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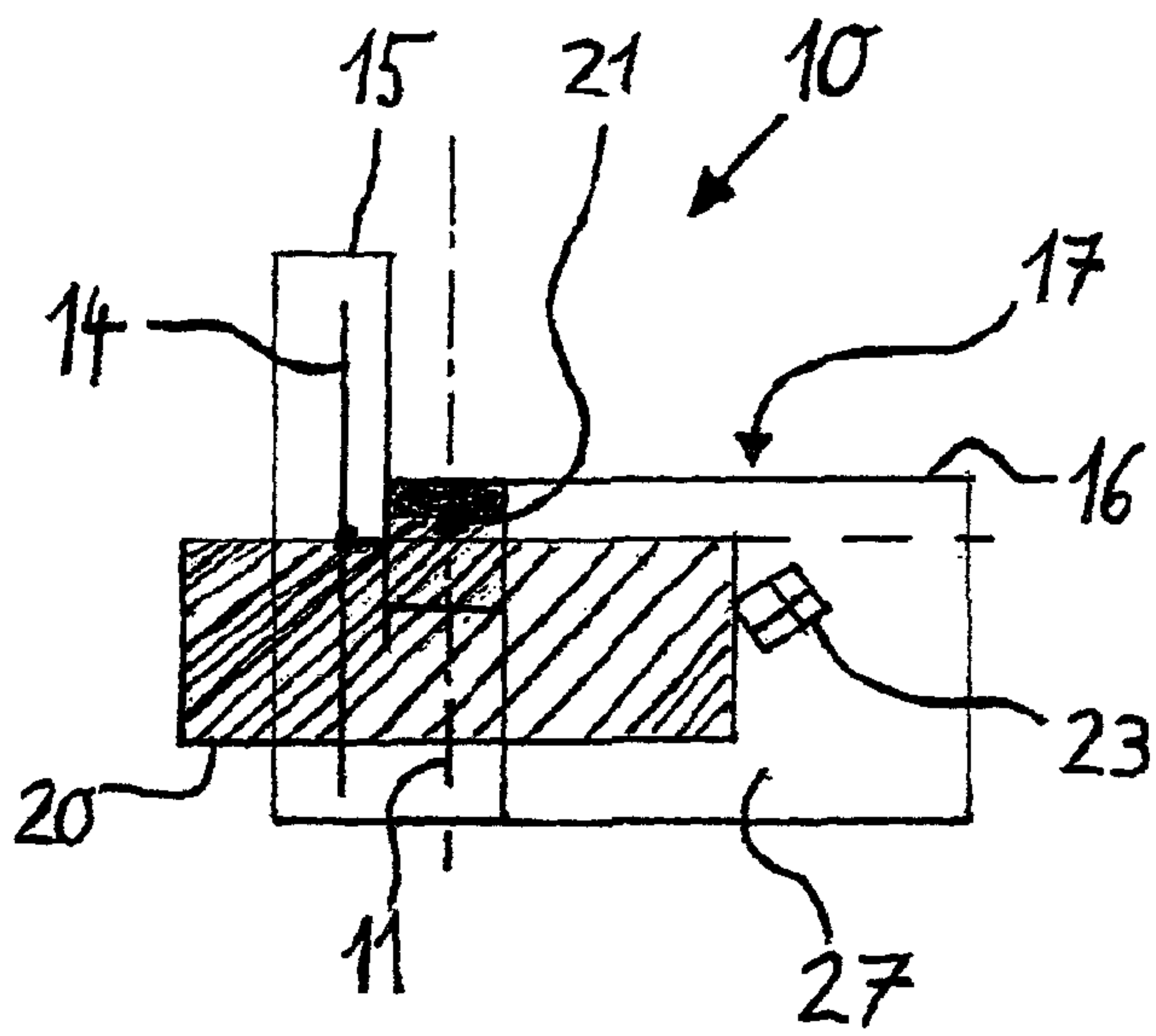


(57) Abrégé/Abstract:
The invention pertains to a remote-controlled miniature aircraft with at least one lift surface (17), with at least one pair of propeller drives (12, 13) and with a weight element (20), the position of which can be varied in the longitudinal direction of the miniature aircraft (10) in order to change the center of gravity of the miniature aircraft (10). In order to realize a more compact and more robust construction with improved flying characteristics, the lift surface (17) of the miniature aircraft (10) is arranged above a plane defined by the rotational axes of the propeller drives (12, 13) in order to generate a lifting force for taking off and/or landing from a standstill.

ABSTRACT

The invention pertains to a remote-controlled miniature aircraft with at least one lift surface (17), with at least one pair of propeller drives (12, 13) and with a weight element (20), the position of which can be varied in the longitudinal direction of the miniature aircraft (10) in order to change the center of gravity of the miniature aircraft (10). In order to realize a more compact and more robust construction with improved flying characteristics, the lift surface (17) of the miniature aircraft (10) is arranged above a plane defined by the rotational axes of the propeller drives (12, 13) in order to generate a lifting force for taking off and/or landing from a standstill.

Fig. 1

AIRCRAFT

The invention pertains to an aircraft, particularly a remote-controlled miniature aircraft, with at least one lift surface, with at least one pair of propeller drives and with a weight element, the position of which can be varied in the longitudinal direction of the aircraft in order to change the center of gravity of the aircraft.

An aircraft of this type is known from WO 2008/007147 A1. In this case, a pendulum arranged underneath the aircraft is used as weight element. A hovering state of the aircraft can be achieved if the pendulum is suitably positioned. This aircraft is furthermore equipped with a wing unit, a tail unit and respectively separate control surfaces.

In this case, it is disadvantageous that such aircraft or miniature aircraft can only be safely operated after an extended training period. In addition, such aircraft are relatively bulky, for example, due to a tail boom for the tail unit and/or the pendulum-like arrangement of the weight element. This complicates the transport of the aircraft. Furthermore, the aircraft may be easily damaged during its transport and/or unfavourable flight manoeuver.

This significantly limits the potential applications of an aircraft, for example, as a reconnaissance drone.

The invention therefore is based on the objective of enhancing an aircraft, particularly a remote-controlled miniature aircraft of the initially cited type, in such a way that a more compact and more robust construction with improved flying characteristics is realized.

In the inventive remote-controlled miniature aircraft, it is particularly advantageous that the lift surface is arranged above a plane defined by the rotational axes of the propeller drives in order to generate a lifting force, in particular, for taking off and/or landing from a standstill.

This makes it possible to realize a very compact construction. In addition, the proposed arrangement of the lift surface relative to the propeller drives already results in a high lifting force at a standstill and therefore promotes a very slow take-off and/or landing speed, particularly due to the Custer effect. The aircraft is particularly suitable as a vertical take-off and/or landing aircraft. In this context, the term propeller is also representative of air screws, rotors or other types of aerodynamic motors.

The lift surface is preferably realized in the form of an upper lift surface that is arranged above a lower lift surface, wherein the upper lift surface and the lower lift surface are, in particular, integrated into a single closed wing in order to realize an aircraft without fuselage. In this "closed wing" concept, the upper lift surface and the lower lift surface are rigidly connected to one another and spaced apart from one another by means of lateral surfaces on two lift surface ends that face away from one another, particularly over the entire chord of the upper lift surface and/or lower lift surface. A fuselage of the type used in conventional aircraft is not required. This promotes stable and therefore improved flying characteristics. The aircraft therefore is easier to control. A person can be trained in the operation, for example, of such a remote-controlled miniature aircraft in an accelerated fashion. Furthermore, a more compact and more robust construction is realized due to the closed wing.

The aircraft has a low weight, in particular, of less than 1 kg. Furthermore, the aircraft is essentially formed by the wing. This reduces the risk of damages to the aircraft, particularly in the form of an unmanned and remotely controlled miniature aircraft, during its transport and/or an unfavorable flight maneuver. The aircraft is preferably realized in the form of a flying wing. In a construction in the form of a flying wing or quasi-flying wing, projecting components such as, for example, a tail boom are largely avoided and the risk of damages during the transport or in flight is additionally reduced. The upper lift surface and the lower lift surface may be arranged on top of one another such that they completely overlap and an even more compact construction is achieved. The aircraft particularly stabilizes itself in flight and/or a stall is largely prevented.

According to another embodiment, the closed wing is realized in the form of a ring wing or a box wing. The ring wing is preferably realized in the form of a vertical ring wing such that a tubular body, which is open toward the front and the rear referred to the intended direction of flight, or an open ring results. Ring wings or box wings are known wing concepts that promote a robust construction and/or stable flying characteristics. Furthermore, wing constructions of this type have excellent lift characteristics such that slow take-off speeds can be realized. The lift surfaces and/or the wing may consist of a film material that can be cost-efficiently manufactured and easily transported. When utilizing film material, it can be simply rolled up for its transport. In this case, the installation is realized by simply unrolling and attaching the film material to a frame structure. It would also be conceivable to utilize carbon fiber materials or other suitable composite fiber materials as an alternative or in addition to a film material. This promotes a highly stable and lightweight construction.

According to an enhancement, the upper lift surface, the lower lift surface and/or the wing are realized rigid, film-like or inflatable. A rigid construction of the lift surfaces and/or the wing provides the advantage of a particularly stable and robust construction. In an alternative embodiment, the lift surfaces and/or the entire wing could be realized inflatable such that the aircraft can be packaged in a particularly space-saving fashion for its transport. For a sortie, the lift surfaces and/or the wing may be realized such that they are self-inflatable by means of a flowing air current, for example, like a paraglider or composed of chambers or tanks that can be inflated and closed. The chambers or tanks may be filled with air or with an operating medium for supplying a drive and/or a power supply unit for the aircraft. The chambers or tanks may contain, for example, hydrogen for operating a fuel cell assigned to the aircraft.

The propellers of the pair of propeller drives are preferably arranged in front of or behind the two lift surfaces referred to the longitudinal direction of the aircraft in order to generate an air flow over the upper lift surface and/or the lower lift surface. Consequently, two propellers of two propeller drives are positioned in front of or behind the one or more lift surfaces and/or the wing referred to the intended direction of flight. It is preferred to provide two or more pairs of propeller drives. One or more pairs of propeller drives are preferably arranged coaxially. During the operation, the rotating propellers already conduct and/or suck air over both lift surfaces of the wing with high speed at a standstill or at a very slow flying speed of the aircraft. This makes it possible to realize a particularly slow take-off speed. In an arrangement of an upper lift surface that is arranged above an upper lift surface, a surface area that is approximately twice as large as that of a construction with only a single lift surface can be utilized for generating lift. The aircraft is preferably realized in the form of a miniature aircraft that can take off from the hand of a person. The aircraft is realized, in particular, in the form of a vertical take-off and/or landing aircraft, i.e., it is VTOL-compatible (VTOL: vertical take-off and landing).

The pair of propeller drives is preferably arranged between the upper lift surface and the lower lift surface. This reduces the risk of damages to the propeller drives because the propeller drives are at least partially surrounded or shrouded by the two lift surfaces and/or the wing. In such an arrangement of the propeller drives, it is furthermore possible to realize small propeller diameters in order to generate a simultaneous air flow over the upper and the lower lift surface.

In addition, the upper lift surface and/or the lower lift surface is/are arranged between the rotational axis of the propeller drives and the maximum wingspan of the propellers. This ensures that air is conducted over the upper side of the lower lift surface and/or the upper lift surface with high speed by means of the propellers during the operation of the aircraft. This promotes a slow take-off speed and, in particular, a VTOL-compatible design of the aircraft.

The propellers of the propeller drives preferably are at least partially shrouded by at least one propeller guard in the region of the propeller circumference. This reduces the risk of damages to the propellers during the transport and/or in flight. The propellers of several propeller drives may respectively be shrouded by a propeller guard separately and, in particular, be realized in the form of shrouded propellers or the propellers are jointly shrouded by a single propeller guard. If a separate propeller guard is provided for each propeller, the individual propeller guard elements may be connected to one another by means of braces.

In addition, the propeller guard may be rigidly connected to one or more lift surfaces or the wing, particularly by means of braces, such that an altogether robust and compact construction is achieved. The construction of the aircraft is preferably realized in a semi-rigid fashion. This significantly reduces the risk of resonance effects. The wing lies, in particular, within the circumference of the propeller guard. The maximum height and width of the aircraft are defined, in particular, by the height and width of the propeller guard.

The static thrust of the shrouded propellers is preferably greater than the static thrust of non-shrouded propellers such that a slower take-off speed is additionally promoted. The propeller guard may have, for example, a cylindrical or tubular cross section or a cross section that is similar or identical to the wing shape or lift surface. The wing preferably has a smaller height than the propeller guard and is offset downward relative to a center line of the propeller guard. This promotes an excellent air flow over the upper side of the upper lift surface and/or lower lift surface.

According to an enhancement, a weight element is centrally arranged on the lift surface, particularly between the propeller drives. The weight element makes it possible, for example, to trim the aircraft about its lateral axis, particularly in order to compensate different load distributions. The weight element preferably serves for stabilizing the aircraft against external influences and/or negative aerodynamic effects. The weight element can furthermore be used for controlling the aircraft about its lateral axis such that the flying height can be adjusted. A weight element that can be variably positioned makes it possible, in particular, to eliminate a tail boom for a tail unit such as, for example, an elevator unit and/or rudder unit.

The weight element may be realized such that it can be linearly displaced in the longitudinal direction of the aircraft along its center line by means of a shifting mechanism or pivoted about a lateral axis of the aircraft by means of a pivoting mechanism such as, for example, a servomotor or an ultrasonic motor. The weight element is preferably connected to the lift surface and/or the wing underneath, in particular, the upper lift surface such that it can be pivoted about a lateral axis. In this way, the weight element and the pivoting mechanism are at least partially protected from external influences by the upper lift surface and/or the lower lift surface or by the wing, respectively. The weight element may be designed for accommodating equipment elements such as, for example, a control, sensors, energy cells, payloads, etc.

According to another embodiment, a control is provided for controlling the aircraft, particularly by means of a remote control, wherein the flight attitude referred to a longitudinal axis and/or a vertical axis of the aircraft can be adjusted by means of a difference between the propulsive forces, preferably between the rotational speeds or chord incidences of the propeller drives. The flight attitude referred to the lateral axis may furthermore be adjustable by means of a displacement of the weight element. Consequently, a change of the flight attitude about a longitudinal axis, a vertical axis and/or a lateral axis of the aircraft can be realized without control surfaces. This reduces the risk of damages to the aircraft during its transport and/or in flight. The flight attitude of the aircraft is merely controlled by means of the trust, particularly the rotational speed of the propeller drives, and by means of the weight distribution in the longitudinal direction of the aircraft.

In order to realize the control by means of the rotational speed, it is necessary to provide at least one or more pairs of propeller drives. In this case, the propeller drives of a pair of propeller drives are shifted from the center of the aircraft such that they face away from one another. For example, if the rotational speed of a first propeller drive is reduced, the propulsive force generated by this propeller drive is also reduced. If the rotational speed of a second propeller drive is simultaneously maintained at the original level of the first propeller drive or increased, the propulsive force of the second propeller drive is higher than the propulsive force of the first propeller drive. This causes the aircraft to turn about its vertical axis in the direction of the first propeller drive. If the aircraft should turn about the vertical axis in the direction of the second propeller drive, the rotational speed of the second propeller drive is reduced relative to the rotational speed of the first propeller drive.

Control means and/or energy supply means preferably are integrated and/or imprinted into the lift surface and/or into the wing. For example, at least one antenna may be provided as control means. Furthermore, a solar element may be additionally or alternatively provided as energy supply means. An antenna may also serve as energy supply means, wherein energy is transmitted by means of microwaves in this case. The energy supply means make it possible to charge accumulators of the aircraft. The control means and/or the energy supply means is/are preferably realized in the form of a transponder, particularly a RFID (radiofrequency identification) that preferably features a backward channel.

According to an enhancement that would also be conceivable separately and independently of the present inventive object, the energy supply means is realized in the form of an energy collection panel for a laser beam. Consequently, it is possible, for example, to remotely charge accumulators of the aircraft by means of a laser beam. It is preferred to provide several energy collection panels that are arranged, in particular, adjacent to one another. This makes it possible to realize a self-adjusting guidance of the laser beam such that the charging process is simplified. If several energy collection panels are arranged adjacent to one another, it is furthermore possible to provide an automatic distance control. The greater the distance from the aircraft, the wider the laser beam and the more adjacently arranged energy collection panels are irradiated. The laser beam becomes more focused and narrower as the distance from the aircraft decreases. This results in the laser beam being incident on fewer energy collection panels. This effect can be utilized for a distance control.

The inventive aircraft is particularly suitable for use as a remote-controlled reconnaissance drone, wherein monitoring means are preferably arranged on the reconnaissance drone. For example, monitoring means in the form of imaging sensors may be arranged on the weight element, a leading edge of the lift surface and/or the wing and/or a leading edge of the propeller guard. Due to its compact and lightweight design, the aircraft can be comfortably transported by one person, for example, in a backpack. Furthermore, the flying characteristics are so stable that the drones can be controlled by one person after a shorter training period than that of conventional aircraft models. The slow take-off speed is particularly advantageous with respect to the flying characteristics. This makes it possible to start the aircraft from the hand of a person such that the aircraft is also ready to take off at all times in rough terrain. A special catching device therefore is not required for the landing.

The invention is described in greater detail below with reference to exemplary embodiments that are illustrated in the figures. In addition, enhancements, advantages and potential applications of the invention also result from the following description of an exemplary embodiment and from the figures.

However, it is expressly noted that the invention is by no means limited to the described examples. In the figures:

Figure 1 shows a schematic front view of an inventive aircraft;

Figure 2 shows a partially sectioned schematic side view of the inventive aircraft according to Figure 1; and

Figure 3 shows a partially sectioned schematic top view of the inventive aircraft according to Figures 1 and 2.

Figure 1 shows a schematic front view of an inventive aircraft or miniature aircraft 10. The aircraft 10 is realized axially symmetrical about a vertical axis 11 and provided with two propeller drives 12, 13 that respectively feature a propeller 14. In the exemplary embodiment shown, the propellers 14 are surrounded by a propeller guard 15 in the region of the outer circumference of the propellers 14. A single propeller guard 15 is provided for the propellers 14 of both propeller drives 12, 13 in this case. Alternatively, it would also be conceivable to provide separate propeller guard elements for the propellers 14 of the propeller drives 12, 13, wherein these propeller guard elements may be connected to one another in order to stabilize the construction.

A closed wing 16 is arranged behind the propeller guard 15 in the front view according to Figure 1 or referred to the intended direction of flight of the aircraft 10, respectively. In the exemplary embodiment shown, the wing 16 is realized in the form of a ring wing 16. The aircraft 10 is realized without an additional fuselage. The wing 16 features an upper lift surface 17 that is arranged above a lower lift surface 18. The height of the wing 16 is smaller than the height of the propeller guard 15. In the exemplary embodiment shown, the height of the wing 16 is approximately 1/3 smaller than the height of the propeller guard 15. In addition, the wing 16 is offset downward relative to the propeller guard 15 in comparison with a central, symmetrical arrangement. However, the wing 16 does not protrude over the circumference of the propeller guard 15 in this case, but rather remains within this circumference.

The propeller drives 12, 13 are mounted on an underside 19 of the upper lift surface 17 at a distance from one another and axially symmetrical to the vertical axis 11. Furthermore, a weight element 20 is centrally arranged on the underside 19. In the exemplary embodiment shown, the weight element 20 is mounted on the underside 19 by means of a pivot joint 21. In this case, the pivot joint 21 makes it possible to pivot the weight element 20 about a lateral axis 22.

Figure 2 shows a partially sectioned schematic side view of the inventive aircraft 10 according to Figure 1. In the exemplary embodiment shown, the weight element 20 protrudes forward beyond the propeller guard 15 in the intended direction of flight in this exemplary embodiment. A lateral surface 27 is respectively arranged on the lift surface ends that face away from one another and extends over the entire chord of the upper and lower lift surfaces 17, 18.

A schematically illustrated control means 23 is arranged in an exemplary fashion on the lateral surface 27 of the wing 15. In this case, the control means 23 is realized in the form of an antenna 23 that is integrated into the wing 15 and serves for receiving control signals for remotely controlling the unmanned aircraft 10.

Figure 3 shows a partially sectioned schematic top view of the inventive aircraft 10 according to Figures 1 and 2. A schematically illustrated energy supply means 25 is arranged in an exemplary fashion on the upper lift surface 17. In the exemplary embodiment shown, the energy supply means 25 is realized in this form of a solar module 25.

The aircraft 10 is realized axially symmetrical to a longitudinal axis 25. Furthermore, the upper lift surface 17 features a section 26 that is realized axially symmetrical to the longitudinal axis 25. The section 26 is essentially realized in a V-shaped fashion and tapered in the direction of the weight element 20. The smallest width of the section 26 corresponds to the width of the weight element 20 in order to enable the weight element 20 to protrude beyond the upper lift surface 17 when the weight element 20 is pivoted about the lateral axis 22. In the exemplary embodiment shown, the lower lift surface 18 also features a not-shown section 26 in order to enable the weight element 20 to protrude beyond the lower lift surface

18 when the weight element 20 is pivoted about the lateral axis 22.

The function of the aircraft 10 is elucidated below with reference to Figures 1 to 3:

For example, if the unmanned aircraft 10 should be utilized as a reconnaissance drone, the aircraft is equipped with suitable monitoring means. These monitoring means may form integral components of the weight element 20. The energy required for the operation of the monitoring means, as well as for the control of the aircraft 10, is supplied by accumulators and/or one or more energy supply means 24.

The aircraft 10 has such dimensions and such a weight that the miniature aircraft 10 can be transported by a single person, for example, in a backpack. The aircraft 10 is controlled by means of a remote control that can be operated by one person. The signals of the remote control are detected by the control means 23 and forwarded.

In this case, the control is realized in such a way that the aircraft 10 is pivoted about the longitudinal axis 25 and/or the vertical axis 11 by operating the propeller drives 12, 13 with different rotational speeds. Due to the different rotational speeds of the propeller drives 12, 13, these propeller drives generate a different propulsive force such that the aircraft 10 is turned about its longitudinal axis 25 and/or its vertical axis 11. The direction of flight of the aircraft 10 can be controlled in this fashion.

The weight element 20 is pivoted about the lateral axis 22 of the aircraft 10 in order to control the flying height of the aircraft 10. This causes the center of gravity of the aircraft 10 to shift and the aircraft 10 assumes an ascending position or a descending position in dependence on the pivoting direction.

Consequently, no control surfaces are required for the control of the aircraft 10 such that the aircraft 10 is particularly robust and a high ground readiness is promoted. Furthermore, it is not required to provide a tail boom such that a compact construction is ensured.

The propellers 14 that are arranged in front of or, according to an alternative embodiment, behind the lift surfaces 17, 18 already conduct air over the lift surfaces 17, 18 with high speed at a standstill. This results in a very slow take-off speed such that the aircraft 10 is respectively able to take off from and land in the hand of a person.

List of reference symbols:

10 Aircraft or miniature aircraft
11 Vertical axis
12 Propeller drive
13 Propeller drive
14 Propeller
15 Propeller guard
16 Wing
17 Upper lift surface
18 Lower lift surface
19 Underside
20 Weight element
21 Pivot joint
22 Lateral axis
23 Control means
24 Energy supply means
25 Longitudinal axis
26 Section
27 Lateral surface

CLAIMS

1. A remote-controlled miniature aircraft with at least one lift surface (17), with at least one pair of propeller drives (12, 13) and with a weight element (20), the position of which can be varied in the longitudinal direction of the miniature aircraft (10) in order to change the center of gravity of the miniature aircraft (10), wherein an upper lift surface (17) is arranged above a plane defined by the rotational axes of the propeller drives (12, 13) in order to generate a lifting force, characterized in that the lift surface (17) is arranged above a lower lift surface (18), in that the miniature aircraft is realized in the form of a flying wing, and in that the flight attitude referred to a longitudinal axis (25) and a vertical axis (11) of the aircraft (10) can be adjusted by means of a difference between the propulsive forces of the propeller drives (12, 13).

2. The miniature aircraft according to Claim 1, characterized in that the upper lift surface (17) and the lower lift surface (18) are integrated into a single closed wing (16) in order to realize a miniature aircraft (10) without fuselage.

3. The miniature aircraft according to Claim 2, characterized in that the closed wing (16) is realized in the form of one of a ring wing and a box wing.

4. The miniature aircraft according to any one of Claims 1 to 3 characterized in that the upper lift surface (17), the lower lift surface (18) and the wing (16) are selected from the group consisting of rigid and inflatable structures.

5. The miniature aircraft according to any one of Claims 1 to 4 characterized in that the propellers (14) of the pair of propeller drives (12, 13) are arranged in a position selected from in front of or behind the two lift surfaces (17, 18) referred to the longitudinal direction of the aircraft (10) in order to generate an air flow over one of the upper lift surface (17) and the lower lift surface (18).

6. The miniature aircraft according to any one of Claims 1 to 5 characterized in that the upper lift surface (17) and the lower lift surface (18) are arranged between the rotational axis of the propeller drives (12, 13) and the maximum wingspan of the propellers (14) or that the pair of propeller drives (12, 13) is arranged between the upper lift surface (17) and the lower lift surface (18).

7. The miniature aircraft according to any one of Claims 1 to 6 characterized in that the propellers (14) of the propeller drives (12, 13) are shrouded by at least one propeller guard (15) in the region of the propeller circumference.

8. The miniature aircraft according to any one of Claims 1 to 7 characterized in that the weight element (20) is centrally arranged on the lift surface (17), wherein the weight element (20) is connected to the upper lift surface (17) underneath the upper lift surface (17) such that it can be pivoted about a lateral axis (22).

9. The miniature aircraft according to any one of Claims 1 to 8 characterized by a remote control for controlling the miniature aircraft (10), wherein the flight attitude referred to the lateral axis (22) can be adjusted by means of a displacement of the weight element (20).

10. The miniature aircraft according to any one of Claims 1 to 9 characterized in that control means (23) are integrated or imprinted into the lift surface (17, 18) or the wing (16).

11. The miniature aircraft according to any one of Claims 1 to 10 characterized in that energy supply means (24) are integrated into one of the lift surface (17, 18) or the wing (16).

12. The miniature aircraft according to any one of Claims 1 to 9 characterized in that the energy supply means (24) are imprinted to one of the lift surface (17, 18) or the wing (16).

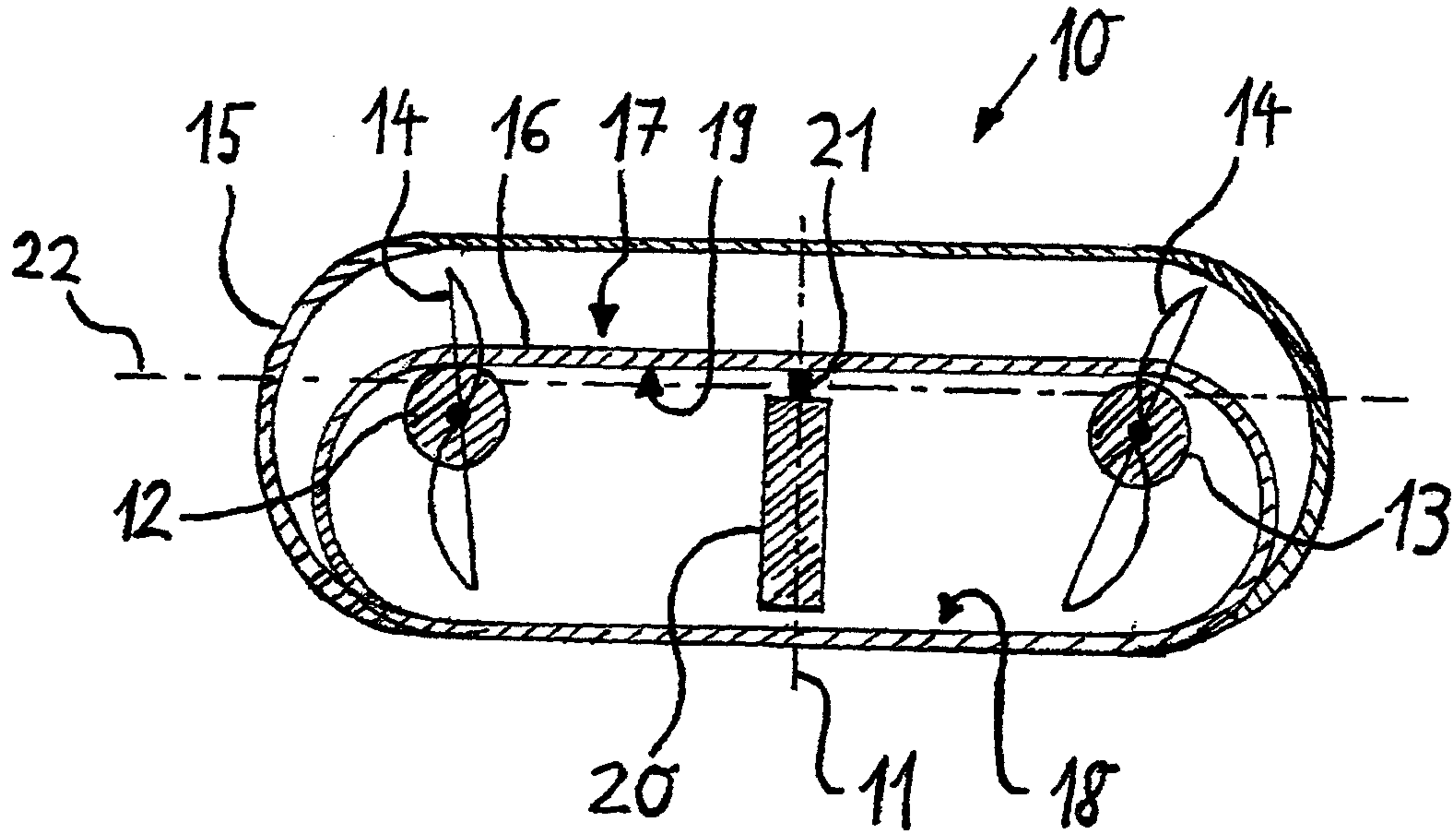


Fig. 1

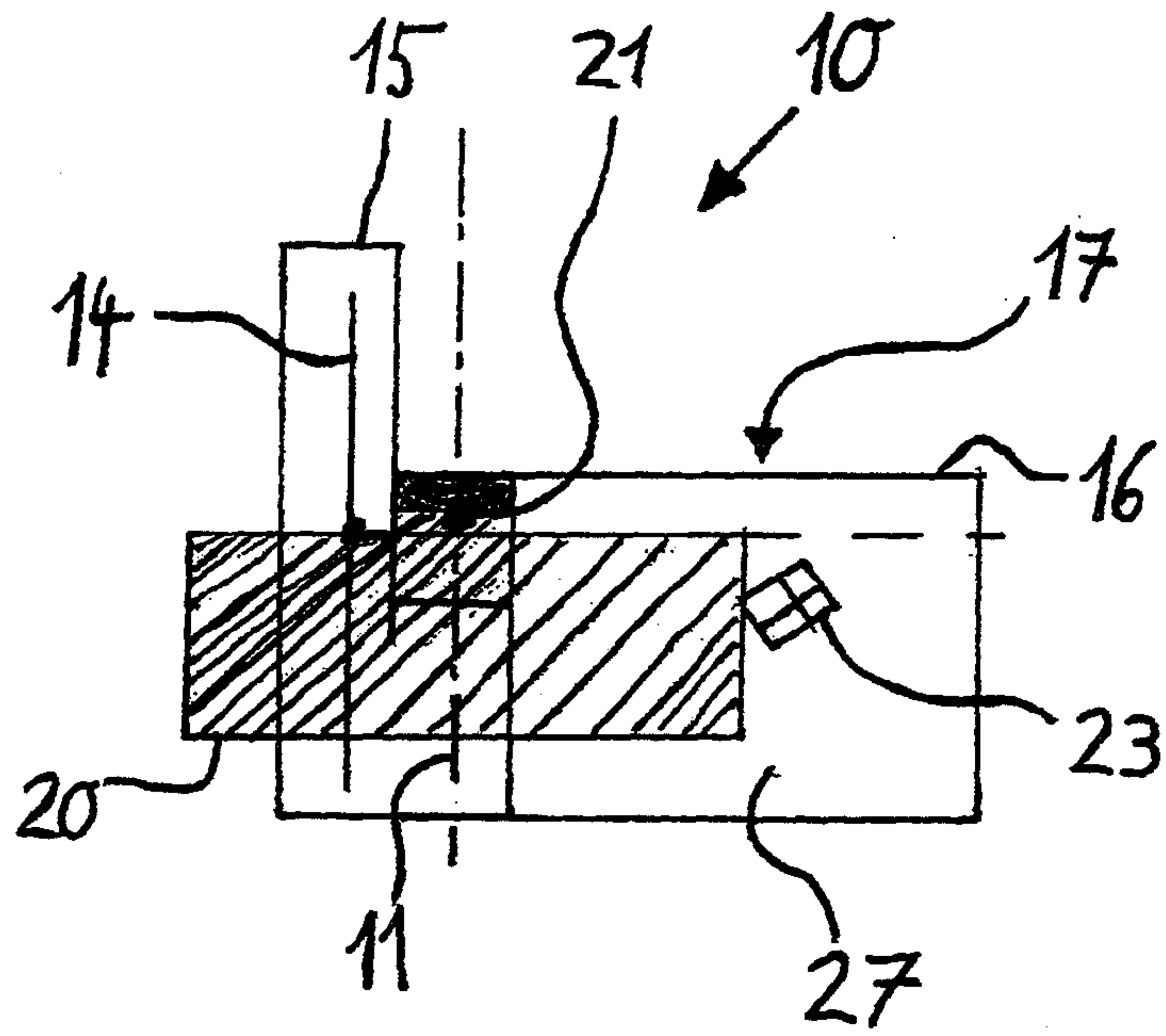


Fig. 2

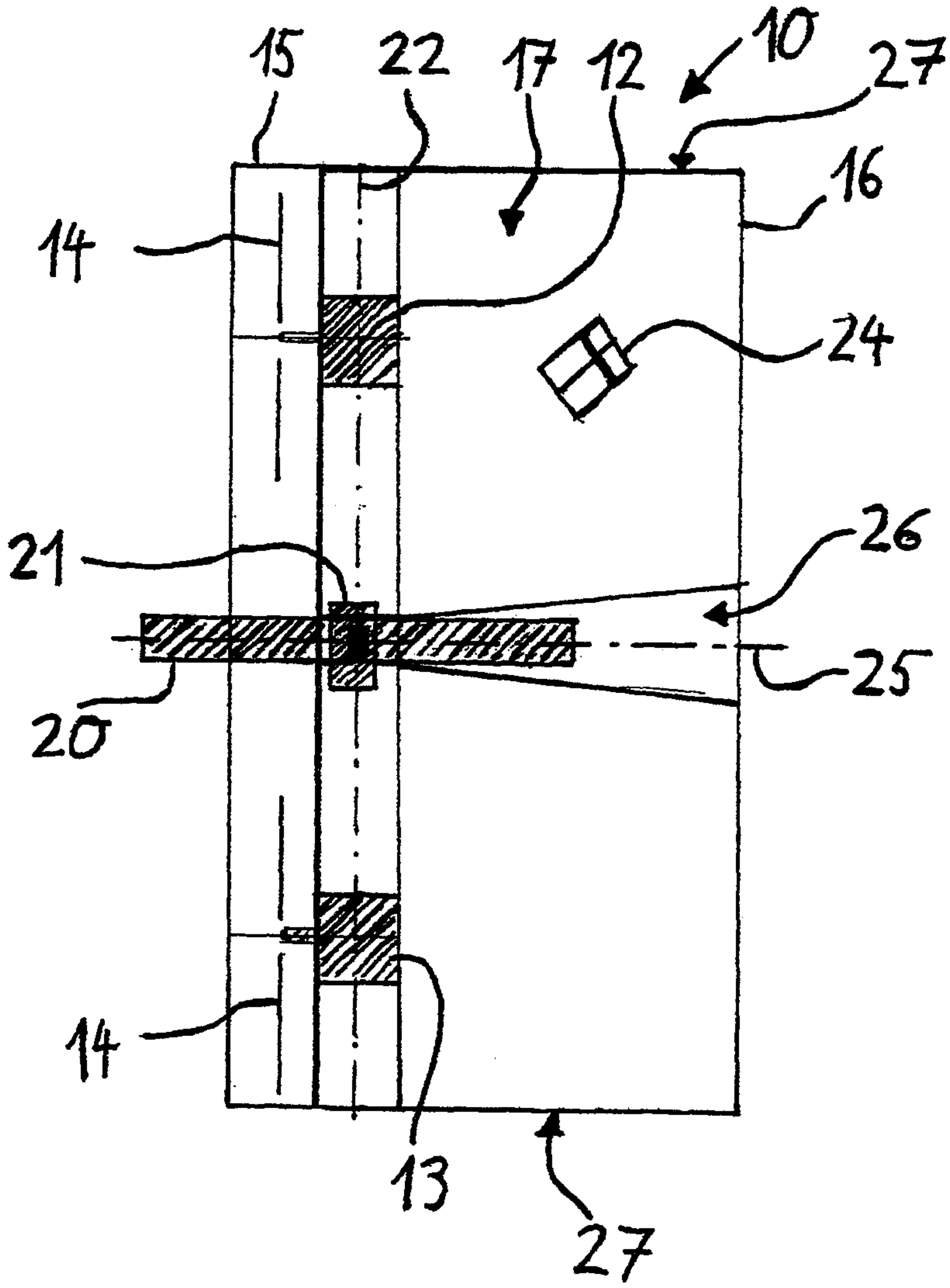
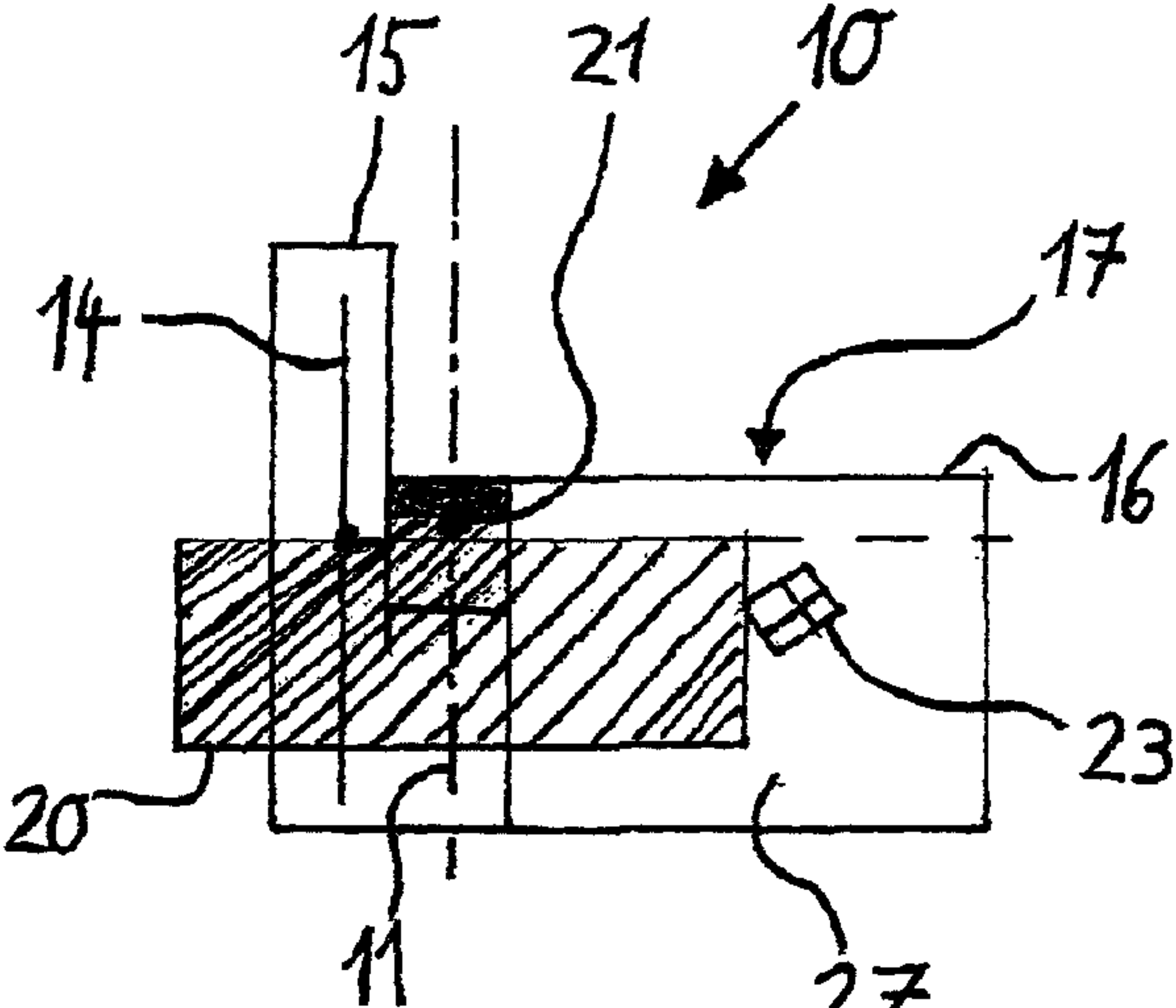


Fig. 3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