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Forward-curved bladed fans

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Foreword

This translation has been made based on the original Japanese Industrial Standard revised by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee, as the result of proposal for revision of Japanese Industrial Standard submitted by The Japan Society of Industrial Machinery Manufacturers (JSIM)/the Japanese Standards Association (JSA) with the draft being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law applicable to the case of revision by the provision of Article 14. Consequently **JIS B 8331 : 1983** is replaced with this Standard.

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Forward-curved bladed fans

1 Scope This Japanese Industrial Standard specifies V-belt driven and motor direct driven centrifugal forward-curved bladed fans (hereafter referred to as “fans”), which have size⁽¹⁾ from 160 mm to 1 600 mm in blade outer diameter and are mainly used for the ventilation and air conditioning of buildings. However, this Standard does not apply to fans with a silencer box, and those fans incorporated in package type air conditioners, fan-coil units and the like are excluded.

In addition, the gas handled by the fans shall be air at a temperature from $-15\text{ }^{\circ}\text{C}$ to $+40\text{ }^{\circ}\text{C}$.

Note (1) See clause 4.

2 Normative references The standards given in Attached Table 1 contain provisions which, through reference in this Standard, constitute provisions of this Standard. The most recent editions of standards (including amendments) shall be applied.

3 Definitions The definitions of the main terms used in this Standard shall be in accordance with **JIS B 0132**.

4 Classification Fans shall be classified according to their suction system and the nominal diameter (size) of the fans as shown in Table 1.

Table 1 Classification of fans

Suction system		Single suction or double suction															
Nominal diameter	Reference blade outer diameter ⁽²⁾ mm	160	200	250	315	400	500	560	630	710	800	900	1 000	1 120	1 250	1 400	1 600
	Nominal number ⁽³⁾	1	$1\frac{1}{4}$	$1\frac{1}{2}$	2	$2\frac{1}{2}$	3	$3\frac{1}{2}$	4	$4\frac{1}{2}$	5	$5\frac{1}{2}$	6	7	8	9	10

Notes (2) The reference blade outer diameter indicates the nominal impeller tip diameter specified in **ISO 13351**.

(3) The nominal number refers to the blade outer diameter of 150 mm as one unit of nominal number used based on the conventional practice.

Remarks : The actual design dimension may deviate from the nominal diameter if not to a significant extent.

5 Performance

5.1 Gas quantity and static pressure When fans are tested according to the method specified in 12.3.1, their gas quantity and static pressure shall be within the range of the values shown in a) and b) of Fig. 1. However, slight changes may be permitted depending on the design by the individual manufacturer.

In addition, changes in the respective performances from the representative performance curve⁽⁴⁾ may be allowed if they satisfy the following requirements even if the gas quantity or static pressure is less than the specified value.

- a) The gas quantity at the specified static pressure shall be not less than 95 % of the specified gas quantity.
- b) The static pressure at the specified gas quantity shall be not less than 95 % of the specified static pressure.

Where these requirements fail to be satisfied, the judgment on acceptance shall be carried out according to agreement between the parties concerned with delivery.

Note (4) The representative performance curve means the average performance curve obtained by testing many fans of the same type and the same specification according to the method specified in 12.3.1.

5.2 Shaft power The shaft power of fans obtained by the test method specified in 12.3.1 shall not exceed the rated output of the electric motor at the specified gas quantity.

Provided that the loss power of the V-belt pulley shall be regarded as part of the shaft power of the fan.

5.3 Rotational speed The rotational speed of fans obtained by the test method specified in 12.3.1 shall mean the rotational speed measured in the normal condition of motor power source and V-belt driving.

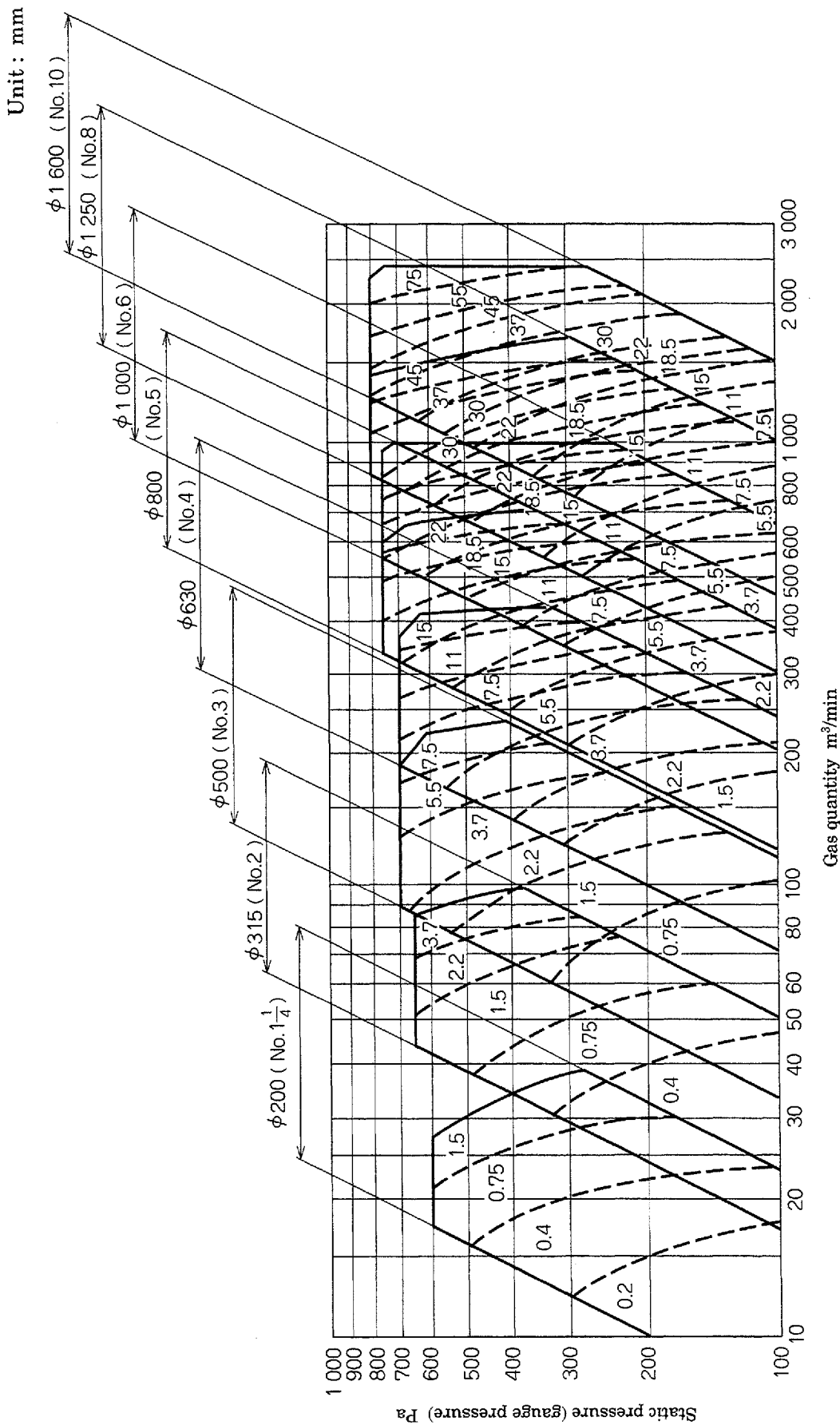
5.4 Maximum total pressure efficiency The maximum total pressure efficiency⁽⁵⁾ of fans obtained by the test method specified in 12.3.1 should be not less than the values shown in Fig. 2.

Note (5) The total pressure efficiency here includes the value of efficiency of V-belt pulley and devices actually attached to fans, and it is also referred to as the fan motor shaft efficiency.

5.5 Noise The noise of fans obtained by the test method specified in 12.3.2 should be such that the maximum noise value measured at the point of maximum total pressure efficiency does not exceed the values shown in Fig. 3.

5.6 Vibration When fans are tested according to the method specified in 12.3.2, the tolerance on vibration measured shall not exceed the vibration speed of 6 mm/s in Fig. 23 in 9.6 of JIS B 8330.

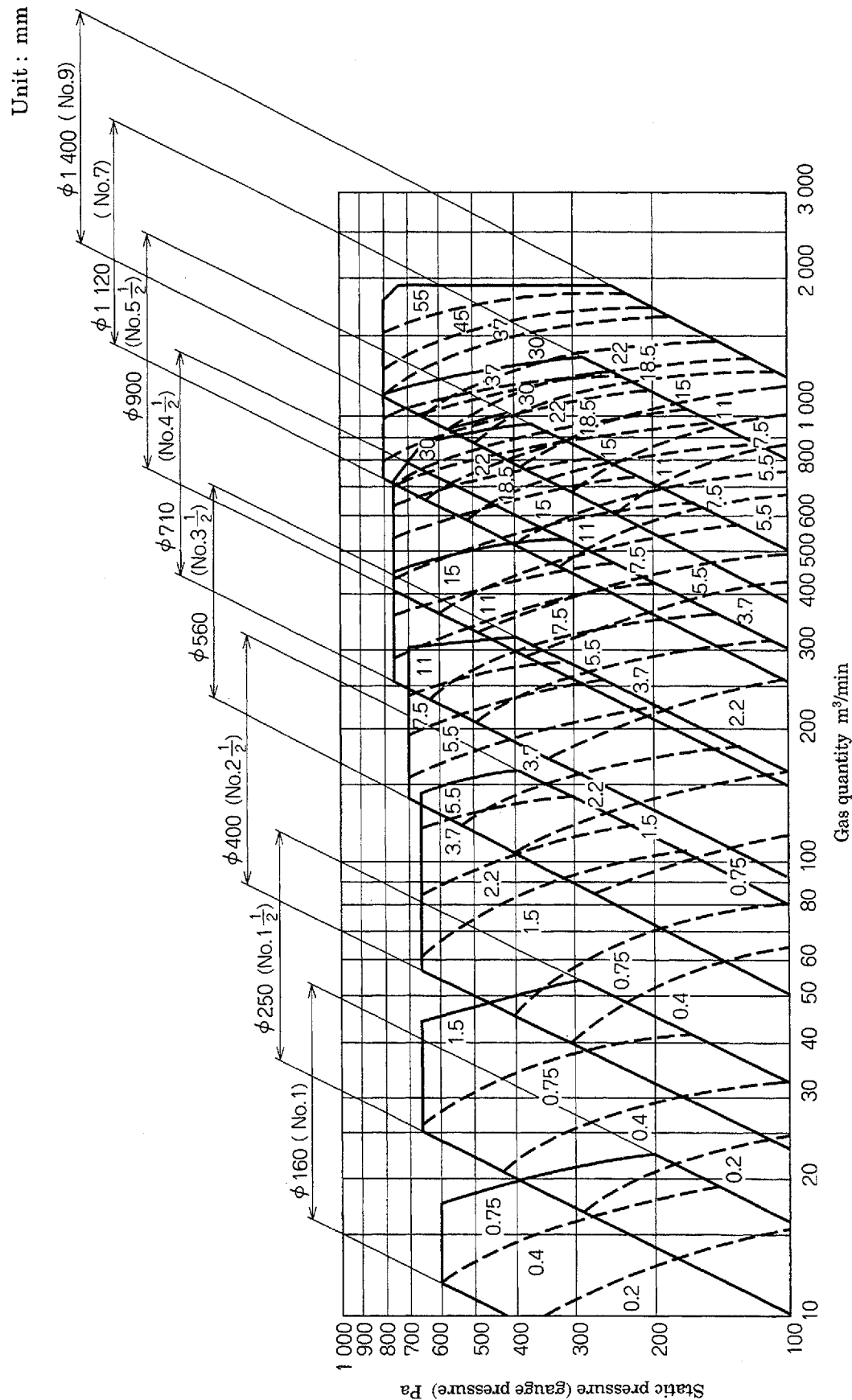
In addition, although there is a case where an operation is performed with an antivibration device, in this case it should not exceed the vibration speed of 10 mm/s.



- Remarks
- 1 The static pressure (gauge pressure) shall be that measured in the standard suction condition.
 - 2 The motor output (kW) shown by broken lines is shaft power $\times 1.2$.
 - 3 In the case of double suction type fans, the gas quantity and output shall be twice the values in this Table.

a)

Fig. 1 Gas quantity and static pressure (single suction)



Remarks 1 The static pressure (gauge pressure) shall be that measured in the standard suction condition.

2 The motor output (kW) shown by broken lines is shaft power $\times 1.2$.

3 In the case of double suction type fans, the gas quantity and output shall be twice the values in this Table.

b)

Fig. 1 Gas quantity and static pressure (single suction) (concluded)

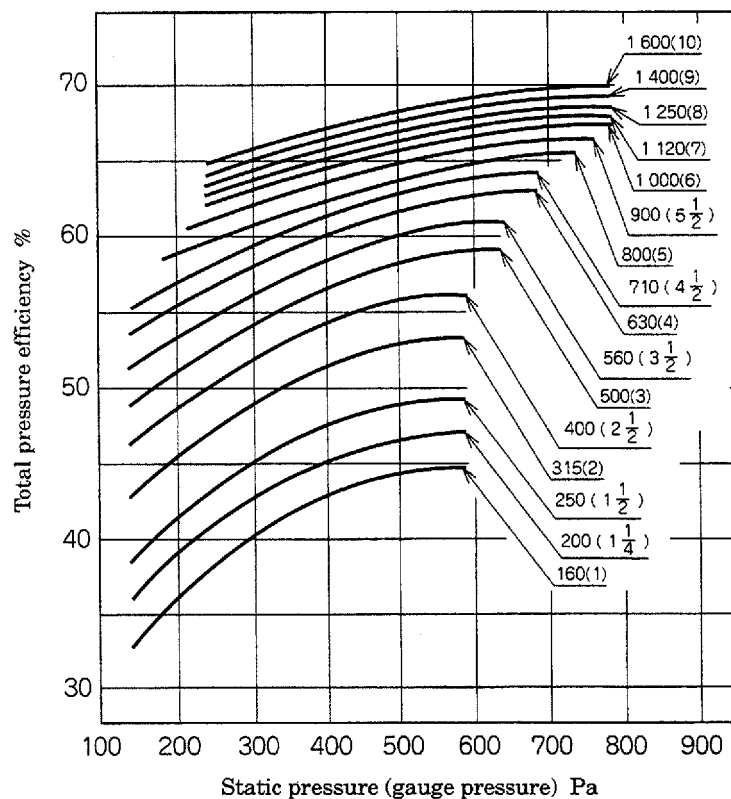


Fig. 2 Total pressure efficiency

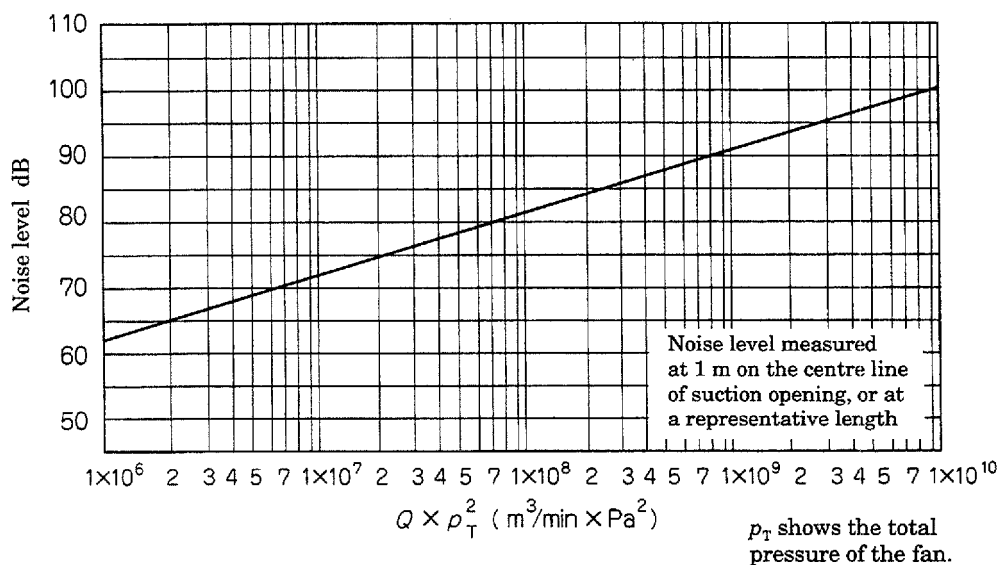


Fig. 3 Noise level (at maximum efficiency point)

5.7 Bearing temperature The bearing temperature of fans measured by the test method specified in 12.3.2 shall be not higher by 40 °C or more than the ambient temperature.

5.8 Other performances The other performances shall be as follows:

- During the operation of the fan, there shall not occur any abnormal sound inside the casing or bearings, or from the V-belts.

- b) There shall not occur any abnormal rise in temperature due to slipping between the V-belts and V-belt pulley or by other causes.

6 Types

6.1 Types Fans shall be classified into the single suction centre impeller type (S1), single suction overhang impeller type (S2), double suction centre impeller type (D1), and direct driven type according to the suction system and the method of connection between the bearings and V-belt pulley, as shown in Fig. 4.

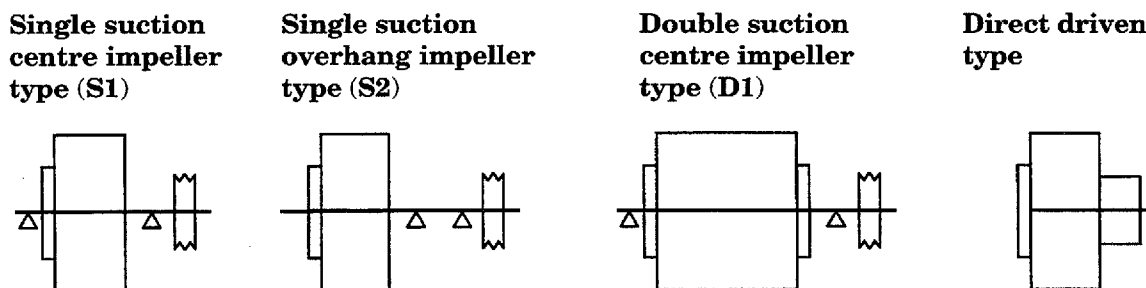


Fig. 4 Types of fans

6.2 Rotating direction and discharge direction The rotating direction of a fan shall be expressed as clockwise rotation where the impeller rotates clockwise when viewed from the V-belt pulley side, and as counter-clockwise rotation where the impeller rotates in the opposite direction. The discharge direction shall be classified into the three kinds consisting of "top horizontal discharge", "top vertical discharge", and "bottom horizontal discharge" (see Fig. 5).

Discharge direction		Top horizontal discharge	Top vertical discharge	Bottom horizontal discharge
Rotating direction	Number Symbol	1	2	3
Clockwise rotation	R			
Counter-clockwise rotation	L			

Fig. 5 Discharge directions of fans

7 Construction

7.1 Construction The construction of fans shall meet the following requirements and shall be as illustrated in a), b) and c) of Fig. 6.

- a) Fans shall be so constructed that there is no contact between the rotary parts and the stationary parts and there is no short-circuit of air, no leakage from those parts penetrated by the axis, or no air leakage from joints which may cause trouble to the operation or performance of the fan.

- b) The rotary parts of fans shall be supported by sufficiently strong bearings fixed on a sufficiently strong casing or bearing beds, be well aligned with the axial centre, and be capable of smooth running.
- c) Fans shall not produce any vibration, abnormal noise or the like which may cause trouble to the operation of the fan within the prescribed ranges of gas quantity, pressure, and temperature.

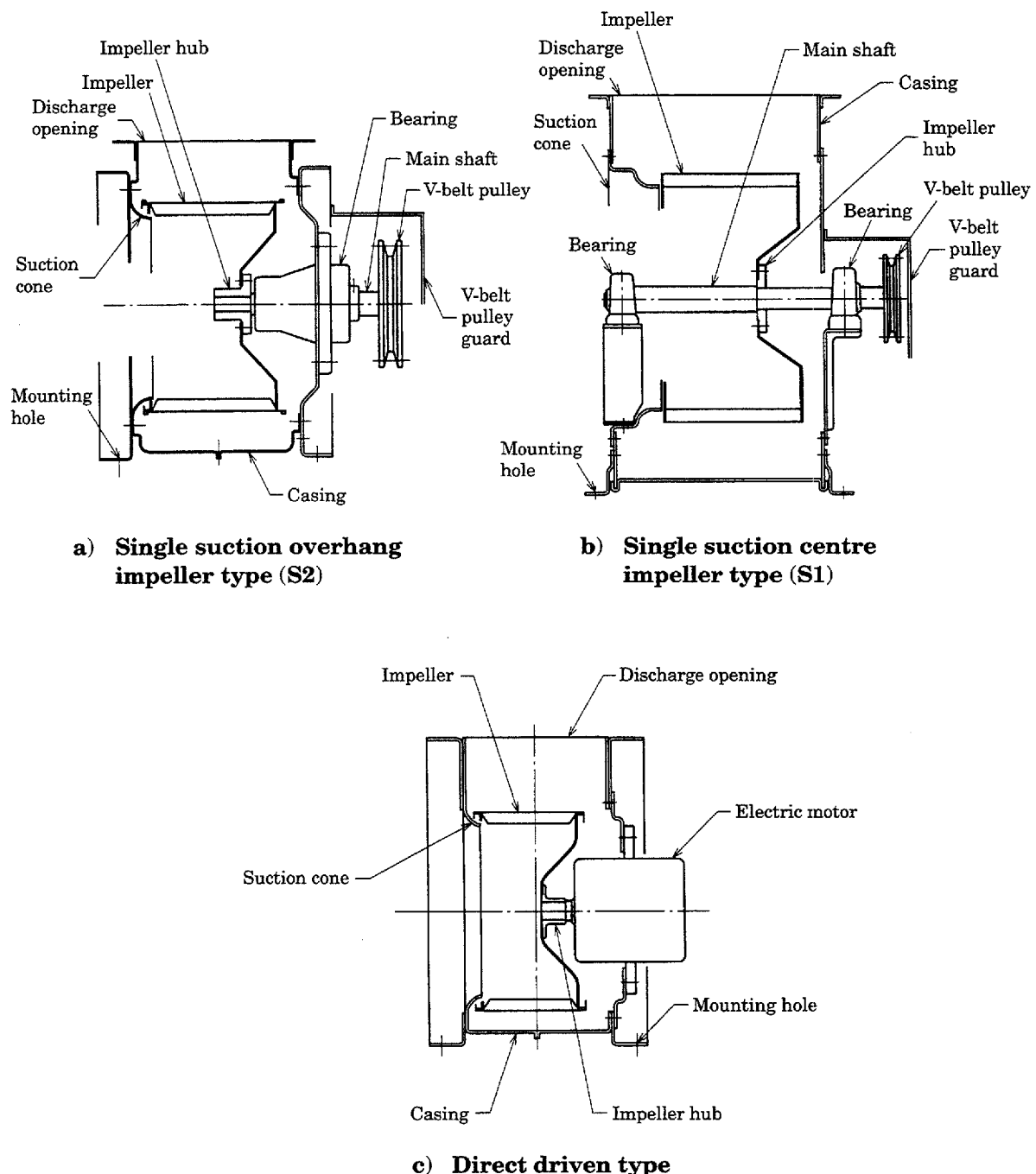


Fig. 6 Structure of fans

- d) Fans shall have a plane mounting face and be capable of being easily installed on a foundation or vibration-proof bed.

- e) V-belt driving fans shall have a construction which allows the installation of V-belt pulley guards with safety to the human body taken into consideration and facilitates maintenance and checking operations without obstructions.
- f) Fans shall have a construction which allows the attachment of heat insulating material as required.
- g) The dimensional tolerances of unmachined fabricated parts shall be as specified in Table 2. However, where there is a special specification, such specification shall be applied.

Table 2 Dimensional tolerances

Unit : mm

Reference dimension	Tolerances
120 and under	± 1.8
Over 120 up to and incl. 315	± 2.6
Over 315 up to and incl. 630	± 3.5
Over 630 up to and incl. 1 000	± 4.5
Over 1 000 up to and incl. 1 600	± 6.0
Over 1 600 up to and incl. 2 000	± 8.0
Over 2 000 up to and incl. 2 500	± 9.0
Over 2 500 up to and incl. 3 150	± 10.0
Over 3 150 up to and incl. 4 500	± 11.0

7.2 Casing The casing of fans shall be as follows:

- a) The casing shall be formed in smoothly curved volute shape so that the suction air enters the impeller uniformly and the air discharged from the impeller is introduced efficiently into the discharge opening and shall not produce extremely violent vortex flow likely to produce a head loss or vibration.
- b) The plate thickness of the casing (in the case of materials in Table 11) shall be the value specified in Table 3.

Table 3 Plate thickness of casing

Unit : mm

Impeller outer diameter	Back plate	Side plate
160 and under	0.6	0.6
Over 160 up to and incl. 250	0.8	0.8
Over 250 up to and incl. 400	1.0	1.0
Over 400 up to and incl. 630	1.2	1.2
Over 630 up to and incl. 1 000	1.6	1.6
Over 1 000 up to and incl. 1 120	1.6	2.3
Over 1 120 up to and incl. 1 600	2.3	2.3

- c) The respective parts of the casing shall be free from deformation, vibration, or air leakage from joints which is likely to cause trouble to the operation performance and shall have sufficient strength by means of welding, riveting or the like to prevent trouble to the installation or operation of the fan.

7.3 Impeller The impeller shall be as follows:

- a) The nominal diameter of the impeller shall be as specified in Table 4, and the actual design dimension may deviate from the nominal diameter if not to a significant extent.

Table 4 Nominal diameter of impeller

Reference blade outer diameter mm	160	200	250	315	400	500	560	630	710	800	900	1 000	1 120	1 250	1 400	1 600
Nominal number	1	$1\frac{1}{4}$	$1\frac{1}{2}$	2	$2\frac{1}{2}$	3	$3\frac{1}{2}$	4	$4\frac{1}{2}$	5	$5\frac{1}{2}$	6	7	8	9	10

- b) The impeller shall have a number of forward-directed blades fitted to a main plate and side plate, and the main plate shall be fitted firmly to the hub.
- c) The blades shall be formed precisely in uniform curved surface and their fitting precision shall be as specified in Table 5.

Table 5 Blade fitting precision

Blade outer diameter mm	250 and under	Over 250 up to and incl. 400	Over 400 up to and incl. 1 000	Over 1 000 up to and incl. 1 250	Over 1 250 up to and incl. 1 600
Tolerance on pitch (outer periphery)	± 5 %	± 4 %	± 3 %	± 2 %	± 2 %
Tolerance on blade fitting angle	± 4°	± 3°	± 2°	± 1°	± 1°
Tolerance on chord length	± 4 %	± 3 %	± 2 %	± 2 %	± 1 %
Perpendicularity between blade and main plate	± 60'	± 60'	± 45'	± 30'	± 30'

Remarks 1 Measurement place shall be at a distance of about $\frac{1}{3}$ of the blade width from the side plate.

2 The above tolerances shall be the values based on the dimensions and angles indicated in the drawing.

- d) The plate thickness of the impeller (in the case of materials in Table 11) shall be the value specified in Table 6.

Table 6 Plate thickness of impeller

Unit : mm

Blade outer diameter	Main plate	Side plate	Blade
200 and under	1.0(0.8)	1.0(0.6)	0.8(0.6)
Over 200 up to and incl. 250	1.2(1.0)	1.0(0.8)	0.8(0.6)
Over 250 up to and incl. 315	1.6(1.0)	1.2(0.8)	1.2(0.6)
Over 315 up to and incl. 400	1.6(1.2)	1.2(1.0)	1.2(1.0)
Over 400 up to and incl. 630	2.3(1.6)	1.6(1.2)	1.2(1.0)
Over 630 up to and incl. 710	3.2(1.6)	2.3(1.6)	1.2
Over 710 up to and incl. 800	3.2(1.6)	2.3(1.6)	1.6
Over 800 up to and incl. 900	4.5(2.3)	2.3(1.6)	1.6
Over 900 up to and incl. 1 000	4.5(2.3)	3.2(2.3)	1.6
Over 1 000 up to and incl. 1 250	6.0(2.3)	3.2(2.3)	2.3
Over 1 250 up to and incl. 1 600	8.0	4.5	2.3

Remarks : Where the values shown in parentheses () are used, strength and rigidity equivalent to those of the plates having the thickness values outside the parentheses () shall be guaranteed by the manufacturer by employing a special processing method.

In addition, where the atmosphere or handling gas in the place where the fan is used is detrimental, an effective surface treatment shall be applied to the impeller plates.

- e) The main plate fitting part of the impeller hub shall have particularly good perpendicularity and concentricity to the shaft hole of the hub, and the deflection at the impeller periphery in the shaft and radial directions after fitting and forming of the main plate shall be the value specified in Table 7.

Table 7 Deflection of impeller

Unit : mm

Blade outer diameter	250 and under	Over 250 up to and incl. 400	Over 400 up to and incl. 1 000	Over 1 000 up to and incl. 1 600
Lateral deflection of main plate outer diameter ⁽⁶⁾	1.5	1.5	2	3
Deflection of main plate periphery ⁽⁷⁾	1	1.5	2	3
Lateral deflection of side plate outer diameter ⁽⁶⁾	2.5	2.5	3	4
Deflection of side plate periphery ⁽⁷⁾	1.5	2	2.5	3.5

Notes ⁽⁶⁾ The lateral deflection of outer diameter means the difference between the maximum and the minimum value of the readings of the measuring instrument, measured in the vicinity of the outer diameter of the side surface of the main plate or side plate.

⁽⁷⁾ The deflection of periphery means the deflection of the periphery of the main plate or side plate, expressed by the difference between the maximum and the minimum values of the readings of the measuring instrument.

- f) The impeller shall have sufficient strength and vibration rigidity during the transportation or operation, especially variable speed operation of the fan.

7.4 Main shaft The main shaft shall be as follows:

- The main shaft shall be precisely worked and be free from bending, flaws and the like.
- The thickness of the main shaft shall be such that the dangerous speed of the main shaft is not less than about 1.3 times the working maximum number of revolutions.
- The diameter⁽⁸⁾ of the main shaft shall be not less than the value calculated by the following formula. However, this formula is applicable to the case of using a steel conforming to S30C specified in **JIS G 4051**, and where a material having a quality superior thereto is used, the diameter may be smaller than the above value according to the material used.

In addition, the value d shall mean the minimum value for the parts required for power transmission, and practically a sufficiently safe value for operation shall be adopted by considering the bearing distance and other factors.

$$d = 125 \sqrt[3]{\frac{L}{n}} \text{ (mm)}$$

where, L : shaft power at the maximum working rotational speed (kW)

n : maximum working rotational speed (min⁻¹)

Note (8) The diameters of those parts not related to power transmission may be smaller than that specified here.

- d) The shaft diameter at the V-belt pulley fitting part and the bearing parts close thereto shall be made 10 % to 15 % larger than the value d specified in c) considering the tensile load of the belts and other factors.

7.5 Bearings The bearings used shall be as follows:

- a) Bearings used shall be usually rolling bearings.
b) The respective bearings shall be usually lubricated with grease, and the grease used shall be that conforming to **JIS K 2220** suitable for the service conditions or the equivalent.

7.6 V-belt pulley The V-belt pulley used shall be as follows:

- a) The shape of the grooved section of the V-belt pulley shall conform to **JIS B 1854** or **JIS B 1855**.
b) The speed of V-belts shall be not more than 30 m/s for wide V-belts, and not more than 35 m/s for narrow V-belts, and the minimum pitch diameter of the V-belt pulley shall be as specified in Table 8.

Table 8 Minimum pitch diameter of V-belt pulley

Unit : mm

	Wide				Narrow		
Type of V-belt	A	B	C	D	3V	5V	8V
Minimum pitch diameter	75	125	200	355	65.8	177.4	310

- c) The V-belt pulley shall be well balanced.

7.7 Beds The beds used shall be as follows:

- a) **Bearing beds** Bearing beds which support the bearings shall be durable against the load, have sufficient strength to prevent the occurrence of strains and vibrations, consist of a welded construction of gauge steel or steel plate, and be firmly bolted to the common bed.
b) **Common bed** The common bed, which supports the casing, bearing beds, and motor, shall be durable against the load, have sufficient strength to prevent the occurrence of strains and vibrations, consist of a welded construction of gauge steel (including light gauge steel) or steel plate, processed either by press forming or bolting and have 4 or more foundation bolt holes.

7.8 Fit between respective parts The fit between the respective parts shall be usually as specified in Table 9.

Table 9 Fit

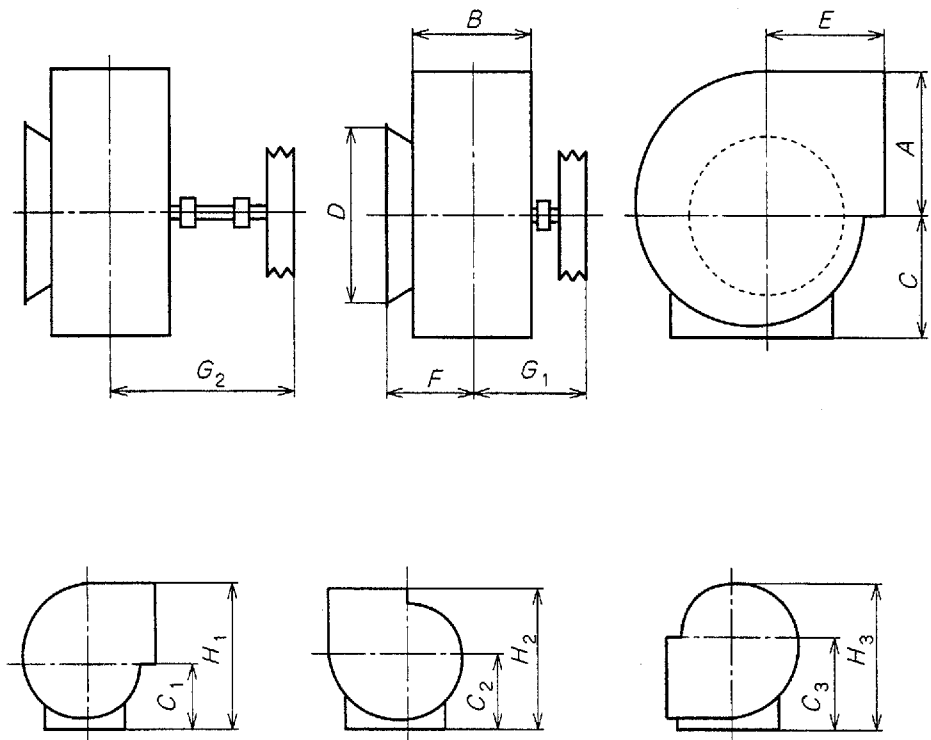
Fitting parts	Fit	
Between impeller hub and shaft	H7	h6
V-belt pulley and shaft	H7	h6
Rolling bearing and shaft	KB ⁽⁹⁾	h6
Bearing box and rolling bearing	H7	hB ⁽⁹⁾
Key groove of hub and parallel key	Js9	h9
Key groove of shaft and parallel key	N9	h9
Key groove and headed key	D10	h9

Note ⁽⁹⁾ As specified in **JIS B 1558**.

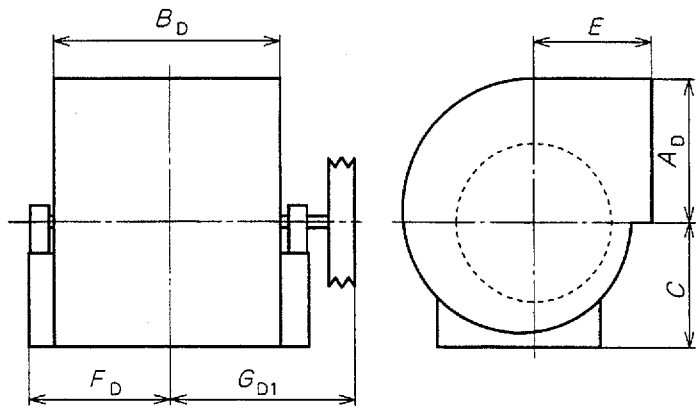
8 Dimensions The reference dimensions of fans shall conform to the dimensional table of fans in Table 10.

Table 10 Dimensional table of fans

Single suction type



Double suction type



Common bed

