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CONVENTION APPLICATION FOR A PATENT

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DIETER WURZ

of Haid-und-Neu-Strasse 8, 7500 Karlsruhe,
Federal Republic of Germany

hereby apply for the grant of a Patent for an invention entitled:

A FINNED TUBE ARRANGEMENT

which is described in the accompanying complete specification. This application is a
Convention application and is based on the application numbered

P 3 3 2 5 8 7 6 . 7

for a patent or similar protection made in

Federal Republic of Germany

on 18th July 1983

My address for service is Messrs. Edwd. Waters & Sons, Patent Attorneys,
50 Queen Street, Melbourne, Victoria, Australia.

DATED this 17th day of July 1984.

DIETER WURZ

L. J. Dyson

Registered Patent Attorney

To:

THE COMMISSIONER OF PATENTS.
DECLARATION IN SUPPORT OF A CONVENTION
APPLICATION FOR A PATENT OR PATENT OF ADDITION

30825/84

In support of the Convention Application made by:

DIETER WURZ

for a patent: ____________________________ for an invention entitled:____________________

A FINNED TUBE ARRANGEMENT

I X X X X

DIETER WURZ

of: ____________________________________________________________________________

Haid und Neu Strasse 8, 7500 Karlsruhe,

Federal Republic of Germany

_____________________________________________________________________________

I solemnly and sincerely declare as follows:

1. I am the applicant for the patent.

2. The basic application as defined by Section 141 of the Act was made in:

Federal Republic of Germany

on the 18th day of July 1983,

by

X X X X


3. I am the actual inventor of the invention referred to in the basic application:

X X X X


4. The basic application referred to in paragraph 2 of this Declaration was the first application made in a Convention country in respect of the invention the subject of the application.

DECLARED at Karlsruhe, Germany

this _____ day of ______ 19__

(1) Signature of Applicant or Applicants.

To: THE COMMISSIONER OF PATENTS.

and operating a direct condensation of steam through heat transfer to cooling air, the power required for operation of fans which suck the gaseous medium past the finned tubes is approximately 10 kW (this corresponds to costs of about 4 million German marks per year). For this reason it has
A FINNED TUBE ARRANGEMENT
DIETER WURZ

A finned tube arrangement for heat transfer between a first medium flowing in the finned tubes and a second medium flowing outside of the finned tubes and in a direction transversely thereof, comprising flow guide elements, characterized in that the flow guide elements are disposed in the inflow and/or outflow of the second medium toward and/or away from the finned tubes and shaped like airfoils.

direction 8 generate a regular turbulent flow in the area behind the front edge 82 including longitudinal vortices.
A FINNED TUBE ARRANGEMENT

The following statement is a full description of this invention, including the best method of performing it known to me:

1.
A finned tube arrangement

The invention relates to a finned tube arrangement for heat transfer between a first medium flowing in the finned tubes and a second medium flowing outside of the finned tubes and in a direction transversely thereof, comprising flow guide elements.

In a known finned tube arrangement of this kind, embodied by a sheet metal finned heat exchanger the flow guide elements are designed as spacer bands between the individual finned sheets and surrounding the inner tubes (DE-OS 31 6033). The known structure impairs the heat flow between the inner tubes and the sheet metal fins and does not present the optimum in flow techniques and, moreover, its manufacture and assembly are costly.

If heat is to be transferred from a liquid or gaseous condensing medium (e.g. water or steam) to another gaseous medium (e.g. air) through separating walls, the predominant part of the heat transfer resistance lies at the wall side along which the gaseous medium flows. The side facing the gaseous medium must be given the greatest possible surface area in order to improve the heat transfer. This requirement has led to the development of the well known finned tubes. These finned tubes are provided at their outer side around which the gas flows with fins which enlarge the heat transfer area quite considerably and extend transversely of the longitudinal direction of the tubes, surrounding the same annularly.

Often finned tubes are arranged in a layer or in several consecutively disposed layers or bundles. The pressure loss particularly of the gaseous medium flowing through the bundles of finned tubes is quite considerable. For instance, in a power plant generating some 1000 MW of electric power

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A finned tube arrangement for heat transfer between a first medium flowing in the finned tubes and a second medium flowing outside of the finned tubes and in a direction transversely thereof, comprising flow guide
and operating by direct condensation of steam through heat transfer to cooling air, the power required for operation of fans which suck the gaseous medium past the finned tubes is approximately 10 MW (this corresponds to costs of about 4 million German marks per year). For this reason it has long been desired to reduce the pressure loss at the outside or the side of the gas of the finned tubes.

On the other hand, however, the reduction of the pressure loss was not to cause a disproportionately great reduction of the heat transfer coefficient. This would provide poorer heat transfer so that a correspondingly greater number of relatively expensive finned tubes would have to be used.

It is an object of the invention to provide a finned tube arrangement of the kind mentioned initially with which the coefficient of pressure loss is as low as possible and the coefficient of heat transfer is as high as possible. The optimum values of the coefficients of pressure loss and heat transfer depend on the manufacturing costs of the finned tubes and on the price to be paid for the fan performance.

The object is met, in accordance with the invention, with a finned tube arrangement of the kind specified initially by flow guide elements which are disposed in the inflow and/or outflow of the second medium (gas) toward and/or away from the finned tubes and shaped like airfoils.

The expression "airfoil" is understood to include flow guide elements of symmetrical and even circular cross sections.

The flow guide elements according to the invention lower the coefficient of pressure loss without reducing the coefficient of heat transfer. This permits savings in the performance.

The finned tube arrangement as claimed in claim 7, comprising wide-apart finned tube layers, characterized in that additional flow guide elements are provided between the finned tube layers also in the planes containing the axes of the finned tubes.
An advantageous modification of the invention is characterized in that the flow guide elements include surfaces by means of which the second medium can be guided toward the inner tubes of the finned tubes.

It is favourable under aspects of the manufacturing technique to have the flow guide elements consist of sectional elements or profiles, particularly made of plastics and extending in longitudinal direction of the finned tubes. With present day manufacturing methods such flow guide elements can be produced inexpensively by extrusion.

It is advantageous to have the flow guide elements disposed in planes which are offset with respect to the main flow planes of the finned tubes. In this manner the inflowing medium (gas) is directed toward the inner tubes of the finned tubes. This is true particularly if the flow guide elements have tapering portions each fitting snugly into the constriction between two adjacent finned tubes. This modification of the invention is favorable also from the point of view of the manufacturing technique because, at the same time, the flow guide elements can be secured or connected in simple manner to the peripheries of the fins.

If flow guide elements or parts thereof disposed at the outflow side of the finned tubes are designed to form diffusor or diffusion channels in accordance with another advantageous modification of the invention, speed energy may be recovered at the outflow side so that further savings of fan performance are obtained.

The invention is applicable with particular advantage in finned tube arrangements in a pack comprising a plurality of layers of finned tubes which are offset with respect to one another. In this case additional flow guide elements are disposed between the individual layers of finned tubes in planes which are offset with respect to the main inflow planes of the finned tubes in the outer layers of the pack.

One specific embodiment of flow guide elements disposed in
the inflow, in accordance with the invention, is characterized in that these flow guide elements are thickened in the direction of flow from their leading edge to a place of maximum thickness behind their middle and subsequently have an end which is concavely curved at both sides in adaptation to the construction between the fins of adjacent finned tubes.

One specific embodiment of flow guide elements disposed in the outflow is characterized in that these flow guide elements have a place of maximum thickness upstream of their middle and subsequently have a V-shaped tapering portion along the major part of their length.

It is advantageous particularly with single layer finned tube arrangements including oval tubes to have the flow guide elements at the inflow side formed integral with those at the outflow side, in accordance with a corresponding further development of the invention each flow guide element thus has an inlet portion located in the inflow, an outlet portion located in the outflow, and a tapering portion in between.

A contribution to reducing the pressure loss coefficient is obtained also if the inner tubes themselves have an outline which is designed to provide favorable flow.

A flow and heat transfer boundary layer of increasing thickness in the direction of flow is formed along the fins. This boundary layer impairs the coefficient of heat transfer in the direction of flow. To reduce this effect, another modification of the invention provides for flow guide elements to be located at the front edges of the fins so as to generate a regular turbulent flow.

The longitudinal vortices of the regular turbulent flow transport cool air to the fins, whereas the warmer air
collects in the eye of the vortex.

The flow guide elements are formed advantageously of triangular lugs cut out of the front edges of the fins and bent into the flow. The arrangement of this latter type of flow guide elements at the front edges of the fins is advantageous in that the flow velocities at that location still are relatively slow because there is not yet a strong displacing effect of the inner tubes in this area. The longitudinal vortices released at the front edge of the fins increase in circumferential speed during the acceleration of the cooling air because of the displacing effect of the inner tube. All this contributes to increasing the heat transfer coefficient.

The inventor recognized and verified by calculations that only a rather small proportion of the pressure loss at the side of the gas is caused by the wall shear stress of the boundary layers of the flow (frictional resistance). Consequently considerable proportions of the pressure loss should result from inhomogeneous distributions of velocities and subsequent turbulences.

The flow guide surfaces formed at the flow guide elements reduce these inhomogeneous phenomena of the fields of flow. Forming diffusion channels at the outflow sides of the flow guide elements permits recovery of a considerable portion of the dynamic pressure of the gas flow. It should be possible to reduce the overall pressure loss to approximately 40% by the measures of the invention without getting a poorer heat transfer coefficient. On the contrary, it must be expected that the coefficient of heat transfer is raised because the invention provides for improved flow around the inner tubes.

The invention will be described further, by way of example, with reference to the accompanying drawings, in which:
Fig. 1 is a cross section through a perspective presentation of a finned tube arrangement according to the invention;

Fig. 2 is a cross section like Fig. 1 through a finned tube arrangement without any flow guide elements for purposes of comparison;

Fig. 3 is a section through a finned tube arrangement in a pack including closely spaced finned tube layers and flow guide elements according to the invention;

Fig. 4 is a sectional presentation of a finned tube arrangement in a pack including widely spaced finned tube layers and flow guide elements according to the invention;

Fig. 5 shows a finned tube arrangement in a pack, including two layers of finned tubes disposed in the same planes and flow guide bodies according to the invention;

Fig. 6 shows a finned tube arrangement according to the invention including oval tubes and continuous flow guide elements according to the invention;

Fig. 7 shows a finned tube arrangement including finned tubes of favorable flow design and flow guide elements according to the invention;

Fig. 8 is a sectional presentation of a finned tube arrangement according to the invention with which flow guide elements each are provided at the front edge of the fins; and

Fig. 9 is a part side elevational view of the finned tube arrangement shown in Fig. 8.

The finned tube arrangement shown in fig. 1 comprises finned tubes 2 including inner tubes 4 in which a first medium flows, such as water to be cooled. Fins 6 of annular disc shape are arranged at uniform spacings along the axis of the inner tubes 4. In the embodiments shown the fins 6 lie in radial planes with respect to the inner tube 4. Instead of the fins 6 one continuous fin may be wound like a
spiral around the inner tubes 4.

A second radius, such as air passing to cool the first radius flowing in the inner tubes 4 passes in cross current transversely of the single layer finned tube arrangement 5 according to fig. 1, as indicated by the direction of the arrows 5. Flow guide elements 10, 12 are disposed in planes 14 upstream and downstream in the inflow direction of the single layer finned tube arrangement shown in fig. 1. The planes 14 are offset parallel to the main inflow planes 16 so that they just divide in half the distance between two adjacent main inflow planes and core to lie in the gap between two adjacent finned tubes 2. The flow guide elements 10 disposed in the inflow of the air are thickened in the direction of flow from their rounded leading end 16 to a place 20 of maximum thickness behind their middle. Subsequently they terminate in a trailing end 22 which is concavely carved at both sides in adaptation to the peripheries of the fins 6 of adjacent finned tubes. Because of this design the trailing end 22 fits snugly into the gap between adjacent finned tubes 2 where it can be anchored easily by known bonding methods, such as cementing, welding, screwing or the like. If the flow guide elements 10 are made of extruded plastic sectional elements, a circumstance which may be favorable for manufacturing reasons, and if the finned tubes 2 are made of metal, a hook or snap connection is convenient with which elastic parts of the flow guide elements are pushed resiliently on the finned tubes and held by clamping. The flow guide elements 12 disposed in the outflow have a leading end 24 which is designed symmetrically with respect to the trailing end 22 of the flow guide elements 10. The leading end 24 thus fits snugly from the other side of the finned tube arrangement into the gap formed between adjacent finned tubes 2. The place of maximum thickness 26 of these flow guide elements 12 is at the same distance from the leading end as the place of maximum thickness 20 of the flow guide elements 10 at the
trailing end. From this place 16 of maximum thickness the flow guide elements 12 taper almost rectilinearly throughout a rather long stretch 25 up to the trailing rounded end 30. The long stretch 26 is reinforced by two cross walls 32, 34 placed inside the flow guide elements 12.

Therefore, as seen in the direction of flow 6, adjacent flow guide elements 12 open outwardly so as to form a diffusion channel 36 between two flow guide elements. Contrary to that, adjacent flow guide elements 10 at the outer flow side form nozzle channels 36 which are constricted toward the places 26 of maximum thickness. With the central finned tube 2 of the arrangement according to fig. 1 flow paths 40 are shown in the upper half to represent the course of the flow of air as guided by the flow guide elements 10, 12. Reference numerals I, II, III, IV indicate four reference planes which extend transversely of the main flow direction. In reference plane I the air flow still is practically undisturbed. In reference plane II the flow experiences its greatest constriction prior to entering between the individual fins 6 of the finned tubes 2. In other words, reference plane II contains the places 16 of maximum thickness of the flow guide elements. Thereafter the flow divides to pass around the inner tubes 4, the flow guide elements 10 taking care that the flow between the fins 6 is guided close to the inner tubes 4.

In plane III which contains the places 26 of maximum thickness of the flow guide elements 12 the flows are again united. Here the velocity profile 44 of the flow is shown in plane III between two flow guide elements 12. The profile discloses no pronounced excessive velocities, i.e. the difference between the velocity maximum and minimum is rather small. Plane III is followed by the diffusion channel 36 in which the flow is delayed until plane IV is reached so that a considerable proportion of kinetic energy
is recovered in the form of pressure energy.

For comparison fig 2 shows a conventional finned tube arrangement similar to that of fig 1, but without any flow guide elements. The flow paths designated 41 in this case are more narrowed than in fig. 1 at the inflow side and in the direction toward the gap plane 14 between two adjacent finned tubes 2. In other words, the air flow is not guided close to the inner tubes 4 of the finned tubes 2, as is the case in fig. 1. The resulting velocity profile 45 is shown in the drawing in a reference plane in the outlet. This velocity profile has its maximum in the planes 14 each and has a negative minimum in the main inflow planes 16 of the finned tubes 2. This means that a dead water area in which air flows back is formed in the range of the inner tubes at the outflow side. This causes loss. It should also be noted that the maximum of the flow velocity at the outflow side is much higher than in the case of the velocity profile 44 according to fig. 1. With such a velocity profile even the downstream provision of diffusion members permits recovery of rather a small proportion only of pressure energy.

Since the air flow is directed toward the inner tubes 4 in the case of fig 1, the coefficient of heat transfer is increased as compared to fig. 2 where the major portion of the gas flow is passed at a greater distance from the inner tubes, i.e. along the colder outer areas of the fins.

In the simplest case the flow guide elements 10 or 12 may be embodied by round cylindrical tubes. Of course, the embodiment shown of slender sectional elements is more favourable under aspects of the flow technique, i.e. the pressure losses of the flow can be kept smaller.

In actual embodiments the angle of opening of the diffusion channel 36 advantageously should be in a range of from 4° to 10°.
Fig. 3 shows a finned tube arrangement including a pack of three finned tube layers A, B, C arranged offset with respect to one another. The finned tubes 2 of this arrangement are designed as shown in fig. 1 so that they are not described again. The layers of finned tubes are disposed offset with respect to each other in a tight pack, i.e. with the fins 6 of the individual finned tubes having circumferential contact. Also the flow guide elements 10, 12 are designed as shown in fig. 1. In accordance with fig. 1 these flow guide elements are disposed in planes 14 which are offset with respect to the main inflow planes 16 as regards the finned tube layers A and C. In this case the main inflow planes or the planes containing the axes of the finned tubes 2 of intermediate layer 4 coincide with the planes 14.

As the flow guide elements 10, 12 are designed exactly as shown and described with reference to fig. 1, they are not described again. In the upper part of fig. 3 a circular tube shaped flow guide element 48 each is disposed in front of and behind the intermediate layer. This flow guide element is to contribute to a useful flow around the inner tubes 4 of the finned tubes 2 in the intermediate layers B and C. As an alternative these additional flow guide elements 48 may be dispensed with, as shown in the lower half of fig. 3. The flow paths designated 47 in this case extend as shown in fig. 1 in the inflow area between reference planes I and II and in the outflow area between reference planes III and IV. In principle also the same velocity profile 44 of the flow as shown in fig. 1 is formed in reference plane III. When applying the flow guide elements 10, 12 in a tight pack finned tube arrangement as shown in fig. 3, therefore, practically the same effects are obtained as described with reference to fig. 1, at least as regards the first and the last layer.

Fig. 4 shows a finned tube arrangement which has finned
tube layers A, B, C disposed spaced apart and also com-
prises flow guide elements 10 and 12 in accordance with
fig. 1 in the inflow and outflow ranges. In this respect
it is unnecessary to repeat the description. However, in
this case streamlined flow guide elements 50 are disposed
also between individual finned tube layers. These flow
guide elements 50 which likewise extend throughout the
length of the tubes are designed at one end 52 similar to
the trailing end 22 of the flow guide elements 10. Thus
they also fit snugly into the gap formed between two adja-
cent finned tubes 2 where they may be fixed. At their other
end 54 the flow guide elements 50 terminate in a drop-shap-
ed cross section. For simplicity the same flow guide ele-
ments 50 are used which, however, are rotated through 180°
when provided at the inflow side as compared to the flow
guide elements 50 disposed at the outflow side. Thus the
end 54 faces the inflow direction and the end 52 which is
designed to fit into the gap formed between two finned tu-
bes 2 is orientated in outflow direction. The flow guide
elements 50 provide a favorable flow guidance of the gas
stream between layers A and C.

Fig. 5 shows a finned tube arrangement comprising only two
finned tube layers in which the finned tubes 2 of the indi-
vidual layers are disposed in the same inflow planes 16
and their fin peripheries are spaced apart by a distance a.
In the area of plane 14 in which flow guide elements 10
and 12 are disposed at the inflow and outflow sides, re-
spectively, as in figs. 1, 3, and 4, additional flow guide
elements 60 are provided which are designed symmetrically
as seen in the direction of flow, i.e. they have ends 62
which fit snugly into the corresponding gaps between two
finned tubes 2 each at the inflow and outflow sides. The
resulting cross sectional shape of these flow guide ele-
ments 60 is similar to a lemon. The flow guide elements 60
provide a favorable streaming distribution of the flow
between the two finned tube layers and good flow toward the
inner tubes 4 at the downstream finned tube layer. It should also be mentioned that the flow guide elements 60 may be connected to the fins 6 in the same manner as flow guide elements 10, 12.

5 Fig. 6 shows a single layer arrangement of finned tubes 2' having oval inner tubes 4' and angular fin plates 6' which may be made in one piece for the entire layer. Unitary flow guide elements 70 are provided in the planes 14 at the same spacing from the main inflow planes 16 of the inner tubes 4' and parallel to the same. These flow guide elements have an inlet portion 72, a tapering portion 74 of an outline adapted to the oval inner tubes 4', and an outlet portion 76 which tapers at both sides like the flow guide elements 12 so as to define diffusion channels 36.

75 It is obvious that also in this case the gas (air) flowing in in the direction of arrow 8 is guided in favorable flow close to the oval inner tubes 4' and is passed away from the finned tube arrangement at the outflow side, while permitting pressure recovery.

20 The embodiment shown in fig. 7 differs from the one according to fig. 6 only in that the inner tubes 4'' have a favorable flow outline so as to reduce the losses still further as compared to the embodiment shown in fig. 6.

The tapering intermediate portion 74, of course, in this case is adapted to the outline of the inner tubes 4''.

Figs. 8 and 9 show a modified embodiment. The oval inner tubes 4' of a tube arrangement are furnished with rectangular fins 80 which extend transversely of the longitudinal axis of the inner tube, as was the case with the other embodiments described. Triangular lugs are cut out of the front edge 82 and bent at an angle so as to form flow guide elements 84. These flow guide elements 84 facing the inflow
direction 8 generate a regular turbulent flow in the area behind the front edge 82 including longitudinal vortices in the center of which warmer air collects in accordance with the law of cyclones, while the colder air circulates in the outer ranges of the turbulences produced. When passing between the fins 80 the circumferential speed of the longitudinal vortices increases, while the air is accelerated because of the displacing effect of the inner tubes 4'. In this manner again cool air is brought into contact with the inner tubes 4' and the fins to provide improved cooling. Hereby the coefficient of heat transfer is increased.

Fig. 9 is a front elevational view of the arrangement according to fig. 1 showing two fins 80 side by side. It may be seen that with each fin 80 the flow guide elements 84 are bent alternatingly toward opposed sides of each edge 82, as described, so that the flow guide elements 84 protruding from the one fin 80 into the channel 86 defined between two fins 80 are offset with respect to the flow guide elements 84 which protrude into the same gap 86 from the other fin 80. The longitudinal vortices released from both sides of the flow guide elements rotate in opposite directions, as indicated in the presentation of fig. 9. Application of the flow guide elements 84 described with reference to figs. 8 and 9 provides a marked increase of the coefficient of heat transfer as compared to the former solutions (cf. fig. 2).

The flow guide elements 84 as shown in figs. 8 and 9 may be provided in addition in the embodiments according to figs. 1 to 7 so as to obtain an advantageous combination of the effects described.
THE CLAIMS

1. A first medium for directic elements are disp medium to like air

2. Character surfaces toward the

3. Or 2, ch embodied plastic finned

4. Claims are disp main in

5. Character portion two adj

6. Claims dispose designe

7. Plural respect character behind in plan of the
THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A finned tube arrangement for heat transfer between a first medium flowing in the finned tubes and a second medium flowing outside of the finned tubes and in a direction transversely thereof, comprising flow guide elements, characterized in that the flow guide elements are disposed in the inflow and/or outflow of the second medium toward and/or away from the finned tubes and shaped like airfoils.

2. The finned tube arrangement as claimed in claim 1, characterized in that the flow guide elements include surfaces by means of which the second medium can be guided toward the inner tubes of the finned tubes.

3. The finned tube arrangement as claimed in claim 1 or 2, characterized in that the flow guide elements are embodied by sectional elements, particularly made of plastics and extending in the longitudinal direction of the finned tubes.

4. The finned tube arrangement as claimed in one of claims 1 to 3, characterized in that the flow guide elements are disposed in planes which are offset with respect to the main inflow planes of the finned tubes.

5. The finned tube arrangement as claimed in claim 4, characterized in that the flow guide elements have tapering portions each fitting snugly into the constriction between two adjacent finned tubes.

6. The finned tube arrangement as claimed in one of claims 2 to 5, characterized in that flow guide elements disposed at the outflow side of the finned tubes are designed to form diffusion channels.

7. A finned tube arrangement in a pack comprising a plurality of finned tube layers which are offset with respect to one another, as claimed in one of claims 1 to 6, characterized in that flow guide elements are disposed behind and between the individual layers of finned tubes in planes which are offset with respect to the main planes of the finned tubes in the outer layers of the pack.
8. The finned tube arrangement as claimed in claim 7, comprising wide-apart finned tube layers, characterized in that additional flow guide elements are provided between the finned tube layers also in the planes containing the axes of the finned tubes.

9. The finned tube arrangement as claimed in one of claims 2 to 8, characterized in that flow guide elements disposed in the inflow are thickened in the direction of flow from their leading edge to a place of maximum thickness and subsequently have an end which is concavely curved at both sides in adaptation to the constriction between the fins of adjacent finned tubes.

10. The finned tube arrangement as claimed in one of claims 1 to 9, characterized in that flow guide elements disposed in the outflow have a place of maximum thickness upstream of their middle and subsequently have a V-shaped tapering portion along the major part of their length.

11. The finned tube arrangement as claimed in one of claims 1 to 4 or 6, characterized in that each flow guide element comprises an inlet portion located in the inflow, an outlet portion located in the outflow, and a tapering portion in between.

12. The finned tube arrangement as claimed in one of claims 1 to 11, characterized in that the inner tubes themselves have an outline which is designed to provide favorable flow.

13. The finned tube arrangement as claimed in one of claims 1 to 12, characterized in that flow guide elements are provided at the front edges of the fins to generate a regular turbulent flow.

14. The finned tube arrangement as claimed in claim 13, characterized in that the flow guide elements are formed by triangular lugs cut out of the front edges of the fins and bent into the flow.

DATED this 17th day of July 1984.

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