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(71) Demandeur/Applicant:
SANFRITSCH GMBH, DE

(72) Inventeur/Inventor:
WOLL, OLIVER, DE

(74) Agent: SMART & BIGGAR IP AGENCY CO.

(54) Titre : EOLIENNE REGLABLE EN HAUTEUR RATTACHEE AU SOL
(54) Title: HIGH-ALTITUDE WIND TURBINE TETHERED TO THE GROUND

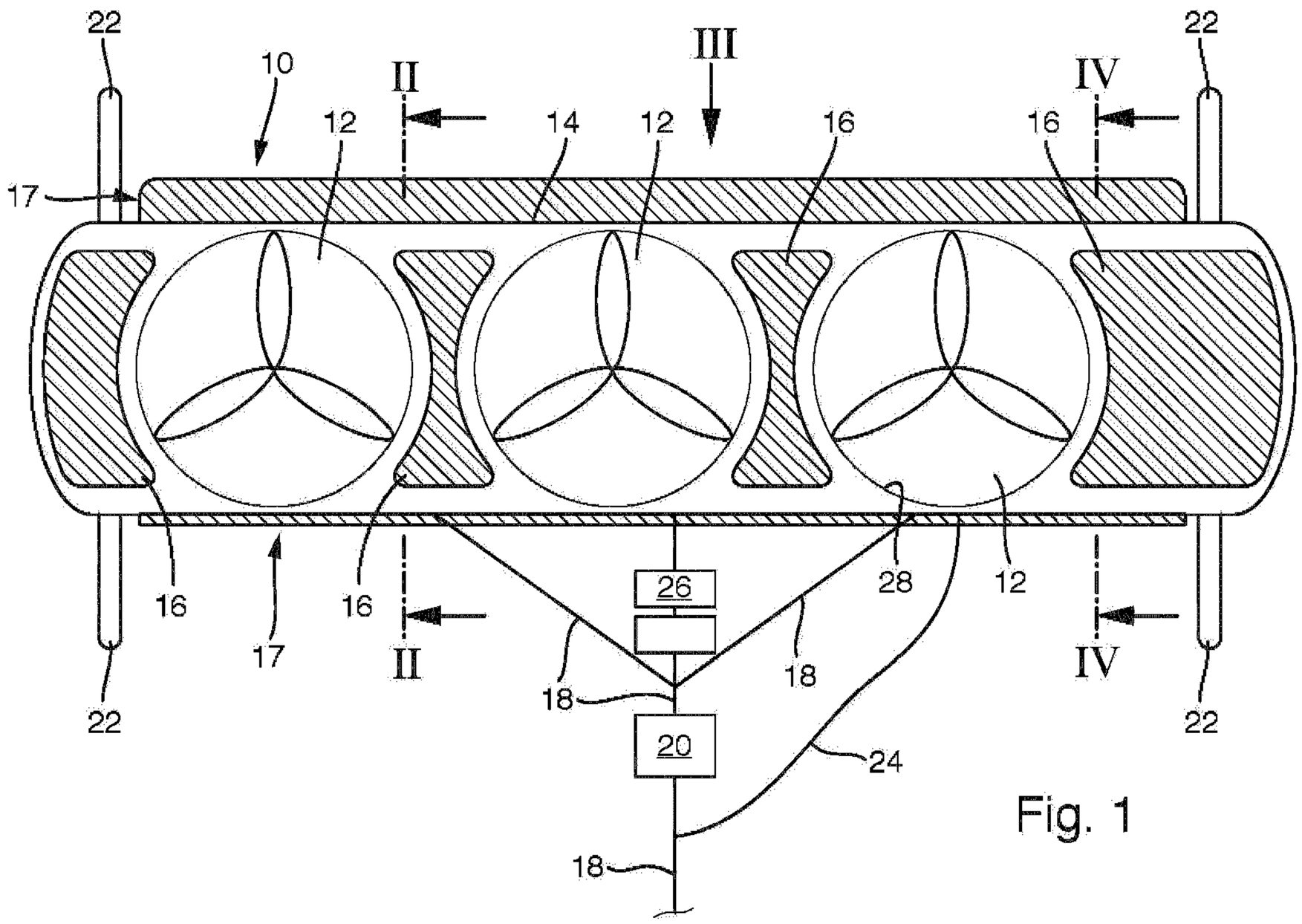


Fig. 1

(57) Abrégé/Abstract:
The invention relates to a high altitude wind turbine for generating electrical energy at different altitudes, having a flexible connection to the ground and an envelope enclosing carrier gas, wherein the envelope at least regionally forms a preferably fixed wing and a plurality of rotors are accommodated in the wing.

ABSTRACT

The invention relates to a high altitude wind turbine for generating electrical energy at different altitudes, having a flexible connection to the ground and an envelope enclosing carrier gas, wherein the envelope at least regionally forms a preferably fixed wing and a plurality of rotors are accommodated in the wing.

HIGH-ALTITUDE WIND TURBINE TETHERED TO THE GROUND

The invention relates to a high-altitude wind turbine for generating energy at different altitudes, having a flexible connection to the ground and an envelope enclosing carrier gas.

Prior art:

High-altitude wind turbines are known, that include a wind wheel or a rotor. These are also partially filled with helium or another gas that is lighter than air, so that they produce an uplift. High-altitude wind turbines are normally secured by a cable anchored to the ground (US 2008/0290665 A1).

These high-altitude wind turbines are also available in various forms, usually with a round shape. They are made of a substance or a material similar, by way of example, to a balloon or a kite (DE 656194 C).

However, these known high-altitude wind turbines are not designed to remain at altitude for a long period and to withstand all winds and weathers.

Due to the fixed connection to the ground and the fact that all winds and weathers must be withstood by the design over a long period, for this purpose a wind- and weather-resistant wing must be present, which can also align independently in the wind direction.

Furthermore, at very high altitudes the air pressure is significantly lower than at ground level and the average temperature is significantly lower. This means that the electronic controllers previously used for wind power generation are no longer functionally capable.

The volume for accommodating a carrier gas, such as, for example, Helium, is limited by the size of the wing.

If power is generated in the high-altitude wind turbine, then this may be present in a current type that is unsuitable for transport. In addition, the mains voltage present may not be suitable for transporting the current. If compressed air is generated in the high-altitude wind turbine, this must be transported in a suitable manner to ground level.

A further problem area is the securing of the cable to the wing. Due to the high tensile forces, the cable must be suitable for absorbing these forces.

The only high-altitude wind turbines known to date have a rotor. This restricts the power to the size of this rotor.

At least part of this problem is solved according to the invention in a high-altitude wind turbine for generating compressed air or electrical energy at different altitudes, having a flexible connection to the ground and an envelope enclosing carrier gas, in that the envelope at least regionally forms an aerodynamic wing and a plurality of rotors are accommodated in the wing. Between the rotor or rotors and the power generator(s) one or more gear units are preferably present.

The invention concerns a high-altitude wind turbine secured to the ground and located at very high altitudes of between 2,000 m and 15,000 m, in particular between 8,000 m and 12,000 m (Jetstream). The high-altitude wind turbine is designed to exploit air speeds of 200 to 500 km/h and to remain at such altitudes for a long time. To this end, the envelope comprises a tear-resistant surface in order to be able to withstand all weather conditions. The envelope is equipped with rudders and elevators. A carrier gas is also present in the envelope of the high-altitude wind turbine. There is similarly a pressure chamber for the electronic components in the high-altitude wind turbine.

In order to transform or convert the electrical energy generated a transformer is present in the high-altitude wind turbine. For the generation of compressed air compressors are provided, upstream of one or more gear units. The air compressed by means of the compressors is transported by means of insulated air hoses to ground level. At ground level compressed air reservoirs or potential energy stores are immediately available. To generate power the compressed air reservoirs are emptied and a generator thereby operated. The efficiency is approximately 65% including storage.

The high-altitude wind turbine, which must guarantee constant energy generation, must be capable of withstanding all winds and weathers. Accordingly, the envelope and the anchoring cable must be made from a flexible and high tensile strength material, in particular from carbon fibre or polyaramids (Kevlar).

To this end the rotors are accommodated inside the wing in order, for example, to withstand hail damage.

To this end, the wing must be manufactured from a material that is wind- and weather-proof and at the same time still have the flexibility to adapt to the wind conditions. This is achieved, by way of example, by installing rudders and elevators that align the wing.

By fitting a pressurised cabin and thermal insulation at least in part of the wing, conditions can be achieved that ensure that the control electronics are able to function. In addition, a heating device may be fitted as necessary.

In order to increase the volume of the carrier gas, the wing or special gas tanks in or on the wing are filled with carrier gas. The pressure in the wing or in the tank is increased, resulting in an increase in the volume of the carrier gas and the stiffness of the envelope.

The current type is converted by a converter into another current type and the voltage or the current strength altered as necessary. For safety reasons, this can take place in a Faraday cage in the wing.

The transformer can also charge up an energy store, so that a flash can be generated in order to convert the current.

In order to reduce the tensile forces of the cable at the fastening point to the envelope, in particular preloaded hydraulic cylinders can be fitted, which absorb some of the force.

Alternatively, or also additionally, electromagnets can be fitted which are able to absorb an additional part of the energy.

In order to increase the power, a plurality of rotors are accommodated in the wing.

Further advantages, features and details of the invention are indicated in the subclaims and the following description, in which, by using the drawing, a particularly preferred exemplary embodiment of the invention is described.

The drawing shows as follows:

Fig. 1: a frontal view of the high-altitude wind turbine;

Fig. 2: a longitudinal view II - II through the high-altitude wind turbine according to Fig. 1; and

Fig. 3: a top view III of the high-altitude wind turbine according to Fig. 1.

Fig. 1 shows a frontal view of a wing 10 in the form of a flying wing. In this flying wing there are a number of rotors 12. Here the wing 10 is formed by an envelope 14, in which apart from the rotors 12 stabilisers 16 filled with carrier gas are provided. Additional space for the carrier gas also exists in a kind of windpipe 17 above and/or below the envelope 14. The stabiliser 16 and/or the windpipe 17 comprises or comprise a high tensile strength material like that of a weather balloon, which can also absorb the pressure of the expanding gas. These stabilisers 16 have an inherent

rigidity and are pressure-tight and they serve as a support structure for the envelope 14 and the rotors 12. In the envelope 14 itself framework-like braces are also arranged. The wing 10 is secured to a restraining cable 18, wherein a hydraulic cylinder 20 is incorporated into the restraining cable 18. The restraining cable 18 branches after the hydraulic cylinder 20 and grips at a plurality of points the envelope 14 of the wing 10. The lateral ends of the wing 10 have winglets 22 for stabilisation. Energy transport takes place by means of a power cable, which is secured after the hydraulic cylinder 20 to the restraining cable 18. Finally, electromagnets 26 are also identifiable, which similarly serve for damping of the wing 10.

Fig. 2 shows the wing 10 according to Fig. 1 in longitudinal section II - II. A rotor 12 is identifiable, which is located in a windpipe 28. At the end of the wing 10 two of the winglets 22 are shown. In the windpipe 28 there is a mounting 30, with which a nacelle 32 is secured. The restraining cable 18 with preloaded pressure or hydraulic cylinder 20 and the electromagnet, as well as the power cable 24, grip on the underside of the front end of the wing 10. In the nacelle 32 there is a transformer 34 and a heating device 36. Reference numeral 42 denotes the wind direction.

Fig. 3 shows the wing 10 in top view. On the sides the winglets 22 which stabilise the wing 10 are shown. On the rear end of the wing 10 there are elevators and rudders 38. The nacelle 32 is surrounded by a thermal insulation 40 and supports the shaft for the rotor 12.

The wing 10 is filled with the propellent helium, so that the entire weight of the wing 10 is borne by the helium. To this end the stabilisers 16 of the wing 10 are filled with the helium. The wing 10 is connected via the restraining cable 18 to the ground level.

The wind flows in direction 42 through the rotors 12, wherein the rotors 12 drive the generators located in the nacelle 32, as a result of which the wind energy is converted into electrical energy. This electrical energy is transported via the power cable 24, which is secured to the restraining cable 18, to ground level. In order to maintain the appropriate current type and voltage, the electrical energy generated is converted in transformer 34. Alternatively, compressors can also be provided, to generate compressed air, which are driven by the rotors.

With the help of the rudders and elevators 38 the wing 10 can position itself optimally in the wind. The winglets 22 increase the stability of the wing 10.

The inwardly-facing rotors 12 within the windpipe 28 prevent damage from, by way of example, hail. In addition, the air is optimally fed to the rotors 12. Here the windpipe 28 can be provided with air baffles and adjacent rotors 12 may also work in opposite directions.

The nacelle 32 configured as a pressure cabin and the heating device 36 are able to create environmental conditions like those encountered at ground level. The thermal insulation 40 around or in the nacelle 32 also contributes to this.

In order to absorb the tensile forces from the wind, the preloaded pressure or hydraulic cylinders 20 absorb part of the mechanical energy. A further part can be absorbed by the connected electromagnets 26. The electromagnet electrical draws the electrical energy from the generator. The electromagnet 26 is only switched on as necessary.

The compressed air generated is passed via one or more air hoses to ground level where it is stored or converted to another type of energy, e.g. into electrical energy. The air hose is secured to the restraining cable 18.

Claims

1. High-altitude wind turbine for generating electrical energy at different altitudes, having a flexible connection (18) to the ground and an envelope (14) enclosing carrier gas, characterised in that the envelope (14) at least regionally forms a preferably fixed wing (10) and a plurality of rotors (12) for an energy generator are provided in the wing (10) and the rotors (12) are accommodated within the wing (10).

2. High-altitude wind turbine according to claim 1, characterised in that the envelope (14) and/or the flexible connection (18) is manufactured from a material, in particular polyaramid, able to withstand all the wind and weather conditions occurring at the usage location.

3. High-altitude wind turbine according to any one of the preceding claims, characterised in that rudders and elevators (38) are fitted in or on the wing (10), in order to align the wing (10).

4. High-altitude wind turbine according to any one of the preceding claims, characterised in that a nacelle (32) is

provided in the wing (10), having a pressure cabin, in order to generate an increased pressure in the nacelle (32).

5. High-altitude wind turbine according to any one of the preceding claims, characterised in that a nacelle (32) is provided in the wing (10) and a thermal insulation layer (40) and/or a heating device (36) is/are fitted around or in the nacelle (32), in order to generate an increased temperature in the nacelle (32).

6. High-altitude wind turbine according to any one of the preceding claims, characterised in that the wing (10) has special stabilisers (16) and/or a windpipe (17) above and/or below the envelope (14) to accommodate as carrier gas.

7. High-altitude wind turbine according to claim 6, characterised in that the stabiliser (16) and/or the windpipe (17) comprises or comprise a high tensile strength material.

8. High-altitude wind turbine according to any one of the preceding claims, characterised in that a current converter is provided, in particular in a nacelle (32), in order to convert and/or transform the current generated into another type of current or into a flash.

9. High-altitude wind turbine according to claim 8, characterised in that in the wing (10) a Faraday cage is provided for a current converter.

10. High-altitude wind turbine according to any one of the preceding claims, characterised in that between wing (10) and the flexible connection at least one pressure or hydraulic damper (20) is provided, in order to absorb part of the tensile force.

11. High-altitude wind turbine according to claim 10, characterised in that the pressure or hydraulic damper (20) grips the wing (10).

12. High-altitude wind turbine according to any one of the preceding claims, characterised in that electromagnets (26) are secured to the wing (10), in order to absorb part of the tensile force.

13. High-altitude wind turbine according to any one of the preceding claims, characterised in that the energy generator is a compressor for compression of air.

14. High-altitude wind turbine according to claim 13, characterised in that the compressor has one or more gear units upstream, so that the rotors (12) are able to drive the compressor.

15. High-altitude wind turbine according to any one of the preceding claims, characterised in that for the transport of compressed air one or more air hoses are provided, which connect the compressor with a compressed air reservoir at ground level, wherein the air hoses are in particular insulated.

16. High-altitude wind turbine according to claim 15, characterised in that the insulation of the air hose takes place by means of krypton gas, aerogels or vacuum insulation.

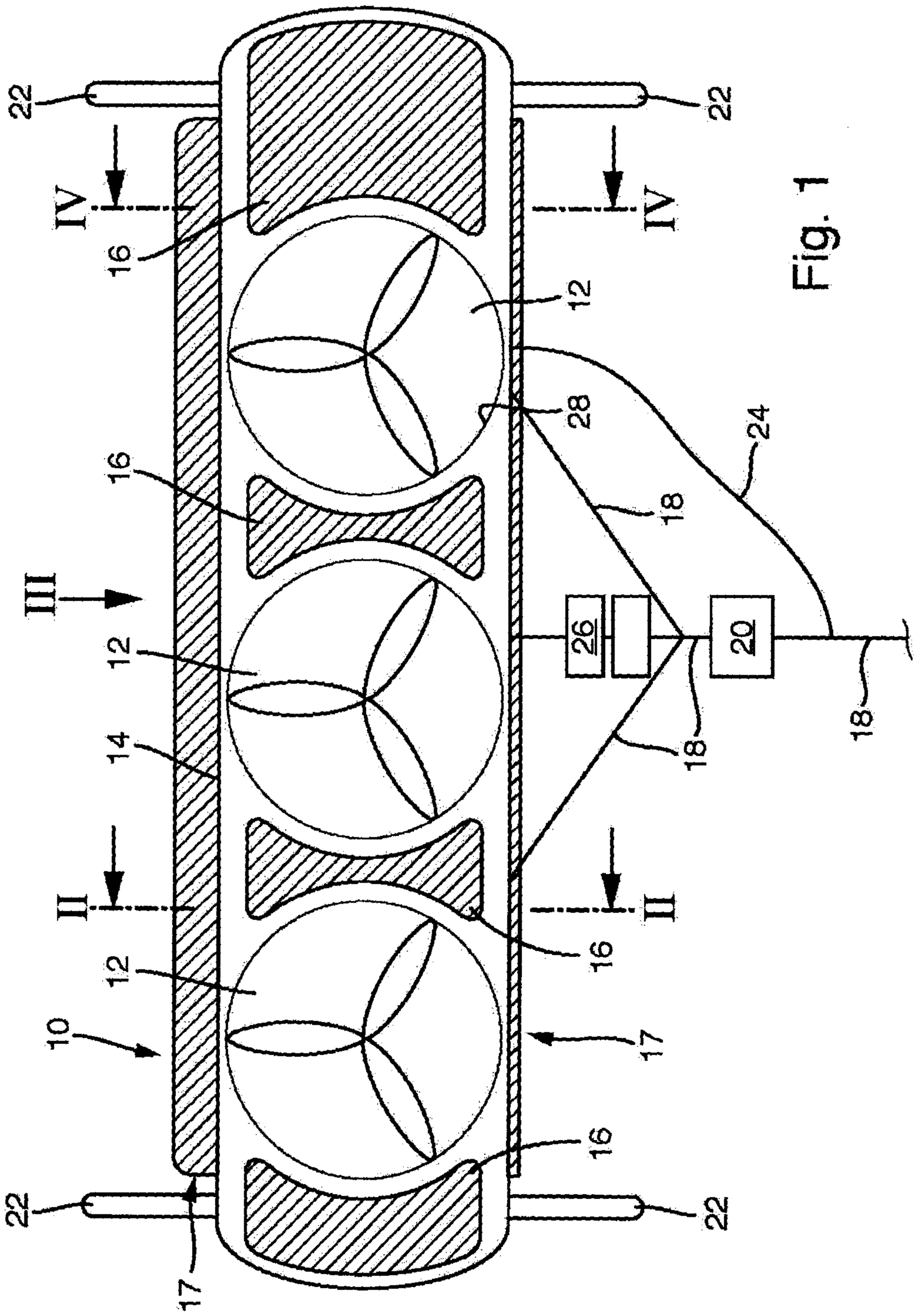

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Fig. 1

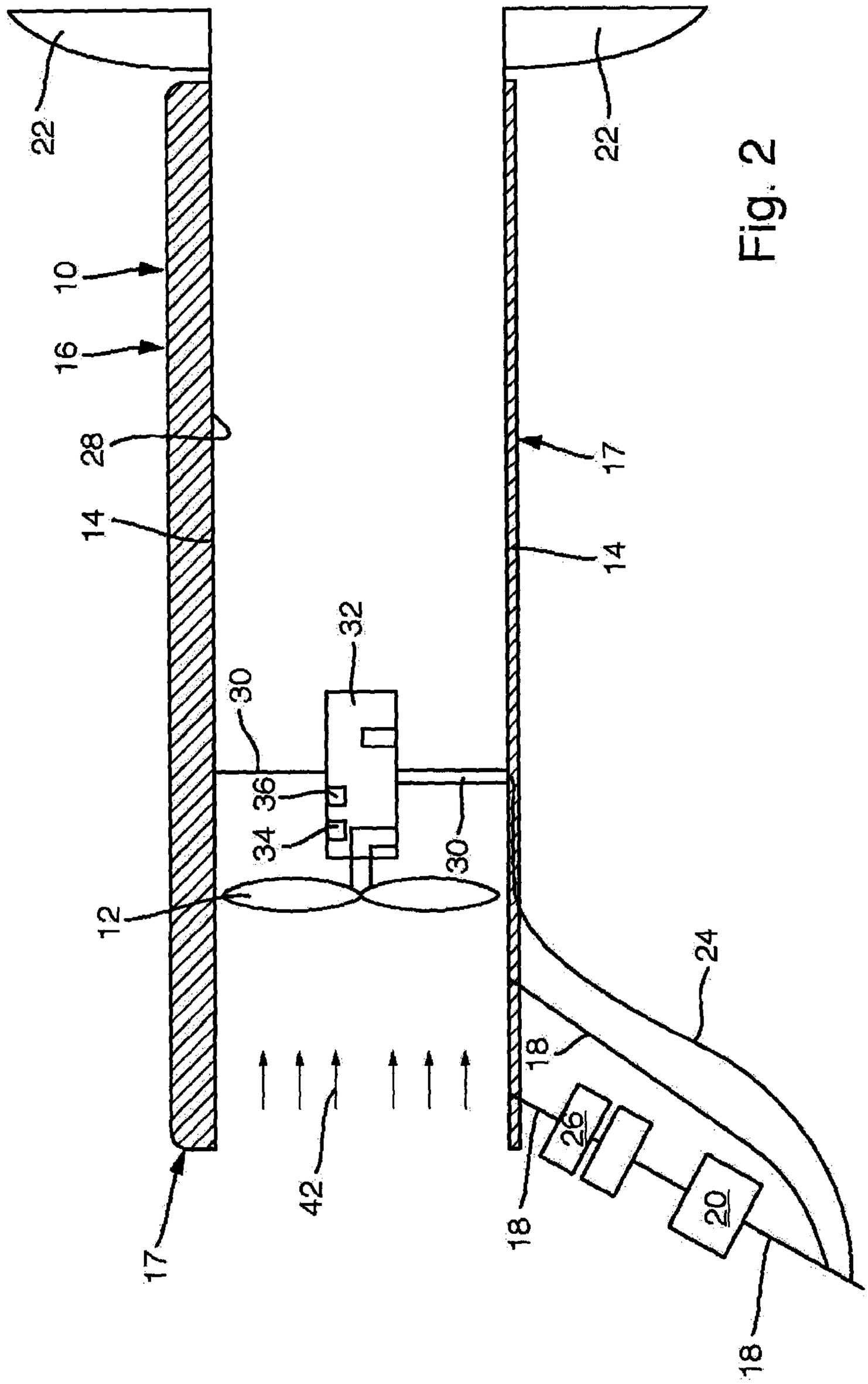


Fig. 2

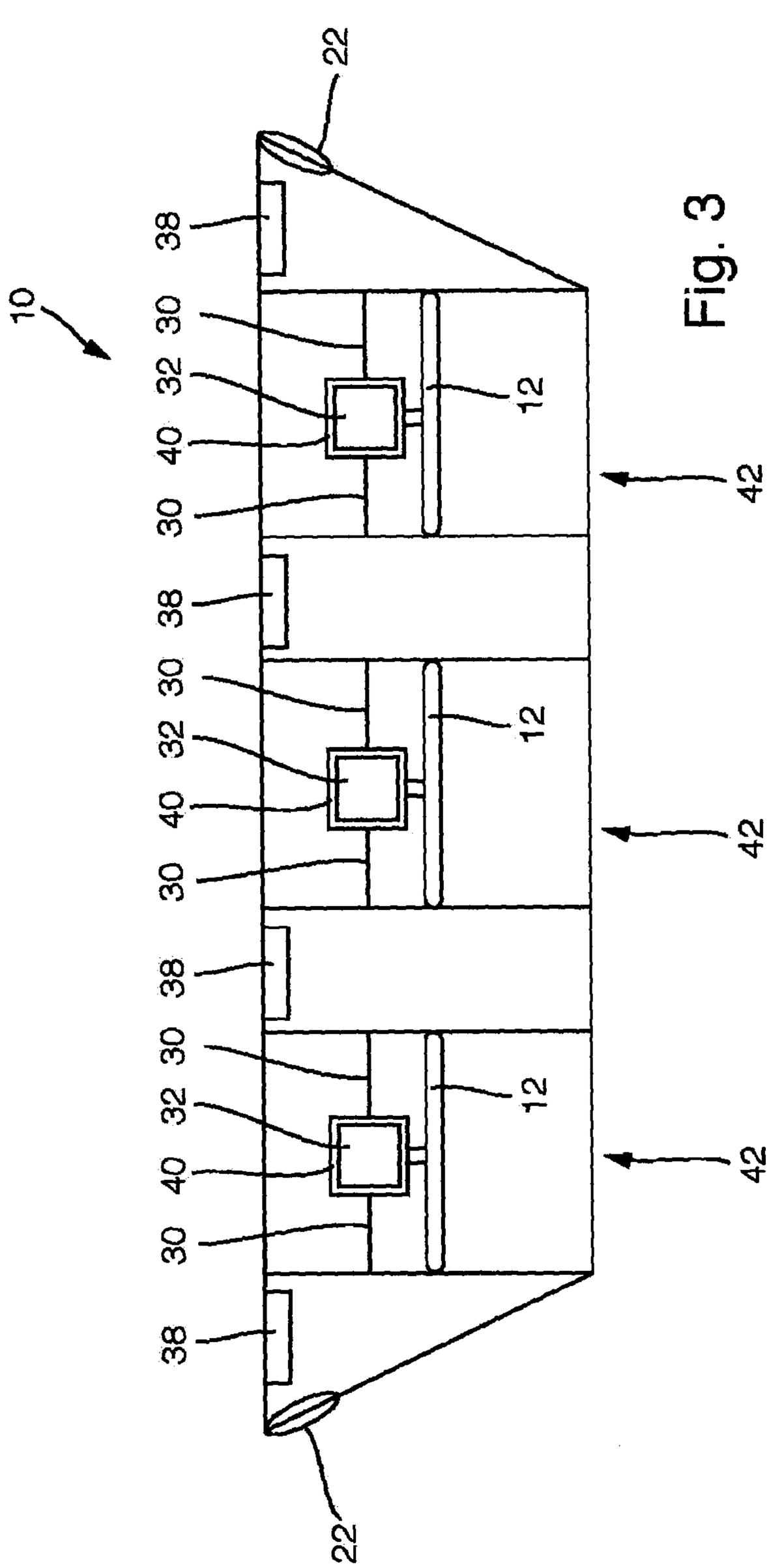

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Fig. 3

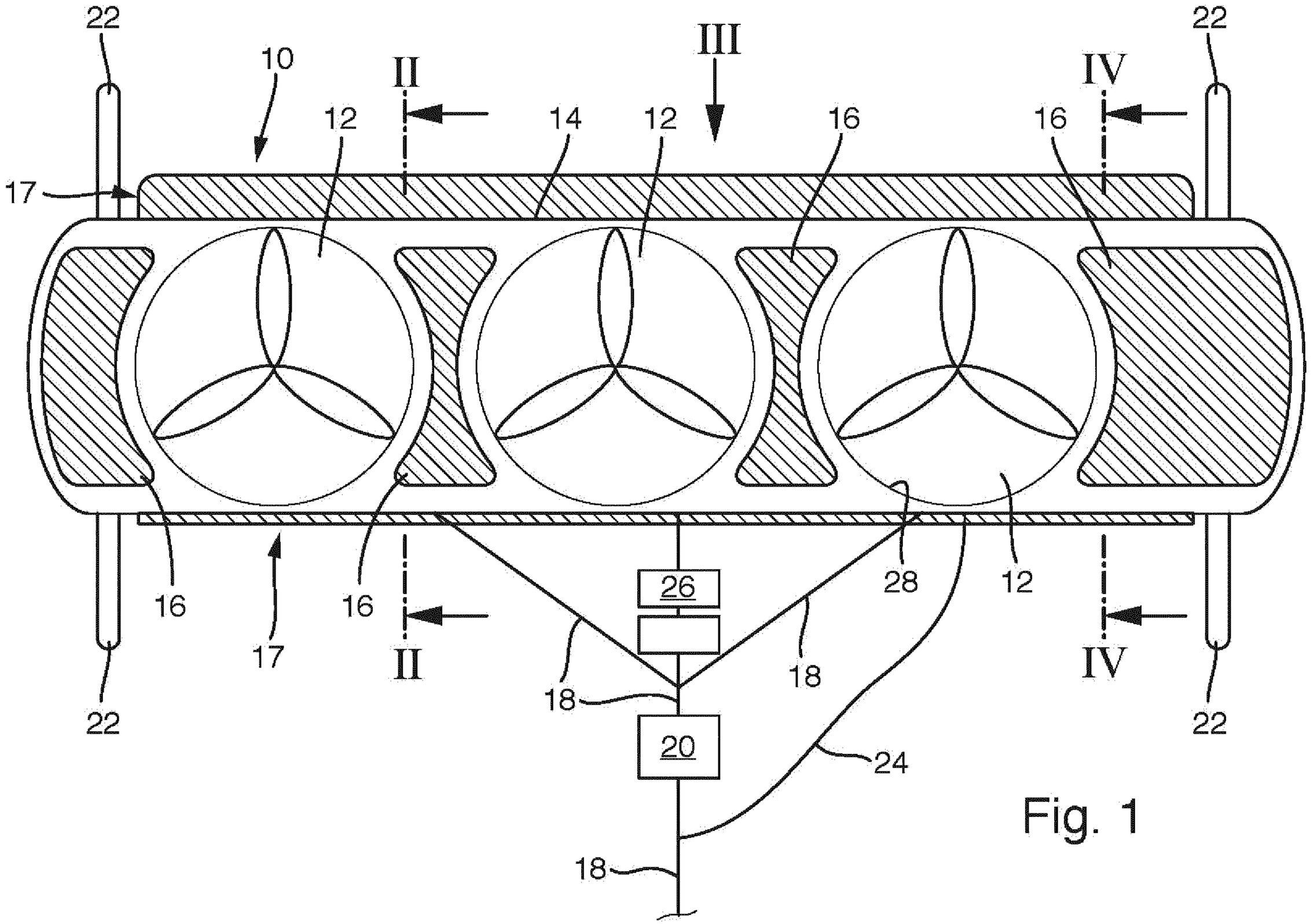

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Fig. 1