APPLICATION ACCEPTED AND AMENDMENT ALLOWED 4.4.90

FORM 1

COMMONWEALTH OF AUSTRALIA

PATENTS ACT 1952

598319

APPLICATION FOR A STANDARD PATENT

LODGED AT SUB-OFFICE
13 NOV 1987
Melbourne

I\We,

SANDVIK AKTIEBOLAG

of S-811 81 Sandviken,
Sweden

hereby apply for the grant of a standard patent for an invention entitled:

CYLINDER FOR HEAT EXCHANGERS

which is described in the accompanying complete specification

Details of basic application(s):

Number of basic application	Name of Convention country in which basic application was filed	Date of basic application
8604906-1	SE	17 NOV 86

My/our address for service is care of CLEMENT HACK & CO., Patent Attorneys, 601 St. Kilda Road, Melbourne 3004, Victoria, Australia.

DATED this 13th day of November 1987

SANDVIK AKTIEBOLAG

CLEMENT HACK & CO

TO: The Commissioner of Patents.

FEE STAMP TO VALUE OF $1,155 ATTACHED
MAIL OFFICER

PATENT OFFICE 100 LODGED AT SUB-OFFICE 13 NOV 1987 Melbourne ONE HUNDRED DOLLARS

PATENT OFFICE 50 LODGED AT SUB-OFFICE 13 NOV 1987 Melbourne FIFTY DOLLARS

PATENT OFFICE 5 AUSTRALIA FIVE DOLLARS

Forms 7 and 8

AUSTRALIA

Patents Act 1952

DECLARATION IN SUPPORT OF A CONVENTION OR NON-CONVENTION APPLICATION FOR A PATENT OR PATENT OF ADDITION

Name(s) of Applicant(s)

In support of the application made by Sandvik AB

Title

for a patent for an invention entitled Cylinder for heat exchangers

Name(s) and address(es) of person(s) making declaration

I/We, Lennart Tåquist
Sandvik AB
S-811 81 Sandviken, Sweden

do solemnly and sincerely declare as follows:-

1. I am/we are the applicant(s) for the patent, or am/are authorised by the abovementioned applicant to make this declaration on its behalf.

2. The basic application(s) as defined by Section 141 of the Act was/were made in the following country or countries on the following date(s) by the following applicant(s) namely:-

Country, filing date and name of Applicant(s) for the or each basic application

in Sweden on November 17, 1986
by Sandvik AB
in _____ on _____ 19____
by _____

3. The said basic application(s) was/were the first application(s) made in a Convention country in respect of the invention the subject of the application.

Name(s) and address(es) of the or each actual inventor

4. The actual inventor(s) of the said invention is/are
Carl Thomas Odelstam
Myrmalmsvägen 16
S-811 32 Sandviken
Sweden

See reverse side of this form for guidance in completing this part

5. The facts upon which the applicant(s) is/are entitled to make this application are as follows:-
The applicant is the assignee of the actual inventor

DECLARED at Sandviken this 2nd day of November 1987

Lennart Tåquist

This form may be completed and filed after the filing of a patent application but the form must not be signed until after it has been completely filled in as indicated by the marginal notes. The

(12) PATENT ABRIDGMENT (11) Document No. AU-B-81224/87
(19) AUSTRALIAN PATENT OFFICE (10) Acceptance No. 598319

(54) Title
CYLINDERICAL TUBE FOR HEAT EXCHANGERS

International Patent Classification(s)
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(71) Applicant(s)
SANDVIK AKTIEBOLAG

(72) Inventor(s)
CARL THOMAS ODELSTAM

(74) Attorney or Agent
GRIFFITH HACK & CO. MELBOURNE

(57) Claim

1 A scraped surface heat exchanger comprising a heat transfer tube in which scraper knife blades are rotatably mounted and through which in use a fluid is pressed whilst chilled or heated by means of a cooling or a heating medium applied towards the exterior surface of said tube and whereby the interior surface of the tube is even, characterized in that,

a) the tube is made of a duplex stainless steel alloy comprising in weight-%, max 0.03 % C, 18-30 % Cr, 4-8 % Ni, 0-6 % Mo, 0.5-2% Mn, 0.5-2 % Si, 0.05-0.30 % N, and the remainder Fe and usual impurities, whereby the amounts of these constituents are selected such that the ferrite content is 35-65 %, and

b) the exterior surface of the tube has a plurality of spaced grooves with a profile the bottom of which is smoothly rounded at a radius (R) whereby the profile depth (A) of each said groove is essentially larger than said radius (R).

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Form 10

COMPLETE SPECIFICATION

(ORIGINAL)

FOR OFFICE USE

Short Title:

Int. Cl:

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Complete Specification-Lodged:
Accepted:
Lapsed:
Published:

This document contains the amendments made under Section 49 and is correct for printing

Priority:

Related Art:

TO BE COMPLETED BY APPLICANT

Name of Applicant: SANDVIK AKTIEBOLAG

Address of Applicant: S-811 81 Sandviken,
Sweden

Actual Inventor:

Address for Service: CLEMENT HACK & CO.,
601 St. Kilda Road,
Melbourne, Victoria 3004,
Australia.

Complete Specification for the invention entitled:
CYLINDER FOR HEAT EXCHANGERS

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

Cylinder for heat exchangers

The present invention relates to a hollow cylinder for use in a scraped surface heat exchanger for chilling or heating fluid, half fluid or highly viscous products. Inside this cylinder the product is pressed from one end of the cylinder towards the other end whilst said product is being scraped towards the interior walls of said cylinder and whilst the cylinder is subjected to heating or cooling on its exterior surface.

A necessary condition for such a heat exchanger to function property in producing an acceptable product, often food, is that the interior surface of said cylinder is so even that the scraper blades do not interfere therewith or the product is being contaminated, and, further, that the thermal conductivity of the exterior surface is good. The cylinder must be able to withstand contact with both said product and also with cleaning liquids as well as being wear resistant towards the scraper blades. The material presently being used in such cylinders is nickel, chromium plated nickel and chromium plated carbon steel the interior surface of which often becomes uneven due to pitting damanges which reduce the lifetime of such cylinders.

Especially the chromium plated cylinders are susceptible of aggression due to porosities in the chromium plated zone through which the underneath material can be subject of aggression. In view thereof it would be desirable to use a homogenous cylinder material without a chromium plating zone. Cylinders of pure nickel metal without a chromium plating would be a possible solution but its wear resistance and its corrosion resistance towards certain products and certain cleaning liquids is too low. Further, the scraper blades might rip off small nickel particles that will contaminate the product and might also cause nickel allergy. A cylinder made of homogenous stainless steel would be able to eliminate aggression from said product but its wear

resistance towards the scraper knife blades is mostly insufficient and, further, its thermal conductivity is worse than for those materials presently used. Therefore, such type of cylinders would not be practically useful.

It is a purpose of the invention to eliminate the above related problems by providing a cylinder having a unique combination of cylinder material and cylinder design. Therefore, a duplex stainless steel is selected with high strength and very good resistance towards pitting damages from transmitted products and cleaning liquids. This selection of material enables that a thinner cylinder wall thickness can be used. Simultaneously the exterior surface of the cylinder has been given a special form so as to provide an increased heat transfer. The cylinder of the present invention therefore has very good heat transfer combined with highly improved resistance to pitting damages whilst also having an improved wear resistance towards scraper knife blades.

The invention will now be described more in detail with reference to the accompanying drawings in which Fig. 1 is a cross section of a scraped surface heat exchanger of conventional design, and Fig. 2 is an enlarged longitudinal section of a preferred embodiment of a cylinder of the present invention intended for use in a scraped surface heat exchanger.

In Fig. 1 a hollow cylinder 10 of tubular shape is provided from the inlet end of which a viscous medium, such as margarine, is to be pressed through the cylinder to its outlet end. A rotor 11 is rotatably mounted in the cylinder 10, said rotor 11 having a radial extension 12 at which a scraper knife blade 13 is fastened. The scraper knife blades 13 are intended, whilst rotated and axially displaced, to scrape off the fluid or viscous medium from the interior surface of the cylinder 10. The viscous medium is transmitted forwardly through the space 14. It is of great

importance that the interior surface of this cylinder 10 is even and finely polished in order to enable good scraping efficiency and good cleanness. An exteriorly provided heating source 15 is arranged to transmit desired temperature to the exterior surface of the cylinder 10.

In accordance with the invention the exterior surface of the cylinder 10 has been provided with grooves 16 similar to a thread contour, see Fig. 2, which design has been selected for cylinders to be used in horizontally oriented heat exchangers. Alternatively these grooves 16 can be provided as concentrical grooves. These grooves should preferably have a uniform profile depth A. Each such groove 16 shall have a smoothly rounded bottom portion in order to eliminate the risk for fatigue cracks due to the high product pressure. The radius R at the bottom of said groove 16 should be 0.4-1.0 mm. The flank portions should have a straight contour and the flank angle α should be 10^{o}-30^{o} measured in relation to a normal with regard to the centre axis 17 of said cylinder 10. The depth A of the groove 16 depends on the strength of the selected cylinder material and should be 3-5 mm for a cylinder diameter in the range 100-300 mm whilst the wall thickness B from the bottom of the groove 16 to the interior surface 18 of the cylinder should be 2.5-5 mm. The general dimensioning rule is that the size of the depth A of said groove 16 should be essentially larger than the size of the bottom radius R of same groove 16.

The top portions 19 of the exterior profile could either be flat as shown in Fig. 2, or somewhat rounded or even peaky. If said top portion 19 is rounded its radius should preferably be of same size as the radius R at the bottom of the groove 16. The pitch C between adjacent grooves 16 should be 0.1-10 mm, preferably 1.5-10 mm. If a thread contour is selected the thread pitch should be in the range 1^{o}-50^{o}. By optimizing the design of the exterior surface of the cylinder 10 as described above it has been possible to

achieve 75-100 % surface enlargement in comparison with a cylinder having an even exterior surface where the external diameter is measured from the bottom of said grooves 16.

For cylinders to be used in vertically oriented installations the grooves 16 can be applied longitudinally on the exterior surface of the cylinder 10. In accordance with an alternative embodiment these grooves can be applied like a thread contour oriented at an angle of 40^{o}-50^{o} in relation to the longitudinal axis of said cylinder.

The material to be selected for the manufacture of the cylinder 10 shall be a duplex stainless steel alloy with ferritic-austenitic microstructure and with a strictly optimized chemical analysis. The steel alloy should have an analysis comprising, in weight-%, max 0.03 % C, 18-30 % Cr, 4-8 % Ni, 0-6 % Mo, 0.5 - 2 % Mn, 0.5-2 % Si, 0.05-0.30 % N the remainder being Fe and normally occurring impurities, whereby the amounts of said constituents should be selected such that the ferrite content amounts to 35-65 %.

By selecting the above mentioned type of material it will be possible to achieve high hardness and good wear resistance towards the scraper knife blades 13 whilst also achieving improved corrosion resistance. This will give a better protection towards salt containing media such as margarine and cleaning media than compared with conventional tubes of chromium plated carbon steel the interior surface of which is too porous. The strength of such improved duplex material is about double as high as that of regular stainless steels type SIS 2343. Thanks to this essential improvement of the stength in the selected duplex material in comparison with previous steels it has been possible to make the wall thickness of the tubular cylinder 10 much thinner. This has further enabled a more substantial profile depth of said grooves 16 which will compensate for the somewhat lower thermal conductivity of said duplex material in comparison with previous carbon steels.

In a preferred embodiment of the invention the flank angle α was selected to be 17.5^{o} the profile depth A of the groove 16 was 4.6 mm and the wall thickness B at the bottom of said groove 16 was 2.9 mm. The radius R was 0.8 mm och the pitch C was 5.6 mm. As a general recommendation it has been found that the profile depth A should be at least three times larger than the radius R and preferably four times larger than the Radius R at the bottom of the groove 16.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1 A scraped surface heat exchanger comprising a heat transfer tube in which scraper knife blades are rotatably mounted and through which in use a fluid is pressed whilst chilled or heated by means of a cooling or a heating medium applied towards the exterior surface of said tube and whereby the interior surface of the tube is even, characterized in that,

a) the tube is made of a duplex stainless steel alloy comprising in weight-%, max 0.03 % C, 18-30 % Cr, 4-8 % Ni, 0-6 % Mo, 0.5-2% Mn, 0.5-2 % Si, 0.05-0.30 % N, and the remainder Fe and usual impurities, whereby the amounts of these constituents are selected such that the ferrite content is 35-65 %, and

b) the exterior surface of the tube has a plurality of spaced grooves with a profile the bottom of which is smoothly rounded at a radius (R) whereby the profile depth (A) of each said groove is essentially larger than said radius (R).

2. Heat exchanger as defined in claim 1, characterized in that the grooves each comprise straight flanks the flank angle of which is 10-30° measured in relation to a normal to the longitudinal axis of said tube.

3. Heat exchanger as defined in claim 1 or 2, characterized in that the pitch (C) between the grooves is 0.1-10 mm, preferably 1.5-10 mm.

4. Heat exchanger as defined in any one of claims 1-3, characterized in that the radius (R) at the bottom of each groove is 0.4-1.0 mm.

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5. Heat exchanger as defined in any one of claims 1-4, characterized in that the top portions of the profile are smoothly rounded and have the same radius as the bottom radius (R) of said grooves.

6. Heat exchanger as defined in any one of claims 1-5, characterized in that the profile depth (A) of the groove is at least three times and preferably four times larger than the radius (R) at the bottom of said groove.

7. Heat exchanger as defined in any one of claims 1-4, characterized in that the top portions of the profile are flat.

8. Heat exchanger as defined in any one of claims 1-8, characterized in that the wall thickness (B) at the bottom of each groove is 2.5-5.0 mm with interior tube diameters of 100-300 mm.

9. Heat exchanger as defined in any one of claims 1-8, characterized in that the grooves are provided as concentrical recesses around the mantle surface of the tube.

10. Heat exchanger as defined in any one of claims 1-8, characterized in that the grooves are provided with a thread contour with a thread pitch of 1°-50°.

11. Heat exchanger as defined in claim 10, characterized in that the grooves are provided with a thread pitch of 40°-50°.

12. Heat exchanger as defined in any one of claims 1-8, characterized in that the grooves are straight and extending in the longitudinal direction of the tube.

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13. Heat exchanger as defined in any one of claims 1-12, characterized in that the radius (R) at the bottom of the groove is 0.4-1.0 mm with interior tube diameters of 100-300 mm.

14. Heat exchanger as defined in any one of claims 1-13, characterized in that the profile depth (A) amounts to 3-5 mm with interior tube diameters of 100-300 mm.

15. Heat exchanger as defined in any one of claims 1-14, characterized in that the profile depth (A) of said grooves is larger than the wall thickness (B) at the bottom of said groove.

16. A scraped surface heat exchanger substantially as described herein with reference to the accompanying drawings.

Dated this 8th day of March, 1990
SANDVIK AKTIEBOLAG
By its Patent Attorneys:
GRIFFITH HACK & CO.
Fellows Institute of Patent
Attorneys of Australia.

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81224/87

Fig.1

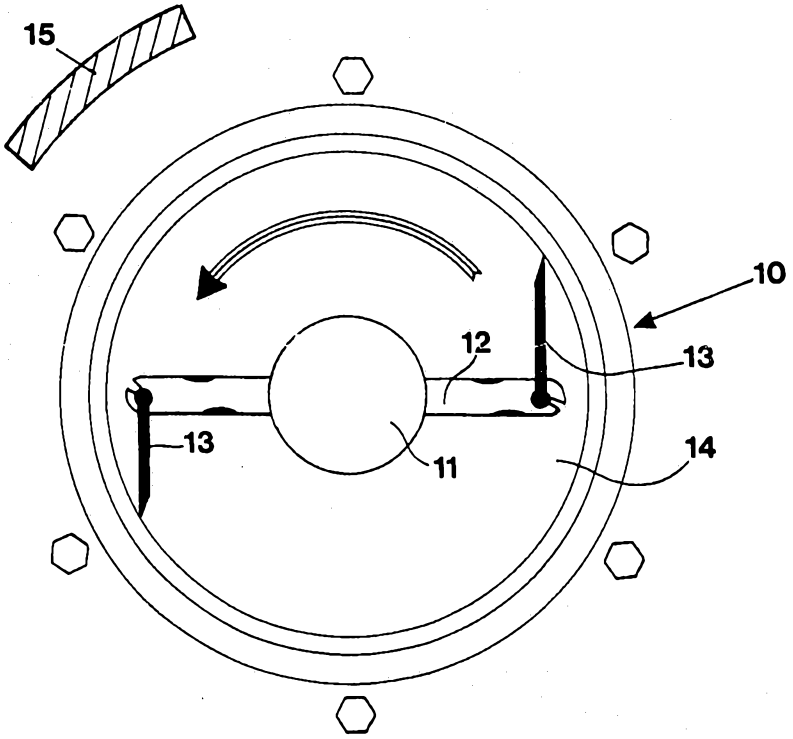

Fig.2