of the piston 2.

In principle, however, the blocking mechanism can also be integrated into the device such that a holding means is superfluous. Fig. 3 shows a second embodiment form of the expelling device according the invention that does without a holding means. According to Fig. 3, the ratchet wheel 9 is attached directly to one end of a threaded bar 21 serving the piston propulsion. Prior to the placing into operation of the device, the ratchet wheel 9 is turned back against the restoring force of a torsion spring 23 or another suitable restoring means. The blocking spindle represented schematically in Fig. 3 then triggers a turning of the ratchet wheel 9, in the manner described above, by one tooth in each case. The outer thread of the threaded bar 21 engages an inner thread, provided on a housing of an infusion pump or on the ampoule 1, of a section 22, so that the rotation of the threaded bar 21 is converted into a piston advance. If the section 22 is fixedly connected to the housing, then the threaded bar can be connected to the ratchet wheel 9 in a rotationally-secured and axially-movable manner and itself form a piston rod. Alternatively, the threaded bar 21 can be fixedly connect to the ratchet wheel. In this case, the section 22 is guided by the housing in an axially-linear manner and can form the piston rod.

It goes without saying that the ratchet wheel 9 according to Fig. 3, instead of being provided with a ratchet toothing 15 on the top side, can as well be provided with a ratchet toothing on the outer circumference of the ratchet wheel 9, comparably to Fig. 1. As is evident to the specialist, the ratchet wheel 9 can also be connected to the threaded bar 21 serving the piston propulsion via a gearing mechanism, so that the turning movement of the ratchet wheel 9 is transferred to the threaded bar 21 via the gearing mechanism.

Figure 4 shows a further embodiment form of the expelling device according to the present invention that does without a holding means. In this device, serving the piston propulsion is a rod 24 that is designed as a toothed rack with a ratchet toothing 25. The ratchet toothing 25 works together with the rotatably-supported anchor escape lever 11, which in the functions in the same manner as the anchor escape blocking represented in Fig. 1. Thus, in a first end position of the anchor escape lever 11 the pawl 14 lies against one of the teeth of the ratchet toothing 25. Through a swinging of the anchor escape lever 11 into the other end position, the pawl 14 becomes disengaged from the ratchet toothing 25 and the other pawl 13 becomes engaged with another tooth of the ratchet toothing 25. Due to the permanently-active propulsion force generated by the propulsion mechanism (not shown), the toothed rack 24 is advanced, in order to effect the expelling of the agent from the receptacle 1. In this, the pawl 13 glides along the profile of a ratchet tooth and is lifted, so that the anchor escape lever 11 is swung back into the initial position, in which the pawl 14 blocks the further propulsion of the piston. Here, the anchor escape lever 11, during the swinging from the first end position shown in Fig. 4 into the other end position (not shown), is swung against the restoring force of a restoring means (not shown), so that the swinging back of the anchor escape lever 11 into the blocking position represented in Fig. 4 is ensured.

Fig. 5 shows a third embodiment form of the expelling device according to the present invention. According to Fig. 5, the force for the propulsion of the piston is applied by a gas stored in a pressurized chamber 26. Prior to the placing into operation of the device, the pressurized chamber 26, in the rearward end position of the piston 2, is filled with a pressurized gas under high pressure. The pressurized chamber 26 has a flexible wall, so that the gas expands and the pressurized chamber 26 can expand when the blocking mechanism enables the piston advance. As is shown in Fig. 5, the pressurized chamber 26 is supported on a housing section 5 and on the rearward base of the piston 2 and is laterally guided by a sleeve 27, so that the gas can expand the pressurized chamber 26 only in one direction, namely in the piston-propulsion direction, i.e. in the axial direction of the receptacle 1. In principle, the blocking mechanism can be designed according to any of the embodiment forms described here. In order that the pressurized chamber 26 can expand, at least its side walls must be flexibly formed. The pressurized chamber can, for example, be ring-shaped, so that the holding means 4 can be guided through the pressurized chamber up to the piston 2.

Fig. 6 shows a further embodiment form of the expelling device according to the invention. Instead of the above-described anchor escape blocking (cf. Figs. 1, 4) or blocking spindle (cf. Figs. 2, 3), the blocking mechanism includes a first catch 28 and a second catch (not shown) that is identical in design to the first catch. The ratchet wheel 9 displays on its outer periphery a ratchet toothing 10, which works together with the first catch 28. Further provided is a second ratchet toothing (not shown), which works together with the second catch. The second ratchet toothing can be provided on the same or on another ratchet wheel. The two catches can be swung, as indicated by the double arrow, it being ensured, however, that when one catch swings away from the corresponding ratchet toothing, the other catch automatically engages the other corresponding toothing. Thus, it is always ensured that the ratchet wheel cannot spin uncontrolled. Through a coordinated displacement of the catches, the ratchet wheel is thus turned forward by a half tooth. Upon the coordinated swinging back of the two catches, the ratchet wheel is again turned forward by a half tooth and the two catches revert to their initial positions. Upon the turning of the ratchet wheel 9, the other end of the holding means 4 is unwound. Due to the permanently active propulsion force of the compression spring 3, the piston 2 is advanced in order to expel the agent.

According to a further, unrepresented variant of this embodiment form, the catch according to Fig. 6 has a forked shape, with two blocking projections that, according to the angular position of the fork, engage the ratchet toothing 10 either on the left or on the right peripheral edge of the ratchet wheel 9. Here, the spacing between the two blocking projections is dimensioned such that during the swinging of the fork-shaped catch, one of the two blocking projections engages the ratchet toothing at all times.

To operate the expelling device, first the propulsion mechanism is prestressed, for example through a pushing back of the compression spring or rotating back of a torsion spring. At the same

time, the blocking mechanism is brought into a starting position, in which a pawl or a blocking projection engages the ratchet toothing 10 or 15, as the case may be. Through displacement of the blocking mechanism, for example through a swinging of the anchor escape lever shown in Fig. 1 or 4 or the blocking spindle shown in Fig. 2 or 3, a turning forward of the ratchet wheel 9 is triggered, until a tooth of the ratchet toothing 10, 15 again becomes engaged with a pawl or a blocking projection. In this, the movement of the ratchet wheel or of the piston rod shown in Fig. 4 is converted into the piston propulsion. The propulsive force necessary for this originates from the propulsion mechanism and not from the blocking mechanism. For a renewed expelling of the agent, the blocking mechanism is actuated again.

In principle, the actuation of the blocking mechanism can occur manually, for example through the pressing of a button on a mechanically-actuated injection apparatus, for example an injection pen for diabetes patients. Preferably, however, the expelling device according to the present invention is electronically controlled, for which purpose an electronic control (not shown) is provided, which control with the aid of an actuation means (likewise not shown) releases the blocking mechanism in a controlled manner. Through a simple counting of the occurrences of the releasing of the blocking mechanism, the administered dose can be calculated at any time. Since the piston advance, as described above, is predetermined on a one-to-one basis through the ratchet toothing, with knowledge of the conversion ratio a piston stroke and thus an expelled agent dose can be associated one-to-one with the displacement of the blocking means by one ratchet wheel of the ratchet toothing. Thus, through a simple multiplication of the number of occurrences by this agent dose, the total agent dose can be calculated at any time.

While it was stated above that the blocking mechanism includes a blocking toothing and a catch that works together with this toothing, in principle any suitable blocking mechanism known from the prior art can be used for the expelling device according to the present invention. For example, the holding means can be a band that is permanently blocked by a band block known from the prior art and that, upon release of the band block, slips through until the band block again clamps the band. It goes without saying that such a band block can be combined with each of the above-described blocking mechanism. In such a variant, the dose to be expelled would, as described above, be determined on a one-to-one basis through a ratchet toothing and a catch working together with this toothing. The catch could, however, be moved back and forth between the two end positions without greater forces of resistance. The actual forward turning of the blocking means would then be triggered through the release of the band block. When the catch becomes engaged again with the ratchet toothing, the further advance of the piston is ended. Subsequently, the band block again clamps the band.

It goes without saying that the catch, e.g. the anchor escape lever or the rotatable spindle, can be locked into each of its end positions in order to prevent an uncontrolled displacement of the catch.

As described above, the expelling device according to the invention can be installed in both manually-actuated and electronically-actuated infusion or injection apparatuses. These can be used for injection of a medical agent, but also of a diagnostic agent, in human, animal, or plant tissue. Due to the low energy demand of the expelling device according to the invention, the latter is especially suitable for application in infusion pumps for the repeated release of comparatively small doses of a therapeutic agent over a comparatively long period of time.

An especially preferred use relates to the long-term release of insulin for adjustment of the blood-sugar level of diabetes patients. For this purpose, the infusion pump can be controlled by a controller that is connected to a system of sensors for determining the blood-sugar level. The minimally administrable agent dose is here substantially predetermined through the ratchet toothing of the blocking means and through the conversion ratio of the expelling device selected in each case and can be selected so as to be appropriately low. Through a simple counting of how often the blocking mechanism is released, the control electronics at all times know how large the expelled dose is. This simplifies the control expense considerably, since simple timing-control circuits can be used. Due to the low energy consumption of the expelling device, the infusion pump can be operated over an advantageously long period of time. In particular for diabetes treatment, such an infusion pump could expel the insulin through a 31-gauge needle.

patent claims

1. Device for the dosed expelling of a liquid agent, especially for an infusion pump, comprising:

   a receptacle (1) for the storing of the liquid agent and

   a propulsion mechanism for the propelling of a piston (2) toward an outlet of the receptacle in order to expel the agent,

   characterized in that the propulsion mechanism continuously acts on the piston with a propulsive force, wherein a blocking mechanism (9, 11; 9, 16) is provided whereby a piston advance is permanently blocked and, in order to expel the agent, released.

2. Device according to claim 1, wherein the blocking mechanism is designed such that upon the release of the propulsive force the piston is advanced by a preset stroke in order to expel a preset dose of the agent.

3. Device according to claim 1 or 2, wherein the propulsion mechanism prestresses the piston (2) in relation to a reference point that is stationary in relation to the blocking mechanism.

4. Device according to one of the previous claims, wherein the propulsion mechanism includes a compression spring (3), one end of which acts on the piston (2) and the other end of which is held fixed.

5. Device according to one of the claims 1 through 3, wherein the propulsion mechanism includes a pressurized chamber (26) in which a gas is stored under pressure and which has a flexible chamber wall, so that the gas can expand in order to propel the piston when the blocking mechanism has been released.

6. Device according to one of the previous claims, wherein the blocking mechanism includes a blocking means (9; 24) and a catch (11) that works together with the latter, which catch in a first position blocks the piston propulsion and in a second position releases the piston propulsion in order to effect the expelling of the agent.

7. Device according to the previous claim, wherein the blocking means includes a toothing and the catch includes an anchor escape lever (11) with two pawls (13, 14), which lever can be swung around an axis (12) in order to block and release the blocking means.

8. Device according to the previous claim, wherein the anchor escape lever (11) is designed such that when the first pawl (13) is engaged with the toothing (10, 15) of the blocking means, the other pawl (14) is positioned centrally between two teeth of the toothing.

9. Device according to one of the claims 6 through 8, wherein the catch works together with an outer toothing (25) of a toothed rack (24).

10. Device according to one of the two previous claims, wherein the catch (11) works together with an outer toothing of a blocking means (9).

11. Device according to one of the claims 6 through 10, wherein the catch is designed as a blocking spindle with a rotatable shaft (18) that carries two blocking projections (16, 17) that work together with a toothing (15) on the top side of the blocking means (9).

12. Device according to the previous claims, wherein the blocking projections (16, 19) are applied to the rotatable shaft (18) in a staggered manner, so that in a first angular position of the shaft a first blocking projection (16) engages a toothing of the blocking means and the second blocking projection (17) is positioned centrally between two teeth of the toothing, and so that in a second angular position of the shaft the second blocking projection (17) engages the toothing of the blocking means and the first blocking projection is positioned between two teeth of the toothing.

13. Device according to one of the claims 10 through 12, wherein the blocking means as a ratchet wheel (9) is attached to one end of a toothed or threaded rod (21, 24), the other end of the toothed or threaded rod transferring the propulsive force to the piston (2).

14. Device according to one of the claims 6 through 13, wherein the blocking means includes two toothings that are offset with respect to each other, which toothings in each case work together with a blocking projection of the catch, so that in a first position of the catch one blocking projection works together with a first toothing of the blocking means and in a second position of the catch the other blocking projection works together with the other toothing, the other blocking projection in each case releasing the corresponding toothing.

15. Device according to one of the claims 6 through 13, wherein in order to trigger the expelling of the agent the catch (11, 18) is displaced against a restoring force that restores the catch to an initial position.

16. Device according to one of the previous claims, wherein the blocking mechanism is electronically controlled.

17. Device according to one of the claims 1 through 15, wherein the blocking mechanism includes a mechanical actuation means in order to release the blocking of the piston propulsion.

18. Device according to one of the previous claims, wherein the propulsion mechanism (3) is prestressed over the entire stroke of the piston (2).

19. Device according to one of the claims 1 through 17, wherein the propulsion mechanism (3) is prestressed over a displacement distance that is shorter than the entire stroke of the piston (2),

a detector being provided for determining whether the propulsive force has fallen below a threshold value, and a mechanism being provided for increasing the propulsive force of the propulsion mechanism.

20. Device according to one of the previous claims, wherein a holding means (4) restrains the piston (2) against the permanent propulsive force of the propulsion mechanism (3).

21. Device according to one of the claims 1 through 5, wherein a band restrains the piston (2) against the permanent propulsive force of the propulsion mechanism (3), the blocking mechanism being designed as a band block whereby the band is permanently blocked and temporarily released in order to expel the agent.

22. Infusion pump for the long-term release of an agent, including a device according to one of the previous claims and a control apparatus that repeatedly releases the blocking mechanism in order to expel the agent.

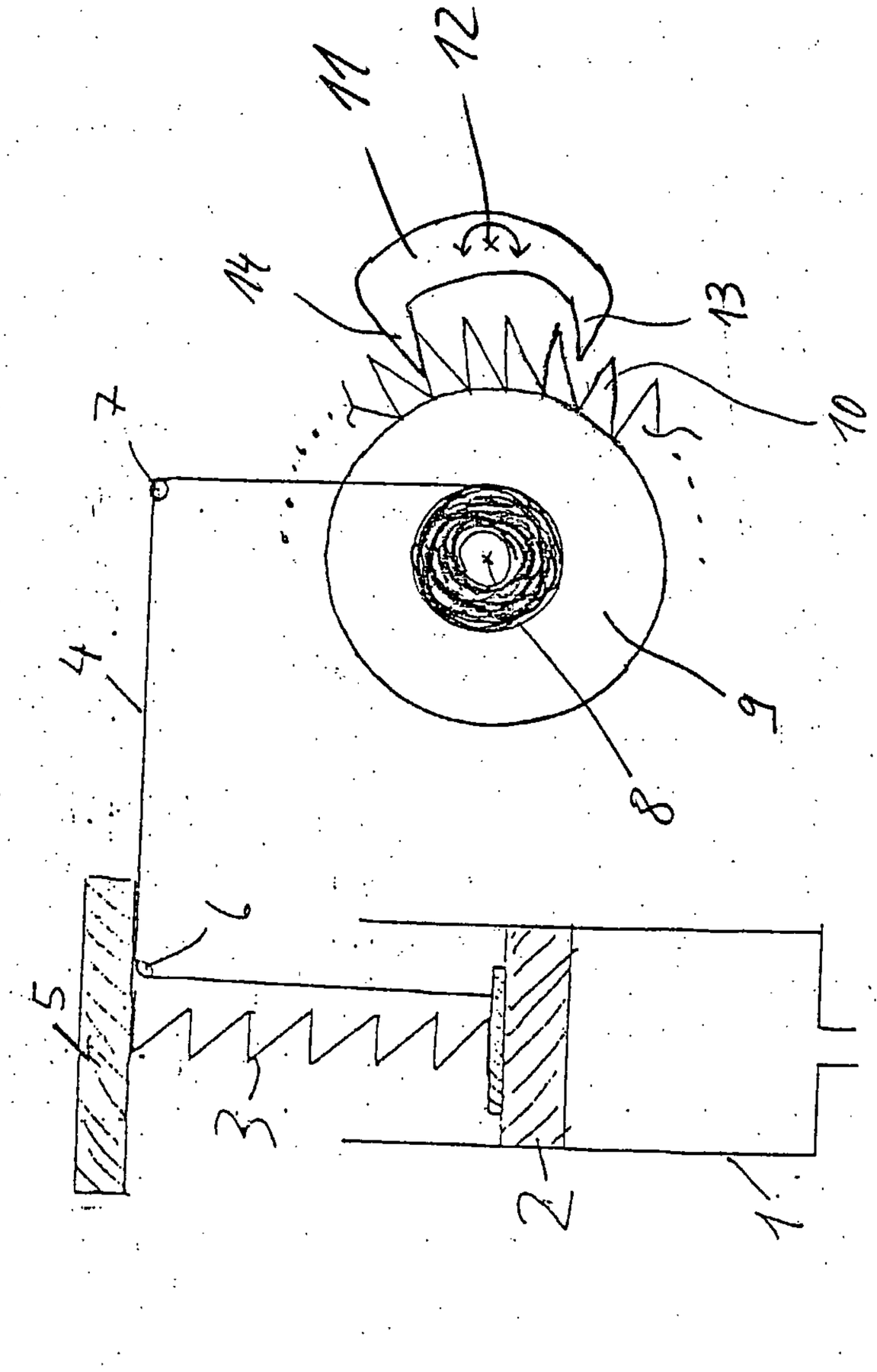


Fig. 1

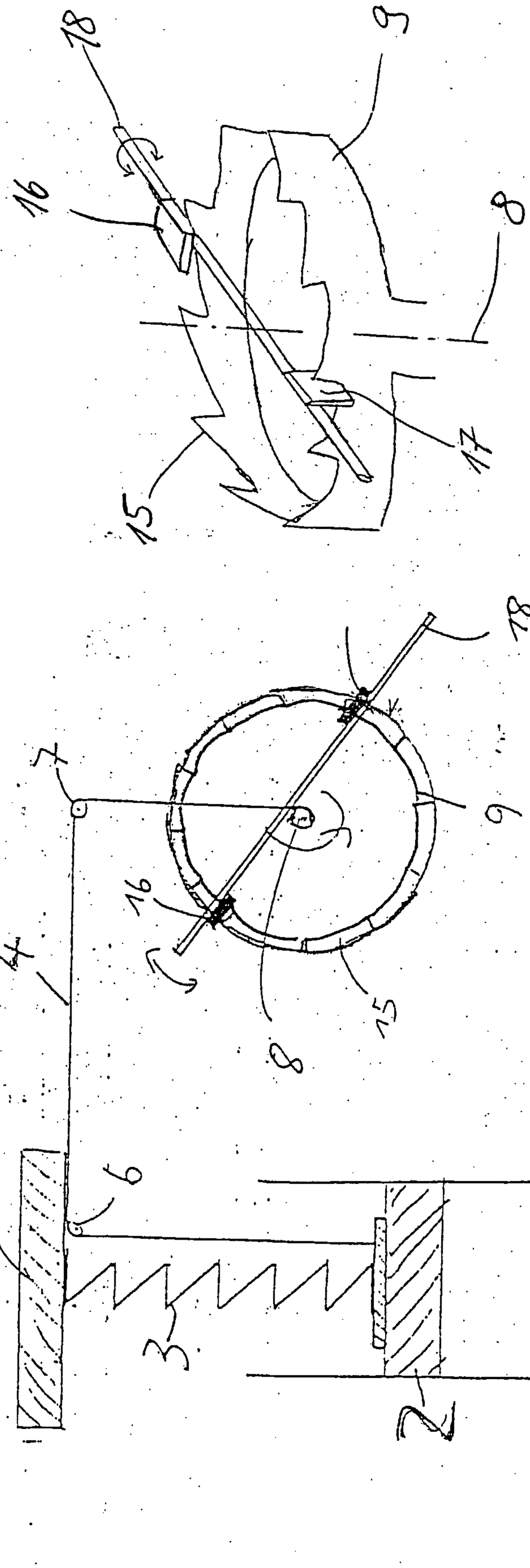


Fig. 2

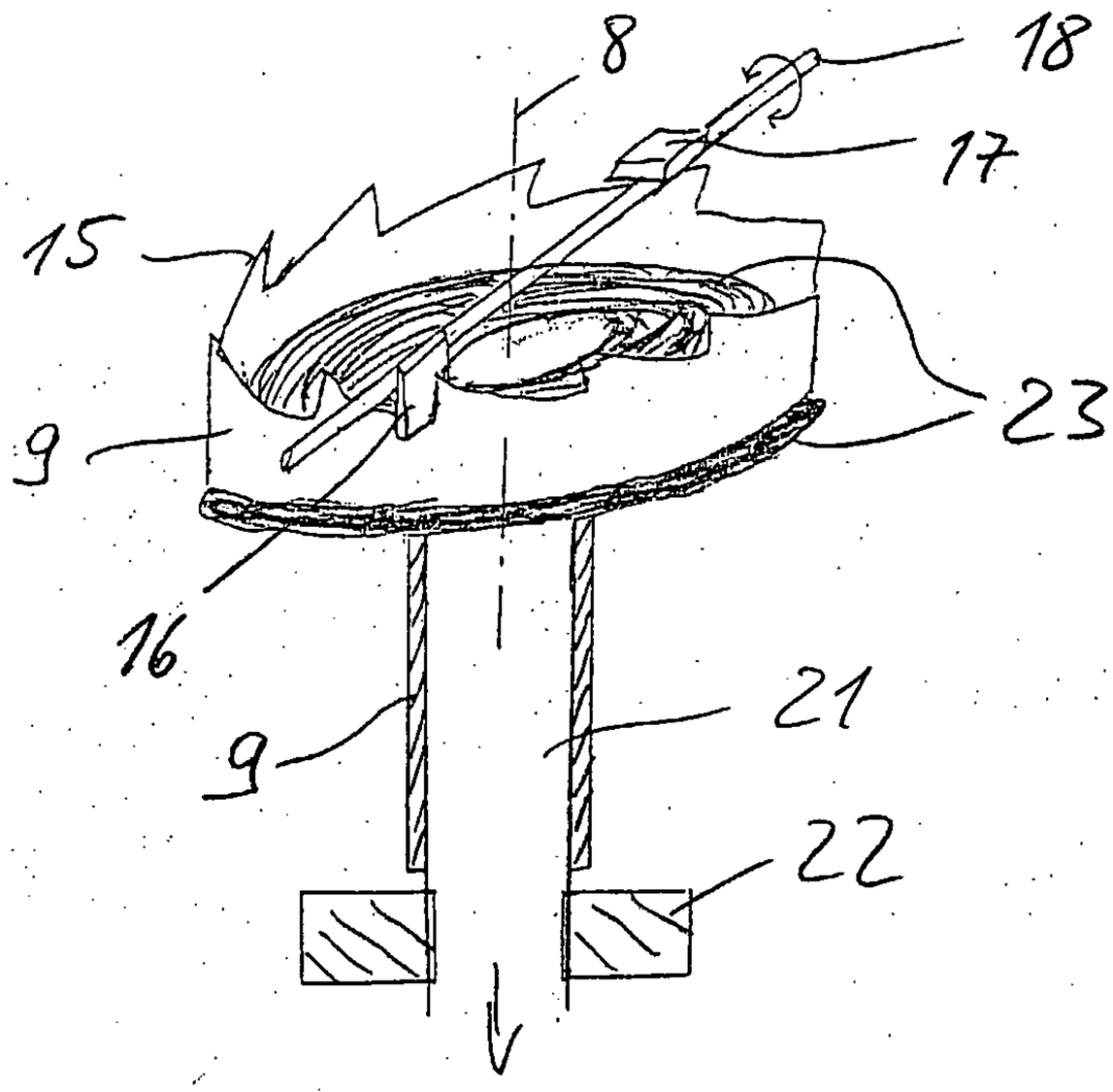


Fig. 3

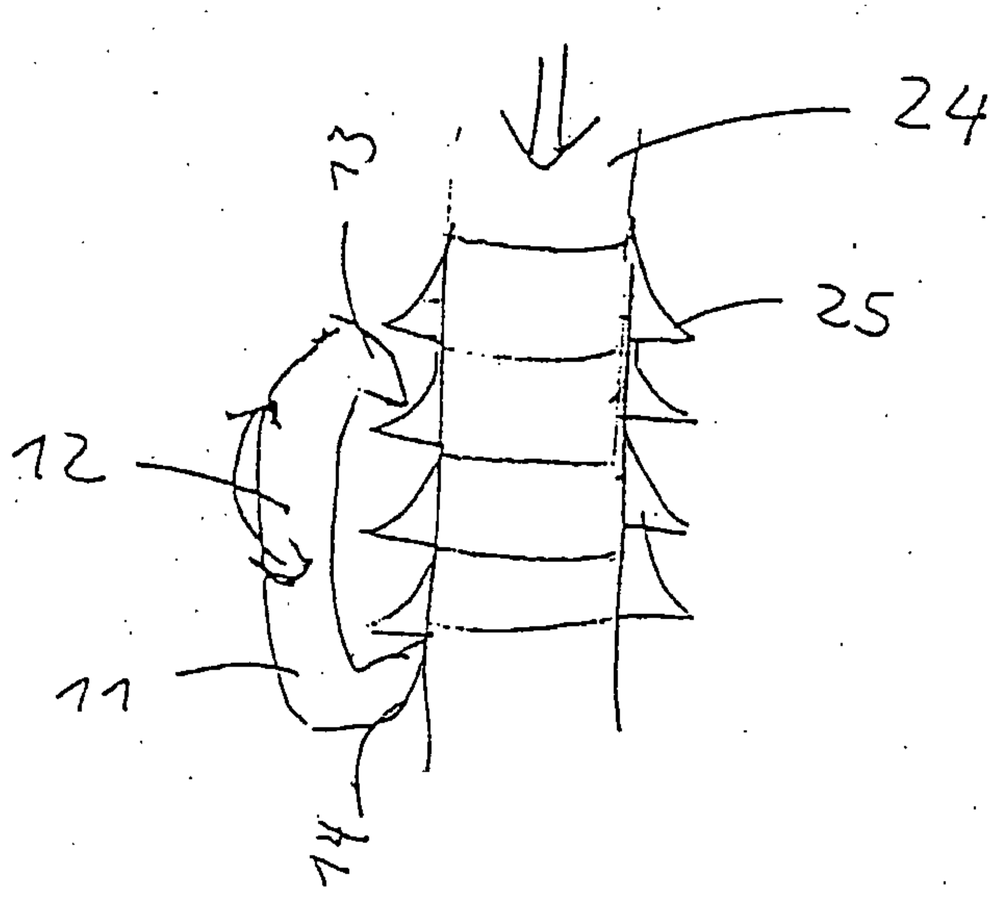


Fig. 4

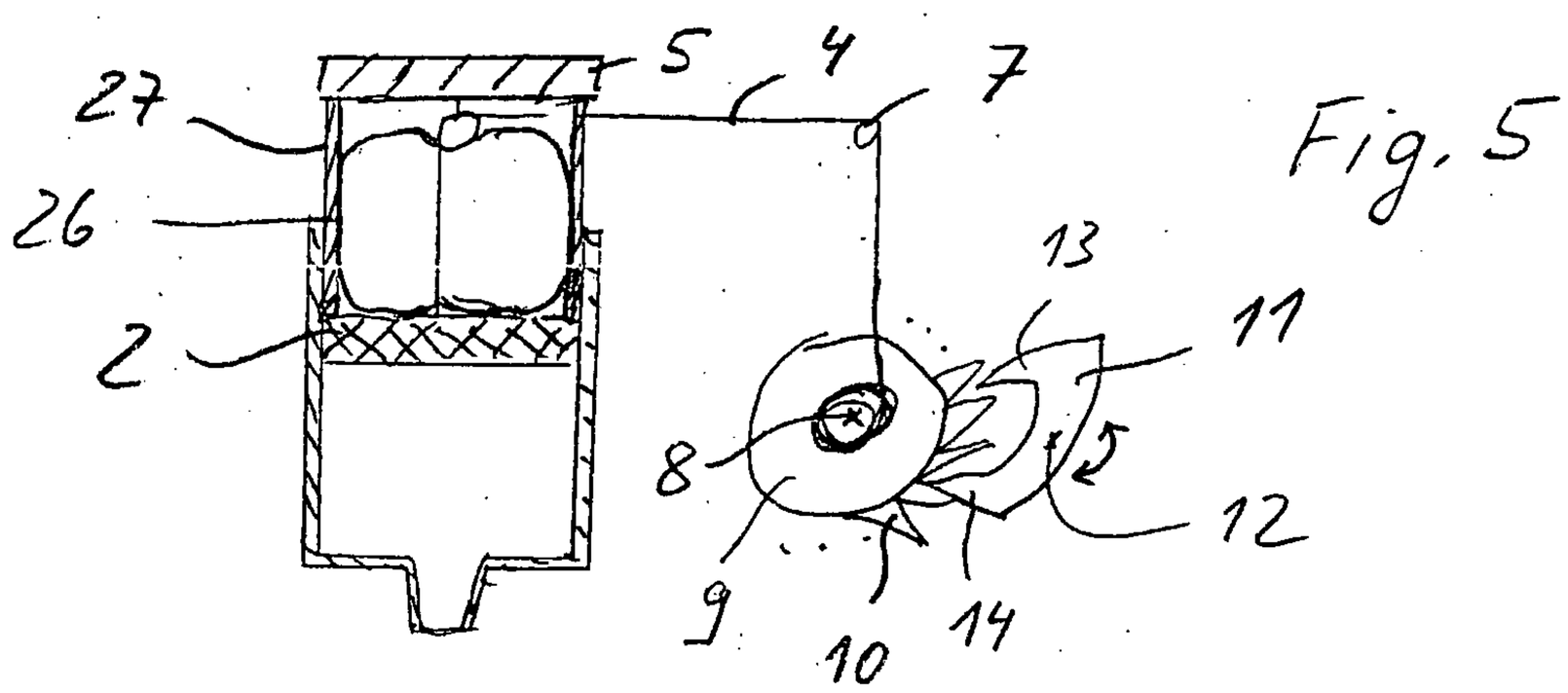


Fig. 5

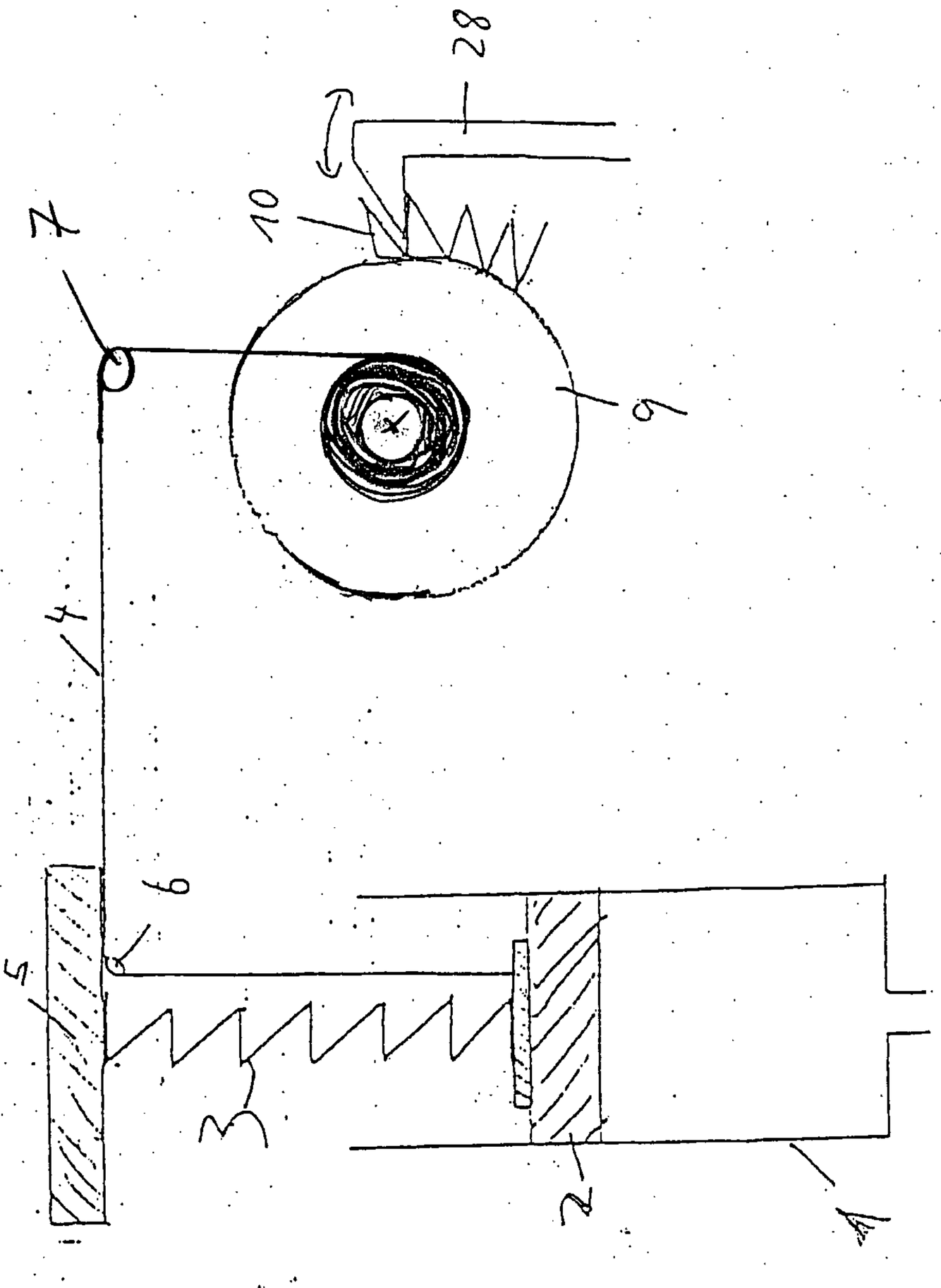
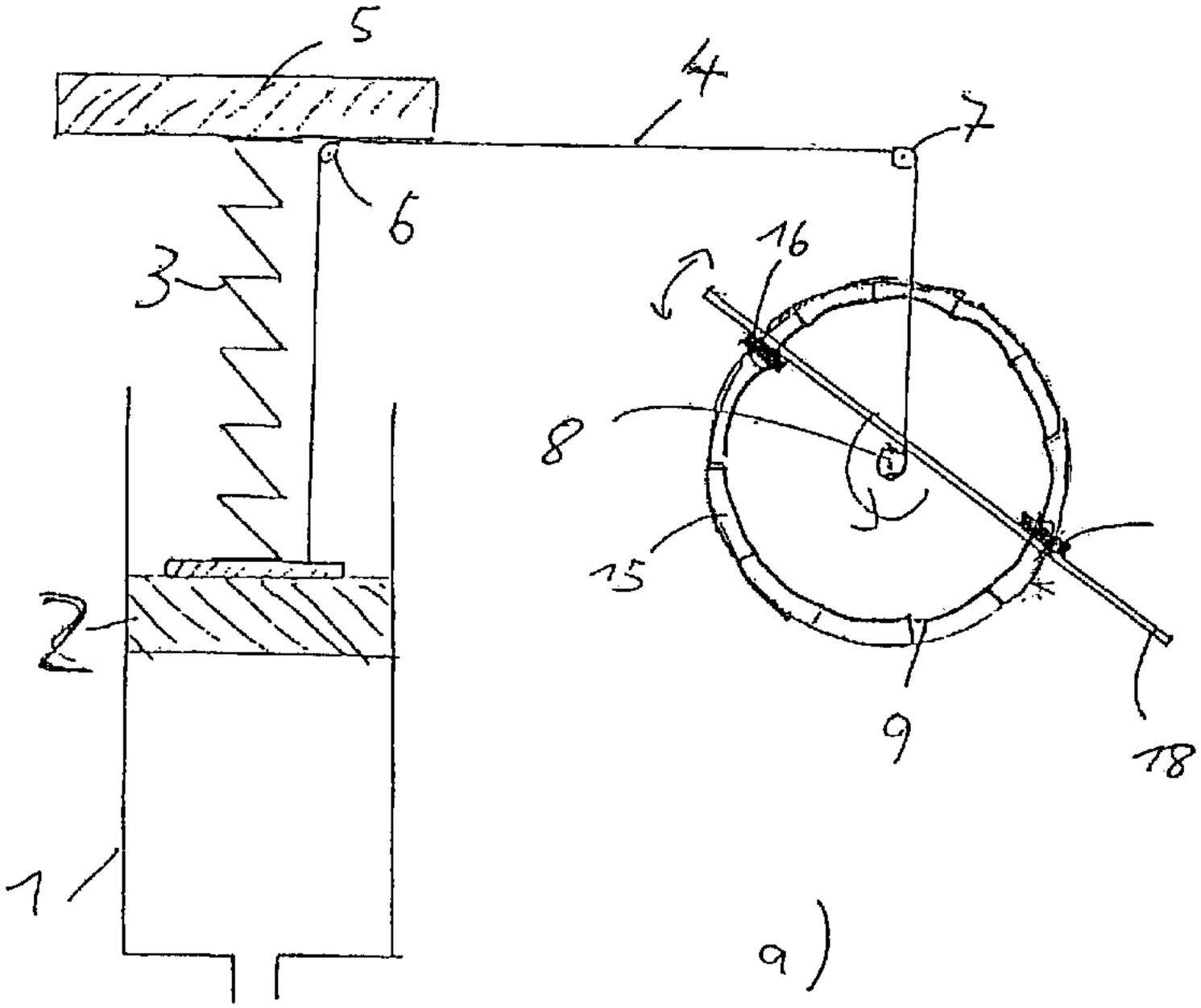
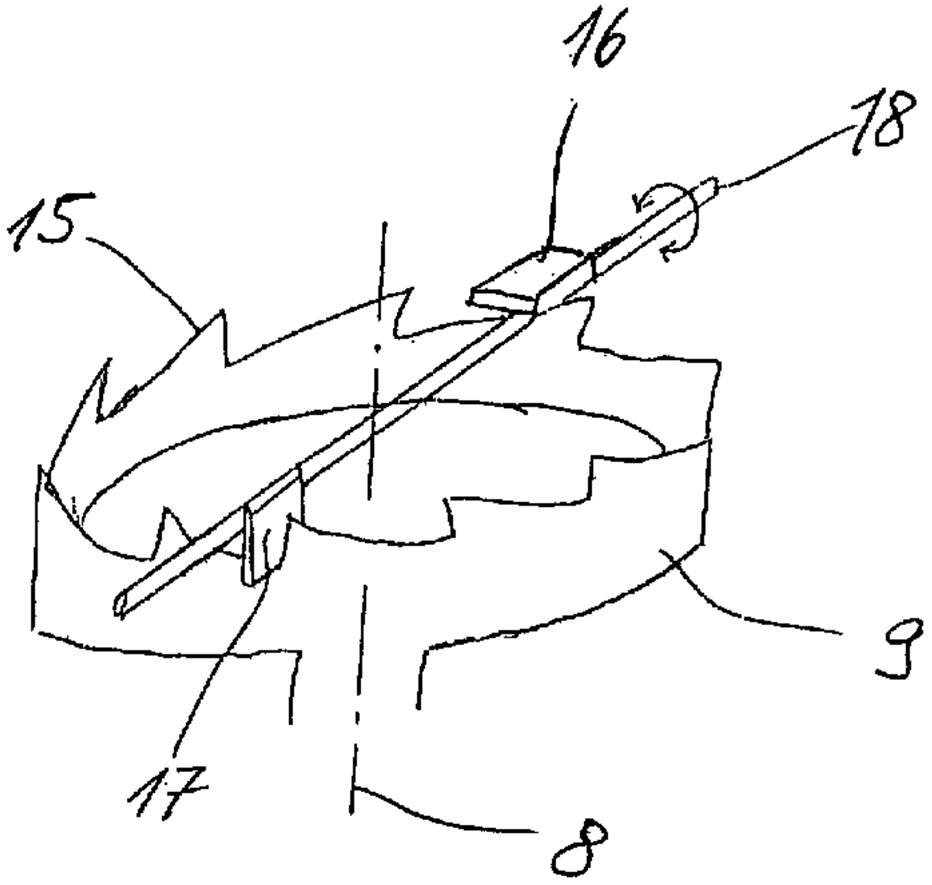


Fig. 4



a)



b)