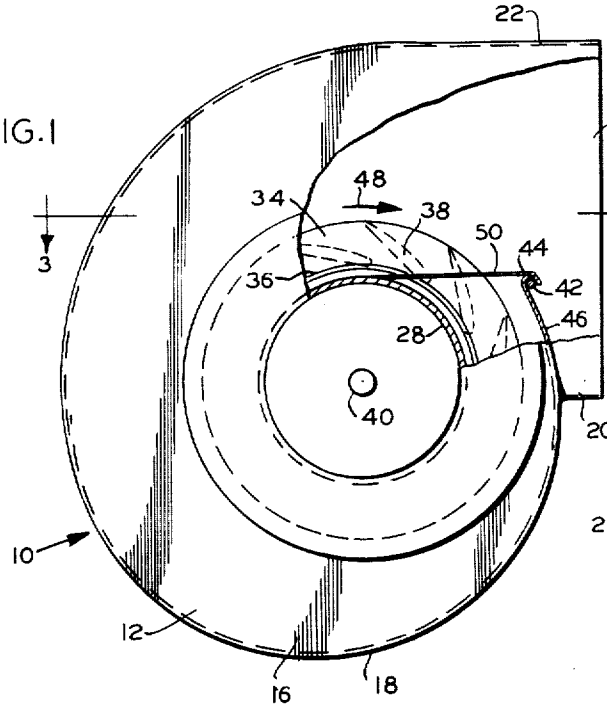
April 16, 1963 K. W. BURKHARDT 3,085,741

CENTRIFUGAL FANS

Filed Nov. 23, 1959

FIG.1



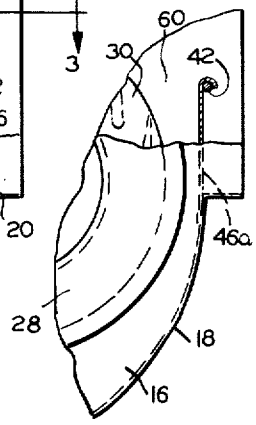


FIG.4

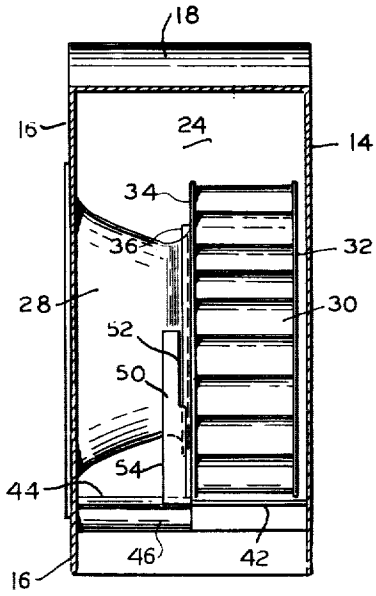


FIG.3

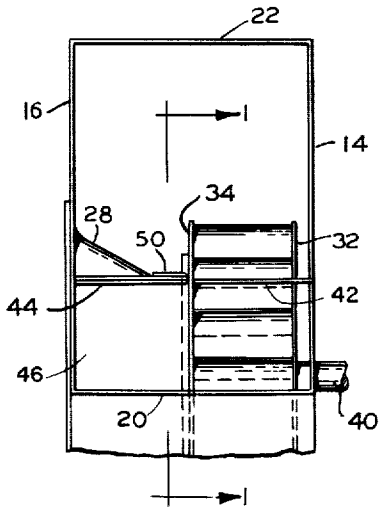


FIG.2

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CENTRIFUGAL FANS

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This invention relates to centrifugal fans and particularly to a centrifugal fan having an improved means for obtaining increased operating efficiencies over wide ranges of volumetric deliveries.

In many installations requiring the use of centrifugal fans the fan is chosen on the basis of such factors as size, horsepower requirements, or operating pressure conditions, or a compromise between these variables. It is for this reason that centrifugal fans should have high operating efficiencies over wide variations in volumetric delivery, since in many cases the fan will be operated under conditions of less than maximum efficiency.

Over the years many fans have been developed for the attainment of a relatively high peak efficiency in the moderate volumetric delivery range. In most cases the attainment of a high peak efficiency has been at the sacrifice of a relatively low efficiency in the higher delivery ranges.

It is an object of the present invention to provide a centrifugal fan construction wherein relatively high operating efficiencies are attained throughout a wide variation in volumetric delivery.

A further object is to provide a fan having an improved delivery efficiency curve.

A further object of the invention is to provide a centrifugal fan wherein a high peak efficiency is attained with a relatively small sacrifice in efficiency in the higher volumetric delivery ranges.

A further object of the invention is to provide a centrifugal fan which can be satisfactorily employed under a variety of operating conditions without material sacrifice in output or efficiency.

An additional object is to provide a centrifugal fan construction having novel mechanisms for attaining a controlled recirculation of gas within the fan housing so as to minimize turbulence in the gas stream adjacent the fan wheel in a manner to achieve an improved efficiency.

A further object is to provide a centrifugal fan construction with an improved cut-off structure for reducing turbulence at the exit of the fan wheel, the arrangement being such as to deflect a portion of the gas which would normally recirculate around the inlet throat and cause the deflected gas to be discharged through the fan outlet.

A further object is to provide a centrifugal fan design with an improved cut-off structure which is susceptible to employment in various different size fans, as for example from a relatively large fan construction having a ten foot diameter fan wheel down to a relatively small fan construction having a two foot diameter wheel.

Other objects of this invention will appear in the following description and appended claims, reference being had to the accompanying drawings forming a part of this specification wherein like reference characters designate corresponding parts in the several views.

In the drawings:

FIGURE 1 is a side elevational view of a centrifugal fan construction constructed according to the invention;

FIG. 2 is a front elevational view showing the upper portion of the FIG. 1 construction;

FIG. 3 is a sectional view taken substantially on line 3—3 in FIG. 1; and

FIG. 4 is a partial elevational view taken in the same direction as FIG. 1 but of a second embodiment of the invention.

Before explaining the present invention in detail, it is to be understood that the invention is not limited in its application to the details of construction and arrangement of parts illustrated in the accompanying drawings, since the invention is capable of other embodiments and of being practiced or carried out in various ways. Also, it is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation.

Referring to the drawings, and particularly to FIGS. 1 through 3, there is shown a centrifugal fan construction **10** comprising a scroll-shaped fan housing **12** defined by a pair of side walls **14** and **16**, and an interconnecting arcuate wall **18**. One end of wall **18** is turned to provide a wall portion **20**, and the other end of wall **18** is flattened to provide a wall portion **22**, the space between wall portions **20** and **22** forming a discharge opening **24** extending entirely across the space between side walls **14** and **16**.

Extending inwardly from wall **16** is an annular inlet throat **28** of generally conical configuration, the purpose of this throat being to introduce gas to the eye of the centrifugal fan wheel **30**. Fan wheel **30** is comprised of two substantially parallel side plates **32** and **34**. Plate **32** is imperforate, and plate **34** is annular in configuration to permit gas to be received within the wheel. An annular lip **36** extends from plate **34** so as to closely surround the downstream end portion of throat **28**, said downstream end portion flaring slightly as it enters within the lip **36** so as to form a close fit therein in a manner to prevent leakage of exit air around the wheel and back into the fan wheel interior. The fan wheel is of generally conventional construction, and includes a plurality of blades **38** suitably secured between the side plates **32** and **34**. Plate **32** is suitably affixed to a drive shaft **40** which may be driven directly from a motor (not shown) or belt-driven as desired.

It will be appreciated that operation of the fan is such that gas is drawn through the inlet throat **28** into the interior of fan **30**, from whence the fan rotation is effective to carry the gas outwardly through the fan blades so as to be discharged through opening **24**.

Fixedly extending across the discharge opening **24** is a rod **42** which serves to mount the upper curled end portion **44** of a cut-off structure **46**. It will be noted from FIG. 3 that cut-off structure **46** extends from housing side wall **16** to a point in radial alignment with fan wheel side plate **34** so that the portion of discharge opening **24** in radial alignment with fan wheel **30** is entirely unobstructed from wall portion **20** to wall portion **22**. By this arrangement there is provided a relatively large discharge area from the wheel which promotes a high volumetric delivery.

As the fan wheel rotates in the arrow **48** direction the gas issuing from the blades tends to fan out in lateral directions (i.e., to the left of plate **34** in FIG. 3) so as to be discharged in the left portion of discharge opening **24**. It has been found that provision of the cut-off structure **46** (extending only to a point in radial alignment with plate **34**) has the desirable effect of intercepting a portion of this left-most gas and recirculating it around the exterior surface of inlet throat **28**. Without the provision of cut-off structure **46** the efficiency of the fan appears to be less than when such a cut-off structure is employed.

In the FIG. 1 embodiment there is extended between cut-off structure **46** and the surface of throat **28** a relatively narrow band **50**, which may be fixedly connected to the structures **46** and **28** by riveting, bolting, welding or the like. The inlet throat **28** is in the illustrated embodiment curved at its point of connection with band **50**, and the band is in actual practice twisted slightly from a

flat configuration when it is installed in position. Also the band is preferably provided with a cut-away at 52 (FIG. 3) for enabling it to clear the lip 36 on the wheel 30 while maintaining a fairly close position adjacent the wheel side plate 34. Preferably the spacing between band 50 and plate 34 is in the neighborhood of one-half inch or less for relatively small fan wheels, as for example a forty inch diameter wheel.

Band 50 serves to intercept some of the very turbulent gas adjacent plate 34 and deflect it outwardly through the discharge opening 24. The action is such as to prevent much of the turbulence which would occur at the juncture between the relatively fast moving gas in radial alignment with wheel 30 and the relatively slow moving gas to the left of the wheel. Without the provision of band 50 the different speeds of the air in the two zones tends to promote a turbulence at the zone juncture so as to reduce the operating efficiencies.

It will be noted from FIG. 3 that the left edge 54 of band 50 is spaced a considerable distance from housing wall 16 so that a gas recirculation space of considerable extent is provided around the throat 28. In an illustrative example band 50 has an axial dimension (i.e., parallel to rod 42) of about three inches in a construction wherein the wheel 30 is spaced from the side wall 16 by twelve inches. The actual width of the member 50 is determined to a large extent by the diameter of wheel 30, in general the axial dimension of member 50 being less than one-tenth the wheel diameter. Thus, in a construction having a twenty-seven inch diameter wheel the band 50 was provided with a two inch axial dimension. In a construction having forty inch diameter wheel the band was given an axial dimension of about three inches, and in a construction having a one hundred thirty-two inch wheel diameter the band was given an axial dimension of ten inches. In fan constructions the inlet throat 28 and the wheel 30 are varied in accordance with the wheel diameter. Thus the width of the wheel and the axial length of the throat 28 are substantially larger for the larger diameter wheels. The throat is usually about the same length as the axial width of the wheel in any given installation.

In operation of the fan construction shown in FIGS. 1 through 3, the wheel was driven at various different speeds, and the wheel was found to give higher efficiencies over a relatively wide range of speeds than prior art constructions. As previously pointed out, in many commercial installations there is some sacrifice in efficiency in some instances, particularly when the user is concerned with initial cost or size of the unit. Thus the fan should deliver a relatively high peak efficiency at moderate deliveries as well as a relatively high efficiency at other delivery conditions. This does not mean to imply that the efficiency of the FIG. 1 fan is the same over all speed ranges, but is is rather meant to indicate that the drop in efficiency which normally takes place in the relatively higher delivery ranges is not as great as with the prior art arrangements. This result is attained without sacrifice in peak efficiency. In fact the peak efficiency of the FIG. 1 embodiment is as great or greater than competitive units.

The improved results of the FIG. 1 construction are achieved through the cut-off structure 46 in combination with the anti-turbulence band 50, the arrangement being such as to materially reduce a turbulence adjacent the side edge of the wheel while allowing a controlled recirculation of gas around the inlet throat. It has been found that the design of FIG. 1 is susceptible to effective utilization in centrifugal fans of relatively small dimension as well as the relatively larger size fans.

The embodiment shown in FIG. 4 is similar to that shown in FIG. 1 in many respects, and similar reference numerals are employed wherever applicable. In the FIG. 4 embodiment the fan housing is identical with that shown in FIG. 1. Also the inlet throat 28 is the same and the wheel 30 is the same. The partial cut-off at 46*a* extends to a point in radial alignment with the left side plate of the fan wheel in the same manner as that shown in FIG. 3. However the cut-off structure 46*a* is extended as a relatively flat wall structure so as to define a relatively wide mouth portion 60 for accommodating the recirculation gas. The action of cut-off structure 46*a* is such as to intercept the relatively slowly moving gas and direct it around the inlet throat 28. The FIG. 4 structure does not utilize a fill-in band similar to band 50 of the FIG. 1 embodiment. The peak efficiency of the FIG. 4 arrangement is comparatively good, but the efficiency in the higher speed ranges is somewhat less than with the FIG. 1 construction.

It will be understood that, while specific embodiments of the invention have been shown in the drawings and described herein, yet variations therefrom will occur to those skilled in the art, and modifications may be employed without departing from the spirit of the invention as set forth in the appended claims.

I claim:

1. The combination comprising a fan housing including two substantially parallel side walls; at least one of said side walls having an inlet opening therein; an inlet throat structure extending into the housing from said inlet opening; a centrifugal fan wheel within the housing in alignment with the inlet throat structure for receiving gas within its interior; said fan housing defining a discharge opening extending entirely across the space between the side walls; a cut-off structure extending within the discharge opening from said one side wall to a point in substantial radial alignment with a side surface of the wheel to intercept a portion of the gas discharged from the wheel and recirculate it around the outside of the annular inlet throat; and a wall structure extending from the cut-off structure toward the throat structure adjacent a side surface of the fan wheel for intercepting a portion of the gas discharged from the wheel and deflecting it through the discharge opening.

2. The combination comprising a fan housing having a side wall provided with an inlet opening; a discharge opening for said housing; a centrifugal fan wheel within said housing but spaced a substantial distance from said side wall; and a wall structure positioned within the fan housing adjacent a side surface of the fan wheel to intercept a portion of the gas discharged from said wheel and direct it through the discharge opening; said wall structure being spaced a substantial distance from said housing side wall to define an open space for permitting a portion of the gas discharged from the wheel to recirculate within the fan housing.

3. The combination of claim 2 wherein the diameter of the fan wheel is at least ten times the axial dimension of the wall structure.

4. The combination comprising a fan housing having a discharge opening and side wall provided with an inlet opening; a centrifugal fan wheel within said housing but spaced a substantial distance from said side wall; a frustroconical inlet throat extending from said side wall for conveying gas into the wheel; said fan wheel including an annular side plate having a lip portion located adjacent an end of the throat; and a wall structure positioned within the fan housing adjacent the annular side plate of the wheel to intercept a portion of the gas discharged from said wheel and direct it through the discharge opening; said wall structure being spaced a substantial distance from said housing side wall to define an open space for permitting a portion of the gas discharged from the wheel to recirculate within the fan housing.

5. The combination of claim 11 wherein the axial dimension of the inlet throat is approximately the same as the axial width of the fan wheel, wherein the diameter of the fan wheel is at least ten times the axial dimension of the wall structure, and wherein the space between the wall structure and housing side wall is substantially larger than the axial dimension of the wall structure.

6. The combination comprising a fan housing having an inlet opening and a discharge opening; a centrifugal fan wheel positioned within said housing; an inlet throat extending from the inlet opening toward the fan wheel; said discharge opening being substantially the same width as the housing; and a cut-off structure within the discharge opening extending in radial registry with the inlet throat and out of radial registry with the fan wheel; said cut-off structure terminating a substantial distance from the inlet throat to intercept a portion of the gas discharged from the wheel and direct it around the outside of the inlet throat.

7. The combinaion of claim 6 wherein the cut-off structure is formed as a substantially flat wall extending parallel with the plane of the discharge opening.

8. The combination comprising a scroll-shaped fan housing having an inlet opening and a discharge opening; a cylindrical fan rotor within the housing with its eye aligned with the inlet opening; an inlet throat extending from said inlet opening toward the eye of the fan; a gas cut-off wall in the discharge opening in radial alignment with the inlet throat and out of radial alignment with the rotor so as to intersect a portion of the gas discharged from the rotor and recirculate it around the inlet throat within the housing; and a band extending from the cut-off wall toward the inlet throat and beyond the periphery of the fan rotor at a point closely adjacent the side surface of the fan rotor for intercepting a portion of the gas discharged from the rotor and directing it through the discharge opening.

9. The combination comprising a scroll-shaped fan housing having an inlet opening and a discharge opening; a cylindrical fan rotor within the housing with its eye aligned with the inlet opening; and an inlet throat extending from said inlet opening to the eye of the fan; a gas cut-off wall in the discharge opening in radial alignment with the inlet throat and out of radial alignment with the rotor so as to intersect a portion of the gas discharged from the rotor and recirculate it around the inlet throat within the housing; and a band extending from the cut-off wall toward the inlet throat and beyond the periphery of the fan rotor at a point closely adjacent the side surface of the fan rotor for intercepting a portion of the gas discharged from the rotor and directing it through the discharge opening; said band being spaced from the housing to provide a space around the inlet throat for accommodating recirculation of gas.

10. The combination comprising a fan housing including two substantially parallel side walls; one of said side walls having an inlet opening therein; an inlet throat structure extending into the housing from said inlet opening; a centrifugal fan wheel within the housing in alignment with the inlet throat structure for receiving gas within its interior; said fan housing defining a discharge opening extending entirely across the space between the side walls; a cut-off structure extending within the discharge opening from said one side wall to a point in substantial radial alignment with a side surface of the wheel to intercept a portion of the gas discharged from the wheel and recirculate it around the outside of the annular inlet throat; and a wall structure extending along a side surface of said fan wheel in the space between the cut-off structure and throat structure for intercepting a portion of the gas discharged from the wheel and deflecting it through the discharge opening.

11. In a centrifugal fan having a housing including a side wall defining an inlet opening, an outlet opening, a fan wheel positioned in the housing, and having one side spaced from the inlet opening, the outlet opening being wider than the fan wheel, and with an inlet throat extending from the inlet opening to the spaced side of the fan wheel, the improvement of a cut-off wall extending across a portion of the outlet opening from a point adjacent the spaced side of the wheel toward the inlet side of the housing and an anti-turbulence baffle extending from the cut-off wall toward the inlet throat and positioned adjacent the spaced side of the fan wheel.

12. In a centrifugal fan having a housing including a side wall defining an inlet opening, an outlet opening, a fan wheel positioned in the housing and having one side spaced from the inlet opening, the outlet opening being wider than the fan wheel, and with an inlet throat extending from the inlet opening to the spaced side of the fan wheel, the improvement of a cutoff wall extending across a portion of the outlet opening from a point adjacent the spaced side of the fan wheel to the inlet side of the housing, and an anti-turbulence baffle extending from the cut-off wall toward the inlet throat and positioned adjacent the spaced side of the fan wheel, said anti-turbulence baffle comprising a relatively narrow band twisted slightly from a flat configuration, and said band being cut-away to a configuration conforming to the spaced side of the fan wheel.

References Cited in the file of this patent

UNITED STATES PATENTS

820,398	Davidson	May 15, 1906
2,107,897	McMahan	Feb. 8, 1938
2,452,274	Walters	Oct. 26, 1948
2,841,326	Davis	July 1, 1958

FOREIGN PATENTS

455,092	Germany	Jan. 25, 1928