United States Patent [19]

Lievens et al.

[11] **3,924,964**

[45] **Dec. 9, 1975**

[54] **AXIAL FLOW FAN APPARATUS**

[75] Inventors: **Ronald J. Lievens,** Onalaska; **Richard W. Kabat,** Genoa, both of Wis.

[73] Assignee: **The Trane Company,** La Crosse, Wis.

[22] Filed: **Dec. 23, 1974**

[21] Appl. No.: **535,430**

[52] **U.S. Cl.**..... **415/210;** 415/219 R; 417/423 R

[51] **Int. Cl.²**..... **F01D 1/02**

[58] **Field of Search**..... 417/423 R; 415/207, 209, 415/210, 219 R

[56] **References Cited**

UNITED STATES PATENTS

1,604,448	10/1926	Hosch	417/423 R
2,031,688	2/1936	Bowen	417/423 R
2,191,341	2/1940	Curley	415/210
2,410,450	11/1946	Kroon	415/219 R
2,717,554	9/1955	Stalker	415/210
3,403,843	10/1968	Cox	415/219 R
3,708,242	1/1973	Bruneau et al.	415/219 R

Primary Examiner—Henry F. Raduazo

[57] **ABSTRACT**

A vane axial flow fan is shown having a shroud construction which provides greater than normal rigidity in the areas co-extensive with the stator vanes and fan wheel blades. These areas of the shroud are formed as metal spinnings to permit unusually deep flanges with well-rounded transition areas to reduce turbulence of the fluid stream passing around them as it passes through the fan. The fan shroud is disposed within a rectangular cage formed of interconnected axially extending and tangentially extending angle bars. The tangentially extending bars are directly connected to the flanges of the fan shroud.

8 Claims, 5 Drawing Figures

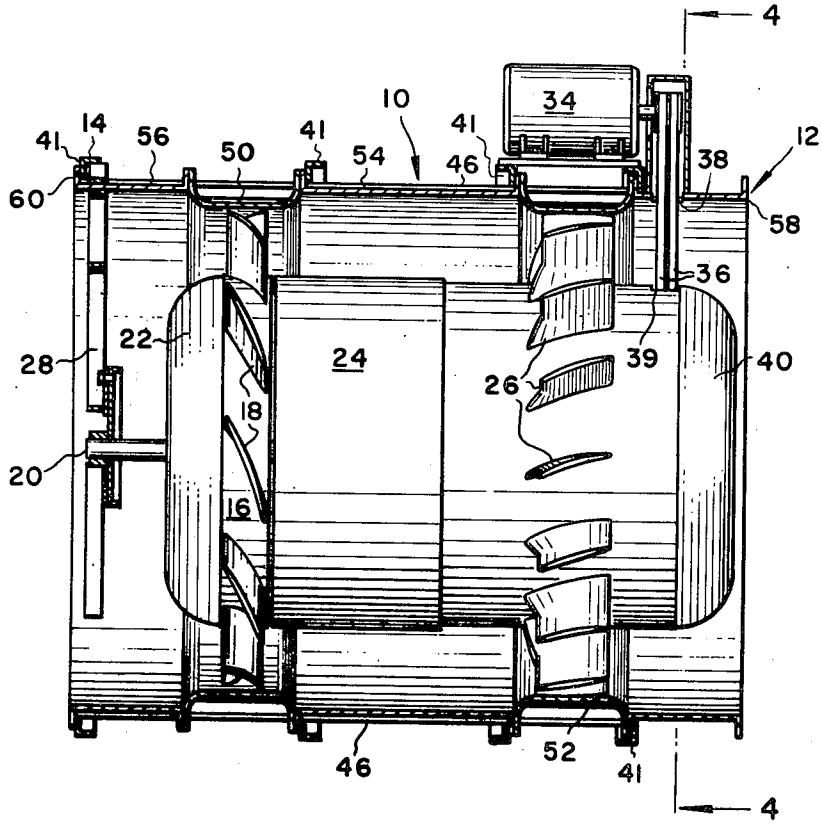
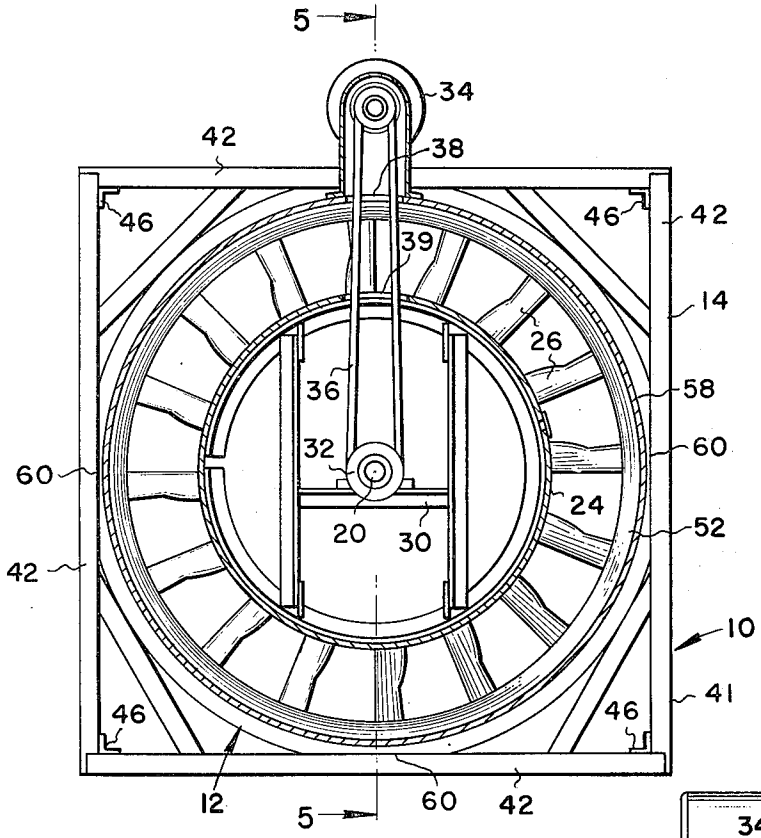


FIG. 4



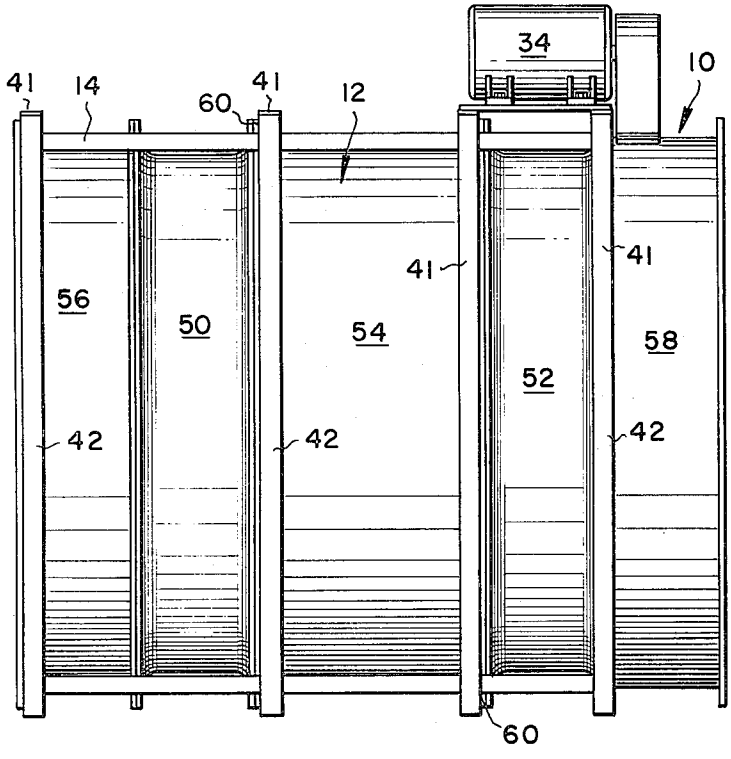


FIG. 1

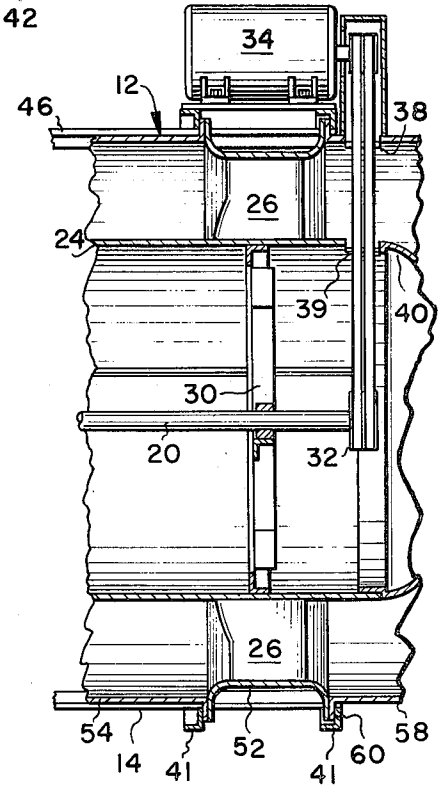


FIG. 5

FIG. 2

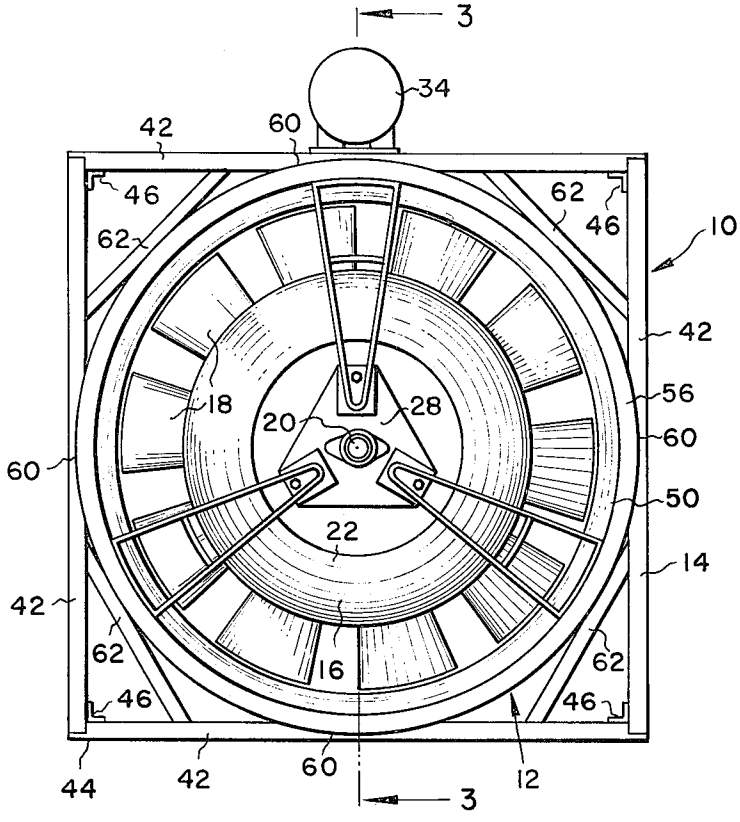
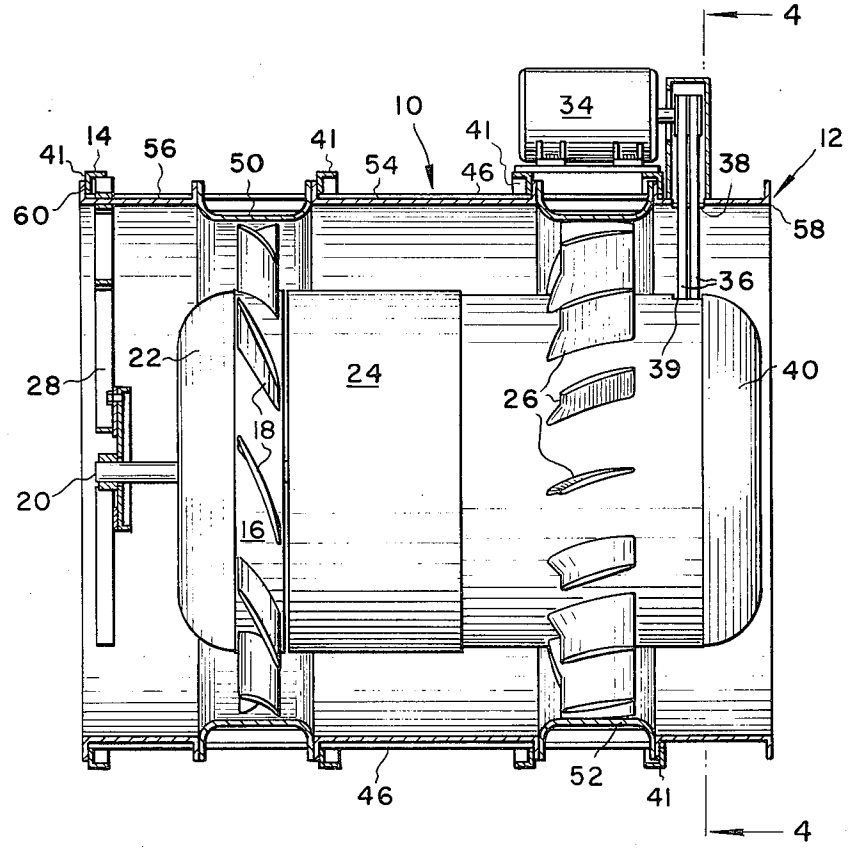

3
34
42
60
46
62
62
46
10
42
18
20
28
56
60
60
50
22
14
42
62
62
16
46
46
44
42
60
12
3

FIG. 3


4
34
10
41
14
41
56
50
41
54
46
12
38
60
58
36
22
24
39
40
28
26
18
20
16
46
52
41
4

AXIAL FLOW FAN APPARATUS

A great variety of axial flow fans are known to the prior art. They have been constructed in sizes ranging from fractional horsepower to hundreds of horsepower. Some employ shrouds formed of plural annular U-shaped channel members. On large fans it becomes increasingly important to provide a shroud which is rigid but that uses a minimum of material. Furthermore, the interior of the shroud must be acceptable from an aerodynamic point of view so as not to adversely affect the fan efficiency and noise generation.

It is the purpose of this invention to achieve these objectives. This has been accomplished through the use of a fan shroud comprised of a plurality of specially constructed annular U-shaped channel members or hoops connected at their flanges. The web or cylindrical central portion of the U-shaped members differs in diameter from one member to the next member. In the areas where it has been discovered that greater strength and rigidity are required, the annular members are provided with substantially smaller diameter webs with substantially greater flange depths. In areas requiring less rigidity channel members having substantially reduced flange depth and increased web diameter are provided. The outer diameter of the flanges of both types of channel members are the same so they may be readily interconnected. Furthermore, the fan shroud is disposed within a rectangular cage which supports the flanges of the annular channel members.

More specifically this invention involves an axial flow fan including a shroud having: a first annular channel member of U-shaped cross section having a substantially circular axially extending first web disposed intermediate first and second radially outwardly extending flanges; a second annular channel member of U-shaped cross section having a substantially circular axially extending second web disposed intermediate first and second radially outwardly extending flanges; a third annular channel member of U-shaped cross section having a substantially circular axially extending third web disposed intermediate first and second radially extending flanges, said first and second webs being of a diameter less than the diameter of said third web, said third channel member being disposed axially intermediate said first and second channel members in co-axial flange-to-flange facing relationship; and means for fixedly connecting the adjacent facing flanges of said first and third and said second and third channel members.

Thus it will be seen that through the use of a very specialized fan construction, both the desired rigidity and minimum use of material can be achieved to provide a higher quality of fan at reduced cost.

These and other objects of the invention will become more apparent as this specification proceeds to describe the invention with reference to the drawings in which:

FIG. 1 is a side elevation of an axial flow fan containing the invention herein described;

FIG. 2 is an end elevation showing the inlet end of the fan shown in FIG. 1;

FIG. 3 is a vertical sectional view taken along line 3—3 of FIG. 2;

FIG. 4 is a vertical sectional view taken near the outlet end of the fan at line 4—4 of FIG. 3; and

FIG. 5 is a vertical section taken substantially through the center of the stator vane portion of the fan showing the bearing support and drive mechanism.

Now with reference to the drawings it will be seen that the axial flow fan **10** includes a fan shroud or housing **12** disposed within a cage **14** constructed of angle iron bars.

A fan wheel **16** is mounted with the fan shroud **12** near the inlet end thereof. Fan wheel **16** is provided with a plurality of circumferentially spaced radially outwardly extending airfoil blades **18.** Fan wheel **16** is fixedly mounted on shaft **20** for rotation therewith. The fan wheel **16** is further provided with a rounded nose piece **22** for efficiently directing air or other fluid to the fan blades.

A stator core **24** of generally circular cylindrical configuration is disposed immediately downstream of fan wheel **16.** At the downstream portion of the stator core there is provided a plurality of circumferentially spaced stator vanes **26** which extend radially outwardly from stator core **24** to the shroud **12.** The vanes **26** are welded at each end whereby the stator core is supported by shroud member **12.**

Shaft **20** extends from the inlet end of shroud **12** to a point rearwardly of i.e., downstream of stator vanes **26.** The forward end of shaft **20** is rotatably supported by way of a forward bearing bracket **28** which is preferably constructed in accordance with the teachings of U.S. Pat. No. 3,403,843. The rear portion of shaft **20** is rotatably mounted within a bearing supported by a rear bearing bracket **30** rigidly connected to the interior of stator core **24.** The rear end of shaft **20** is provided with a sheave **32** drivingly connected to motor **34** via belts **36** which extend through an openings **38** in shroud **12** and **39** in stator core **24.** The downstream side of stator core **24** is preferably closed by way of an end bell **40.** Motor **34** is preferably mounted on cage **14.**

Cage **14** is constructed of several square frames **41** each having four tangentially arranged angle bars **42** connected to each other at their ends as at **44.** The several frames are interconnected by a longitudinally extending angle bar **46** passing just inside each corner of the square frame. Connections are preferably made by welding. The tangentially extending bars **42** and axially extending bars **46** provide a support cage for shroud **12** as will be hereinafter described.

Shroud **12** is comprised of five annular channel members of U-shaped cross section each having a cylindrical substantially circular web disposed intermediate radially outwardly extending flanges. A first annular channel member **50** is disposed primarily in the vincinity of the fan wheel **16** and is axially co-extensive therewith. A second annular channel member **52** is disposed primarily in the vicinity of stator vanes **26** in axially co-extensive relationship therewith. A third annular channel member **54** bridges between channel members **50** and **52.** A fourth annular channel member **56** extends forwardly or upstream of annular channel member **50** and the fifth annular channel member **58** extends rearwardly or downstream of annular channel member **52.** The flanges of all of the channel members **50, 52, 54, 56,** and **58** all have substantially the same outer diameter. However, the flanges of annular channel members **50** and **52** are substantially deeper than those of channel members **54, 56,** and **58.** The webs of channel members **50** and **52** are of equal diameter and of substantially less diameter than the webs of channel members **54, 56,** and **58.** In the embodiment shown the

webs of channel members **54, 56,** and **58** are of equal diameter. Furthermore, it will be noted that the transition portion of the flanges on channel members **50** and **52** have a very large radius of curvature as seen in FIG. **3** so as to avoid excessive turbulence within the shroud **12.** The increased depth of the channel of each of members **50** and **52** thus provides a relatively greater rigidity in critical areas of the fan. The radius of curvature of a transition areas of channel members **50** and **52** is between 0.01 and 0.1 times the diameter of the web portion thereof. The radius of curvature of the transition area of the flanges of channel member **54** are less than 0.01 times the diameter of the web thereof.

In order to achieve this unique channel configuration and relationship, it is preferred to form channel members **54, 56,** and **58** by roll forming at low cost and to form channel members **50** and **52** by spinning whereby transition areas of sufficiently large radius of curvature may be formed.

The fan shroud is supported with and by cage **14** heretofore described. The plane of each frame **41** of the four tangentially extending angle bars **42** is positioned adjacent and welded as at **60** directly to flanges of the U-shaped channel members. In the embodiment shown having five support frames, the shroud **12** may be supported at sixteen spaced points by cage **14.** If corner braces **62** are employed on each frame, the number of support points can be doubled.

It will thus be seen that relative shape and position of U-shaped channel members **50, 52, 54, 56,** and **58** disposed within, and supported at multiple spaced points provides an unusually strong and light fan construction. The substantially more rigid member **50** permits closer blade tip clearance while the substantially more rigid member **52** provides ample support for the rear bearing through the stator core and vanes. The large radius on the flanges of members **50** and **52** efficiently direct the fluid flow to and from the fan blades and stator vanes.

Although we have described a specific embodiment of our invention, it is contemplated that various changes may be made without departing from the spirit of our invention, and we desire to be limited only by the claims.

We claim:

1. An axial flow fan including a shroud having: a first annular channel member of U-shaped cross section having a substantially circular axially extending first web disposed intermediate first and second radially outwardly extending flanges; a second annular channel member of U-shaped cross section having a substantially circular axially extending second web disposed intermediate first and second radially outwardly extending flanges; a third annular channel member of

U-shaped cross section having a substantially circular axially extending third web disposed intermediate first and second radially extending flanges, said first and second webs being of a diameter less than the diameter of said third web, said third channel member being disposed axially intermediate said first and second channel members in co-axial flange-to-flange facing relationship; and means for fixedly connecting the adjacent facing flanges of said first and third and said second and third channel members.

2. The axial flow fan as defined by claim **1** further including an axial flow fan wheel having circumferentially spaced radially outwardly extending blades disposed in axially co-extensive relationship with said first web.

3. The axial flow fan as defined by claim **2** further including a plurality of circumferentially spaced stator vanes extending radially inwardly of said second web; and a centrally disposed diffuser core spaced radially inwardly of and axially co-extensive with said second and third webs.

4. The axial flow fan as defined by claim **3** further including means for rigidly fastening said stator vanes at their radially outer ends to said second web and their radially inner ends to said core.

5. The axial flow fan as defined by claim **4** further including a rotatable shaft; means fixedly mounting said fan wheel to said shaft for rotation therewith; bearing means disposed radially inwardly of said core for rotatably supporting said shaft; and bearing support means including said stator blades and said second web for supporting said bearing means.

6. The axial flow fan as defined by claim **1** further including a rectangular shroud support cage disposed about said shroud including a plurality of axially extending support bars and a plurality of tangentially extending support bars fixedly connected to each other; and means directly fixedly connecting at least some of said annular channel flanges to said tangentially extending support bars.

7. The axial flow fan as defined by claim **1** wherein the transitions between the web and flanges of said first and second channel members have a radii of curvature greater than 0.01 times the diameters of said first and second webs respectively and the transition between the web and flanges of said third channel member has a radius of curvature less than 0.01 times the diamter of said third web.

8. The axial flow fan as defined by claim **7** wherein said first and second channel members are metallic spinnings and said third channel member is a rolled annulus.

* * * * *