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CA 2685978 A1 2010/05/12

(21) **2 685 978**

(12) **DEMANDE DE BREVET CANADIEN**
CANADIAN PATENT APPLICATION

(13) **A1**

(22) Date de dépôt/Filing Date: 2009/11/12
(41) Mise à la disp. pub./Open to Public Insp.: 2010/05/12
(30) Priorité/Priority: 2008/11/12 (IT MI2008A 002006)

(51) Cl.Int./Int.Cl. *E03D 11/00* (2006.01), *E03D 9/00* (2006.01)
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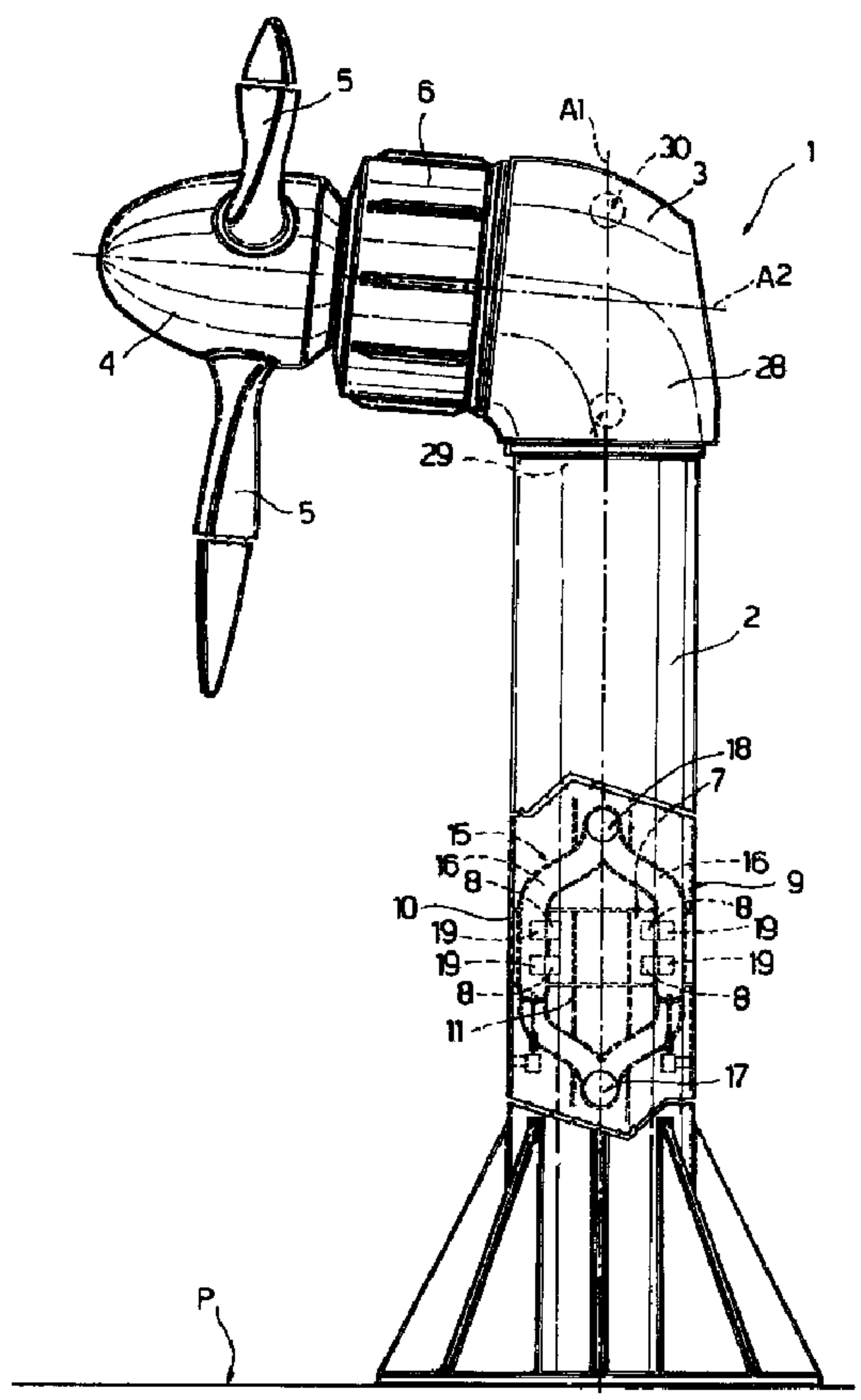
(54) Titre : AEROGENERATEUR
(54) Title: WIND POWER TURBINE



(57) Abrégé/Abstract:
A wind power turbine having a pylon; a nacelle; an electric generator fitted to the nacelle to produce electric energy; a frequency converter housed inside the pylon; and a cooling system for cooling the frequency converter, and which has an open-loop circuit provided with a conduit, and at least one cooling fin thermally connected to the frequency converter and housed in the conduit.

ABSTRACT

A wind power turbine having a pylon; a nacelle; an electric generator fitted to the nacelle to produce electric energy; a frequency converter housed inside the pylon; and a cooling system for cooling the frequency converter, and which has an open-loop circuit provided with a conduit, and at least one cooling fin thermally connected to the frequency converter and housed in the conduit.

(Figure 1)

WIND POWER TURBINE

The present invention relates to a wind power turbine equipped with a cooling system.

More specifically, the present invention relates to a wind power turbine comprising a pylon; a nacelle; an electric generator fitted to the nacelle to produce electric energy; a frequency converter inside the pylon; and a cooling system for cooling the frequency converter.

Many of the component parts, such as the electric generator, frequency converter, etc., of a wind power turbine for producing electric energy generate heat that must somehow be dissipated.

In some cases, some components are cooled by a coolant circuit, as described, for example, in US 6,520,737.

Fluid cooling, however, calls for careful maintenance of the circuit and provision of a coolant tank.

Alternatively, as described, for example, in EP 1,200,733 or in WO 01/06121 A1, cooling is performed by a closed-loop circuit formed partly by the pylon itself, and in which an air stream is conveyed.

Alternatively, as described in WO 2007/110719, heat-producing component parts are cooled by fixing them directly to the wall of the pylon, trusting in wind action on the pylon to cool them sufficiently.

Document WO 99/30031 discloses a cooling system for wind power turbine wherein the pylon itself define the conduit and the chimney effect of the same is used to convey an air stream from the base to the top of the pylon and to cool those heat producing devices housed inside the pylon.

In the latter solutions, the pylon - more specifically, the outer wall of the pylon - is the main heat exchange element. Even in exceptionally windy locations, however, wind action on the pylon is not always sufficient to adequately cool, directly or indirectly, component parts subject to overheating. That is, in weather conditions characterized by strong sunlight heating the pylon wall, and by relatively mild wind, the pylon fails to ensure adequate cooling of the converter.

In accordance to the arrangement disclosed in WO 2007/110719 WO 99/30031 humid and dirty air is permitted entering into the inner compartment wherein sophisticated electronic components are housed.

Document DE 199 47 915 A1 discloses a wind power turbine comprising a pylon having a first outer wall; a nacelle having a second outer wall; an electric generator fitted to the nacelle to produce electric energy; a heat generating apparatus housed at in an apparatus space arranged at the base of the pylon; and a cooling system for cooling the heat generating apparatus. The cooling system is of the open-loop circuit type and includes a conduit, which is housed inside the pylon and the nacelle and connects an inlet port, formed in the apparatus space, to an outlet port formed in the nacelle.

The cooling conduit extends across the heat generating device and therefore introduces humid and dirty air into the heat generating device. Since the heat generating devices are often electronic power devices, such a cooling system may cause severe drawbacks to the operativeness of the wind power turbine.

In general, known cooling techniques are invariably far from satisfactory.

One object of the present invention is to provide a wind power turbine featuring a cooling system designed to ensure highly effective cooling in any operating and weather condition.

Another object of the present invention is to provide a wind power turbine featuring a straightforward, low-cost cooling system designed to keep the inside of the pylon, and in particular the frequency converter, free of dirt and humidity.

According to the present invention, there is provided a wind power turbine comprising a pylon having a first outer wall; a nacelle having a second outer wall; an electric generator fitted to the nacelle to produce electric energy; a frequency converter housed in an inner compartment of the wind power turbine; and a cooling system for cooling the frequency converter, and which comprises:

- an open-loop circuit including at least one conduit housed inside said inner compartment and having no outlets into said inner compartment, and connecting an inlet port, formed in the first or second outer wall, to an outlet port formed in the first or second outer wall; and

- at least one cooling fin thermally connected to the frequency converter and housed inside said conduit.

According to the present invention, the cooling system is exceptionally effective and hardly affected by weather conditions, on account of airflow along the conduit flowing directly over the cooling fin. The cooling efficiency is rather high because the flow is concentrated inside the conduit without dispersion in the inner compartment. Moreover, any dirt is confined inside the cooling conduit.

The frequency converter comprises at least one electronic power switch, in particular an insulated-gate bipolar transistor, and is housed in at least an electric cabinet comprising a wall fitted on one side with the electronic power switch, and on the other side with the cooling fin.

In this way the heat transfer is assured and the efficiency of the power converter is very high. At the same time the power switch is protected from any kind of pollution.

A non-limiting embodiment of the present invention will be described by way of example with reference to the accompanying drawing, in which:

Figure 1 shows a partly sectioned side view, with parts removed for clarity, of a wind power turbine in accordance with the present invention;

Figure 2 shows a larger-scale lateral section of a detail of the Figure 1 wind power turbine;

Figure 3 shows a larger-scale section, along line III-III and with parts removed for clarity, of a detail in Figure 2;

Figures 4 to 7 show sections of respective variations of the Figure 3 detail.

Number 1 in Figure 1 indicates as a whole a wind power turbine comprising a pylon 2 extending along a vertical axis A1; a nacelle 3 fitted to the top end of pylon 2 and rotating with respect to pylon 2 about axis A1; a hub 4 mounted to rotate with respect to nacelle 3 about an axis of rotation A2 crosswise to axis A1; and three blades 5, only two of which are shown in Figure 1.

Pylon 2 is substantially defined by a hollow cylinder housing stairs and/or elevators (not shown in the drawings).

Pylon 2 is normally anchored to the ground by a foundation (not shown in the drawings), and projects vertically from a supporting surface P.

Wind power turbine 1 comprises a synchronous electric generator 6 fitted to nacelle 3; and a frequency converter 7, which, in the example shown, is housed inside pylon 2 and comprises electronic power switches 8, in particular, insulated-gate bipolar transistors, commonly known as IGBTs.

Frequency converter 7 provides for converting variable-frequency electric energy to constant-frequency, in particular mains frequency, energy.

Nacelle 3 comprises a hollow body fitted to the top end of pylon 2 to rotate about axis A1, and supports electric generator 6.

Wind power turbine 1 comprises a cooling system 9 housed inside pylon 2 at, and for cooling, frequency converter 7.

Pylon 2 and nacelle 3, in fact, define an inner compartment, in which, more generally speaking, frequency converter 7 may be housed at either pylon 2 or nacelle 3.

With reference to Figure 2, pylon 2 comprises an outer wall 10; and a structure 11 housed inwards of and spaced apart from wall 10. Structure 11 supports two electric cabinets 12, which house frequency converter 7 and are raised off supporting surface P (Figure 1), and each electric cabinet 12 is separated from wall 10 of pylon 2 by a gap.

In the Figure 2 example, each electric cabinet 12 comprises a wall 13 fitted with electronic power switches 8; wall 13 has openings 14, each housing a respective electronic power switch 8; and, as shown more clearly in Figure 3, opening 14 is the same size as electronic power switch 8, which fits snugly inside respective opening 14.

With reference to Figure 2, cooling system 9 comprises an open-loop circuit 15 for drawing in air from outside wind power turbine 1; feeding the air along a given path, extending along the inner compartment of wind power turbine 1, to cool frequency converter 7; and expelling the air from wind power turbine 1. Circuit 15 comprises two conduits 16 connecting an inlet port 17 and an outlet port 18, both formed in wall 10; and a number of cooling fins 19 housed inside conduits 16, directly contacting electronic power switches 8. Inlet port 17 is located below frequency converter 7 and electric cabinets 12, and outlet port 18 is located above frequency converter 7 and electric cabinets 12.

Each conduit 16 extends inside the inner compartment, but has no outlets or openings into the inner compartment, and prevents the cooling air from circulating freely inside the inner compartment. Each conduit 16, in fact, serves to guide the airflow over cooling fins 19.

In the example shown, each conduit 16 is tubular, and, at frequency converter 7, is defined partly by wall 13 of a respective electric cabinet 12.

Cooling system 9 also comprises a number of powered fans 20, each housed at least partly inside a respective conduit 16 to feed air from inlet port 17 to outlet port

18 in the direction indicated by the arrows in Figure 2, and over cooling fans 19. The fans are preferably variable-speed, so as to adjust airflow also as a function of air temperature.

In the Figure 4 variation, wall 13 has no openings, and each electronic power switch 8 and corresponding cooling fin 19 are fixed, e.g. glued, in line with each other to opposite faces of wall 13. Accordingly, wall 13 is made of good heat-conducting material to transfer heat from electronic power switch 8 to cooling fin 19.

In the Figure 5 variation, wall 13 has an opening 14 at each electronic power switch 8, which comprises a flange 21 fixed to wall 13 by screws 22; and cooling fin 19 is fixed, e.g. glued, directly to electronic power switch 8.

In the Figure 6 variation, wall 13 has an opening 14 at each electronic power switch 8, and comprises a tubular flange 23 fixed to electronic power switch 8 by screws 24; and cooling fin 19 is fixed, e.g. glued, directly to electronic power switch 8.

In the Figure 7 variation, wall 13 has a hole 25, and electronic power switch 8 is fitted to a heat pipe 26 extending through hole 25 and fitted to a group of cooling fins 27 on the other side of wall 13.

With reference to Figure 1, as stated, in an alternative embodiment of the present invention, frequency converter 7 and respective cooling system 9 are housed inside the inner compartment at nacelle 3, which has an outer wall 28, in which an inlet port 29 and an outlet port 30 (shown by the dash lines) are formed.

In this embodiment, frequency converter 7 and respective cooling system 9 are identical to those housed inside pylon 2, except possibly for dimensional variations.

The present invention also includes other variations, not shown, such as each conduit comprising a respective inlet port and a respective outlet port.

Cooling system 9 according to the present invention provides for highly effective cooling of electronic power switches 8, regardless of weather conditions, as well as for keeping the inner compartment free of dirt.

Clearly, other changes may be made to the present invention without, however, departing from the scope defined in the accompanying Claims.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1) A wind power turbine comprising a pylon having a first outer wall; a nacelle having a second outer wall; an electric generator fitted to the nacelle to produce electric energy; a frequency converter housed in an inner compartment of the wind power turbine; and a cooling system for cooling the frequency converter, and which comprises:

- an open-loop circuit including at least one conduit housed inside said inner compartment and having no outlets into said inner compartment, and connecting an inlet port, formed in the first or second outer wall, to an outlet port formed in the first or second outer wall; and

- at least one cooling fin thermally connected to the frequency converter and housed inside said conduit.

2) A wind power turbine as claimed in Claim 1, wherein the frequency converter comprises at least one electronic power switch, preferably an insulated-gate bipolar transistor; the frequency converter being housed inside at least one electric cabinet comprising a wall fitted, on one side, with said electronic power switch and, on the other side, with said cooling fin.

3) A wind power turbine as claimed in Claim 2, wherein the pylon projects vertically from a supporting surface; said electric cabinet being arranged in the

pylon in a raised position with respect to the supporting surface.

4) A wind power turbine as claimed in Claim 2, wherein the conduit is formed partly by said wall of the electric cabinet.

5) A wind power turbine as claimed in Claim 2, wherein said cooling fin contacts the electronic power switch directly through an opening in said wall.

6) A wind power turbine as claimed in Claim 2, wherein said cooling fin is connected thermally to the electronic power switch by said wall.

7) A wind power turbine as claimed in Claim 2, wherein said cooling fin is connected thermally to the electronic power switch by a heat pipe fitted through a hole in said wall.

8) A wind power turbine as claimed in Claim 1, wherein the cooling system comprises a fan housed at least partly in the conduit.

9) A wind power turbine as claimed in Claim 8, wherein the fan is a variable-speed fan so as to adjust airflow preferably as a function of air temperature.

10) A wind power turbine as claimed in Claim 1, wherein said frequency converter is spaced apart from the first or second outer wall.

11) A wind power turbine as claimed in Claim 1, wherein said conduit connects the frequency converter to the first or second outer wall.

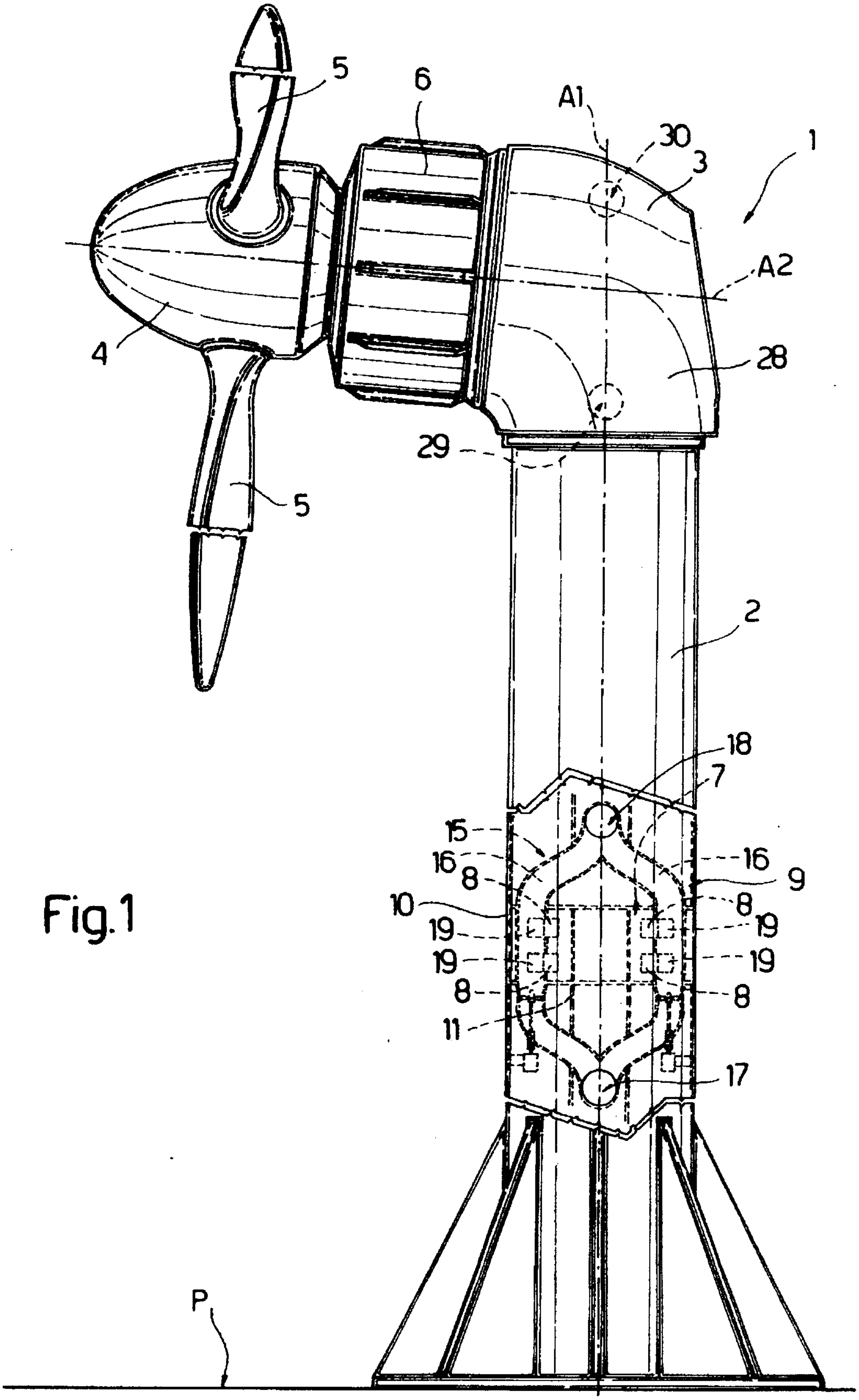


Fig.1

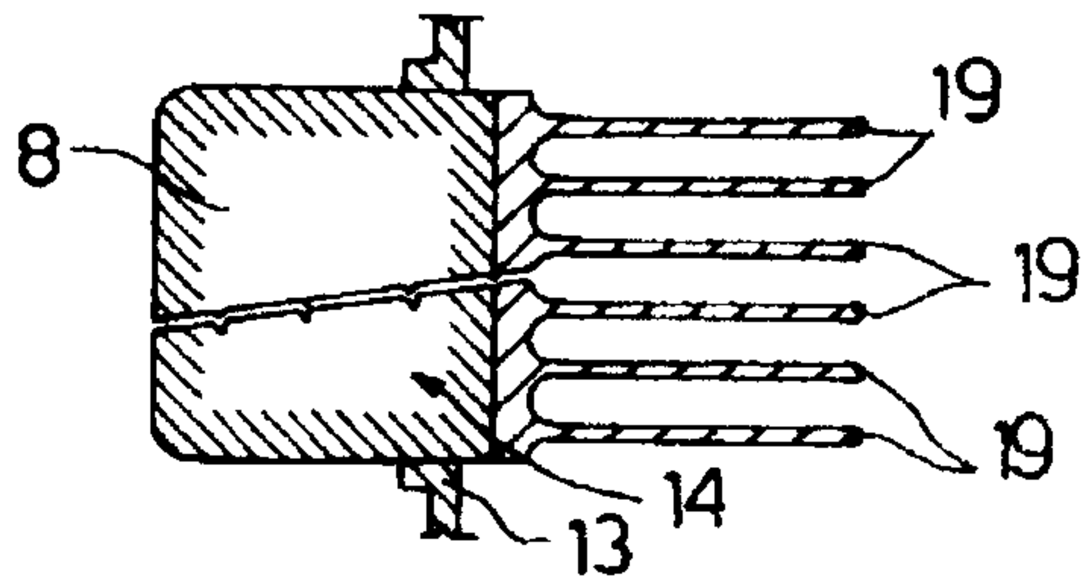

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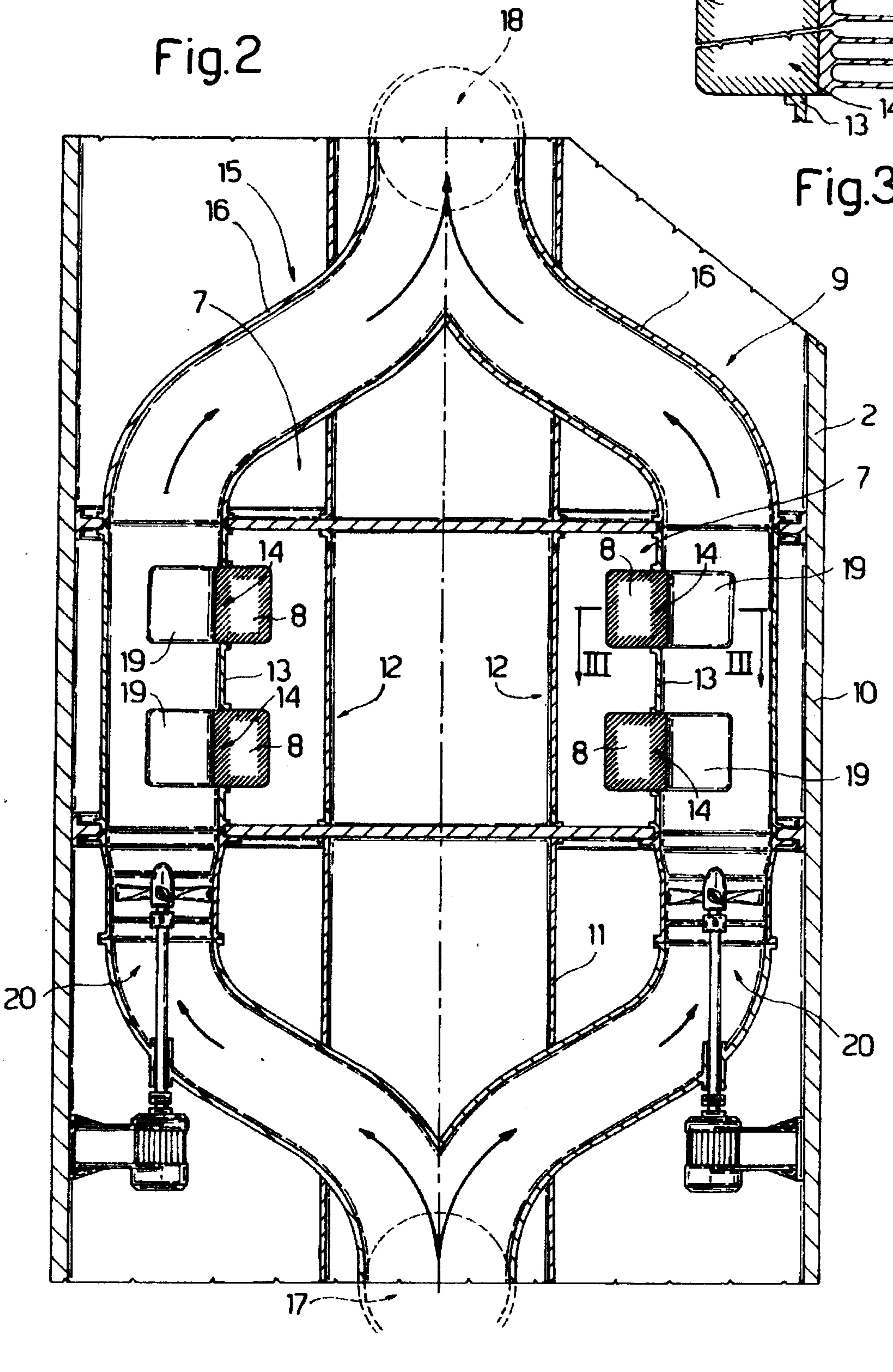
Fig.3

Fig.2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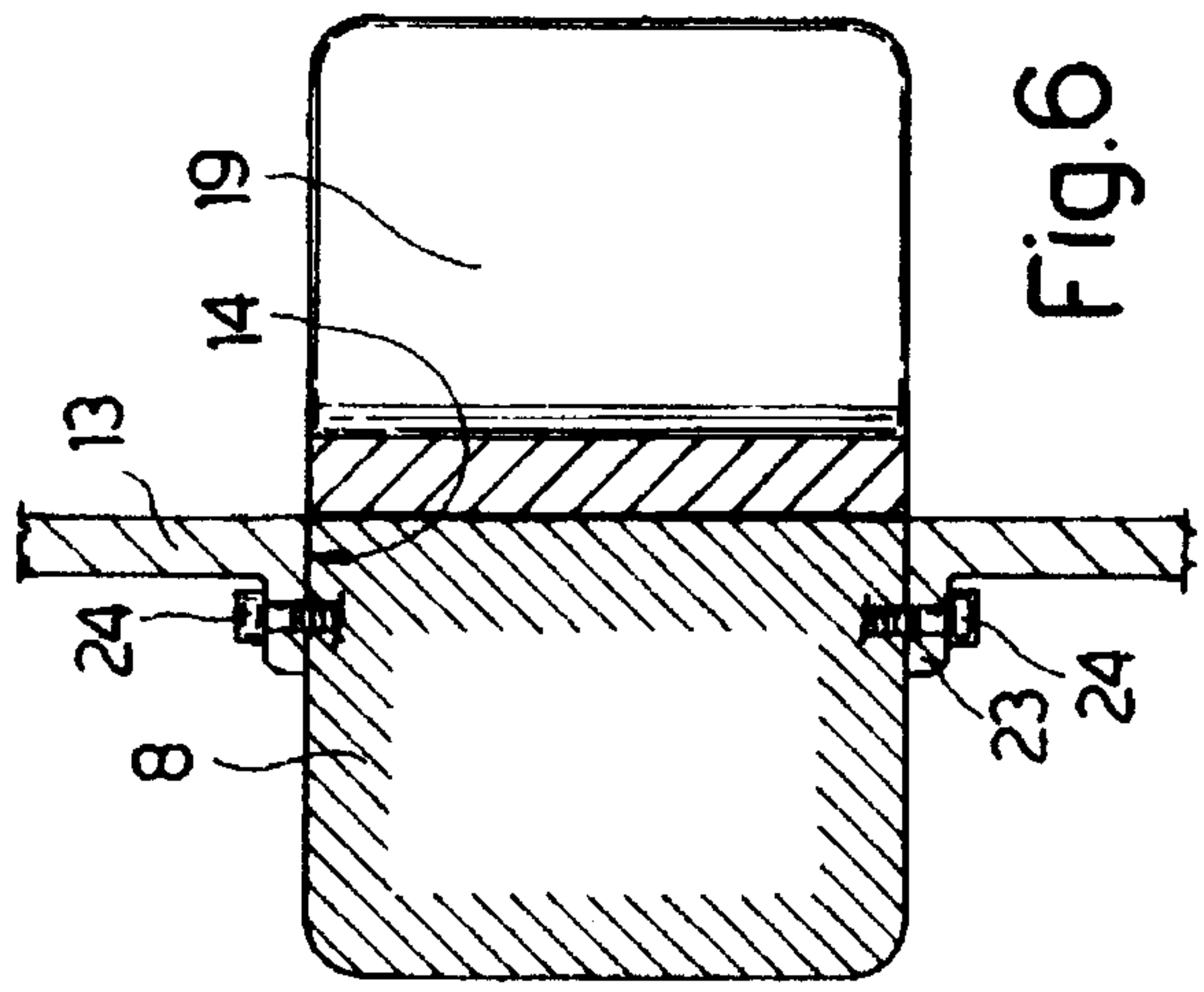


Fig.6

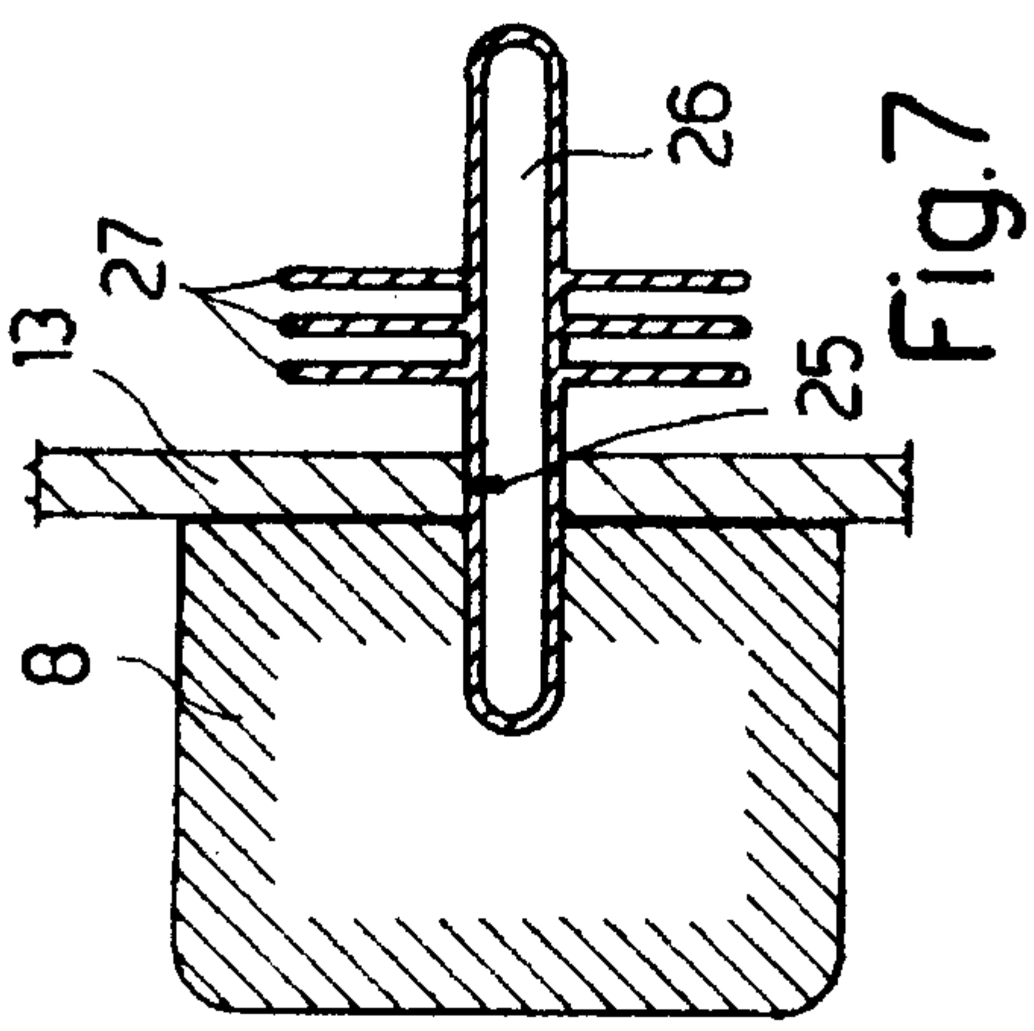


Fig.7

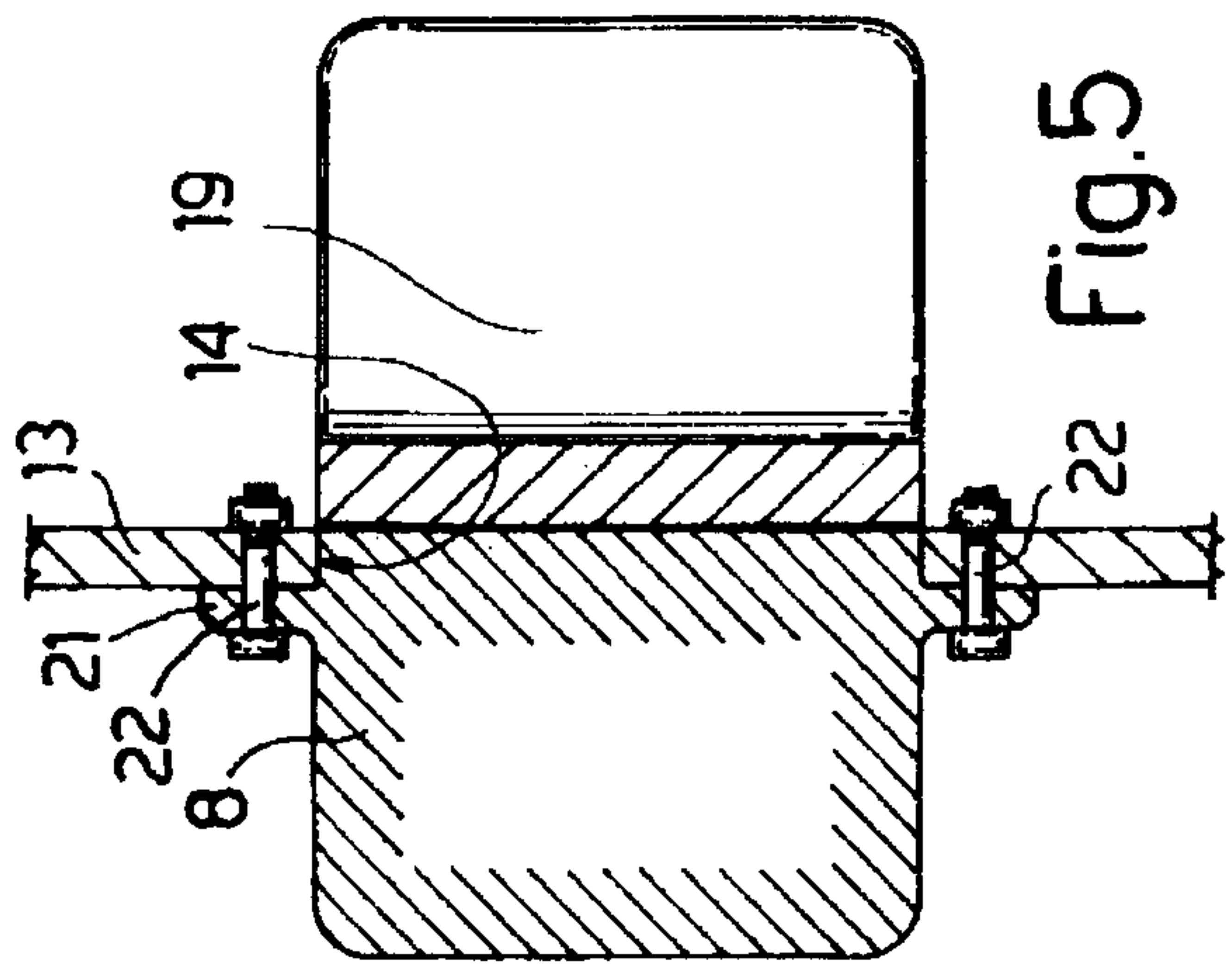


Fig.5

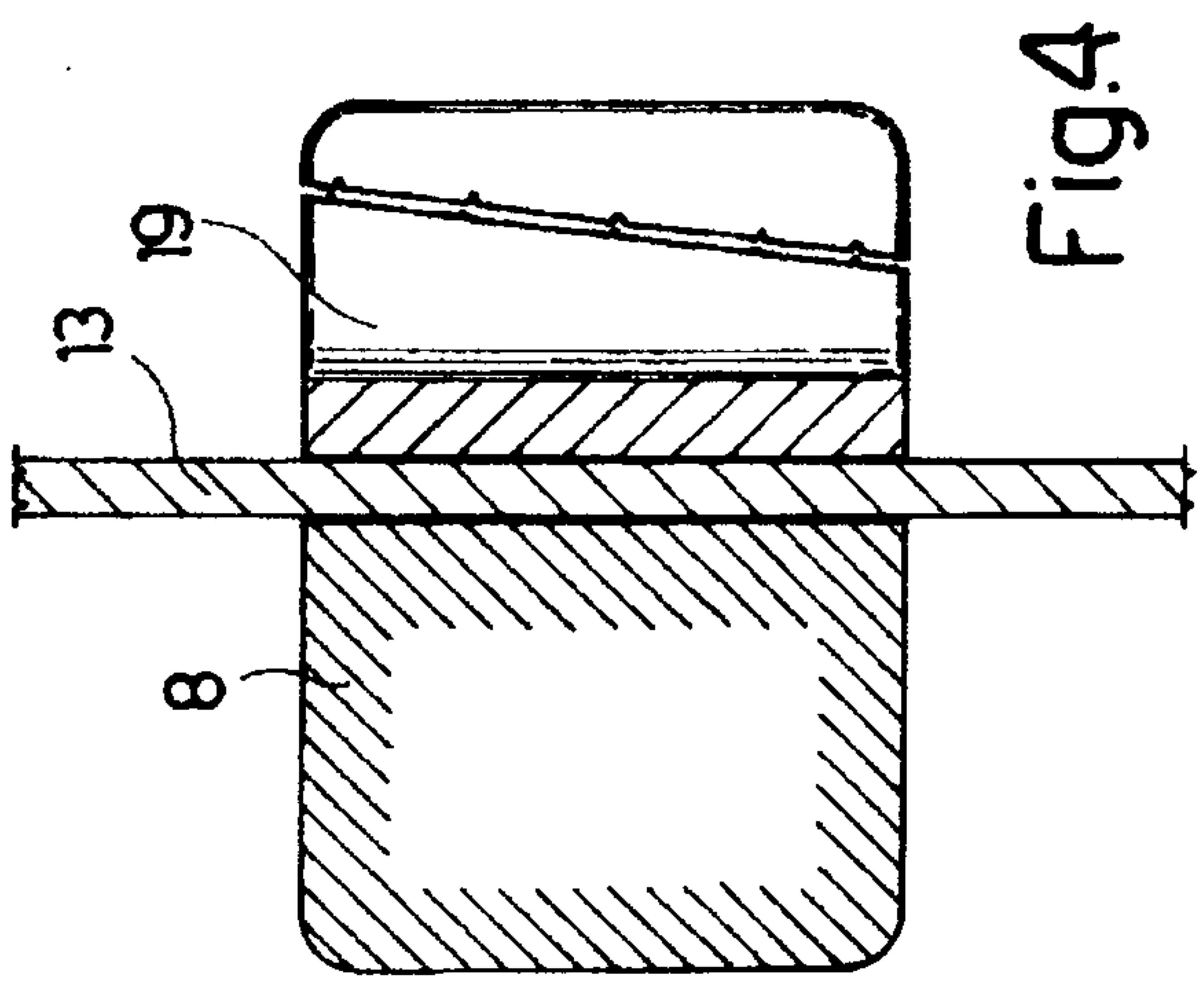
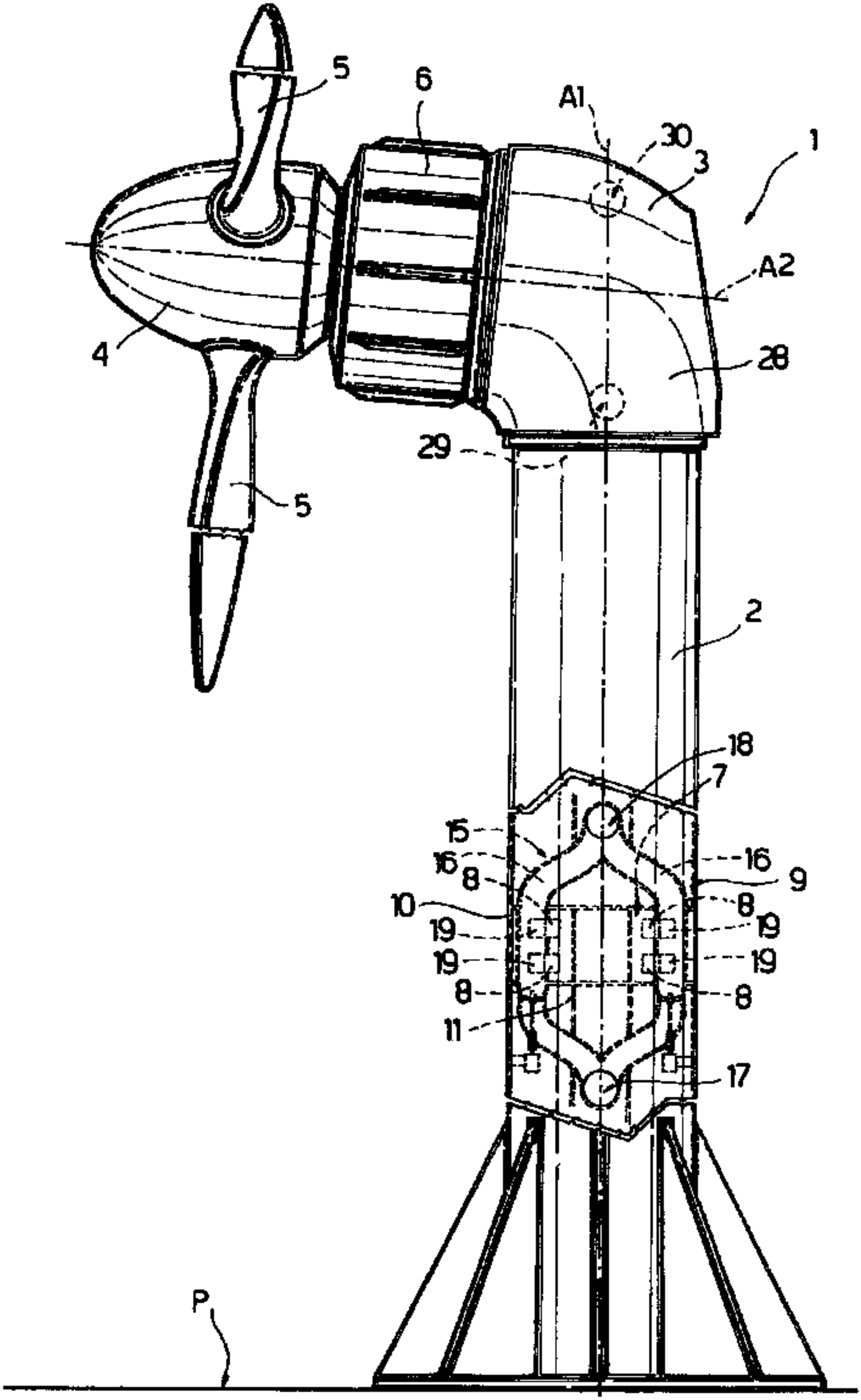


Fig.4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