July 15, 1958 H. J. FINDLEY 2,843,355

WIRE WOUND STRUCTURE

Filed Jan. 4, 1952 4 Sheets-Sheet 1

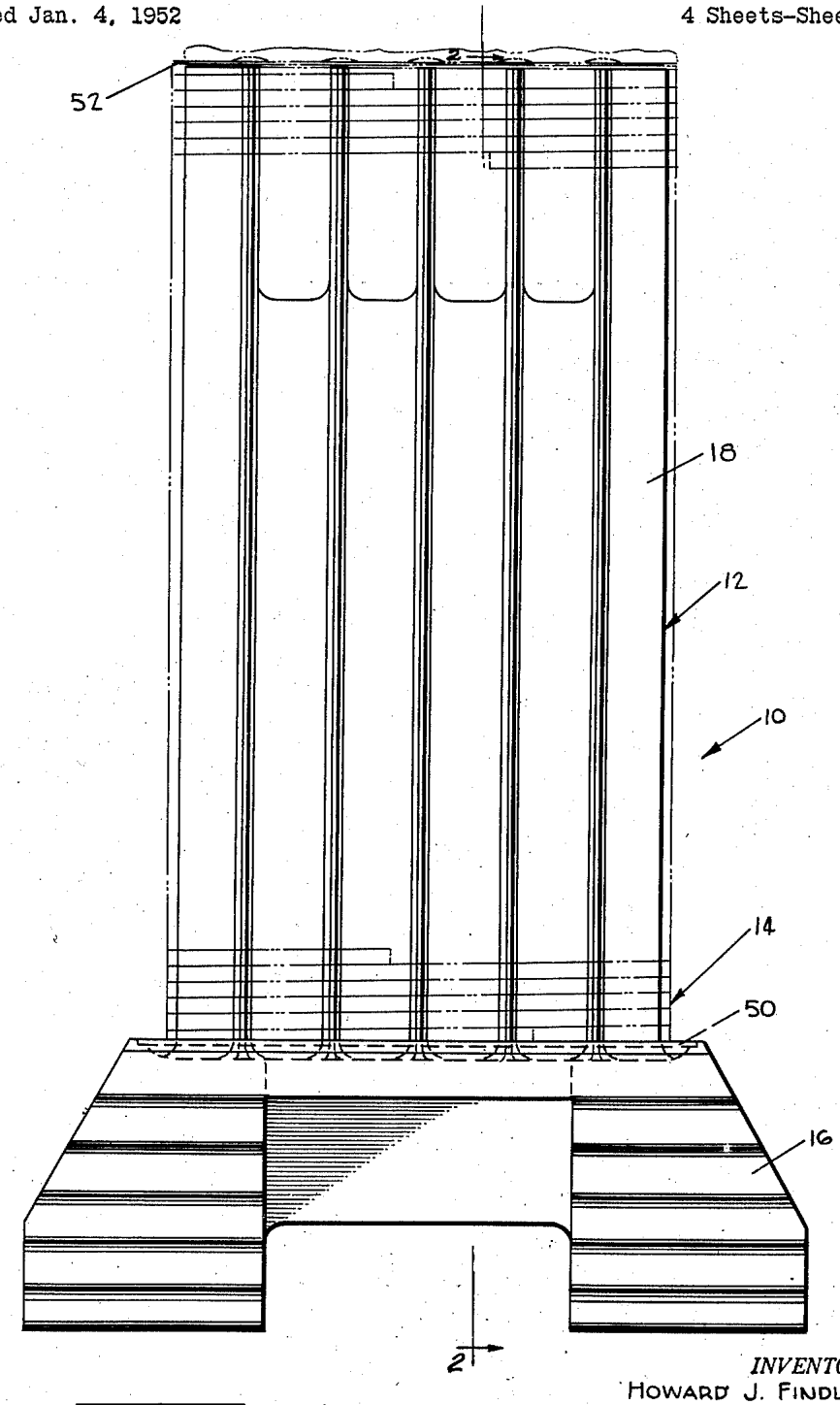



FIG. 1

INVENTOR.
HOWARD J. FINDLEY

BY McDonald & Teagno

ATTORNEYS

July 15, 1958 H. J. FINDLEY 2,843,355

WIRE WOUND STRUCTURE

Filed Jan. 4, 1952 4 Sheets-Sheet 2

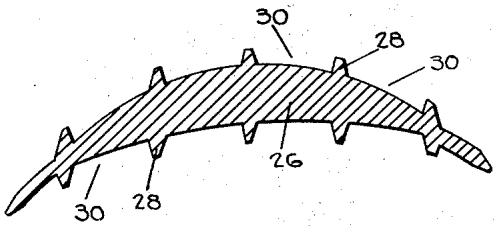



FIG_3

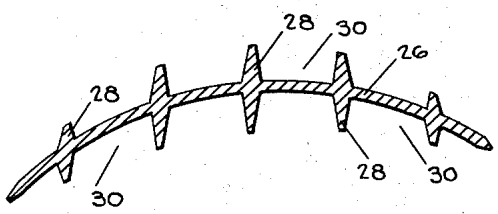



FIG_4

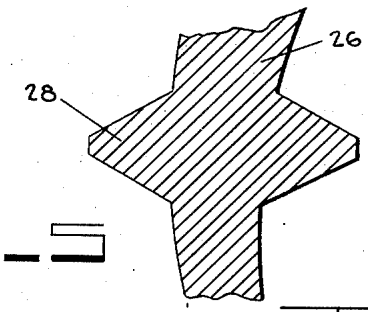



FIG_5

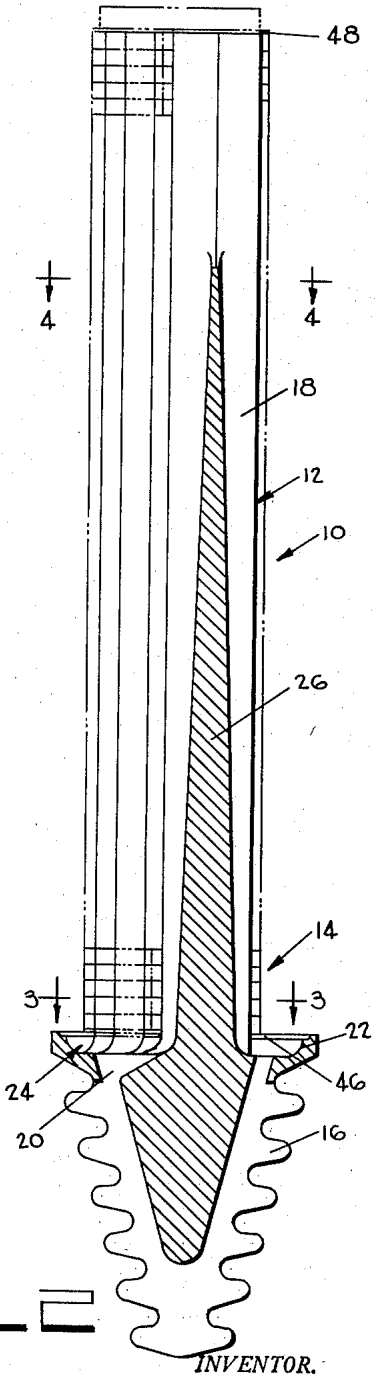



FIG_2

INVENTOR.
HOWARD J. FINDLEY

BY
McDonald & Teagno

ATTORNEYS

July 15, 1958 H. J. FINDLEY 2,843,355

WIRE WOUND STRUCTURE

Filed Jan. 4, 1952 4 Sheets-Sheet 3

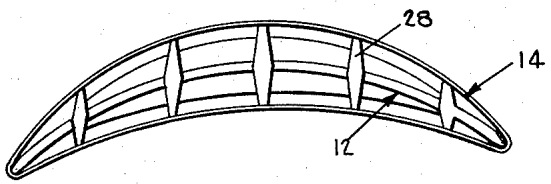



FIG. 6

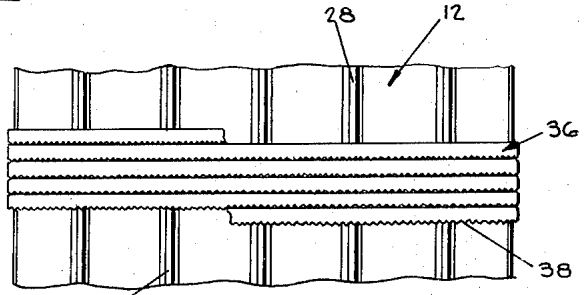



FIG. 7

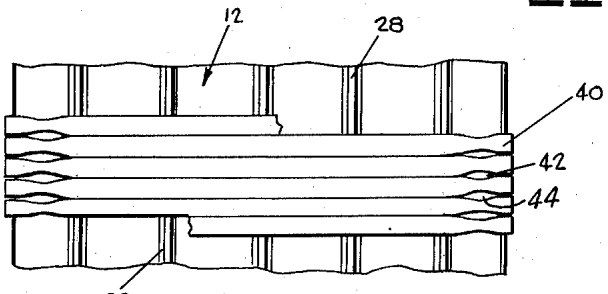



FIG. 8

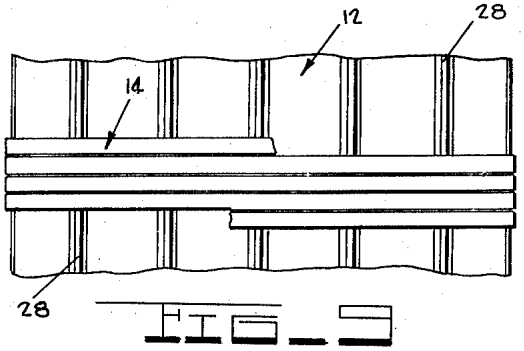



FIG. 9

*INVENTOR.*
HOWARD J. FINDLEY

*BY*
McDonald & Teagno

ATTORNEYS

July 15, 1958 H. J. FINDLEY 2,843,355

WIRE WOUND STRUCTURE

Filed Jan. 4, 1952 4 Sheets-Sheet 4

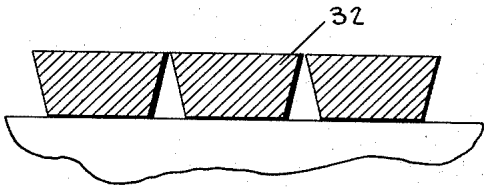



FIG_10

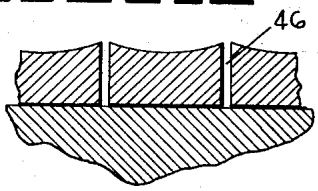



FIG_11

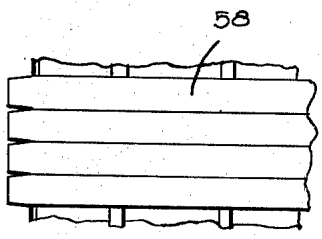
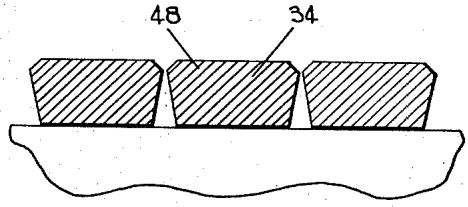



FIG_15

FIG_12



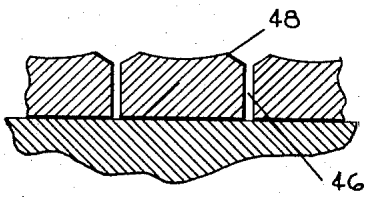




FIG_13

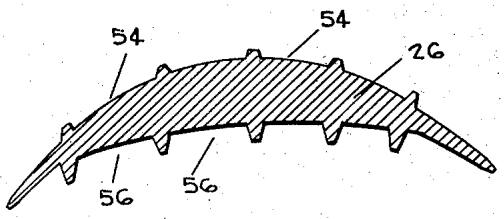



FIG_14

*INVENTOR.*
HOWARD J. FINDLEY

*BY* McDonald & Teagno

ATTORNEYS

United States Patent Office 2,843,355
Patented July 15, 1958



2,843,355

# WIRE WOUND STRUCTURE

Howard J. Findley, Cleveland, Ohio, assignor to Eaton Manufacturing Company, Cleveland, Ohio, a corporation of Ohio

Application January 4, 1952, Serial No. 264,943

18 Claims. (Cl. 253—39.15)

This invention relates to wire wound structures and more particularly for example to air or other fluid cooled blades for use in turbines and the like.

Broadly the invention comprehends the provision of a wire wound structure such as a blade or the like having central air or other fluid passage cavities therein and air or other fluid flow openings throughout the external surface thereof communicating with the passage cavities. The blade or like structure proper comprises a spike or core as a supporting member upon which is wound in spiral array to any desired shape and in the case of the blade to an external air foil shape having fixedly secured upon the supporting member, a wire of predetermined shape, size and composition.

Among the principal objects of the invention are the provision of spirally wound wire constructed hollow structures or blades for turbines and the like:

(1) That are simple and economical of construction;

(2) That do not require the use of strategic materials in the fabrication thereof;

(3) That in the case of blades improve the performance of turbines in which they are utilized;

(4) That are vibrationally dampened;

(5) That can be effectively cooled through the supplying of air or other suitable fluid to the hollow therein for passage through openings in the surface of the structure or blade communicating with the hollow;

(6) That in the case of blades can further increase the output of a given turbine when limited amounts of strategic material are used;

(7) That provides for air or other fluid flow control through the surface thereof for the delivery of air or other fluid in desired amounts to various portions thereof; and

(8) That utilizes a wire of rectangular or other suitable cross-section spirally wound upon a supporting member to provide the outer air foil or other predetermined shaped surface for the blade or other structure wherein air or other fluid passages or spaces are provided intermediate adjacent convolutions thereof.

Other objects and advantages of the invention will appear from the following description taken in connection with the drawings forming a part of the specification and in which:

Fig. 1 is a front elevation partly ghost view of an air cooled blade structure;

Fig. 2 is a cross-sectional view taken substantially along lines 2—2 of Fig. 1;

Fig. 3 is a cross-sectional view taken substantially along lines 3—3 of Fig. 2;

Fig. 4 is a cross-sectional view taken substantially along lines 4—4 of Fig. 2;

Fig. 5 is an enlarged fragmentary portion of the cross-sectional view Fig. 3;

Fig. 6 is a cross-sectional view of the blade structure of Fig. 1 with the air foil wire member thereon;

Figs. 7 through 9 are enlarged fragmentary elevation



view of three different forms of wire member as wound on the spike of Fig. 1;

Fig. 10 is an enlarged cross-sectional view of one shape of wire as wound on the spike;

Fig. 11 is a cross-sectional view of the wire of Fig. 10 as wound around either the leading or trailing edge of the spike of Fig. 1;

Fig. 12 is an enlarged cross-sectional view of a modified shaped wire as wound on the spike from that of Fig. 10;

Fig. 13 is a cross-sectional view of the wire of Fig. 12 as wound around either the leading or trailing edge of the spike of Fig. 1;

Fig. 14 is a cross-sectional view of a modified form of spike from that of Fig. 3; and

Fig. 15 is a fragmentary elevation view of a modified section wire as wound around one end of a blade core.

Similar reference characters indicate corresponding parts throughout the several views of the drawings.

The present structure was devised for the purpose primarily of providing a blade for turbines and the like of simple and economical construction which is effective in operation such that with the use of non-strategic materials in the fabrication thereof the performance of a given turbine can be improved. Further with the use of limited amounts of strategic material higher temperature operation of the like given turbine is possible thereby providing for still better performance thereof. In so utilizing wire formed of a non-strategic material it is possible to provide a blade structure wherein an ample and controlled amount of air or other suitable fluid can be delivered centrally through a supporting member for the wire and thence through spacing between spirally wound convolutions of the wire. The wire in being wound upon the supporting member can be easily made to follow the general desired outline of the supporting member to thus assume a specific outline such as an air foil cross-section. Through the provision of serrating or otherwise forming one side of the side which is adapted to bear upon the adjacent convolution or oppositely disposed smooth surface of the wire a controlled spacing of the wire can be maintained throughout the full length of the blade thereby assuring air passage spaces communicating directly with the external surface of the blade. Furthermore the wire in being made of stock which is not too hard can have the serrations crushed so as to restrict the opening between selected adjacent convolutions or portions thereof, and thus permit for control of the cooling thereof as to quantity and location. So that a sturdy and strong blade structure is obtained the wire is brazed or welded at spaced points internally of the blade structure to the supporting member therefor.

In addition to the serrating or otherwise forming of one side of the wire the provision of spacing between adjacent convolutions of the wire as wound on the spike can be obtained by the insertion of a pointed or otherwise suitable tool between the convolutions at selected spaced locations to provide enlarged openings at said locations or through the coating of the wire or insertion of paper between convolutions of the wire, said coating or paper to be subsequently burned out.

The controlling of air or other fluid used as a cooling medium can be further regulated through the appropriate designing of the wire supporting member such that larger passageways may be provided where it is desired to have more cooling fluid pass as compared to smaller passageways where it is desired to restrict cooling along certain portions of the blade.

The winding of a wire upon a core, such as in the case of the blade structure, lends itself to other uses wherein the distribution of air or other fluid through its surfaces is required and accordingly a plurality of structures for

varied other purposes are adaptable of construction in this manner.

Referring to the drawings for more specific details of the invention **10** represents generally a blade structure comprising basically a spike or supporting member **12** and an air foil shape spirally wound wire member **14**.

The spike or supporting member **12**, which can be formed as a casting or the like, includes a base **16** and a longitudinally extended core **18** made integral with the base. The base **16** is appropriately machined so as to provide means by which the spike can be rigidly supported in a suitable ring, housing or the like, not shown, with which the blade is to be associated. Passages **20** extend longitudinally through the base and communicates with a channel **22** formed in the upper face **24** of the base adjoining the root of core **18** of the spike, said channel constituting a plenum chamber as will hereinafter be noted.

The core **18** in addition to embodying a generally air foil cross-sectional shaped main central body **26** includes a plurality of fins or ribs **28** integral with the body and extending therefrom predetermined distances so as to define in conjunction with the body **26**, an air foil shape at their extremities upon which the inner surface of wire member **14** is to have contacting relation. Longitudinal channels **30** communicating with channel **22** are provided intermediate each pair of fins and provide passageways, for the flow of air or other fluid as supplied to the blade structure by way of base passages **20**, to the inner surfaces of the wire member.

The wire member **14** can for example, be made of keystone **32** or modified keystone **34** cross-section as illustrated by Figs. 10 and 12 respectively and of suitable size as requirements from such as S. A. E. 1010 steel wherein it is desired to employ non-strategic metals.

Fig. 7 illustrates one manner of providing controlled perimetral spacing between the convolutions wherein a wire stock **36** having one serrated side **38** is used such that the serrated side is placed in contacting relation upon the opposite side of the wire thereby providing a specific continually interrupted spiral path spacing between the convolutions of the wire member **14** so as to provide passageway communication between the exterior and interior of member **14** over the entire perimetral surface thereof. If it is further desired that the spacing be varied throughout the length of the blade from place to place the serrations may be crushed where desired to so restrict spacing at these locations.

Fig. 8 illustrates a modified form **40** of wire stock wherein as a means of spacing the convolutions of the wire member the material is gathered or compressed at **42** to provide enlarged window openings **44** between the adjacent convolutions of wire. By a predetermined sizing of the openings **44** a proper spacing as desired can be obtained for the desired and requisite cooling of the blade. These openings **44** can be made after the wire is wound upon the supporting member and at locations determined for a proper cooling of the blade.

A further illustration for spacing the convolutions of wire stock from one another is shown in Fig. 9 wherein the wire member **14** is made to achieve the desired air passage spacing of the convolutions thereof merely by the coating of the wire or by the placing of paper wound in spiral fashion with the wire whereby upon burning of the coating or paper subsequent to the winding of the wire member to the spike a permanent spiral uninterrupted spacing is had.

In providing the wire stock of slight keystone cross-section **32** when the sharp bend is made at the leading and trailing edges of the blade, the stretch in the outer fibers caused by this sharp bend causes a reduction in width at the outside surface of the wire member which provides for substantially parallel walled openings **46** at the leading and trailing edges of the blade as shown at Fig. 11 assuring of the delivery of an ample amount of air therethrough whereas at the same time because of the keystone cross-section the wire will so remain of such shape and arrangement between the leading and trailing edges as noted in Fig. 10.



The cross-sectional wire stock **34** as shown by Fig. 12 differs from the stock of Fig. 10 solely in that through the provision of a hexagonal section **48** an amount of material is provided that can be subsequently machined off to provide for finishing thereof if so required without altering the air passage characteristics of the wire stock when wound on the spike. It is conceivable that where a finish machining or grinding operation is to be performed on the wire member after being wound and affixed to the spike that an operation of this nature on the structure of Fig. 10 would result in the passages on the portions of the blade aside from the leading and trailing edges being opened up as the keystone section would prevail at these portions of the blade with a resultant venturi cross-section passageway. Therefore any machining away at the outer periphery of the wire as wound on the spike would expose a wider passageway and therefor more air which may be undesirable.

The wire member in being wound upon the core has its inner surface at spaced points in contacting relation upon the tip ends of the ribs **28** whereby through the utilization of a suitable brazing material or welding operation an effective bond is provided throughout the length of each rib with the wire member. The wire member in having each and every one of its convolutions secured at spaced points to the core **18** upon the ribs thereof provides a sturdy and strong structure capable of withstanding all conditions to which the blade is to be subjected.

With the wire member assembled upon the spike and with a suitable cover plate **50** secured at the root of the spike over the channel **22** enclosing same and with a tip cover **52** secured firmly to the tip end of the core intercommunication is had between the passages **20** in the base of the spike and the openings between the convolutions of the wire member **14** by way of channels **22** and **30**.

Through the appropriate mounting of the blade structure in a wheel for applicational use therewith and through the supply of air to passages **20** adapted to communicate with suitable air passage means in the wheel, not shown, air or other fluid can be conducted by way of channels **22** and **30** to the inner wall surface of the wire member from whence under pressure it flows through the openings in the wire member and effects an air film cooling of the outer surface of the blade.

As a further manner of regulating the flow of cooling medium to various portions of the blade in desired quantity the core of the spike can be modified as shown by Fig. 14 wherein channels **54** on one side of the core have a different cross-sectional opening than channels **56** on the opposite side thereof. By so proportioning these channel openings a desired regulated fluid flow is obtainable and an effective controlled cooling of the blade is achieved especially in conjunction with the openings between the convolutions.

Fig. 15 illustrates the utilization of a wire section **58** such that as it is extended around the corner of one edge of the blade core it has its outer fibers more greatly stretched to an extent as to provide enlarged openings at the edge of the blade and thus the permissible passage of more fluid therethrough at this location in the blade.

While this invention has been described in connection with certain specific embodiments, the principle involved is susceptible of numerous other applications that will readily occur to persons skilled in the art. The invention, therefore, is limited only as indicated by the scope of the appended claims.

What I claim is:

1. A blade comprising a supporting member, and an external surface air foil shaped spirally wound member mounted on the supporting member having a hollow centrally thereof and passage means between the convolutions of the wound member in the air foil surface thereof

interconnecting the hollow and the external surface thereof.

2. A blade according to claim 1 wherein the wound member is made from wire stock of any suitable cross-section.

3. A blade according to claim 2 wherein the wire stock has a keystone cross-section with the wider surface of the keystone disposed outwardly parallel to the longitudinal axis of the blade.

4. A blade according to claim 1 wherein the supporting member includes a base and a ribbed core integral therewith and wherein the inner disposed surface of the spirally wound member is fixedly secured upon the ends of the ribbed portion of the core.

5. A blade according to claim 4 wherein one portion of wire stock through its length is serrated and wherein the serrated portion of the stock in one convolution of the member bears upon an unserrated portion of the adjacent convolution thereby providing a multiplicity of openings throughout the wound member having communication with the hollow center thereof.

6. A blade according to claim 2 wherein the wire stock has a hexagonal cross-section.

7. A blade according to claim 6 wherein the hexagonal cross-section has a pair of parallel sides and one parallel side engages the supporting member upon which the member is wound.

8. A blade according to claim 2 wherein means on the wire stock provide for a regulated spacing of adjacent convolutions from one another.

9. A blade according to claim 8 wherein the means include projections on one surface of the wire stock.

10. A blade according to claim 4 wherein the spirally wound member is bonded to the ribbed portion of the core throughout the longitudinal length of the blade.

11. A blade according to claim 4 wherein the member is made of wire stock of substantially uniform cross-section and wherein the base has passages therein communicating with the hollow of the wound member between the ribbed portions of the core.

12. A blade according to claim 1 wherein the supporting member has a plurality of channels extending the length thereof and a plenum chamber at its root communicating with the channels.



13. A blade according to claim 12 wherein a plurality of openings are provided at spaced locations between the adjacent convolutions of the wound member.

14. A blade according to claim 12 wherein the channels are made of comparative cross-section to one another for a regulated flow of cooling medium therethrough in predetermined proportionate relation to one another.

15. A blade according to claim 14 wherein openings are provided at spaced points between convolutions of the wound member communicating with the hollow centrally thereof.

16. A structure comprising a supporting member and an external surface predetermined shaped spirally wound member mounted on the supporting member having a hollow centrally thereof and passage means throughout the surface thereof interconnecting the hollow and external surface thereof.

17. A structure according to claim 16 wherein spaced openings are provided between the convolutions of the wound member.

18. A structure according to claim 17 wherein the supporting member is a core with the inner peripheral surface of the wound member engaging portions of the supporting member and providing longitudinal chambers therewith centrally of the wound member.

**References Cited** in the file of this patent

UNITED STATES PATENTS

| | | |
|---|---|---|
| 2,149,510 | Darrieus | Mar. 7, 1939 |
| 2,189,785 | Fahrney | Feb. 13, 1940 |
| 2,315,642 | Mosser | Apr. 6, 1943 |
| 2,553,078 | Buck | May 15, 1951 |
| 2,568,726 | Franz | Sept. 25, 1951 |
| 2,613,910 | Stalker | Oct. 14, 1952 |

FOREIGN PATENTS

| | | |
|---|---|---|
| 619,634 | Great Britain | Mar. 11, 1949 |