(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 772 007 A2

# (12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
**07.05.1997 Bulletin 1997/19**

(51) Int. Cl.[6]: **F24F 7/007**

(21) Application number: **96117214.5**

(22) Date of filing: **26.10.1996**

(84) Designated Contracting States:
**DE FR GB**

(30) Priority: **30.10.1995 JP 281282/95**

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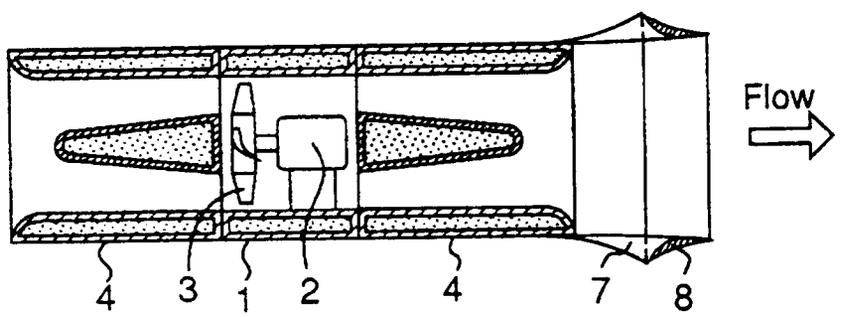
## (54) Jet fan

(57) A jet fan includes a generally cylindrical casing (1), an electric motor (2) accommodated therein, an impeller (3) connected to the electric motor (2), and at least one booster ring (8) disposed concentrically with the casing (1) and located downstream thereof with respect to a direction of an air flow. The booster ring (8) has an aerofoil or arcuated plate sectional profile as viewed in a direction transverse to a longitudinal axis of the casing (1). The booster ring (8) has an upper surface of aerofoil or arcuated plate sectional profile as its inner surface, and also has a leading edge facing an air outlet of the jet fan and a trailing edge of a diameter smaller than that of the leading edge but greater than that of the air outlet.

*Fig.1*

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## Description

### BACKGROUND OF THE INVENTION

Field of the invention

The present invention relates to an axial fan mounted on a ceiling portion of a tunnel for blowing out a jet to ventilate the inside of the tunnel. This kind of axial fan is generally called the jet fan.

Description of Related Art

The jet fan mounted in the tunnel generates a thrust to induce a longitudinal flow of air for ventilation of air inside the tunnel. The air inside the tunnel receives from the jet fan a pressure equal to a value obtained by dividing the generated thrust by the sectional area of the tunnel. Recently, with an increase in traffic in the tunnel or an increase in power consumption, there is an increasing demand toward a strengthening of ventilation by the jet fan such that the jet fan may generate a higher thrust and have a higher efficiency.

Fig. 9 depicts a conventional jet fan comprising a cylindrical casing 101, an electric motor 102 accommodated therein, and an impeller 103 directly connected to the electric motor 102. The jet fan shown in Fig. 9 also comprises generally cylindrical front and rear silencers 104 for absorbing noise generated by the impeller 103.

Fig. 10 depicts another conventional jet fan having a plurality of inlet guide vanes 105.

Fig. 11 depicts a further conventional jet fan having a plurality of outlet guide vanes 106.

In these conventional jet fans, when the electric motor 102 rotates, the impeller 103 increases the air pressure to make a flow of air. Because this kind of air flow has a rotating component, the jet fan shown in Fig. 10 or 11 having the guide vanes 105 or 106 reduces the rotating component of the air flow and, hence, has a higher efficiency than that shown in Fig. 9.

In the conventional jet fans, however, the thrust generated thereby is determined as the product of three values, the air density, the mass low rate passing through the jet fan, and the speed of a jet blown out of the silencer 104. Accordingly, only an increase in either the mass flow rate or the speed of the jet results in an increase in thrust.

### SUMMARY OF THE INVENTION

The present invention has been developed to overcome the above-described disadvantages.

It is accordingly an objective of the present invention to provide a highly efficient jet fan capable of generating a high thrust to further increase the air pressure inside the tunnel without increasing the mass flow rate and the speed of the jet.

Another objective of the present invention is to provide the jet fan of the above-described type which has a simple construction and can be manufactured at a low cost.

In accomplishing the above and other objectives, the jet fan according to the present invention comprises a generally cylindrical casing, an electric motor accommodated therein, and an impeller connected to the electric motor, and is characterized by at least one booster ring disposed concentrically with the casing and located downstream thereof with respect to a direction of an air flow.

Advantageously, the booster ring has an aerofoil or arcuated plate sectional profile as viewed in a direction transverse to a longitudinal axis of the casing.

Also advantageously, the booster ring has an upper surface of aerofoil or arcuated plate sectional profile as its inner surface, and has a leading edge facing an air outlet of the jet fan and a trailing edge of a diameter smaller than that of the leading edge but greater than that of the air outlet.

The above-described construction generates a lift and a drag on the booster ring by making use of a flow of air resulting from ambient air drawn into a high-speed jet. A resultant force of the lift and the drag has an axial component force directed opposite to the direction of the jet and creating a thrust on the booster ring. Because the jet receives a force in the direction thereof as a reaction of the thrust generated on the booster ring, the jet fan of the present invention can further increase the air pressure inside the tunnel compared with the conventional jet fan having no booster ring.

### BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objectives and features of the present invention will become more apparent from the following description of preferred embodiments thereof with reference to the accompanying drawings, throughout which like parts are designated by like reference numerals, and wherein:

Fig. 1 is a sectional view of a jet fan according to a first embodiment of the present invention;

Fig. 2 is a view similar to Fig. 1, but according to a second embodiment of the present invention;

Fig. 3 is a view similar to Fig. 1, but according to a third embodiment of the present invention;

Fig. 4 is a view similar to Fig. 1, but according to a fourth embodiment of the present invention;

Fig. 5 is a view similar to Fig. 1, but according to a fifth embodiment of the present invention;

Fig. 6 is a diagram illustrating forces exerting on a booster ring;

Fig. 7 is a graph indicating a relationship between the distance from a jet outlet to a leading edge of the booster ring and a thrust generated on the booster ring;

Fig. 8 is a sectional view of the booster ring measured;

Fig. 9 is a sectional view of a conventional jet fan;

Fig. 10 is a view similar to Fig. 9, but illustrating another conventional jet fan; and

Fig. 11 is a view similar to Fig. 9, but illustrating a further conventional jet fan.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawings, there is shown in Fig. 1 a jet fan according to a first embodiment of the present invention. As shown therein, the jet fan comprises a generally cylindrical casing 1, an electric motor 2 accommodated therein, an impeller 3 directly connected to the electric motor 2, and generally cylindrical front and rear silencers 4 for absorbing noise generated by the impeller 3. The jet fan further comprises a booster ring 8 having an aerofoil or arcuated plate sectional profile as viewed in a direction transverse to the longitudinal axis of the casing 1. The booster ring 8 is secured to the generally cylindrical rear silencer 4 in concentric relation therewith via a plurality of radial ribs 7. The booster ring 8 has an upper surface of aerofoil or arcuated plate sectional profile as its inner surface, and also has a leading edge facing an air or jet outlet of the jet fan and a trailing edge of a diameter smaller than that of the leading edge but greater than that of the air outlet.

By the above-described construction, when the electric motor 2 rotates, the impeller 3 generates a flow of air which in turn passes as a jet through the rear silencer 4. The jet draws ambient air into the booster ring 8 to form a flow of air directed thereto. As a result, a lift L and a drag D exert on the booster ring 8, as shown in Fig. 6. A resultant force of the lift L and the drag D has a component force Tt acting in a direction axially of the casing 1. This component force Tt is directed opposite to the direction of the jet and is regarded as a thrust exerting on the booster ring 8.

Fig. 7 indicates one example of measurement results of the thrust Tt exerting on the booster ring 8, while Fig. 8 depicts a booster ring used in the measurement. Fig. 7 indicates a relationship between the distance (x) from the jet outlet (outlet diameter: 100 mm) to the leading edge of the booster ring 8 and the thrust Tt exerting on the booster ring with the speed of the jet as a parameter. Fig. 7 reveals that the thrust Tt has been generated on the booster ring when the speed of the jet is 8 m/s, 17.7 m/s, 21.7 m/s or 27.7 m/s and when the distance (x) ranges 0 to 350 mm.

As a reaction of the thrust Tt thus generated on the booster ring 8, the jet receives a booster force Fj in the direction of the jet. Accordingly, the provision of the booster ring 8 as shown in Fig. 1 allows the jet fan to have an increased thrust and a higher efficiency, thus making it possible to increase the air pressure inside the tunnel.

It is to be noted here that although in the above-described embodiment the booster ring 8 has been described as having an aerofoil section, it may have an arcuated plate section as far as it has a streamline-shaped inner surface. It is further to be noted that the booster ring 8 may be made of a ring-shaped generally flat plate. In this case, however, the generally flat plate is bent so as to have a radially inwardly protruding generally arcuated shape in the direction of the jet.

It is also to be noted that although the radial ribs 7 may have a polygonal section such as a rectangular section or a round section, they preferably have a streamline section to reduce air resistance or pressure loss.

Fig. 2 depicts a jet fan according to a second embodiment of the present invention, which is of a structure similar to the jet fan of Fig. 1, but further comprises a plurality of inlet guide vanes 5 fixedly mounted around the electric motor 2 located upstream of the impeller 3 with respect to a direction of the air flow.

Fig. 3 depicts a jet fan according to a third embodiment of the present invention, which is of a structure similar to the jet fan of Fig. 1, but further comprises a plurality of outlet guide vanes 6 fixedly mounted around the electric motor 2 located downstream of the impeller 3 with respect to the direction of the air flow.

Each of the structures shown in Figs. 2 and 3 can reduce the rotating component of the air flow generated by the impeller 3. Accordingly, the thrust generated by the jet fan and the efficiency thereof can be further enhanced, compared with the jet fan of Fig. 1, to thereby increase the air pressure inside the tunnel.

Fig. 4 depicts a jet fan according to a fourth embodiment of the present invention, which is of a structure identical to the jet fan of Fig. 1, but has another booster ring 8 secured to the generally cylindrical rear silencer 4 in concentric relation therewith via a plurality of radial ribs 7.

It is to be noted that although the jet fan shown in Figs. 1 to 4 has one or two booster rings 8, it may have three or more booster rings disposed concentrically with one another.

Fig. 5 depicts a jet fan according to a fifth embodiment of the present invention, which comprises a generally cylindrical casing 1, an electric motor 2 accommodated therein, an impeller 3 directly connected to the electric motor 2, and generally cylindrical front and rear silencers 4. The jet fan of Fig. 5 further comprises a booster ring 8 not connected directly thereto but secured to the ceiling of the tunnel via a support rod 9 so that the casing 1 and the booster ring 8 are axially aligned in concentric relation.

As described hereinabove, according to the present invention, one or more booster rings 8 disposed concentrically with the casing 1 contribute to an increase in thrust and also in efficiency, thus increasing the air pressure inside the tunnel. Accordingly, supposing that the amount of ventilation required is the same, the jet fan of the present invention can reduce the power consumption or the number thereof can be reduced compared with the conventional case.

Although the present invention has been fully described by way of examples with reference to the

accompanying drawings, it is to be noted here that various changes and modifications will be apparent to those skilled in the art. Therefore, unless such changes and modifications otherwise depart from the spirit and scope of the present invention, they should be construed as being included therein.

## Claims

1. A jet fan comprising a generally cylindrical casing (1), an electric motor (2) accommodated therein, and an impeller (3) connected to the electric motor (2),
**characterized by**:
at least one booster ring (8) disposed concentrically with the casing (1) and located downstream thereof with respect to a direction of an air flow.

2. The jet fan according to claim 1, wherein said booster ring (8) has an aerofoil sectional profile as viewed in a direction transverse to a longitudinal axis of the casing (1), and also has an upper surface of aerofoil sectional profile as its inner surface.

3. The jet fan according to claim 1, wherein said booster ring (8) has an arcuated plate sectional profile as viewed in a direction transverse to a longitudinal axis of the casing (1), and also has an upper surface of arcuated plate sectional profile as its inner surface.

4. The jet fan according to claim 1, wherein said booster ring (8) has a leading edge facing an air outlet of the jet fan and a trailing edge of a diameter smaller than that of the leading edge but greater than that of the air outlet.

Fig.1

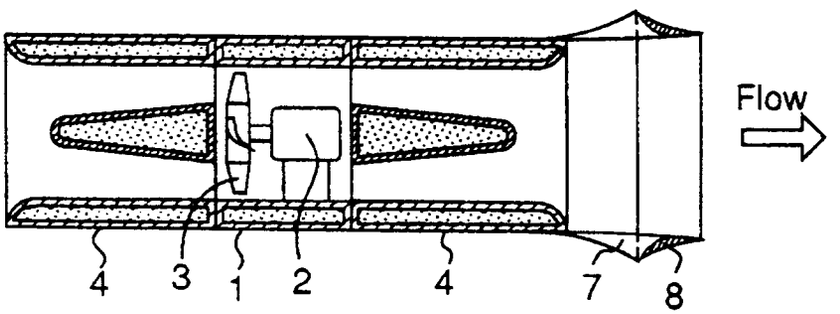


Fig.2

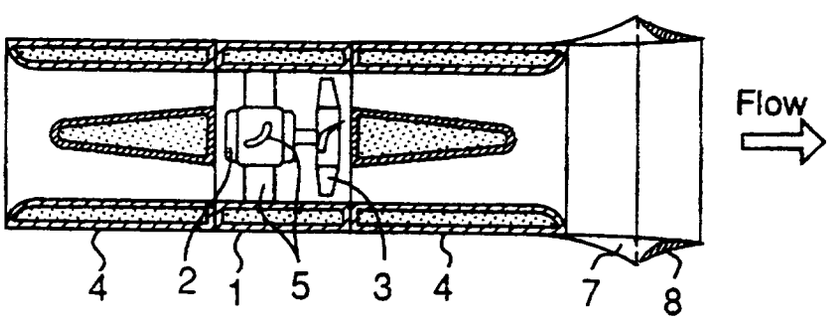

Fig.3

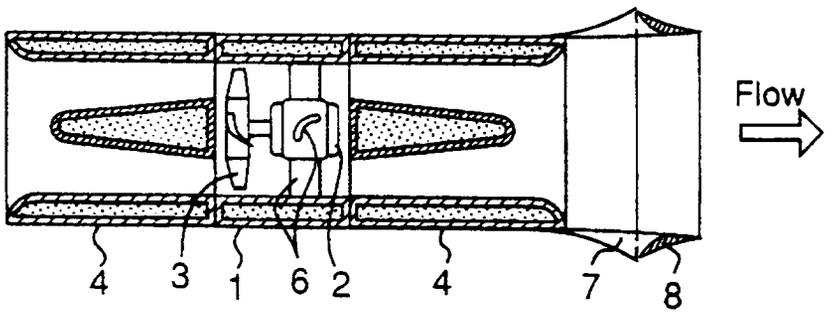


Fig.4

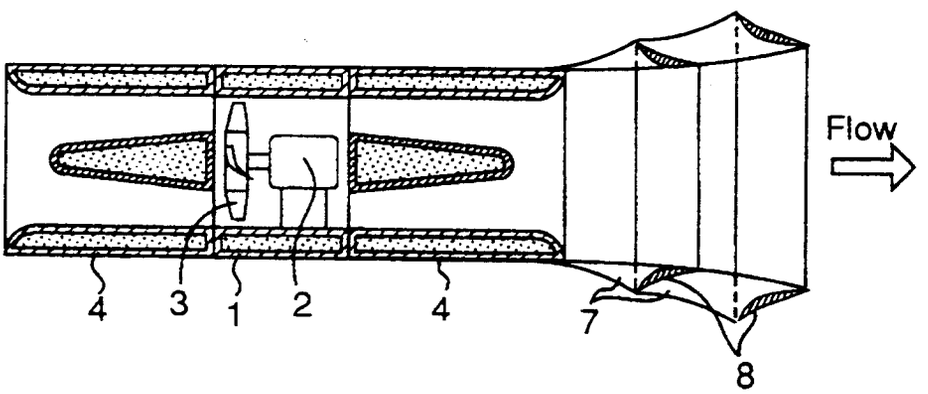


Fig.5

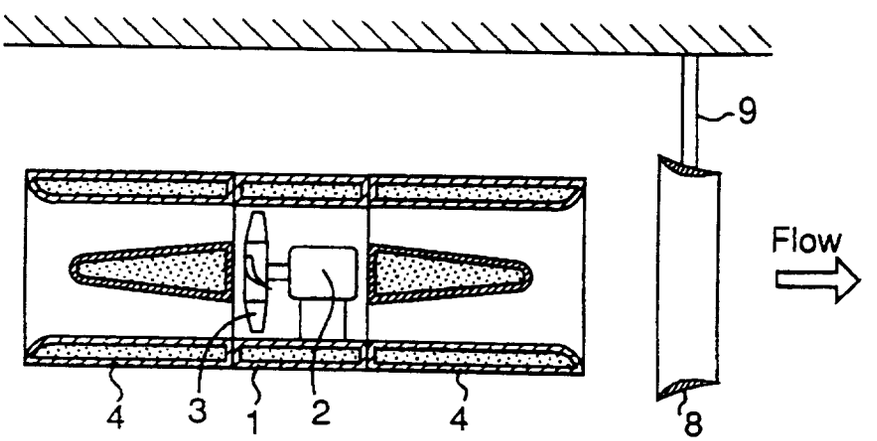

Fig.6

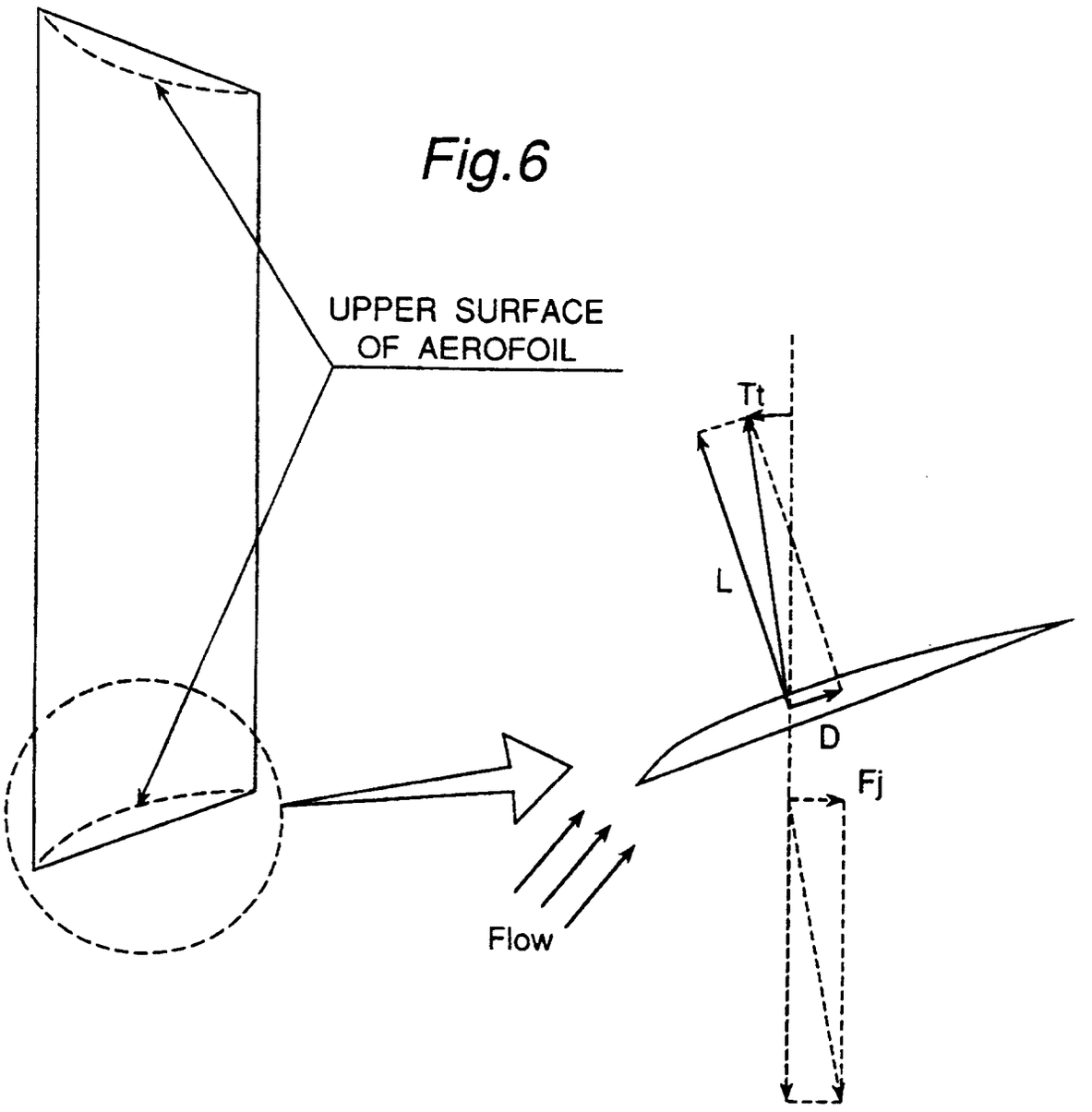

Fig.7

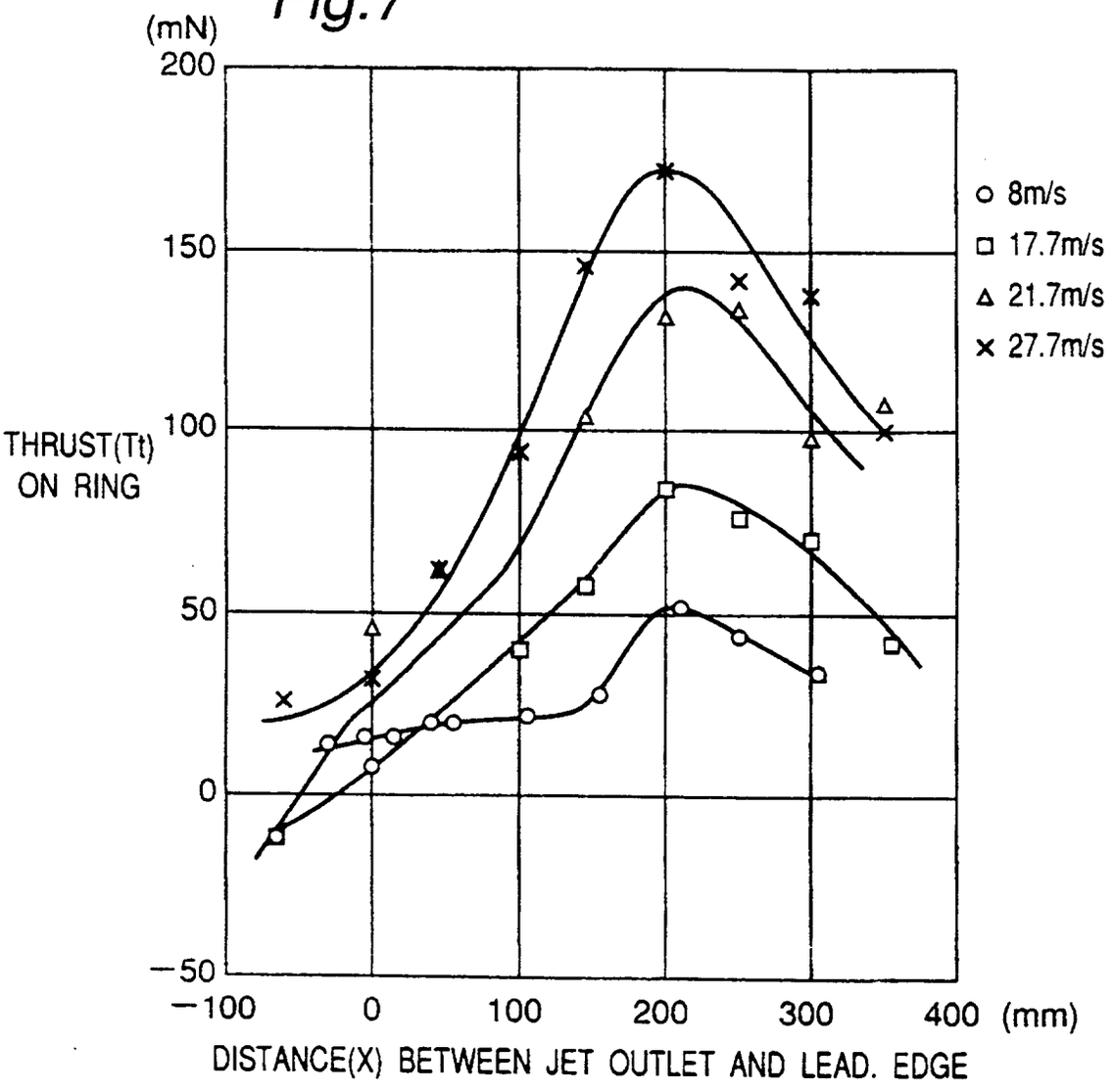
(mN)
200
150
100
50
0
−50
THRUST(Tt)
ON RING
−100
0
100
200
300
400
(mm)
DISTANCE(X) BETWEEN JET OUTLET AND LEAD. EDGE
○ 8m/s
□ 17.7m/s
△ 21.7m/s
× 27.7m/s

Fig.8

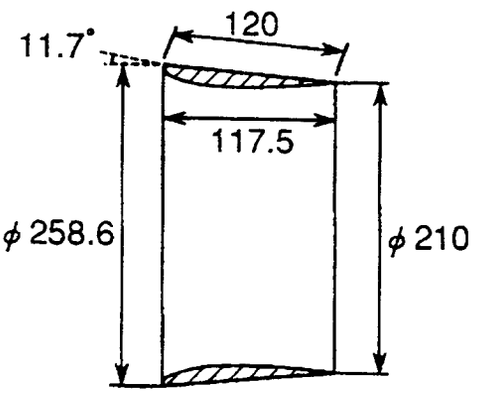
11.7°
120
117.5
φ 258.6
φ 210

*Fig.9*

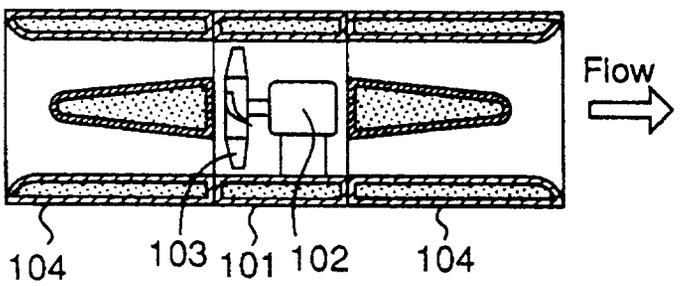


*Fig.10*

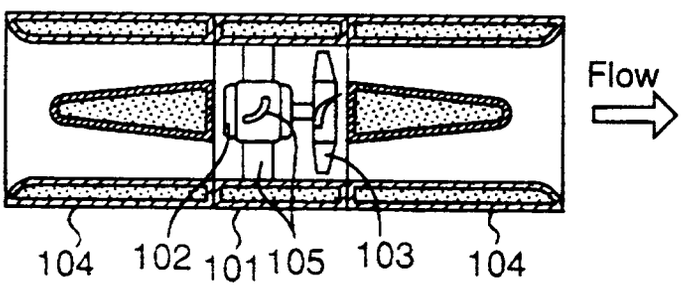


*Fig.11*