Nov. 26, 1957 H. F. BRINEN 2,814,433

PROPELLER FAN NOZZLE

Filed Feb. 19, 1954

Fig. 1

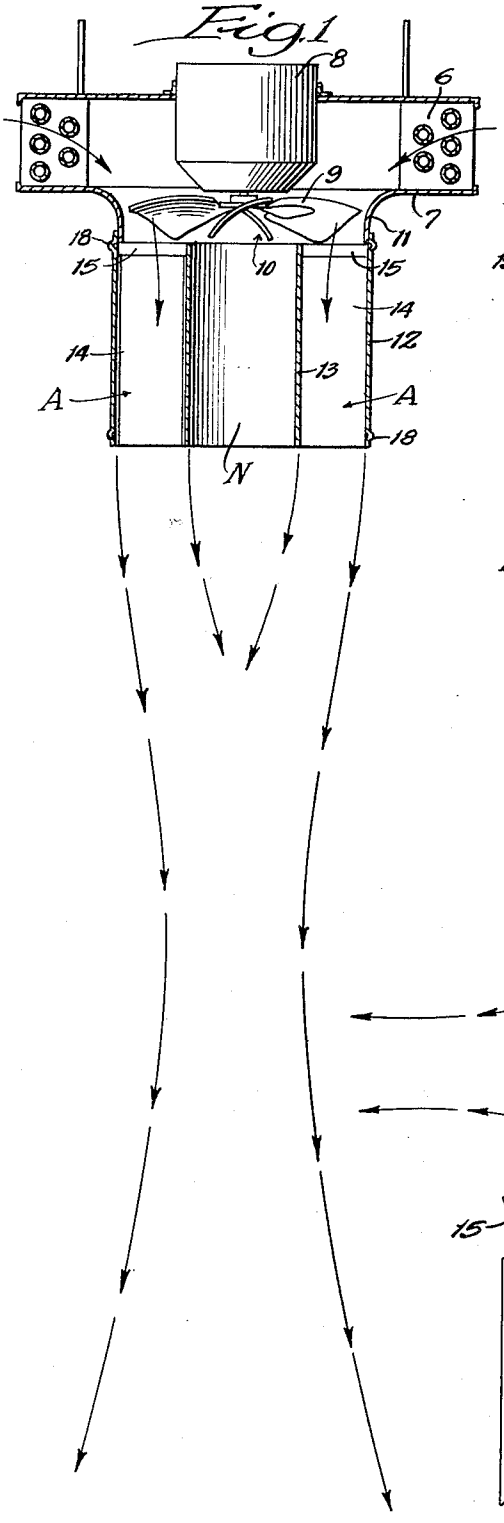


Fig. 2

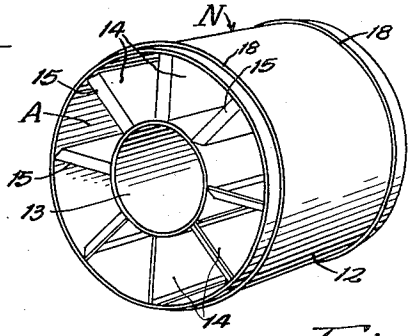


Fig. 3

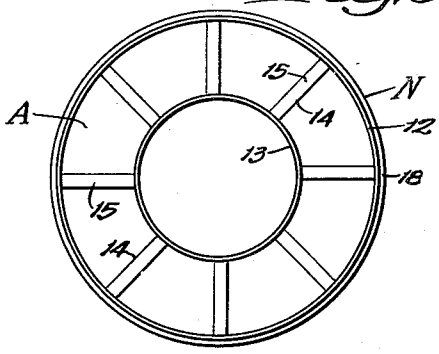


Fig. 4

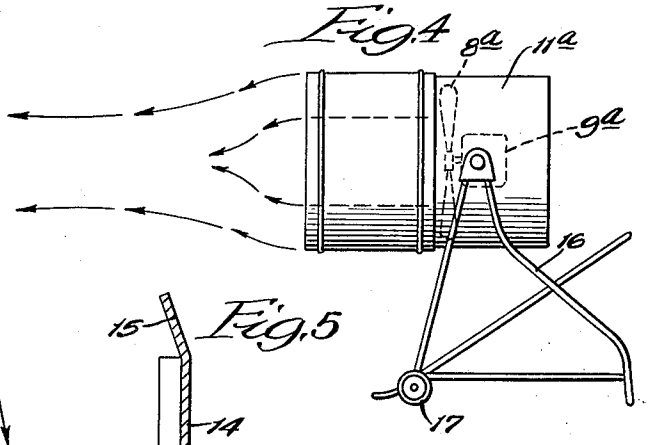
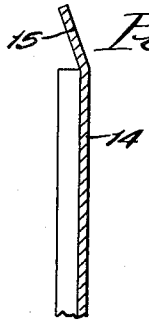


Fig. 5



INVENTOR:
Howard F. Brinen,
BY
Erwin Phelps
ATTORNEY.

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PROPELLER FAN NOZZLE

Howard F. Brinen, Racine, Wis., assignor to Young Radiator Company, Racine, Wis., a corporation of Wisconsin

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2 Claims. (Cl. 230—120)

This invention relates to a nozzle structure for propeller type fans used for any space conditioning equipment, and particularly such as known as a "unit heater" and "man coolers." In either case, the propeller fan is mounted to rotate in a shroud with a view to securing a suitable flow of air to favorably effect atmosphere conditions at some point remote from the fan. In unit-heater equipment the fan is associated with a heat-exchange coil, through which flows the heated fluid. The fan draws air through the coil for taking up heat from the fluid and delivers a stream of such heated air to a point of need. In man-cooler equipment the fan generally draws the ambient air through the fan shroud and delivers a stream to the point of need.

Unit heaters are designed primarily for use in industrial and commercial fields. Very often they are required as a solution to difficult and specialized heating problems in these fields. Since they are intended to provide a high degree of control over the velocity and direction of the heated air delivery, unit heaters are especially suited for heating large floor areas in factory buildings, especially those with high ceilings. Here, by reason of the forced circulation of air, the unit heater serves to pull in surrounding high temperature layers, which may have collected, and utilize this heat blowing it downwardly, mixed with its own heated stream. Furthermore, this directed air flow from the unit heater makes very advantageous their use for heating other extensive areas, such as found in restaurants, shops, stores, warehouses, and institutions. In many situations, unit heaters are required for spot heating, as for example, to blanket large expanses of windows, entry-ways and vestibules of office buildings and department stores, and, on occasion, to supplement the heat derived from the more conventional types of heating equipment.

Man cooler units, as the name indicates, are for creating such a circulation of air in places where human beings are located and the air is excessively warm. The aim is to so stir the movement of air around those human beings as to increase their comfort over what it would be if the air movement were not effected. This would be required in almost any open environment where excessive heat is being generated, as for example, in steel mills, foundries, blast furnace areas and the like.

Very often, in order to have the requisite acceptability, it has been required that such units project the heated air within a limited area and, at times, to a point quite remote from the fan. This has been especially true with overhead unit heaters constructed to effect a vertical down-flow of the heated air. The achievement of these particular ends necessitates the use of nozzles.

Many types and forms of nozzle have been employed. As a rule all types or forms of nozzle heretofore used have involved certain disadvantages. Prominent among these have been (1) a material reduction in air flow, over that achieved with units without a nozzle, (2) a back pressure of air, tending at times, (*a*) to overload the motor and, with unit heaters, (*b*) cause a loss of heating input with a subsequent reduction in efficient heated air flow,

and (3) a "yaw" or diversionary twist to the air stream leaving the nozzle and resulting in a failure to have the full benefit of the air stream at the desired point.

The main objects of this invention, therefore, are to provide an improved form of nozzle for use with propeller fans; to provide an improved form and construction of a nozzle which in use will achieve a higher rate of air flow, a more acceptable air stream temperature and a longer air stream blow-out, and, with unit heaters, a greater heating coil input than has been obtained with any of the other known forms and constructions of nozzle; and to provide a nozzle of this kind which is simple in construction and hence economical to manufacture especially in varying sizes and easy to attach to the fan shroud.

In the accompanying drawings:

Fig. 1 is a cross sectional view of a vertical-discharge unit heater equipped with a nozzle embodying this invention and indicating the form of the blow-down obtained with such a nozzle.

Fig. 2 is an enlarged, perspective view of an improved nozzle structure embodying this invention;

Fig. 3 is a top or inner view of the same;

Fig. 4 shows the nozzle of this type as applied to a horizontal-discharge man-cooler fan of the portable type; and

Fig. 5 is an enlarged, fragmentary section of one of the air-straightening nozzle blades showing the bend formed therein.

The distinctive concept of this invention involves an annulus with axially-disposed air-straightening blades, the length of the annulus and its radial dimensions being somewhat proportioned to the diameter of the air-discharge opening of the fan shroud.

A unit heater, wherewith this improved form of nozzle N is designed for use comprises, a finned heating coil **6** mounted in a housing **7** wherein is arranged a motor **8** on the shaft of which is a fan **9** rotating within an air-discharge opening **10** formed by the housing shroud **11**.

The coil **6** is more or less of conventional construction and provided with suitable inlet and outlet connections (not here shown) to permit it to be connected to the appropriate heat-conveying pipes. The housing **7** is provided with suitable means for suspending the unit (Fig. 1) from a ceiling or overhead mounting. The motor **8** is so mounted in the housing **7** and the fan **9** so arranged on the motor shaft that the fan revolves within the shroud discharge opening **10** with the face edges of the fan blades slightly short of being in the plane of the lower edge of the shroud **11**. A man-cooler (Fig. 4), wherewith this improved form of nozzle N is designed for use comprises, a fan **8***a* and its motor **9***a* mounted on a shroud **11***a*. Generally, the shroud is trunnioned on a frame **16** so that the fan may be tilted to control the direction of the air stream. Where portability is indicated the frame mounts casters **17**.

The nozzle N, as herein shown, comprises the two cylindrical elements **12** and **13** supported in concentric relationship—to form the requisite annulus A—by air straightening plates or blades **14**.

The elements **12** and **13** are preferably sheet metal. The outer element **12** generally would have a reinforcing bead **18** formed therein adjacent the ends. The outer element **12** is of such an inner diameter as to permit it to fit snugly over the housing shroud **11** or **11***a* and be anchored thereto in any suitable manner. The inner element **13** is shorter than the outer element **12** by an amount equal to the overlapping portions of the shroud **11** or **11***a* and outer element **12**. Although herein shown as formed separate from the fan shroud, this improved nozzle could be made integral with what is here indicated as a shroud.

The plates **14**, as will be noted from Figs. 2, 3, and 5, have their lateral edges flanged for suitable bonding of

the plates to the opposed faces of the elements **12** and **13**, thereby supporting the elements in their requisite concentric relationship. These air-straightening plates **14** extend practically the full length of the inner element, thereby spacing the inner ends of the plates but slightly away from the fan **9** or **9***a*. At their inner ends these plates **14** are formed with bends **15**, as clearly shown in Fig. 5. The amount of this bend is determined by the pitch of the fan blades. It should be such as will tend to present the edge of the deflected portion of the plates directly to the air stream leaving the fan blades. Usually this bend or deflection would be about 20 degrees off the plane of the blade.

To appreciate the full significance of the form and relationship of these concentric elements **12** and **13**, it is imperative to comprehend some well-known and verifiable facts about the nature of the air stream, peculiar to a propeller or disk fan, when discharged through its shroud into the atmosphere. That air stream is in the nature of a hollow cylinder rotating in the form of a helix and circling rapidly. There also is a tendency of the air to recirculate from the blade tips to the fan hub causing a turbulent condition on the inside. Moreover, a propeller fan is effective in producing an outward thrust air stream over only about the outer half of the blade. In other words, the air flow generated by a propeller fan comes off a blade in the form of an annulus.

This improved nozzle N was conceived and constructed with a view to preserving that normal, high velocity, annular air flow, slightly under pressure, until it is discharged into the atmosphere. Thus the dimensions of the inner element **13** are rather critical, being such that there is a slightly turbulent but nevertheless dead air condition, so far as air flow is concerned, in the inner element when open. This probably is below atmospheric pressure since there is a tendency for the discharging annular air stream to create a vacuum within the element **13** and since there also is a tendency for the fan hub to recirculate air. These conditions within the element **13**, it is believed, account for the contraction of the annular air stream, as it emerges from the nozzle N, as indicated in Fig. 1. Furthermore, it is believed that this contraction or "necking down" of the emerging annular air stream causes an increase in velocity and accounts for the increased air throw over the discharge from open cylinder or any other form of nozzle heretofore known.

As a result of extended experiments and tests, it is further believed that there is a critical relationship between the axial length of the elements **12** and **13** and the diameter of the inner elements—and possibly the inner end bends **15**—and the blade formation, as well as the size of the shroud discharge, and the speed of the fan wherewith this improved form of nozzle is to be used.

For the type of fan and the unit heater used in the experiments thus far, the length of the elements **12** and **13** ranges from 87 to 66% of the shroud discharge opening **10**. The diameter of inner element **12** is in the neighborhood of 45 to 48% of the shroud discharge opening. The length of the inner end bend **15** of the plates **14** is from ⅞" for the smaller size nozzles to 1⅝" for the larger size nozzles. With a man cooler unit, not involving a heating coil, using a six blade fan and operating at speed higher than used with a unit heater, there very likely would be a somewhat different ratio, but nonetheless critical.

Although the foregoing relationships are believed to be critical, it is to be understood, from the previous statements herein with regard to the normal functioning of a propeller fan—i. e. one without any attachments projecting from the shroud—that it is not imperative to have the inner element **13** open ended. With a view to achieving certain economies in the manufacture of such a nozzle, the inner element is left open as herein shown. However, if one or both ends were closed in any way it would not have any material effect on what is believed to be the significant functioning of the air space between the two elements.

Smoke studies have verified that the air stream upon emerging from the annulus, contracts about 20% of the diameter (see Fig. 1) with absolutely no twist or "yaw." From a short distance below the nozzle the air stream assumes the form of an elongated pear.

I claim:

1. In combination with a propeller type axial fan, a supporting housing having a fan shroud, a shaft journaled on the housing, a plurality of blades fixed to and extending radially outward from the shaft with the inner ends of the blades spaced outwardly from the shaft axis, whereby the revolving fan produces an ineffective annular flow area adjacently outward from the shaft axis, a nozzle comprising a pair of cylindrical elements of substantially equal length, vane means securing the pair of cylindrical elements in concentric relationship, the outer element being attached at one end to the shroud and having the opposite end open to the ambient atmosphere, the inner element being of a diameter substantially equal to the diameter of the aforesaid ineffective air flow area whereby the concentric elements form an air flow annulus of uniform diameter throughout the length of the elements and which discharges an air stream from the nozzle diametrically contracted below the nozzle.

2. A nozzle for use with a propeller type axial fan the radial disposed blades of which are fixed to a shaft journaled in a supporting housing having a fan shroud, the inner edges of which blades are spaced outwardly from the shaft axis whereby the revolving fan produces an ineffective annular flow area outwardly adjacent the shaft axis, the nozzle comprising a pair of concentrically-arranged cylindrical elements of substantially equal length, vane means securing the cylindrical elements in concentric relationship, the outer element being concentrically attachable at one end to the fan shroud and having the opposite end open to the ambient atmosphere, the inner element being of a diameter substantially equal to the diameter of the aforesaid ineffective air flow area whereby the nozzle forms an air flow annulus of uniform diameter throughout the length of the elements and discharges an air stream diametrically contracted below the nozzle.

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