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[Continued on next page]

(54) **Title**: VTOL AIRCRAFT WITH A THRUST-TO-WEIGHT RATIO SMALLER THAN 1

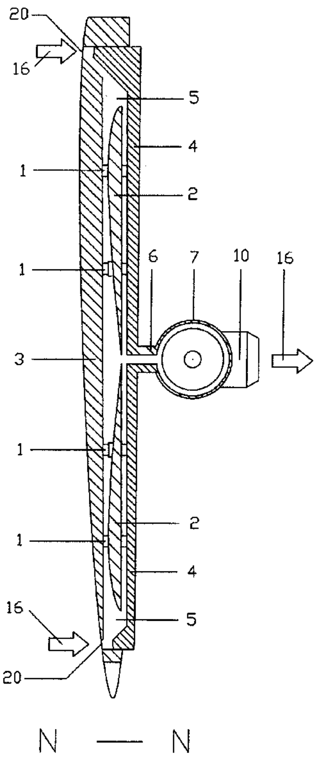

FIG.10

(57) **Abstract**: An aircraft with this VTOL technology (the Invention) (6,7,8,9,10,18,19,20) can achieve VTOL even its thrust-to-weight ratio is smaller than 1.It is impossible for an aircraft with a thrust-to-weight ratio smaller than 1 to take off and land vertically with traditional technologies. The present invention, however, can achieve VTOL on these aircraft (6,7,8,9,10,18,19,20) by generating another lift force for VTOL by horizontally setting a Thin Wing (2) at the middle of the perpendicular line of the horizontal section inside the Air Intake Duct (5,6) in addition to the lift force obtained by traditional ways. This invention can be used to retrofit an existing aircraft to achieve VTOL or manufacture a VTOL aircraft with a thrust-to-weight ratio smaller than 1.

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- *with information concerning one or more priority claims considered void (Rule 26bis.2(d))*

DESCRIPTION

Title of invention

VTOL aircraft with a thrust-to-weight ratio smaller than 1

Technical field

0001 This invention is to achieve VTOL (vertical take-off and landing) on aircraft whose thrust-to-weight ratio is smaller than 1.

Background Art

0002 Currently, VTOL is only possible for aircraft with a thrust-to-weight ratio equal to or greater than 1 because of the limitation of traditional VTOL technologies which, without exception, get the lift force in vertical direction for VTOL from a downward-directed propelling nozzle of a jet engine solely, or its combination with a lift fan.

Summary of Invention

0003 The present invention, however, can achieve VTOL on aircraft whose thrust-to-weight ratio is smaller than 1. According to its first characteristic, this invention can obtain or generate another lift force for VTOL, in addition to the lift force obtained by traditional ways, by horizontally setting a Thin Wing at the middle of the perpendicular line of the horizontal section inside the Air Intake Duct.

0004 According to the characteristics of the present invention, the following are true:

0005 The Thin Wing is a part of the Air Intake Duct and is attached to the inner wall of the latter in a fixed or flexible way. The Thin Wing will produce a lift force when air flows over it and the produced lift force will be then transmitted to the inner wall of the Air Intake Duct to lift the aircraft off the ground.

0006 The Thin Wing is designed such that its area and shape take into full consideration the air inflow of the jet engine and can ensure the produced lift force will be greater than the difference between the maximum take-off weight and the vertical thrust of an aircraft.

0007 The entire or part of the Air Intake Duct with a Thin Wing can be fixed or formed through the transformation of components of an aircraft.

0008 The entire or part of the Air Intake Duct with a Thin Wing can be fitted to the fuselage or wings of an aircraft.

0009 The leading end of the Air Intake Duct with a Thin Wing in horizontal direction can be opened or closed.

0010 The leading end of the Air Intake Duct with a Thin Wing in vertical direction can be opened or closed.

Brief Description of Drawing

0011 The attached figures are an illustration of this invention as follows:

0012 Fig. 1 is a side view of an aircraft with this invention on ground (without landing gear) and during horizontal flight.

0013 Fig. 2 is a front view of the transformable wings of an aircraft with this invention on ground and during horizontal flight.

0014 Fig. 3 is a top view of the transformable wings of an aircraft with this invention on ground and during horizontal flight.

0015 Fig. 4 is A-A Section for Fig. 3.

0016 Fig. 5 is B-B Section for Fig. 3

0017 Fig. 6 is a side view of an aircraft with this invention during vertical taking off and landing.

0018 Fig. 7 is a front view of the transformable wings of an aircraft with this invention during vertical taking off and landing.

0019 Fig. 8 is a top view of the transformable wings of an aircraft with this invention during vertical taking off and landing.

0020 Fig. 9 is M-M Section for Fig. 8

0021 Fig. 10 is N-N Section for Fig. 8

Description of Embodiments

0022 As illustrated in Fig. 1, 2, 6 and 7, an aircraft with this invention is mainly made up of a fuselage (18), transformable wings (19), an extended section (6) of the air intake duct for the wing, an openable/closable leading end (8) of the air intake duct in horizontal direction and that (20) in vertical direction, a jet engine (7) with a propelling nozzle (10) that can be directed downward, and an APU (9) with a propelling nozzle (10) that can be directed downward. The air intake duct (5) formed by the transformable wing (19), together with the extended section (6) of the air intake duct for the wing, jointly forms an intake duct (5,6) with a thin wing (2) to produce an additional lift force besides the one produced by traditional technologies.

0023 As illustrated in Fig. 3, 4, 5, 8, 9 and 10, the transformable wing (19) is made up of a fixed wing (3), a hydraulic sleeve (1), a thin wing (2), a sliding wing (4), a leading edge flap (11,14) and a trailing edge flap (12,15), aileron (17) and hinge (13).

0024 When taking off from the ground, the Fixed Wing (3) of the Transformable Wing (19) is fixed to the Fuselage (18), and the Sliding Wing (4) and Thin Wing (2), under the action of the Hydraulic Sleeve (1), will go down to a position where the Leading End (20) of the Air Intake Duct in vertical direction will open and the Jet Engine (7), with the Leading (8) End of the Air Intake Duct in horizontal direction closed, can freely take air in from the Air Intake Duct (5) of the Transformable Wing (19) at a flow rate enough for the Thin Wing (2) to produce a lift force for VTOL. At the same time, the upper (14) and lower part (11) of the Leading Edge Flap and the upper (15) and lower part (12) of the Trailing Edge Flap as well as the Aileron (17) begin to rotate around the Hinge (13) to increase the lift for the transition between vertical taking off/landing and horizontal flight. The Leading End (8) of the

Air Intake to the Jet Engine (7) is closed to prevent the aircraft from horizontal movement and to increase the Air Flow (16) through the Air Intake Duct (5,6) with a Thin Wing (2). Also, the horizontal thrust generated by the Jet Engine (7) will be directed downward by the Propelling Nozzle (10). Then, the Jet Engine (7) starts to increase the thrust gradually. Now, the Air (16) flows through the Air Intake Duct (4) which is formed as the Sliding Wing and Thin Wing are going down. Because the velocity of the Air flowing over the upper surface of the Thin Wing (2) within the Air Intake Duct (5) of the Transformable Wing (19) is higher than that over the lower surface of the Thin Wing (2), and according to Bernoulli's Principle stating an increase in the speed occurs simultaneously with a decrease in pressure, we know that there will be a lift force produced on the wing due to the lower pressure on the upper surface of the Thin Wing (2) than that on the lower surface of the Thin Wing (2). And this Lift Force is then transmitted to the fuselage through the Hydraulic Sleeve (1) and Fixed Wing (3). Again, this force is never seen before and is an essential feature distinguishing the present invention from any other VTOL technology. The Thin Wing (2) is designed such that its area and shape take into full consideration the air inflow of the Jet Engine (7) and can ensure the produced lift force will be greater than the difference between the maximum take-off weight and the vertical thrust of an aircraft. The Air Intake Duct (5) of the Transformable Wing (19) is extended to the Jet Engine (7) through an extended section (6) (a suspended arm in this case). The air flows through the Air Intake Duct (5) of the Transformable Wing (19) and the Extended Section (6) (a suspended arm in this case) of the Air Intake Duct of the Wing and enters into the Jet Engine (7) where the air is burned and blown out of the Propelling Nozzles (10) which is now directed downward to generate lift force to lift the aircraft off the ground. There are now two lift forces to achieve VTOL, i.e. one generated by the Air (16) flowing through the Air Intake Duct (5,6) with a Thin Wing (2) and the other one generated by the high-temp burned air thrown out of the downward-directed Propelling Nozzles (10) of the Jet Engine (7) and APU (9). The Hydraulic Sleeve (1) now can drive the left and right Sliding Wing (4) to move up and down to balance the aircraft horizontally during vertical taking off and landing, correspondingly, the vertical balance can be controlled by adjusting the angle at which the Propelling Nozzles (10) of the Jet Engine (7) and APU (9) are directed downward.

0025 A transition to horizontal flight from vertical taking off can be achieved by performing the above steps in reverse order. Similarly, a transition to vertical landing from horizontal flight can be achieved by repeating these steps.

Industrial Applicability

0026 All the formulas and calculations for this invention are listed in Annex 1.

0027 All the formulas and calculations used to retrofit an Airbus A-380 based on this invention are listed in Annex 2.

0028 This invention can be used to retrofit an existing aircraft to achieve VTOL or manufacture a VTOL aircraft with a thrust-to-weight ratio smaller than 1.

ANNEX 1

m	S/N of Jet Engine	(Dimensionless Unit)
n	S/N of Thin Wing	(Dimensionless Unit)
F	Total Lift Force of Thin Wing	(Unit: kg)
F_n	Lift Force of Thin Wing	(Unit: kg)
G	Maximum Take-Off Weight of Aircraft	(Unit: kg)
S_m	Area of Air Intake to Jet Engine	(Unit: m^2)
F_m	Jet Engine Thrust	(Unit: kg)
S_n	Area of Air Intake at the Leading End of Thin Wing	(Unit: m^2)
ρ	Air Density	(Unit: kg/m^3)
q_m	Air Intake of Jet Engine	(Unit: kg/s)
$V_{n\ \infty}$	Air Flow at the Leading End of Thin Wing	(Unit: m/s)
a	Sonic Speed	(Unit: m/s)
$Ma_{n\ \infty}$	Mach Number= $V_{n\ \infty}$ /a	(Dimensionless Unit)
λ_n	Aspect Ratio of Thin Wing	(Dimensionless Unit)

(Taking the ratio of the line between the midpoints of left and right edge of the Thin Wing to that between the leading and trailing edge)

C_{nL}	Lift Coefficient of Thin Wing	(Dimensionless Unit)
C_{na}	Lift Curve Slope of Thin Wing	(Unit: 1/rad)
c_a	Lift Curve Slope of Aerofoil of Thin Wing =2 π	(Unit: 1/rad)
α_n	AOA of Aerofoil of Thin Wing	(Unit: rad)
$\alpha_{nL=0}0$	Zero-Lift AOA of Aerofoil of Thin Wing	(Unit: rad)
e	Span Efficiency Factor Oswald's Efficiency Factor= (0.7-0.8)	(Dimensionless Unit)

The Thin Wing can be viewed that the length of the line between the midpoints of the left and right edges is the wingspan, that between the leading and trailing edge is the chord length and the aerofoil is a straight wing taking as its chord line the line between the midpoints of the leading and trailing edges.

$$F=\Sigma F_n \tag{1}$$

$$F_n=\frac{1}{2}\ \rho V^2_{n\ \infty}\ \ S_n\, C_{nL} \tag{2}$$

$$Ma_{n\ \infty}\ =V_{n\infty}\ /a \tag{3}$$

$$V_{n\infty} = \frac{q_m}{\rho} \times \frac{S_n^{\ 2}}{S_m} \quad (m=1,2,3\cdots) \tag{4}$$

$$C_{nL} = C_{na}\,(\alpha_n - \alpha_{nL=0}) \tag{5}$$

When $\lambda_n \geq 5$:

For low-speed flow

$$C_{na} = \frac{c_a}{1+\dfrac{c_a}{\pi e \lambda_n}} = \frac{2\pi}{1+\dfrac{2}{e\lambda_n}} \quad (Ma_{n\infty} < 0.3) \tag{6}$$

For subsonic flow

$$C_{na} = \frac{c_a/\sqrt{1-Ma_{n\infty}^{\ 2}}}{1+\dfrac{c_a\sqrt{1-Ma_{n\infty}^{\ 2}}}{\pi e \lambda_n}} = \frac{2\pi/\sqrt{1-Ma_{n\infty}^{\ 2}}}{1+\dfrac{2\sqrt{1-Ma_{n\infty}^{\ 2}}}{e\lambda_n}} \quad (0.3 < Ma_{n\infty} < 0.8) \tag{7}$$

For supersonic flow

$$C_{na} = \frac{4}{\sqrt{M_{an\infty}-1}} \quad (Ma_{n\infty} > 0.8) \tag{8}$$

When $\lambda_n < 5$:

For low-speed flow

$$C_{na} = \frac{c_a}{\sqrt{1+Ma^2{}_{n\infty}+[c_a/(\pi\lambda_n)]^2}+c_a/(\pi\lambda_n)} \quad (Ma_{n\infty} < 0.3) \tag{9}$$

$$= \frac{2\pi}{\sqrt{1+Ma^2{}_{n\infty}+(2/\lambda_n)^2}+2/\lambda_n}$$

For subsonic flow

$$C_{na} = \frac{c_a}{\sqrt{1-Ma^2{}_{n\infty}+[c_a/(\pi\lambda_n)]^2}+c_a/(\pi\lambda_n)} \quad (0.3 < Ma_{n\infty} < 0.8) \tag{10}$$

$$= \frac{2\pi}{\sqrt{1-Ma^2{}_{n\infty}+(2/\lambda_n)^2}+2/\lambda_n}$$

For supersonic flow

$$C_{na} = \frac{4}{\sqrt{Ma_{n\infty}^{\ 2}-1}}\left(1-\frac{1}{2\lambda_n\sqrt{Ma_{n\infty}^{\ 2}-1}}\right) \quad (Ma_{n\infty} > 0{,}8) \tag{11}$$

VTOL can be achieved once $F + \sum F_m \geq G$

Formula (5) through (11) are taken directly from the literature *Aerodynamics (Ch.4, Vol. 1, edit by Wu Ziniu, Tsinghua University Press, Beijing, April, 2007)* and *Aircraft Performance and Design(Ch. 3, Anderson Jr D J. New York: McGraw-Hill,1999)*

ANNEX 2

S (Total Wing Area) = 845m

G (Maximum Take-Off Weight) = 560,000kg

ΣF_m (Total Jet Engine Thrust) = 1,208,000/9.8 ≈ 123,265kg

q_m (Air Flow to Trent900 Jet Engine) = 2,745 × 0.4536 ≈ 1,245kg/s

R_m (Dia. of Air Intake to Trent900 Jet Engine) = $0.91m^2$

Assuming:

m (S/N of Trent900 Jet Engine) =1~4

n (S/N of Thin Wing) =1~8

S ' (Total Area of Thin Wing) =0.8 × S=0.8 ×845=$676m^2$

ρ (Air Density) =$1.297kg/m^3$

S_m (Area of Air Intake to Trent900 Jet Engine)

S_n (Area of Air Intake at the Leading End of Thin Wing)

λ_n (Aspect Ratio of Thin Wing)=$\dfrac{4}{\dfrac{35}{4}} \approx 0.457$

α_n-$\alpha_{nL=0}$ (AOA of Aerofoil - Zero-Lift AOA of Aerofoil for Thin Wing)

$$= 3.4^\circ \times \frac{\pi}{180} \approx 0.059 \text{ rad}$$

It can be obtained from the above:

$$S_m = \pi \times (\frac{1}{2} \times R_m)^2 = 3.14 \times (\frac{1}{2} \times 0.91) \approx 0.65m^2$$

$$S_n = \frac{1}{2} S_m = \frac{1}{2} \times \pi R_m{}^2 = \frac{1}{2} \times 3.14 \times (\frac{1}{2} \times 0.91) = 0.325 \text{ m}^2$$

$$V_{n\infty} = \frac{q_m}{\rho} \times \frac{S_n{}^2}{S_m} = \frac{1245}{1.297} \times \frac{0.325^2}{0.65} \approx 155.985\text{m/s} \ (m=1\sim8) \qquad (4)$$

$$Ma_{n\infty} = V_{n\infty} / a = \frac{155.985}{340} \approx 0.459$$

$$C_{na} = \frac{c_a}{\sqrt{1 - Ma^2{}_{n\infty} + [c_a/(\pi\lambda_n)]^2} + c_a/(\pi\lambda_n)} \qquad (0.3<Ma_{n\infty}<0.8) \qquad (10)$$

$$= \frac{2\pi}{\sqrt{1 - Ma^2{}_{n\infty} + (2/\lambda_n)^2} + 2/\lambda_n}$$

$$= \frac{2\times 3.14}{\sqrt{1-0.459^2+(\frac{2}{0.457})^2}+\frac{2}{0.457}}$$

$\approx$ 0.71/rad

$C_{nL} = C_{na}\ (\alpha_n - \alpha_{nL=0})$ (5)

$=0.71 \times 0.059$

$\approx\ 0.042$

$F = \Sigma\ F_n$ (1)

$$= \Sigma\ \frac{1}{2}\ \rho V^2{}_{n}\ \infty\ \ S_n\ C_{nL}$$

$$= \frac{1}{2}\ \rho V^2{}_{n}\ \infty\ \ C_{nL}\ S'$$

$$= \frac{1}{2}\times 1.297\times 155.985^2\times 0.042\times 676$$

$\approx$ 447,993 (kg)

$F + \Sigma F_m$=447,993+123,265=571,258 (kg)

G=560,000(kg)

$F + \Sigma F_m > G$

It is clearly demonstrated above that VTOL is achievable on Airbus A380 once remodeled as shown in this Invention.

CLAIMS

Claim 1: An aircraft, in which an integral assembly and innovative parts as well as specific VTOL procedures and/or steps are included to achieve vertical take-off and landing (VTOL) under any type, any MTOW (Max. Takeoff Weight) and any thrust-to-weight ratio (even less than 1):

--- Said aircraft comprising: the innovative parts to generate lift enough for vertical take-off and landing, including: transformable wings (19), which is made up of fixed wing (3), hydraulic sleeve (1), thin wing (2), sliding wing (4), leading edge flaps (11,14), trailing edge flaps (12,15), aileron (17), hinge (13), and which is capable of generating lift internally for vertical take-off / landing by transforming during vertical take-off / landing and of restoring its normal shape in order to reduce the drag during forward flight;

--- And an assembly which is an integral part of the transformable wing (19) and transformable body (18) and which is made up of fixed body (18), the extended section of air intake duct (6), the openable and closable leading end of air intake duct in vertical directions (20), jet engine (7) and auxiliary power unit (APU), both with downward deflectable propelling nozzles (10).

--- And specific vertical take-off and land procedures and/or steps.

Claim 2: The aircraft according to the above-mentioned claim, in which the opening and closing of the vertical leading end of the air intake duct on the fixed wing (3) are a direct result of the sliding of the sliding wing (4) over the fixed wing (3) under the action of the hydraulic sleeve (1) (extending and retracting) in which the air intake duct (5) is formed or closed.

Claim 3: The aircraft according to the above-mentioned claims, in which the thin wings within the transformable wings (19), during vertical take-off or landing and under the extending of the hydraulic sleeve (1), are respectively positioned at a position between the parallel upper and lower wall within the air intake duct (5), which is formed by the fixed wing (3) and sliding wing (4), such that the air can freely flow in the same direction over the upper and lower surface of the thin wing. When the air flows over and through, according to the wall effect, a lift will be generated by the thin wing. During forward flight, the retracting of the hydraulic sleeve (1) will force the thin wing and sliding wing (4) to approach the fixed wing (3) until the upper surface of the thin wing clings to the lower wall of the fixed wing (3) and its lower surface clings to the upper wall of the sliding wing (4).

Claim 4: The aircraft according to the above-mentioned claims, in which the vertical take-off and landing procedure comprises the following steps:

--- Taking off from rest on ground:

The fixed wing (3) is fixed to the fixed body (18), and the sliding wing (4) and thin wing (2), under the action of the hydraulic sleeve (1), will go down to a position where the vertical leading end

(20) of the air intake duct will open and the jet engine (7), with the horizontal leading end (8) of the air intake duct closed, can freely take air in from the air intake duct (5) of the transformable wing (19) at a flow rate enough for the thin wing (2) to generate a lift required for VTOL. At the same time, the upper part (14) of the leading edge flap, the upper part (15) of the trailing edge flap, the lower part (11) of the leading edge flap, the lower part (12) of the trailing edge flap as well as the aileron (17) begin to rotate around the hinge (13) to increase the lift for vertical take-off from rest on ground. The horizontal leading end (8) of the air intake duct to the jet engine (7) will close simultaneously to prevent the aircraft from horizontal movement and to increase the air flow (16) through the air intake ducts (5,6) within the thin wings (2). Also, the propelling nozzles (10) direct downward the horizontal thrust generated by the jet engine (7). Then, the jet engine (7) starts and increases the thrust gradually. Meanwhile, the air (16) flows through the air intake duct (5), which is formed as the sliding wing (4) and thin wing (2) are going down, to generate a lift on the thin wing (2). And this lift is then transmitted to the fixed wing (3) and the fixed body through the hydraulic sleeve (1). The air intake duct (5) of the transformable wing (19) is extended to the jet engine (7) through the extended section (5) of the air intake duct. The air now flows through the air intake duct (5) of the transformable wing (19) as well as through the extended section (6) thereof and enters into the jet engine (7) where the air is burned and blown out of the propelling nozzles (10) which is now directed downward to generate the lift to lift the aircraft off the ground. There are now two lifts to achieve vertical take-off, i.e. One generated by the air (16) flowing through the air intake ducts (5,6) of the transformable wing (19) with a thin wing (2), and one generated by the high-temp burned air thrown out of the downward-directed propelling nozzles (10) of both the jet engine (7) and APU (9). The hydraulic sleeve (1) will drive the left and right sliding wing (4) to move up and down to balance the aircraft horizontally during vertical taking off and landing. Similarly, the propelling nozzles (10) of the jet engine (7) and APU (9) will be directed downward by adjusting the angle to control the vertical balance of the aircraft during vertical take-off and landing.

--- Horizontal flight after vertical take-off:

The sliding wing (4) and the thin wing (2), under the action of the hydraulic sleeve (1), will go up until the upper surface of the thin wing clings to the lower wall inside the fixed wing (3) and the lower surface of the thin wing to the upper wall inside the sliding wing (4). At this position, the vertical leading end (20) of the fixed wing (3) will close respectively and the transformable wing (19) will fold to reduce the drag against horizontal flight. At the same time, the upper part (14) of the leading edge flap, the upper part (15) of the trailing edge flap, the lower part (11) of the leading edge flap, the lower part (12) of the trailing edge flap as well as the aileron (17) begin to rotate around the hinge (13) to reduce the drag against horizontal flight. The horizontal leading end (8) of the air intake duct to the jet engine (7) will open simultaneously and the propelling nozzles (10) will return to the horizontal position to direct the engine thrust to horizontal direction from vertical. The air (16) now flows through the horizontal leading end of the air intake duct and enters into the jet engine (7) where the air is burned and blown out of the propelling nozzles (10) in horizontal position to generate horizontal thrust and to enable the folded transformable wings to generate the lift for horizontal flight.

--- Vertical landing from horizontal flight:

The sliding wing (4) and thin wing (2), under the action of the hydraulic sleeve (1), will go down to a position where the vertical leading end (20) of the air intake duct will open and the jet engine (7), with the horizontal leading end (8) of the air intake duct (8) closed, can freely take air in from the air intake duct (5) of the transformable wing (19) at a flow rate enough for the thin wing (2) to generate a lift required for vertical landing. At the same time, the upper part (14) of the leading edge flap, the upper part (15) of the trailing edge flap, the lower part (11) of the leading edge flap, the lower part (12) of the trailing edge flap as well as the aileron (17) begin to rotate around the hinge (13) to increase the lift during the transition from the horizontal flight to vertical landing. The horizontal leading end (8) of the air intake duct to the jet engine (7) will close simultaneously to prevent the aircraft from horizontal movement and to increase the air flow (16) through the air intake ducts (5,6) within the thin wings (2). Also, the propelling nozzles (10) direct downward the horizontal thrust generated by the jet engine (7). Now, the air (16) flows through the air intake duct (5), which is formed as the sliding wing (4) and thin wing (2) are going down, to generate the lift on the thin wings. And this lift is then transmitted to the fixed wing (3) through the hydraulic sleeve (1). The air intake duct (5) of the transformable wing (19) is extended to the jet engine (7) through the extended section (5) of the air intake duct. The air flows through the air intake duct (5) of the transformable wing (19) as well as through the extended section (6) thereof and enters into the jet engine (7) where the air is burned and blown out of the propelling nozzles (10) which is now directed downward to generate a lift to lift the aircraft off the ground. There are now two lifts to achieve vertical landing, i.e. One generated by the air flowing through the air intake ducts (5,6) of the transformable wing (19) with a thin wing (2), and one generated by the high-temp burned air thrown out of the downward-directed propelling nozzles (10) of both the jet engine (7) and APU (9). The hydraulic sleeve (1) will drive the left and right sliding wing (4) to move up and down to balance the aircraft horizontally during vertical taking off and landing, correspondingly, the vertical balance can be controlled by adjusting the angle at which the propelling nozzles (10) of the jet engine (7) and APU (9) are directed downward. The thrust from the jet engine (7) decreases gradually to ensure a smooth landing.

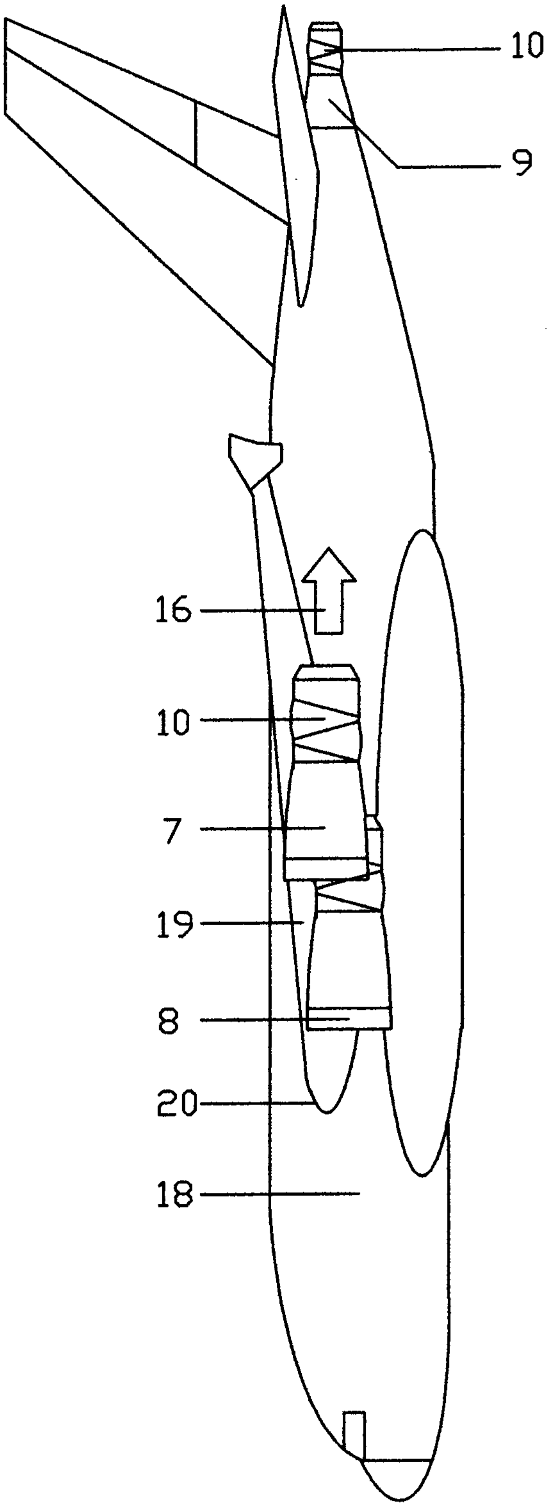


FIG.1

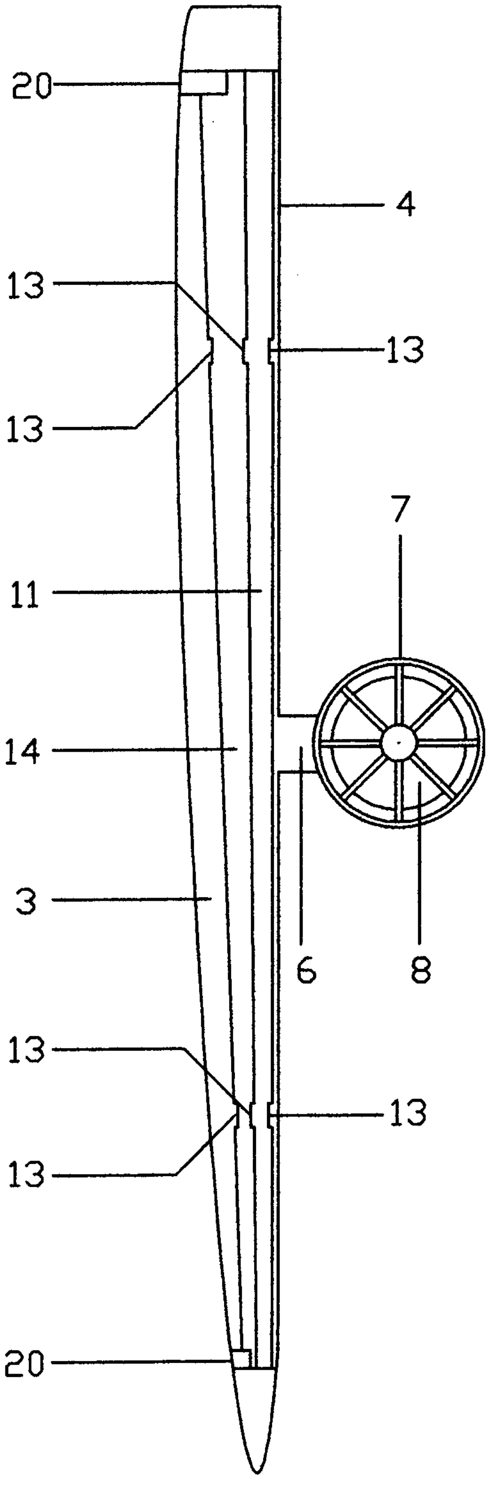


FIG.2

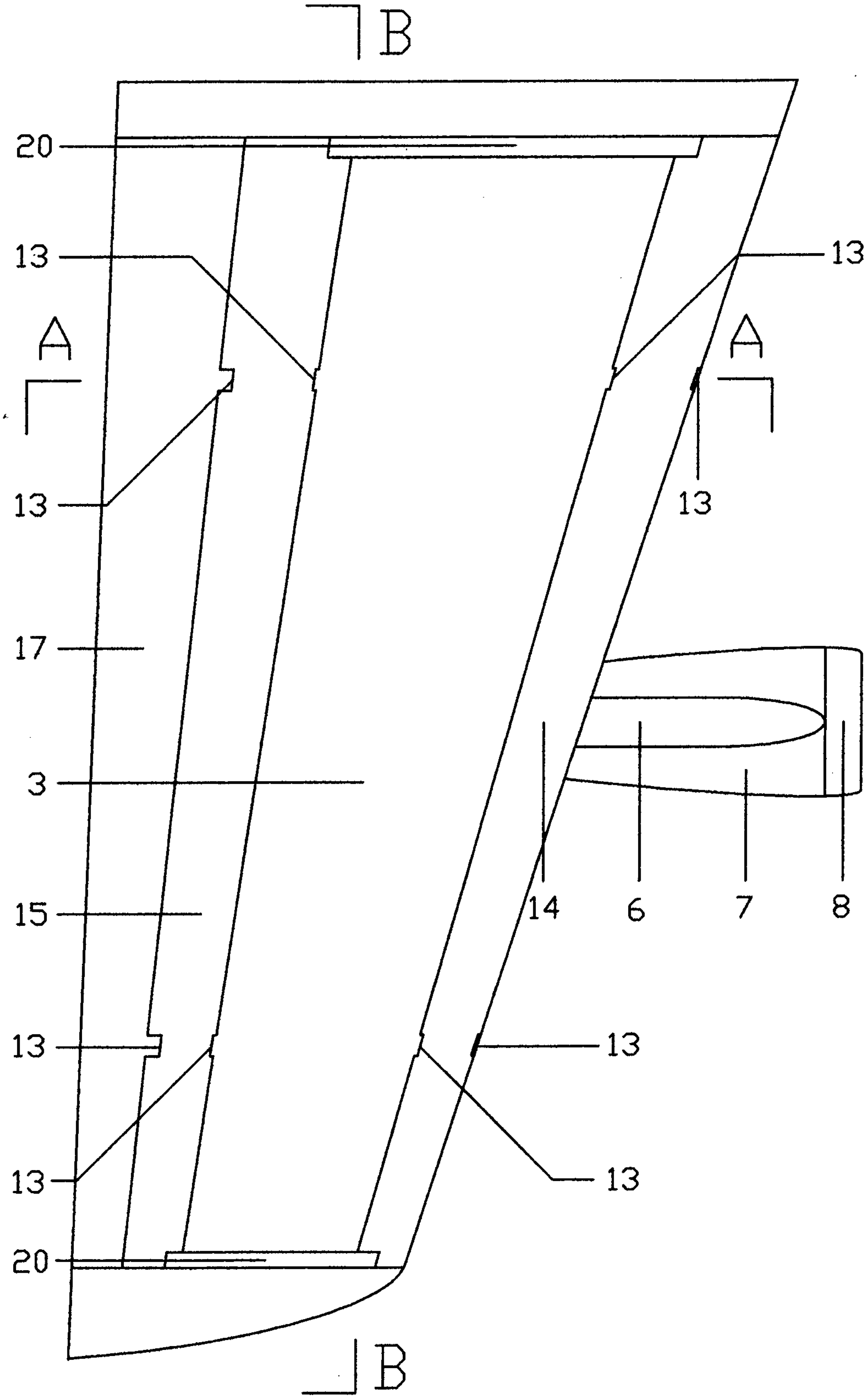
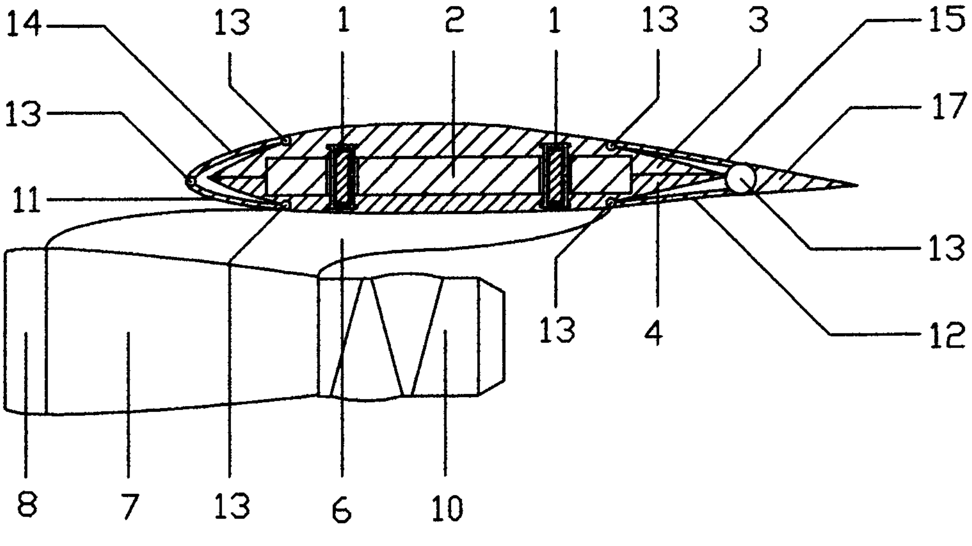
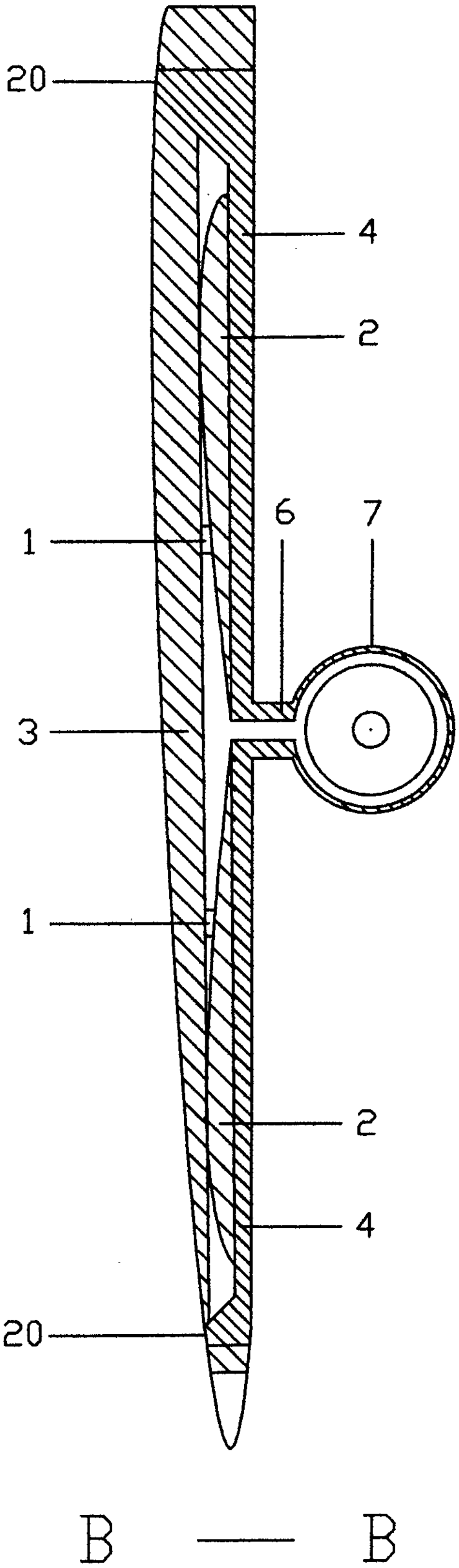


FIG.3



A — A

FIG.4



B — B

FIG.5

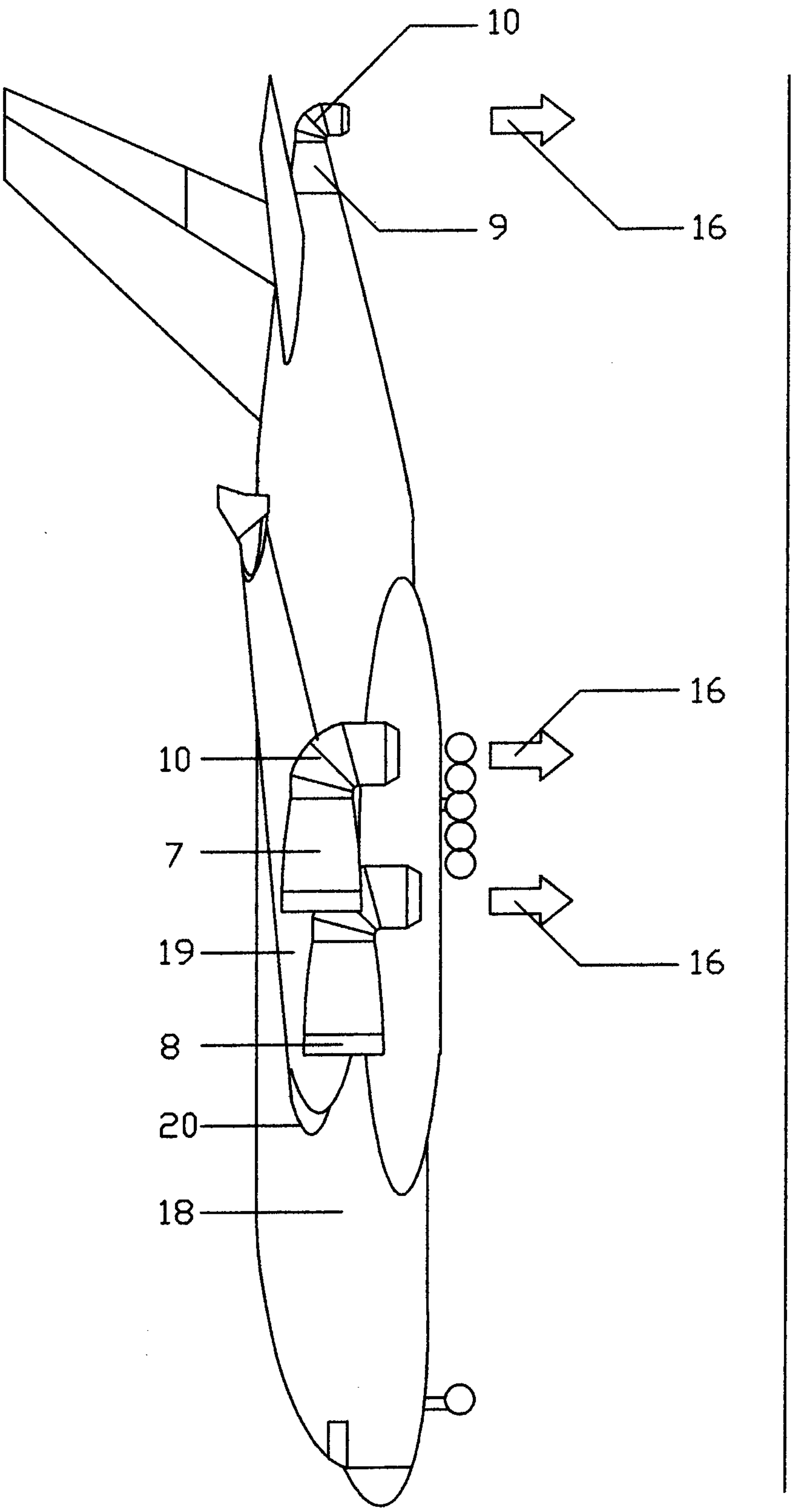


FIG.6

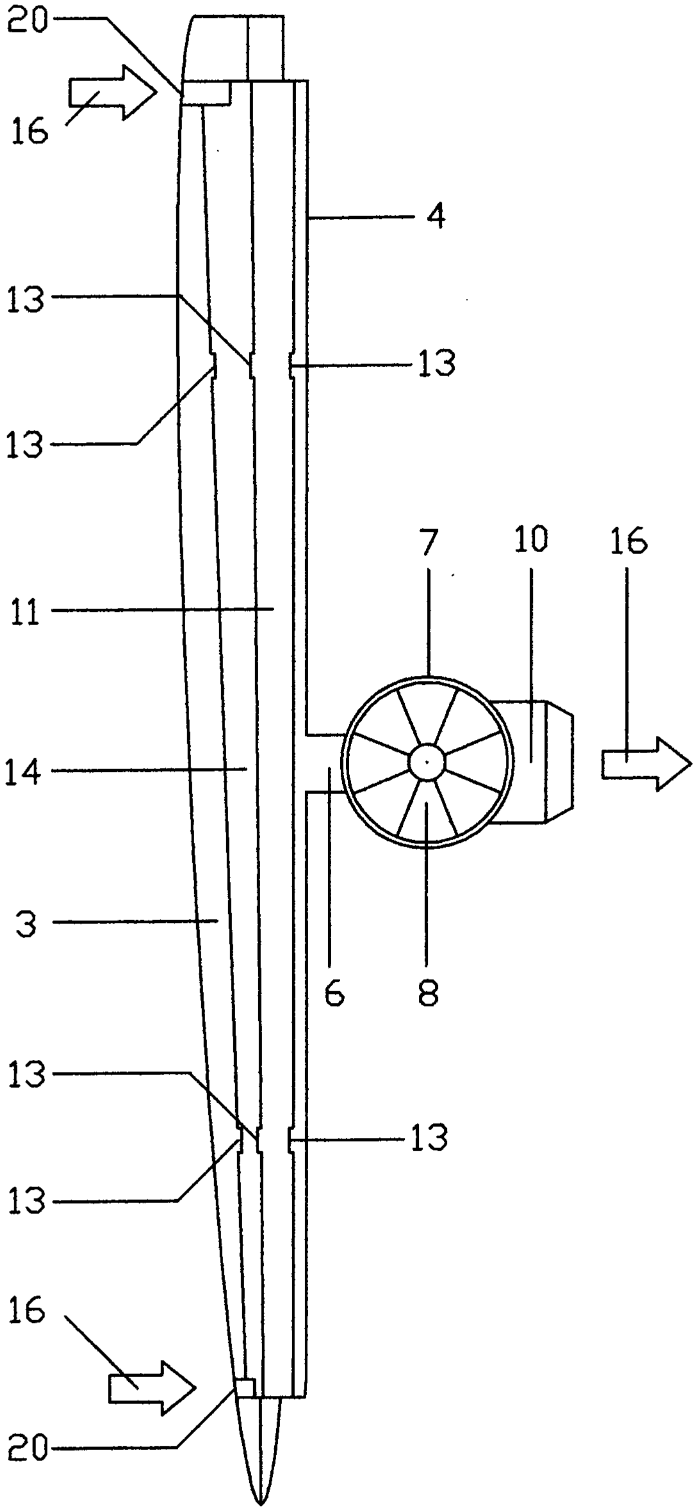


FIG.7

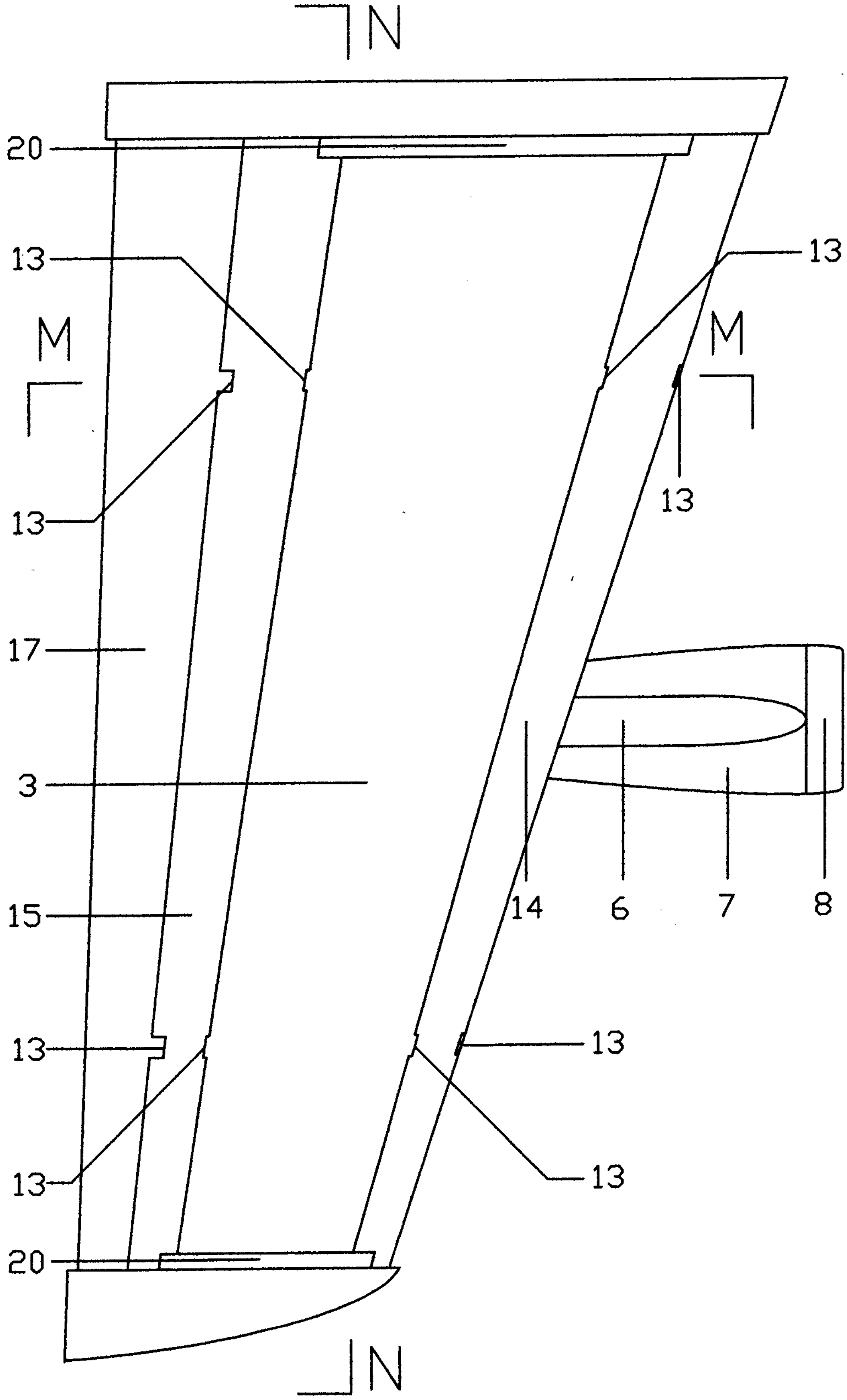
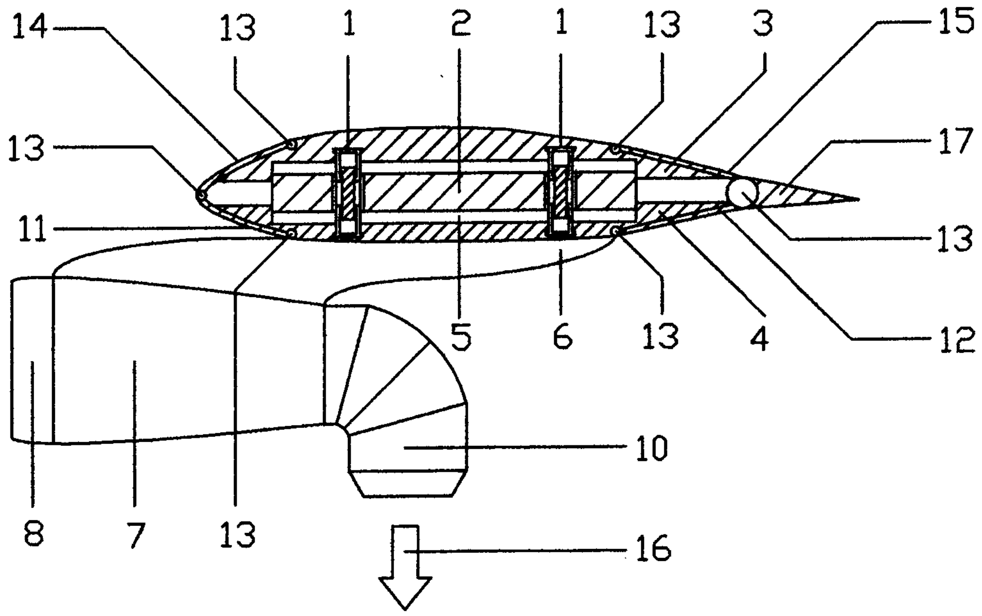


FIG.8



M — M

FIG.9

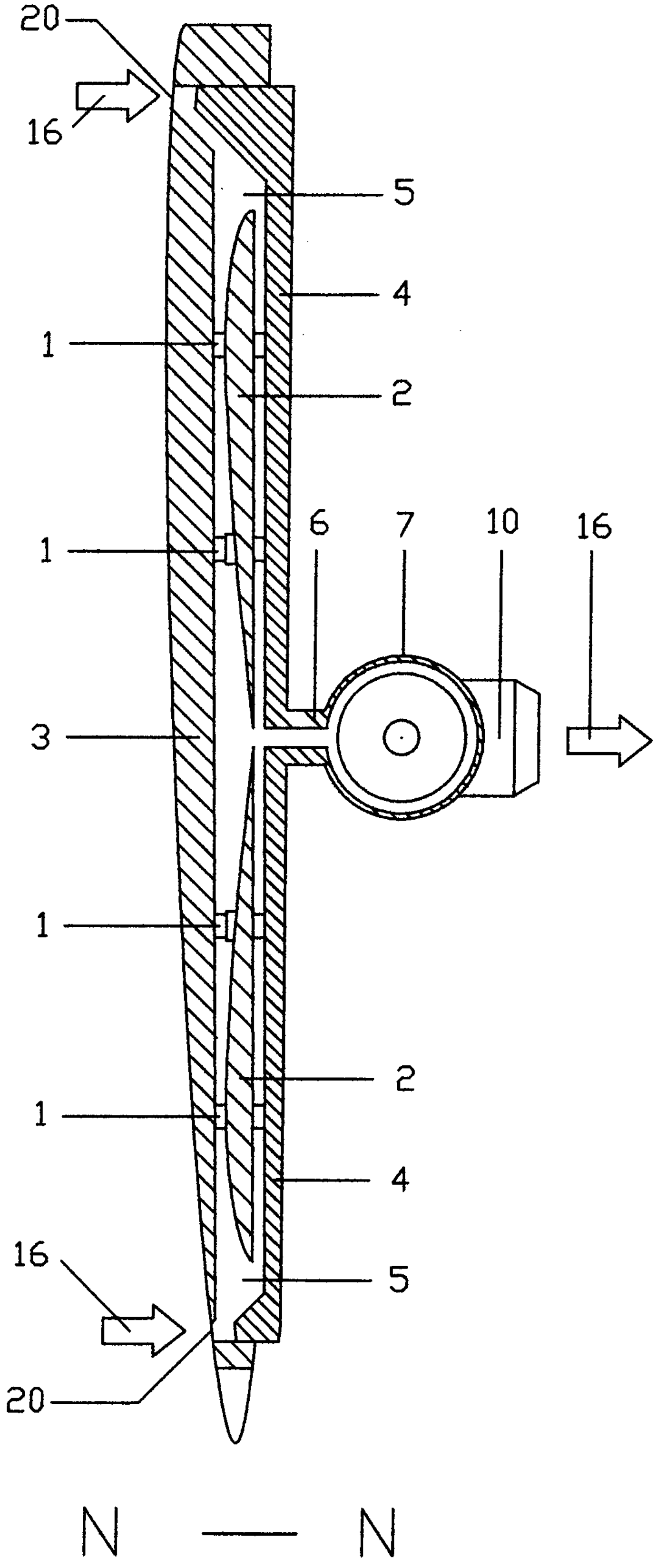


FIG.10