June 24, 1941. R. W. KRITZER 2,247,243

HEAT EXCHANGE ELEMENT AND METHOD OF MAKING THE SAME

Filed July 11, 1938

Fig. 1

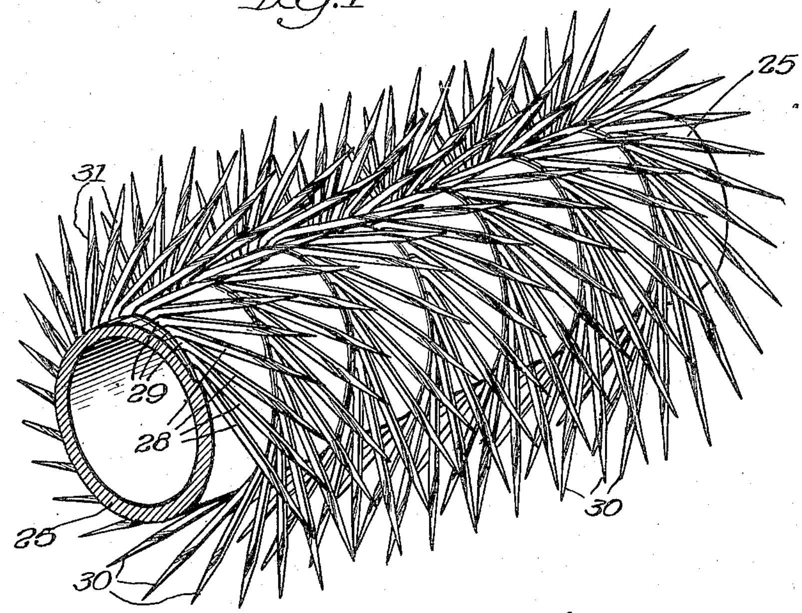


Fig. 2

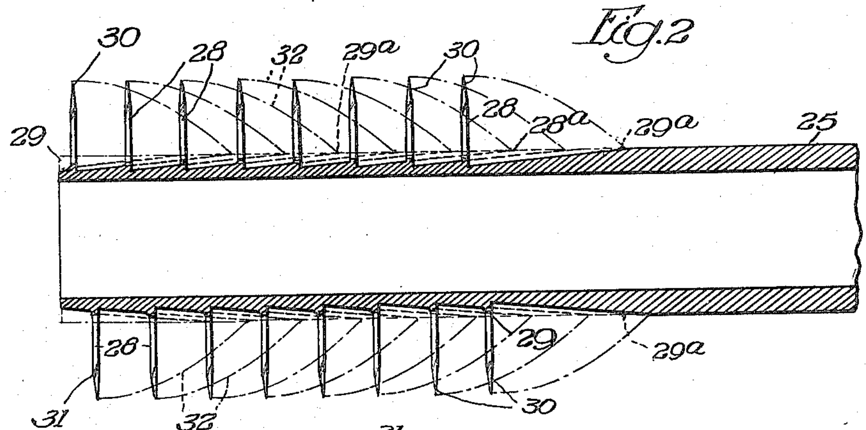
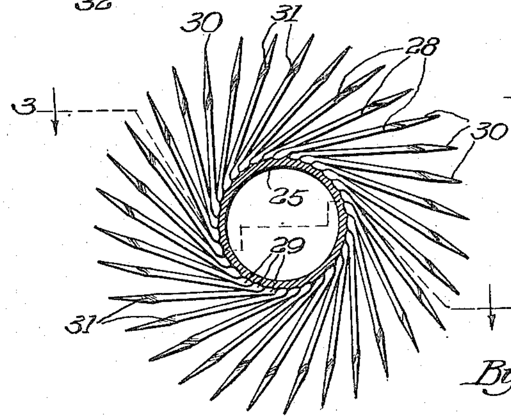


Fig. 3



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UNITED STATES PATENT OFFICE

2,247,243

HEAT EXCHANGE ELEMENT AND METHOD OF MAKING THE SAME

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Application July 11, 1938, Serial No. 218,585

25 Claims. (Cl. 29—157.3)

The invention relates to heat exchange elements for use in refrigeration, heating, cooling or similar purposes.

One object of the invention is to provide a heat exchange element or member which comprises an imperforate wall, for conducting or separating different fluids, or a like fluid of different temperatures, and which is usually formed of thermally conductive metal or stock, with a multiplicity of slivers, spines or filamentary conductors which are integral with the wall at their roots, cut or gouged out of the stock in one face of the wall and have their tips or free ends bent to project away from the wall. An element so constructed provides a multiplicity of conductors integral with the wall and comparatively small in cross-section with a high ratio of exposed surface to the mass in the spines or slivers, for maximum thermal transfer efficiency from the wall.

Another object of the invention is to provide a heat exchange element which is provided with a multiplicity of slivers or spines cut or gouged out of the stock in one face of the wall and in which substantially all of the stock in one face of the wall or tube is cut and bent into slivers for maximum thermal transfer efficiency.

Another object of the invention is to provide a method of making heat exchange elements comprising a wall and a multiplicity of slivers or spines, economically.

Other objects of the invention will appear from the detailed description.

The invention consists in the several novel features which are hereinafter set forth and are more particularly defined by claims at the conclusion hereof.

In the drawing:

Fig. 1 is a perspective of a section of a tube or pipe embodying the invention.

Fig. 2 is a longitudinal section of a tube illustrating the manner of cutting slivers from the stock in its outer periphery which are bent to form outwardly projecting spines for thermal conduction.

Fig. 3 is a section taken on line 3—3 of Fig. 2.

The element is produced from a tube or pipe 25 which is normally provided with a wall-thickness sufficient to provide stock for the multiplicity of slivers or spines to be cut from its outer periphery and to leave an imperforate tubular portion of reduced, but sufficient, wall-thickness for confining within the tube the fluid for which it is to be used.

In making the element, slivers of metal are cut out of the stock in the outer portion of the wall of the pipe, leaving sufficient thickness in the wall so it will function to confine a fluid in the pipe or tube. Each sliver is cut longitudinally of the tube of sufficient length to form a spine 28 of desired length, its root 29 being left integral with the portion of the wall of reduced thickness. After being thus cut each spine is bent transversely from its root so the remainder of the spine will extend a sufficient distance from said surface for efficient heat conduction or radiation. These slivers are cut in close helical succession with the annular series of spines spaced longitudinally as close together as desirable so that substantially all of the stock in the outer portion of the wall of the tube will be cut into spines to provide the desired multiplicity of conductors or radiators for maximum heat transfer efficiency.

The cut for each sliver is made at a slight angle transversely of the thickness of the wall of the tube, so it increases in depth from its point to its root, as illustrated in Fig. 2, which illustrates spines formed on a portion of the tube and the remaining portion before the slivers have been cut therefrom. The base line of each cut slopes from the outer surface of the stock, as at 29a, where it forms a sharp point 30 on the sliver, deeper into the stock to the root 29 of the sliver, as illustrated in Fig. 2. The longitudinal spacing between successive annular rows of slivers is less than the length of the slivers. These sloping cuts leave sufficient stock beneath the outer portion of one sliver for one or more partially overlapping cuts for forming a portion of one or more of the succeeding annular rows of spines, as illustrated in Fig. 2. After each spine is cut it is bent to extend transversely from the wall of the tube, in the direction indicated by dotted lines 32 in Fig. 2. This manner of fabricating makes it possible to produce a great multiplicity of spines and to utilize all of the outer zone of stock in the formation of spines for highly efficient heat transfer.

The slivers have a small cross-sectional area to provide a high ratio of exposed surface to the mass therein and are preferably reduced in thickness toward their tips so that the roots will have the maximum and the tips the minimum heat transfer value. The spines are roughly cut from the stock in the wall of the pipe and with rough edges left by the cutting tool to provide a high ratio of edges on the spines to the mass in the spines. This cutting also leaves the outer periphery of the wall of the tube rough for promoting heat dissipation. The outer portion of each spine may be slightly twisted, as at **31**, while it is being bent and after it has been cut. The spines are filamentary in character requiring only sufficient cross-sectional area to be self-suporting.

For example, a copper pipe of ½″ internal diameter may be provided with spines approximately ¾″ in length and $\frac{1}{64}$″ in thickness with their roots in close helical succession and the longitudinal spacing between the annular rows of spines may be such that a great multiplicity of spines will be provided for highly efficient heat transfer.

The spines may be provided on a straight wall as well as a tubular wall and the number and length of the spines may be varied within a wide range according to the different purposes for which the element is used.

The invention exemplifies a heat transfer element having a wall with integral conductors which have a high ratio of exposed surface and edges to the mass therein. It also exemplifies a heat transfer element with a multiplicity of integral spines formed of metal cut out of one face of the wall. These attributes have been found, in practice, to provide a very high degree of efficiency in thermal transfer. The invention also exemplifies an economical method of producing a heat transfer element with a multiplicity of spines integral with, and cut out and bent away from, the wall.

This element has been found to possess a greater transfer efficiency than tubing with walls provided with non-integral fins or similar elements and can be produced at a low cost. It has a greater efficiency in heat transfer than conductors cast integrally with a wall because of the impossibility of casting them in sufficiently large numbers or small cross-sectional area to provide the necessary high ratio of exposed surface to the mass therein for most efficient heat transfer.

This application is a continuation in part of the co-pending application filed by me November 1, 1937, Serial No. 172,176, for Heat exchange member.

The invention is not to be understood as restricted to the details set forth, since these may be modified within the scope of the appended claims, without departing from the spirit and scope of the invention.

Having thus described the invention, what I claim as new and desire to secure by Letters Patent is:

1. A heat transfer element comprising a wall and spines integral therewith, consisting of rows of slivers of stock cut out of the face of the wall and having their outer portions bent to project from the wall and spread apart, the slivers in the rows having contiguous roots and longitudinally extending edges from the said face of the wall to their outer ends.

2. A heat transfer element comprising a wall having substantially all of the stock in one of its faces cut into spines and bent away from the remaining stock, and substantially all of the wall between the spines of thickness reduced by the cutting away of the spines.

3. A heat transfer element comprising a wall having substantially all of the stock in one of its faces cut into spines and bent away from the remaining stock, and substantially all of the wall between the spines of thickness reduced by the cutting away of the spines, the spines being of greater length than the spaces between the roots of the spines.

4. A heat transfer element comprising a tubular wall having substantially all of the stock in one of its peripheries cut into spines and bent away from the remaining stock, and substantially all of the wall between the spines of thickness reduced by the cutting away of the spines.

5. A heat transfer element comprising a wall and spines integral therewith consisting of rows of slivers of stock cut out of the face of the wall and having their outer portions bent to project from the wall, the slivers being formed in rows, the roots of the slivers in a row being contiguous, the spines being of greater length than the spaces between the rows.

6. A tubular heat transfer element comprising a tubular wall and spines integral therewith consisting of rows of slivers of stock cut out of the face of the wall and having their outer portions bent to project from the wall, the slivers being formed in rows, the roots of the slivers in a row being contiguous, the spines being of greater length than the spaces between the rows.

7. A tubular heat transfer element comprising a tubular wall and spines integral therewith consisting of slivers of stock cut out of the face of the wall and having their outer portions bent to project from the wall, the slivers being arranged in helical succession around the periphery of the wall, the roots of the slivers being transversely contiguous, the spines having lengths at least three times their thickness.

8. A tubular heat transfer element comprising a tubular wall and spines integral therewith consisting of slivers of stock cut out of the face of the wall and having their outer portions bent to project from the wall, the slivers being arranged in helical succession around the periphery of the wall, the roots of the slivers being transversely contiguous and spaced apart longitudinally, the spines being of greater length than the longitudinal spacing and at least three times their thickness.

9. That improvement in making tubular heat transfer elements which comprises cutting from a tubular wall, a substantially contiguous row of spines having all of their longitudinal edges extending from the wall, leaving the roots of the spines integrally attached to the remainder of the wall and bending their free ends away from, and to project beyond, the periphery of the wall.

10. That improvement in making heat transfer elements which comprises cutting a multiplicity of slivers in a row from one face of the wall, leaving one end of the slivers integrally attached to the remainder of the wall, the cuts being made so the roots of the slivers in a row will be contiguous and bending their outer ends away from, and to project beyond, the face of the wall.

11. That improvement in making tubular heat transfer elements which comprises cutting substantially all of the stock in a periphery of the wall into spines having tapered ends, leaving the roots of the spines integrally attached to the remainder of the wall and bending their free ends away from and to project beyond the face of the wall.

12. That improvement in making tubular heat transfer elements which comprises cutting substantially all the stock from one periphery of a wall into a multiplicity of slivers, bending the free ends of the slivers away from and to project beyond the face of the wall and leaving one end of the slivers integrally attached to the remainder

of the wall, the cutting away of the slivers producing a reduction in wall-thickness in substantially the entire area of the tubular portion between the slivers.

13. That improvement in making heat transfer elements which comprises cutting in helical succession a multiplicity of slivers longitudinally in a helical row from the stock in one face of a tubular wall, leaving one end of the slivers integrally attached to the wall, the spines being of greater length than the longitudinal spacing between the slivers, and bending their free ends away from, and to project beyond, the face of the wall.

14. The method of making a tubular heat transfer element including rows of spines extending circumferentially around the tube, the rows being spaced longitudinally of the tube and in which each spine comprises a long thin upstanding portion having its base integral with the tube surface, said method comprising starting along the axis of tube a distance from the base of the first spine to be formed equal to the length thereof and which is a multiple of the spacing between the rows, making a thin narrow cut of gradually increasing depth axially of the tube to the base of said first spine to be formed to cut a sliver, and bending said sliver outwardly to form said first spine, repeating this operation circumferentially around the tube to produce a first row of spines circumferentially around the tube, the cuts being contiguous thereby providing contiguous spine roots, then starting along the axis of the tube and in axial alignment with the base of said first spine a distance from the base of the second row of spines to be formed equal to the length thereof and which is a multiple of the spacing between the rows and making a similar thin narrow cut of gradually increasing depth axially of the tube to the base of said second row of spines to be formed to cut a sliver, and bending said sliver outwardly to form a spine in said second row, said latter cut partially underlying said first cut, then proceeding in like manner around the tube to produce the second row of spines, then proceeding in like manner to produce subsequent rows as desired.

15. The method of making a heat transfer element including rows of spines extending transversely across a wall, the rows being spaced longitudinally of the wall and in which each spine comprises a long thin upstanding portion having its base integral with the wall surface, said method comprising starting on the wall a distance from the base of the first spine to be formed equal to the length thereof and which is a multiple of the spacing between the rows, making a thin narrow cut of gradually increasing depth longitudinally of the base of said first spine to be formed to cut a sliver, and bending said sliver outwardly to form said first spine, repeating this operation on the wall to produce a first row of spines on the wall, the cuts being contiguous transversely thereby providing contiguous spine roots, then starting in longitudinal alignment with the base of said first spine a distance from the base of the second row of spines to be formed equal to the length thereof and which is a multiple of the spacing between the rows and making a similar thin narrow cut of gradually increasing depth longitudinally of the base of said second row of spines to be formed to cut a sliver, and bending said sliver outwardly to form a spine in said second row, said latter cut partially underlying said first cut, then proceeding in like manner across the wall to produce the second row of spines, then proceeding in like manner to produce subsequent rows as desired.

16. A heat transfer element comprising a wall and a multiplicity of spines integral therewith and consisting of stock gouged from and bent to extend outwardly from a face of the wall and of greater length than the distance between the roots of the spines in the direction from which the spines are gouged from the wall, to provide a high ratio of exposed area to the mass for efficient heat transfer between the wall and the outer ends of the spines.

17. A heat transfer element comprising a tubular wall and a multiplicity of spines integral therewith and consisting of stock gouged from and bent to extend outwardly from a peripheral face of the wall and of greater length than the longitudinal spaces between the roots of the spines so as to provide a high ratio of exposed surface to the mass for efficient heat transfer between the wall and the outer ends of the spines.

18. A heat transfer element comprising a tubular wall and a multiplicity of spines integral therewith and gouged and bent to extend away from the wall, the thickness of substantially all of the wall between the spines being reduced by the gouging of the spines from one of the surfaces of the wall for efficient heat transfer between the wall and the outer ends of the spines.

19. A heat transfer element comprising a tubular wall and a multiplicity of spines integral therewith consisting of slivers of stock gouged from and bent away from a peripheral face of the wall, the thickness of substantially all of the tubular wall between the spines being reduced by the gouging of the spines from the outer periphery of the wall for efficient heat transfer between the wall and the outer ends of the spines.

20. A heat transfer element comprising a wall and a multiplicity of spines integral therewith and consisting of slivers of stock gouged and extending outwardly from a face of the wall, the roots of the spines being substantially contiguous transversely and spaced apart longitudinally and of substantially greater length than the longitudinal spaces between the roots of the spines for high efficiency in heat transfer.

21. A heat transfer element comprising a tubular wall and a mulitiplicity of spines integral therewith and consisting of stock gouged and bent to extend away from the outer periphery of the wall, the roots of the spines being substantially contiguous circumferentially and of substantially greater length than the longitudinal spaces between the roots, for high efficiency in heat transfer.

22. A heat transfer element comprising a wall and spines integral therewith and consisting of slivers of stock gouged and extending outwardly from a face of the wall, the roots of the spines being contiguous and their outer ends being twisted and spread apart, the spines having lengths at least three times their width to provide a relatively high ratio of exposed surface to the mass for high efficiency in heat transfer.

23. A heat transfer element comprising a tubular wall and a multiplicity of spines integral therewith and consisting of slivers of stock gouged and extending outwardly from a face of the wall, the roots of the spines being contiguous and their outer ends being spread apart, the

spines comprising substantially all of the stock in the entire surface of the wall from which the spines are gouged to provide a high ratio of exposed surface to the mass for high efficiency in heat transfer.

24. A heat transfer element comprising a tubular wall and a multiplicity of spines integral therewith and consisting of slivers of stock gouged and extending outwardly from a face of the wall, the roots of the spines being contiguous and their outer ends being spread apart, the spines comprising substantially all of the stock in the entire outer peripheral portion of the wall from which the spines are gouged to provide a high ratio of exposed surface to the mass for high efficiency in heat transfer.

25. A heat transfer element comprising a tubular wall and spines integral therewith and consisting of slivers of stock gouged and extending outwardly from a face of the wall, the roots of the spines being contiguous and their outer ends being twisted and spread apart, the spines having lengths at least three times their widths to provide a relatively high ratio of exposed surface to the mass for high efficiency in heat transfer.

RICHARD W. KRITZER.