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YOSHIZO OKAMOTO ET AL

3,295,599

HEAT TRANSFER FIN HEAT EXCHANGING TUBE

Filed April 5, 1963

Fig. 1.

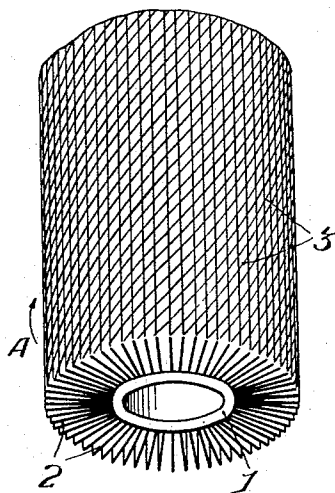


Fig. 3.

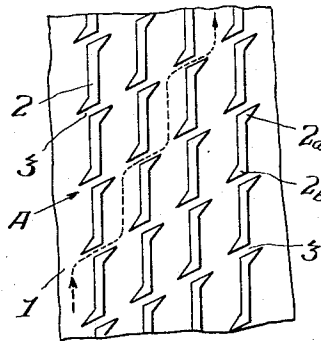


Fig. 2.

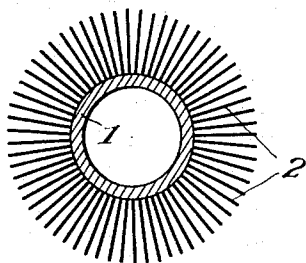


Fig. 5.

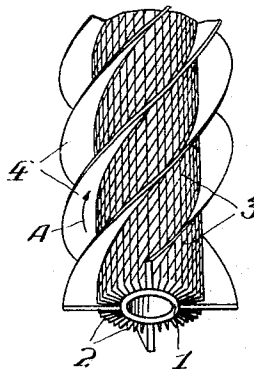
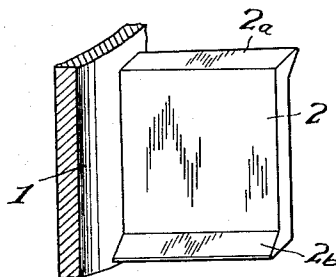
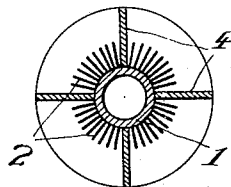


Fig. 4.

Fig. 6.



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HEAT TRANSFER FIN HEAT
EXCHANGING TUBE

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1 Claim. (Cl. 165—184)

The present invention relates to improvements in the
heat dissipating fins of heat exchanging tubes, as for in-
stance, a fin in a cladding tube enclosing a fuel element of
a nuclear reactor, where a number of longitudinal fins are
usually provided.

Generally, longitudinal fins providing heat transfer sur-
faces are, as compared with other kinds of fins, more ad-
vantageous than any other kinds of fins by reason of the
fact that they can furnish a high heat transfer rate without
increasing pressure loss and that they have a much great-
er operative heat transfer area in the cooling passage. As
a consequence, the pressure loss thereby incurred is five or
six times as large as that of the heat transfer surface of a
cylindrical tube, whereas heat transfer rate may be in-
creased up to ten to fifteen times that in the same tube.
However, longitudinal fins have other disadvantages. If
the number of fins is increased in order to obtain a high
efficiency of heat transmission, it follows that the space
between adjacent fins will become narrow and therefore
the flow is turbulent between the closely spaced fins. This
will cause lowering of flow velocity to one third of the out-
side flow, and the effective heat transfer coefficient will be
reduced accordingly as, for instance, when the number of
fins is of the order of several scores, the heat transfer area
becomes thirty times as large as the original tube, but the
effective heat transfer rate will remain at an approximate
value of seven to ten times as large. Also, under high
temperature, non-uniformity of temperature on the sur-
face of fins often gives rise to be repeated stress, thermal
deformation, bending, and excessive local heating of fins,
which may limit the possibility of good design for the heat
transfer surface of a fin.

The present invention is such that a number of helical
grooves are defined between the adjacent ends of axially
aligned radially extending fin elements formed on the ex-
ternal surface of a cylindrical tube, thus to improve the
heat transfer characteristics of fins by diagonally extend-
ing turned-over projections formed during the cutting of
the diagonal or helical grooves in the longitudinal fins to
form the fin elements.

The present invention will be described, by way of ex-
ample, with reference to the accompanying drawing, in
which:

FIGURE 1 is a perspective view of a part of a cooling
tube having heat transmission fins.

FIGURE 2 is a transverse section of FIGURE 1.

FIGURE 3 is an enlarged fragmentary front view show-

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ing the arrangement of fin elements on the tube of present
invention.

FIGURE 4 represents a fragmentary perspective view
showing a single fin element.

FIGURE 5 is a perspective view of a modified heat ex-
changer having helical guide strips extending radially out-
wardly of the fin elements.

FIGURE 6 is a transverse section of FIG. 5.

The embodiment shown in the drawing is explained in
more detail. In FIGURES 1 and 2, 1 is a tube having a
heating source inside as, for instance, a nuclear fuel ele-
ment (not shown). On the outer surface of the tube,
there are provided integrally formed fin elements 2 aligned
axially of the tube. However, between the confronting
ends of adjacent fin elements 2, there are a series of diago-
nally cut grooves 3 defining parallel interrupted helical
slots 4 extending circumferentially around the tube 1.
This is best shown in FIGURE 3, where a number of
interrupted helical slots, extending as indicated by the
arrow A, are defined by the grooves 3. Due to a turning
over of the metal during the cutting of the diagonal
grooves 3, there are produced convergent laterally project-
ing edges 2a, 2b on both ends of each fin element 2.
(Refer to FIGURE 4.) Coolant gas therefore flows be-
tween laterally adjacent longitudinal rows of fin elements
2 and then runs through the diagonal grooves 3, being de-
flected by the convergent projecting edge portions 2b, 2a
of each lower and upper end. For example, the coolant
gas flows along dotted lines in FIGURE 3. Therefore,
each fin element 2 will have much larger effective heat-
transfer area than that of conventional continuous longi-
tudinal fins.

FIGURES 5 and 6 show a modified embodiment where
the fin elements 2 are combined with several helical guide
members 4 for guiding the coolant gas. The guide mem-
bers are positioned in the helical slots defined by diagonal
grooves 3 between longitudinally adjacent fin elements 2,
the cooling effect of each fin element 2 between guide
members 4 being the same as FIGS. 1 to 4.

While we have shown and described what we believe
to be the best embodiments of our invention, it will be
apparent to those skilled in the art that various changes
and modifications may be made therein without departing
from the spirit and scope of the invention as defined in
the appended claim.

What we claim is:

A heat exchanger comprising: an elongated tube; a
series of spaced fin elements formed on the external sur-
face of said tube, each of said fin elements extending
radially outwardly from said external surface and being
elongated axially of said tube, said fin elements being
aligned in regularly circumferentially spaced axially ex-
tending rows, the ends of adjacent fin elements in each
row being spaced to define a groove therebetween the bot-
tom of which extends along said external surface diago-
nally with reference to the axis of said tube, said grooves
in each row being staggered with respect to the grooves in
both adjacent rows to define regularly axially spaced series
of interrupted helical slots extending circumferentially
completely around said tube, each of said fin elements

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having a convergent laterally projecting edge portion formed at each end thereof, said edge portions projecting in one direction at one end of every fin element and on the opposite direction at the opposite end of every fin element, said edge portions extending in opposite directions at opposite sides of each helical slot, whereby cooling fluid flowing longitudinally of said tube in either direction is deflected laterally through said helical slots.

References Cited by the Examiner

UNITED STATES PATENTS

2,267,027 12/1941 Hardgrove ----- 165—184
2,553,142 5/1951 McCreary ----- 29—157.3

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2,613,066 10/1952 Newlin ----- 165—184
2,667,337 1/1954 Chapman ----- 165—184
2,690,060 9/1954 Legatski ----- 165—181 X
2,976,128 3/1961 Latham ----- 165—184 X
2,984,611 5/1961 Fairhurst ----- 165—183
3,100,930 8/1963 Nihlen et al. ----- 29—157.3

FOREIGN PATENTS

540,374 8/1955 Belgium.
820,772 9/1959 Great Britain.

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