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(54) **LIGHTWEIGHT EXCHANGERS FOR HEAT RECOVERY: A GAS-GAS RECUPERATOR AND A GAS-FLUID ECONOMIZER, AND A METHOD OF PROTECTION PARTICULARLY AN EXCHANGER CASING**

(57) A lightweight exchanger for heat recovery: a gas-gas recuperator which includes exchanger tubes, a casing and air flow channels, characteristic in that, it consists of the casing (O) in which two air flow channels (K1) and (K2) cross perpendicularly. In the air flow channel (K2) (inside the casing (O)) there are thin-walled exchanger tubes (R) which are placed in parallel. The ends of the tubes are fixed to a perforated bottom (D) by means of adhesive preferably GUMA SWW, two-component polycondensation rubber, in the form of a layer of adhesive (wk) which forms an adhesive connection. For each of the channels (K1) and (K2), the casing (O) has an air inlet (wl1), (wl2) and an air outlet (wy1), (wy2) ended with a montage flange (Km). The casing (O) is made of thin sheet which is firmly connected pointwise by threaded connections (pg) by thermal drilling so that the connection of thin elements is made by the extrusion of a slot with the formation of a bushing, next the threading of the bushing in one of the elements, and then twisting the element with another element. Adhesive preferably GUMA SWW, two-component polycondensation rubber, is used as a layer of adhesive (wk).

A lightweight gas - fluid economizer which includes exchanger tubes, a casing and an air flow channel, characteristic in that, it consists of the casing (O) in which there is a tubular assembly (WR) placed perpendicularly to the gas flow channel (K). There is a bypass channel (KB), with its volume reduced by preferably 25 %, over the tubular assembly in the casing (O). The bypass channel (KB) which is opened or closed by means of movable mechanical blinds (MB). The tubular assembly (WR) is fed with fluid receiving heat through an inlet port of fluid (wlc). The tubular assembly (WR) is ended by an outlet port of fluid (wyc). The inlet port of fluid (wlc) and the outlet port of fluid (wyc) are preferably placed on one side of the tubular assembly (WR) in its axis. The casing is ended at both sides by a montage flange (KM). The gas inlet (wig) and a gas outlet (wyg) of the gas flow channel (K) go through the montage flange (KM).

The method of protection particularly the exchanger casing, characteristic in that, the whole exchanger or a part of it- the outlet part and / or the inlet part and / or the bypass channel is coated with the protective coating (PO) with a gravimetric composition:
15% ÷ 17% molybdenum,
14.5% ÷ 16.5% chromium,
4.0% ÷ 7.0% tungsten,
≤ 2.5% cobalt,
≤ 0.02% carbon,

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≤ 1.0% manganese,
≤ 0.08% sulphur
≤ 0.04% potassium,
≤ 0.35% vanadium,
the rest is nickel.

The thickness of the depositing protective coating (PO) amounts from 0,1 μm up to 400 μm.

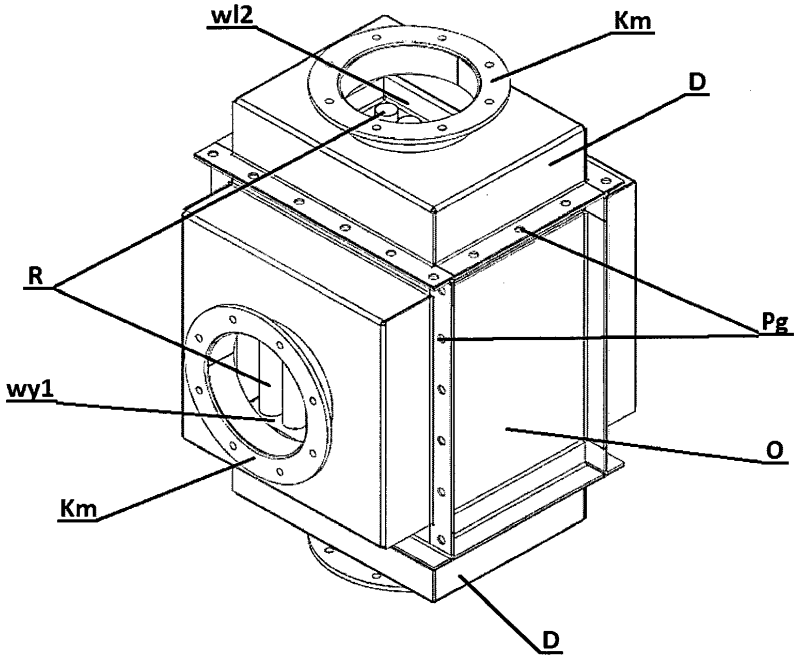

Fig. 1

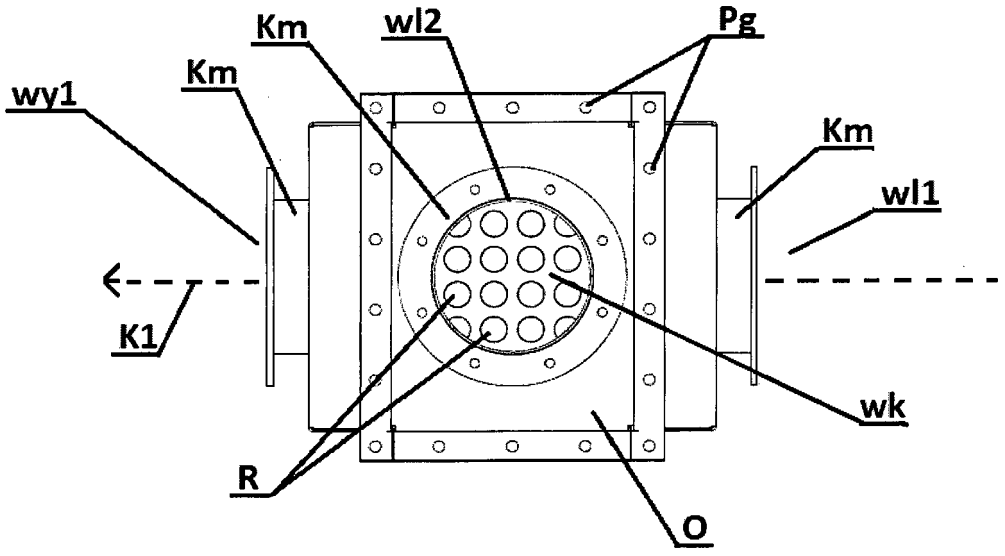

Fig. 4

Description

[0001] The present invention is lightweight exchangers for heat recovery: a gas-gas recuperator and a gas-fluid economizer, and a method of protection particularly an exchanger casing.

[0002] The Chinese patent specification no. CN105772372 presents an anticorrosive method for heat exchangers which enables for regeneration of corroded and rusted heat exchangers by grinding, acid etching, cleaning, pre-drying, spraying of powders and secondary drying. Regeneration allows acquiring the time of the usage of an exchanger again to 1,000 hours.

[0003] The Korean patent specification no. KR20160098157 presents a tubular heat exchanger with high strength and corrosion resistance, and a method for its production.

[0004] The Taiwanese patent specification no. TWM525434 presents a corrosion-resistant plate heat exchanger which is made entirely of stainless steel. Bronze is used as a binder for soldering.

[0005] The Japanese patent specification no. JP2016132711 presents an agent for coating of heat exchangers, which guarantees corrosion and high temperature resistance. The coating consists of (A) epoxy resin, (B) phenolic resin which contains one or more of the following components: phenol and allyl ether or phenol and alkylphenol ether, and (C) metallic mixtures made of one or more compounds selected from zinc, manganese and copper compounds.

[0006] The Korean patent specification no. KR20160115662 presents a method for the production of heat exchangers based on aluminium alloy, which is resistant to corrosion.

[0007] The British patent specification no. GB1065030 presents a method for reducing corrosion of metals in heat exchangers on which flowing fluid affects. The reduction of corrosion is made by increasing the flow speed of fluid on the metal surface by the addition of hydrogen to the flowing fluid.

[0008] The international patent specification no. WO2011006613A2 presents a heat exchange module and compact heat exchangers. The invention relates to a new compact module of heat exchange of heat exchangers, which include at least two heat exchange modules.

[0009] The American patent specification no. US4117884 presents a tubular heat exchanger and a method for its production. A tube assembly of heat exchange includes many of heat exchange tubes placed in the vertical and horizontal direction in a cumulative way. The end parts of the aforementioned tubes are placed at both ends in the wall hardened with elastic material.

[0010] The Swiss patent specification no. CH585887 presents a tubular heat exchanger consisting of glass tubes and silicone rubber. The exchanger consists of two metal frames. Between the frames, there are tubes made of silicate (e.g. glass). They are tightly embedded in a wall made of hardened flexible plastic. Plastic walls may be covered by a plate or film. The film may be made of a plastic, for example, Teflon, or of the metal plate with holes for the tubes. The gap between the plate and the wall is filled with the same material as the walls.

[0011] The international patent specification no. WO2010044723A2 presents a plate heat exchanger which includes a package of plates of a heat exchanger.

[0012] The conception of the invention is to develop new and lightweight heat exchangers: a gas-gas recuperator and a gas-fluid economizer with not worsened parameters. The main purpose is to create new constructions of exchangers characterized by reduced weight and size.

[0013] A lightweight exchanger for heat recovery: a gas-gas recuperator, according to the invention, characteristic in that, it consists of the casing in which two air flow channels cross perpendicularly. In the air flow channel 2 (inside the casing) there are thin-walled exchanger tubes which are placed in parallel. The ends of the tubes are fixed to a perforated bottom by adhesive preferably GUMA SWW, two-component polycondensation rubber, in the form of a layer of adhesive which forms an adhesive connection. For each of the channels, the casing has an air inlet and an air outlet ended with a montage flange. The casing is made of thin sheet which is firmly connected pointwise by threaded connections by thermal drilling so that the connection of thin elements is made by the extrusion of a slot with the formation of a bushing, next the threading of the bushing in one of the elements, and then twisting the element with another element. Adhesive preferably GUMA SWW, two-component polycondensation rubber, is used as a layer of adhesive.

[0014] Non-silicone adhesive, preferably with a temperature resistance to 200 ° C, is used as a layer of adhesive.

[0015] GUMA SWW with the CATALYST KSWW in a proportion of 95% of weight of GUMA and 5% of weight of the CATALYST is used as adhesive GUMA SWW, a two-component polycondensation rubber. GUMA SWW is plastic material - an elastomer which is called MS Polimer.

[0016] A lightweight gas - fluid economizer according to the invention, characteristic in that, it consists of a casing in which there is a tubular assembly placed perpendicularly to the gas flow channel. There is a bypass channel, with reduced volume by 25%, over the tubular assembly in the casing. The bypass channel is opened or closed by means of movable mechanical blinds. The tubular assembly is fed with fluid receiving heat through an inlet port of fluid. The tubular assembly is ended by an outlet port of liquid. The inlet port of fluid and the outlet port of fluid are preferably placed on one side of the tubular assembly in its axis. The casing is ended at both sides by a montage flange. The gas inlet and a gas outlet of the gas flow channel go through the montage flange.

[0017] The length of the tubular assembly is preferably 1.4 times greater than the width of the tubular assembly.

[0018] The ratio of the surface of the inlet port to the front surface of the bundle of exchanger tubes of the tubular assembly, the so-called exchanger window, is not less than 40%.

[0019] The angle between the air stream coming into the space between tubes and the centre of the tubular assembly does not exceed 45 °.

[0020] The gas flow channel is formed in the shape of a cuboid.

[0021] The method of protection particularly of an exchanger casing according to the invention, characteristic in that, whole exchanger or a part of it- the outlet part and / or the inlet part and / or a bypass channel is coated with the protective coating with a gravimetric composition:

15% ÷ 17% molybdenum,
14.5% ÷ 16.5% chromium,
4.0% ÷ 7.0% tungsten,
≤ 2.5% cobalt,
≤ 0.02% carbon,
≤ 1.0% manganese,
≤ 0.08% sulphur
≤ 0.04% potassium,
≤ 0.35% vanadium,
the rest is nickel.

[0022] The thickness of the depositing protective coating amounts from 0,1 μm up to 400 μm.

[0023] In the exchanger an outlet part and / or an inlet part, which is made of sheet metal of carbon steel, is covered with a protective coating.

The advantages of a recuperator

[0024]

- reduced mass of a heat exchanger by replacing partially a welded connection by an adhesive connection. It allows for application of elements with much thinner walls as thin-walled tubes and perforated bottoms made of sheet of less thickness,
- reduced mass of a heat exchanger by combining sheets by means of thermal drilling. It allows for using sheets with a smaller wall thickness for the construction of walls of the exchanger.

[0025] The adhesive connection is used to the montage of exchanger tubes in the perforated bottom in the case of the exchanger of a recuperator type. In this case, the use of adhesive instead of welding allows for the application of elements with much thinner walls. Thin-walled tubes and perforated bottoms are made of sheet of a smaller thickness. Thin walls allow for the better thermal conductivity of tubes. It increases the efficiency of the device or reduces the size of the device as needed.
In order to further reduce the amount of welded joints, which means definitely the reduction of weight of the device, there is a possibility of an alternative joining of thin sheets by the use of thermal drilling.
This technique allows for connecting thin elements by the extrusion of a slot with the formation of a bushing, next the threading of the bushing in one of the elements, and then twisting the element with another element.
It allows for reducing the weight or size of the exchanger and at the same time it allows for creating threaded connections which are impossible to make with a standard screw-nut connection.
The proposed conception substantially affects the weight of the exchanger (a gas-gas recuperator) and allows for mounting the device in places such as ceilings, roofs and chimneys, which were previously inaccessible to standard constructions.

The advantages of an economizer

[0026]

- the lower weight of the whole device while maintaining the operating parameters at an acceptable level by optimizing the geometry of the device,
- decreasing of the bypass channel reduces the weight of the device at an acceptable increase in pressure drop and maintaining other operating parameters,
- the shortening of the inlet / outlet parts results in a further weight reduction of the device while maintaining the operating parameters of the exchanger,
- the placement of the inlet and outlet port in an axis of the tubular assembly reduces pressure drop and improves the dynamics of flow and its regularity.

The advantages of the conception of protection

[0027] The verification of possibility of use of protective coatings in the construction of an economizer was tested. The protective coatings allow using less expansive construction materials (for example, replacing acid-resistant sheet with carbon steel sheet). The most dangerous for the deposited coating are conditions of heat impact when the exchanger is turned off from the system by opening of the bypass channel. The hot exhaust gases flow directly into the outlet part of the exchanger, which may be covered with the protective coating.

[0028] The conception of the invention optimizes the geometry of exchangers and increases the efficiency of the exchanger by eliminating dead zones and standardizing of flows inside the space between the tubes of exchangers. In addition, the size of the exchanger was reduced by downsizing, shortening or complete elimination of some elements while all expected conditions of flow and more effective heat exchange are maintained.

[0029] The following advantage of the invention according to the conception is that the carbon steel from which the heat exchangers are made, is covered with an additional protective coating. The carbon steel has a better resistance in a chloride and an aggressive flue gases

environment.

[0030] ELASTOMERS IN THE PRODUCTION OF HEAT EXCHANGERS- elastomers are plastics - crosslinked polymers with the ability to reversible deformation under the effect of mechanical forces with the maintenance of the continuity of the structure. In the production of exchangers it is important that the used elastomers polymerize in the entire volume and not on the surface, for example, under the influence of moisture from the outside. Hence, the best application is for two-component units: base - catalyst. Such units are characterized by accelerated hardening process.

[0031] The applied GUMA SWW with the CATALYST KSWW in a proportion of 95% of weight of GUMA and 5% of weight of the CATALYST is plastic material called MS Polimer. These polymers combine the advantages of silicones and polyurethanes. MS polymers are modified by silanes (silane) and do not contain harmful isocyanates and polyvinyl chloride. They are hardened by taking moisture (contained in the catalyst) and do not smell. They are used for pasting materials with different physicochemical properties such as metal-glass or metal-wood. They can fill non-capillary cracks and gaps of up to 40 mm. They provide connections resistant to vibration, reduce the effects of noise, have a very good resistance to UV radiation and aging, and they can be painted and varnished.

[0032] The invention is shown on the examples of the drawings in which:

Figure 1 shows a general view of a gas-gas recuperator,
Figure 2 shows a side view of a gas-gas recuperator,
Figure 3 shows a cross-sectional view of the interior from the side of a gas-gas recuperator,
Figure 4 shows a top view of a gas-gas recuperator,
Figure 5 shows a general view of a gas-fluid economizer,
Figure 6 shows a side view of a gas-fluid economizer,
Figure 7 shows a side view from the side of gas outlet of gas-fluid economizer,
Figure 8 shows a view - a section from the top of a gas-fluid economizer.

Example 1 (a recuperator)

[0033] A lightweight exchanger for heat recovery: a gas-gas recuperator which consists of the casing (O) in which two air flow channels (K1) and (K2) cross perpendicularly. In the air flow channel (K2) (inside the casing (O)) there are thin-walled exchanger tubes (R) which are placed in parallel. The ends of the tubes are fixed to a perforated bottom (D) by means of adhesive preferably GUMA SWW, two-component polycondensation rubber, in the form of a layer of adhesive (wk) which forms an adhesive connection. For each of the channels (K1) and (K2), the casing (O) has an air inlet (wl1), (wl2) and an air outlet (wy1), (wy2) ended with a montage flange (Km). The casing (O) is made of thin sheet which is firmly connected pointwise by threaded connections (pg) by thermal drilling so that the connection of thin elements is made by the extrusion of a slot with the formation of a bushing, next the threading of the bushing in one of the elements, and then twisting the element with another element. Adhesive GUMA SWW, two-component polycondensation rubber, is used as a layer of adhesive (wk).

[0034] Non-silicone adhesive, with a temperature resistance to 200 ° C, is used as a layer of adhesive (wk).

[0035] GUMA SWW with the CATALYST KSWW in a proportion of 95% of weight of GUMA and 5% of weight of the CATALYST is used as adhesive GUMA SWW, a two-component polycondensation rubber. GUMA SWW is plastic material - an elastomer which is called MS Polimer.

[0036] The ends of thin-walled exchanger tubes (R) are fixed to the perforated bottom (D) by a layer of adhesive (wk) which forms the adhesive connections. The connections are in the form of funnels for the tube-screen connections with sheet 80x80mm of thickness of 1 mm with a hole in the middle. Sheet was pressed in order to take out a flange in which there is a tube Φ18.

Example 2 (an economizer)

[0037] A lightweight gas - fluid economizer which consists of a casing (O) in which there is a tubular assembly (WR) placed perpendicularly to the gas flow channel (K). There is a bypass channel (KB) over the tubular assembly in the casing (O). The bypass channel (KB), with its volume reduced by preferably 25 %, is opened or closed by means of movable mechanical blinds (MB). The tubular assembly (WR) is fed with fluid receiving heat through an inlet port of fluid (wlc). The tubular assembly (WR) is ended by an outlet port of fluid (wyc). The inlet port of fluid (wlc) and the outlet port of fluid (wyc) are placed on one side of the tubular assembly (WR) in its axis. The casing is ended at both sides by a montage flange (KM). A gas inlet (wlg) and a gas outlet (wyg) of the gas flow channel (K) go through the montage flange (KM).

[0038] The length of the tubular assembly (WR) is 1.4 times greater than the width of the tubular assembly (WR).

[0039] The ratio of the surface of the inlet port to the front surface of the bundle of the exchanger tubes (R) of the tubular assembly (WR), the so-called exchanger window, is not less than 40%.

[0040] The angle between the air stream coming into the space between the tubes and the centre of the tubular assembly (WR) does not exceed 45 °.

[0041] The gas flow channel is formed in the shape of a cuboid.

Example 3 (an economizer with a protective coating)

[0042] According to the method of protection, in a lightweight gas-fluid economizer from the example 2, the out-

let part is coated with a protective coating (PO) with a gravimetric composition:

15% ÷ 17% molybdenum,
14.5% ÷ 16.5% chromium,
4.0% ÷ 7.0% tungsten,
≤ 2.5% cobalt,
≤ 0.02% carbon,
≤ 1.0% manganese,
≤ 0.08% sulphur
≤ 0.04% potassium,
≤ 0.35% vanadium,
the rest is nickel.

[0043] The thickness of the depositing protective coating (PO) amounts to 200 μm.

[0044] In the exchanger an outlet part and / or an inlet part, which is made of sheet metal of carbon steel, is covered with a protective coating (PO).

A list of elements

[0045]

O - casing
K1- air flow channel 1
K2- air flow channel 2
D - perforated bottom
wk - layer of adhesive
wl1 - air inlet 1
wl2 - air inlet 2
wy1 - air outlet 1
wy2 - air outlet 2
Km - montage flange
Pg- threaded connection
R- thin-walled exchanger tubes
K - gas flow channel
WR- tubular assembly
KB- bypass channel
MB-mechanical blinds
wlc - inlet port of liquid
wyc - outlet port of liquid
wlg - gas inlet
wyg - gas outlet

Claims

1. Lightweight exchanger for heat recovery: a gas-gas recuperator which includes exchanger tubes, a casing and air flow channels, **characteristic in that,** it consists of the casing (O) in which two air flow channels (K1) and (K2) cross perpendicularly. In the air flow channel (K2) (inside the casing (O)) there are thin-walled exchanger tubes (R) which are placed in parallel. The ends of the tubes are fixed to a perforated bottom (D) by means of adhesive preferably GUMA SWW, two-component polycondensation rubber, in the form of a layer of adhesive (wk) which forms an adhesive connection. For each of the channels (K1) and (K2), the casing (O) has an air inlet (wl1), (wl2) and an air outlet (wy1), (wy2) ended with a montage flange (Km). The casing (O) is made of thin sheet which is firmly connected pointwise by threaded connections (pg) by thermal drilling so that the connection of thin elements is made by the extrusion of a slot with the formation of a bushing, next the threading of the bushing in one of the elements, and then twisting the element with another element. Adhesive preferably GUMA SWW, two-component polycondensation rubber, is used as a layer of adhesive (wk).

2. Llightweight exchanger, according to claim. 1 **characteristic in that,** non-silicone adhesive, preferably with a temperature resistance to 200 ° C, is used as the layer of adhesive (wk).

3. Lightweight exchanger, according to claim. 1, **characteristic in that,** GUMA SWW with the CATALYST KSWW in a proportion of 95% of weight of GUMA and 5% of weight of the CATALYST is used as adhesive GUMA SWW, a two-component polycondensation rubber. GUMA SWW is plastic material - an elastomer which is called MS Polimer.

4. Lightweight gas - fluid economizer which includes exchanger tubes, a casing and an air flow channel, **characteristic in that,** it consists of the casing (O) in which there is a tubular assembly (WR) placed perpendicularly to the gas flow channel (K). There is a bypass channel (KB) over the tubular assembly in the casing (O). The bypass channel (KB) is opened or closed by means of movable mechanical blinds (MB). The tubular assembly (WR) is fed with fluid receiving heat through an inlet port of fluid (wlc). The tubular assembly (WR) is ended by an outlet port of fluid (wyc). The inlet port of fluid (wlc) and the outlet port of fluid (wyc) are preferably placed on one side of the tubular assembly (WR) in its axis. The casing is ended at both sides by a montage flange (KM). A gas inlet (wlg) and a gas outlet (wyg) of the gas flow channel (K) go through the montage flange (KM).

5. Lightweight economizer, according to claim 4, **characteristic in that,** the length of the tubular assembly (WR) is preferably 1.4 times greater than the width of the tubular assembly (WR).

6. Lightweight economizer, according to claim 4, **characteristic in that,** the ratio of the surface of the inlet port to the front surface of the bundle of exchanger tubes (R) of the tubular assembly (WR), the so-called exchanger window, is not less than 40%.

7. Lightweight economizer, according to claim 4, **char-**

acteristic in that, the angle between the air stream coming into the space between tubes and the centre of the tubular assembly (WR) does not exceed 45 °.

8. Lightweight economizer, according to claim 4, **characteristic in that,** the gas flow channel is formed in the shape of a cuboid.

9. Method of protection particularly the exchanger casing, **characteristic in that,** the whole exchanger or a part of it- the outlet part and / or the inlet part and / or the bypass channel is coated with the protective coating (PO) with a gravimetric composition:

15% ÷ 17% molybdenum,
14.5% = 16.5% chromium,
4.0% ÷ 7.0% tungsten,
≤ 2.5% cobalt,
≤ 0.02% carbon,
≤ 1.0% manganese,
≤ 0.08% sulphur
≤ 0.04% potassium,
≤ 0.35% vanadium,
the rest is nickel.

The thickness of the depositing protective coating (PO) amounts from 0,1 μm up to 400 μm.

10. Method according to claim 9, **characteristic in that,** in the exchanger the outlet part and / or the inlet part, which is made of sheet of carbon steel, is covered with the protective coating (PO).

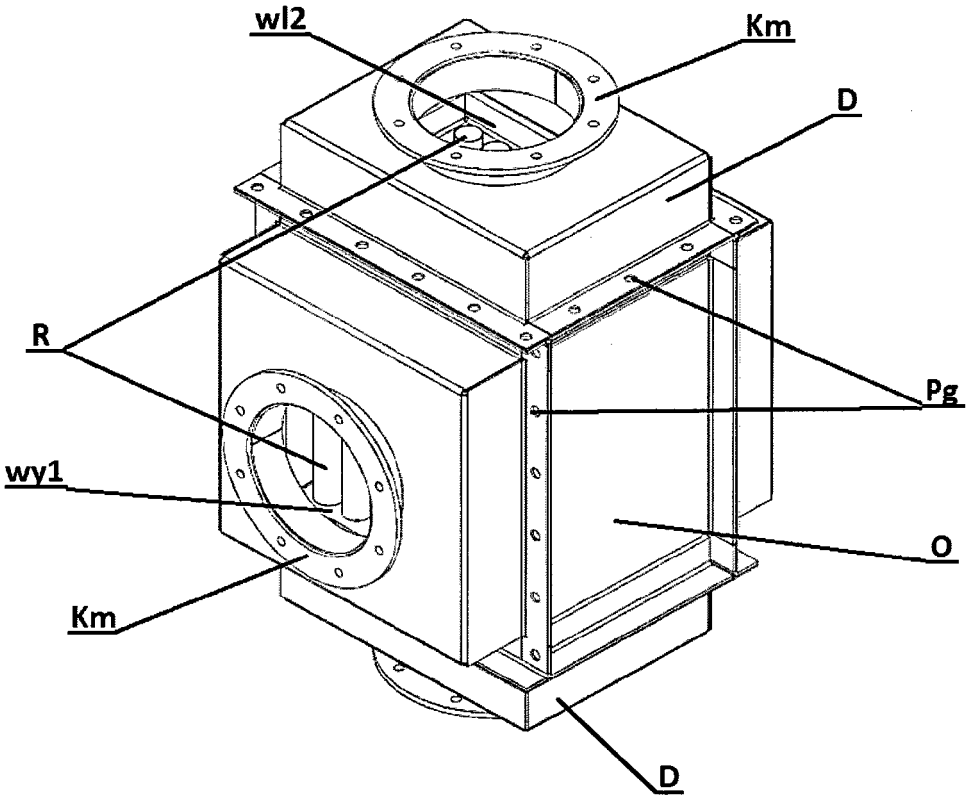
wl2
Km
D
R
Pg
wy1
O
Km
D

Fig. 1

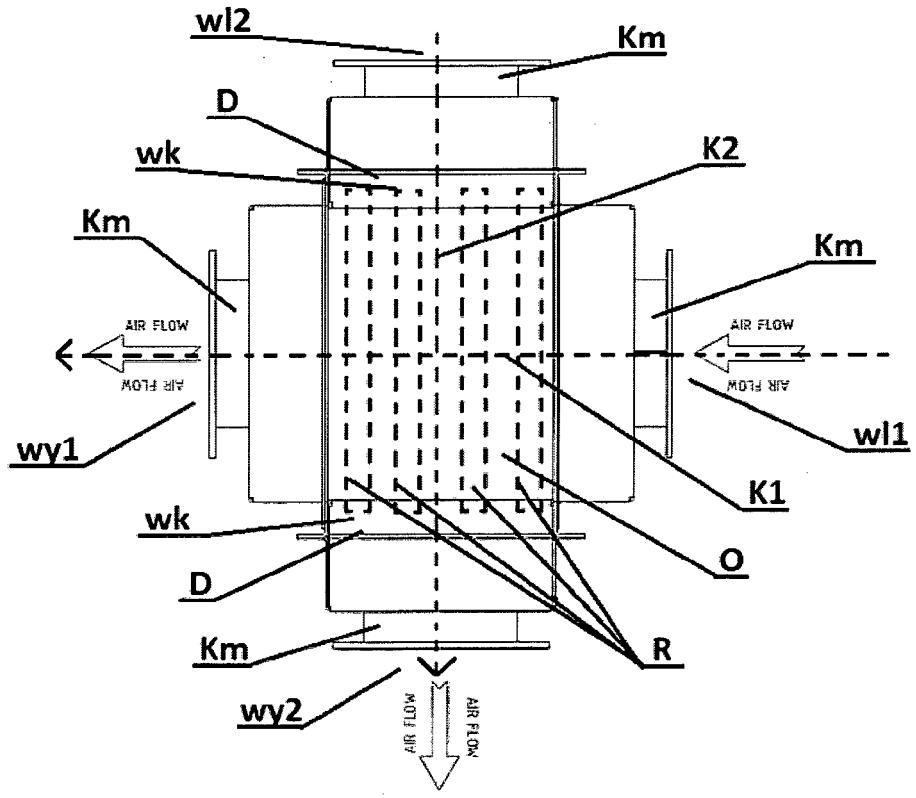
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Fig. 2

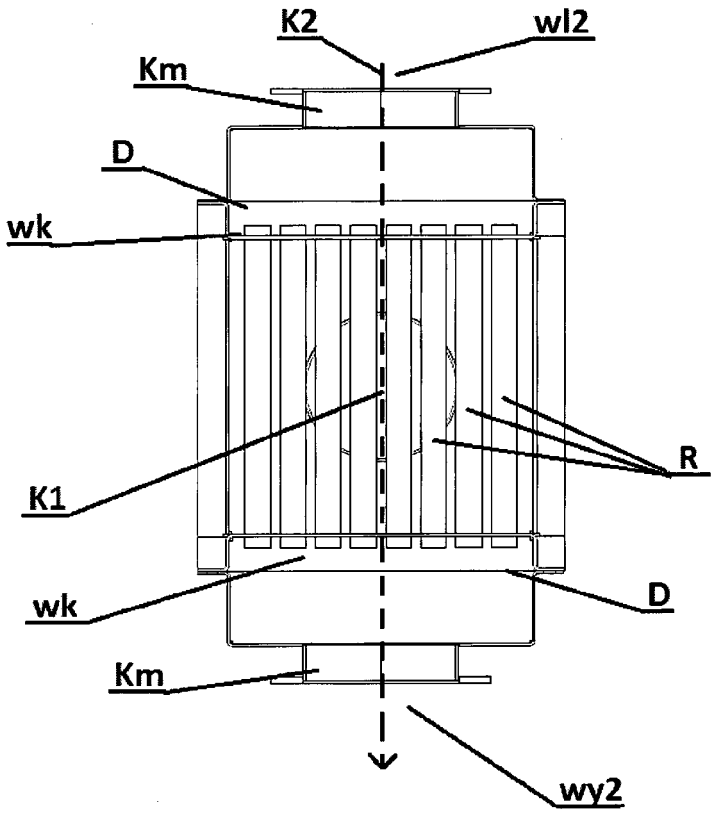

Fig. 3

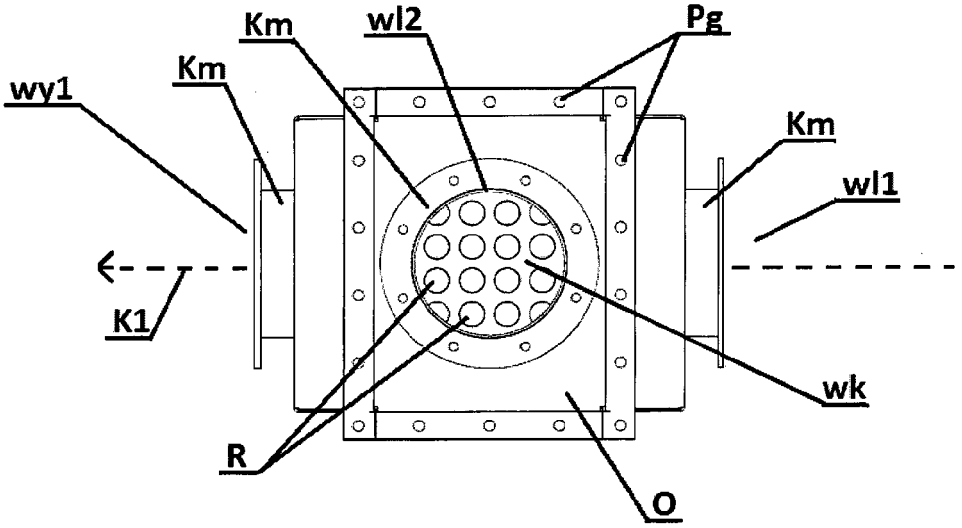

Fig. 4

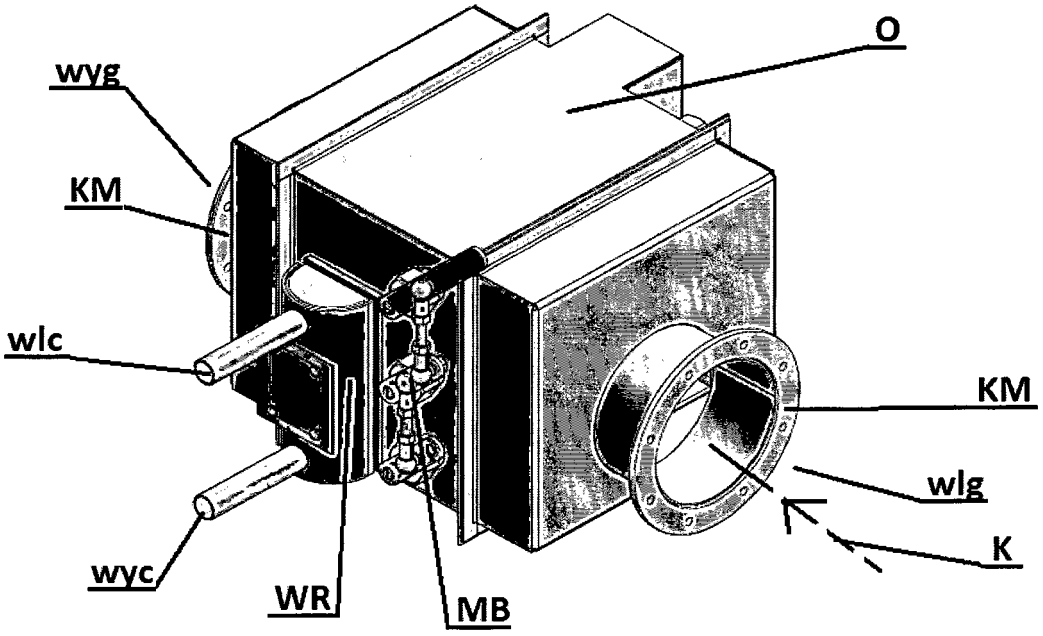

Fig. 5

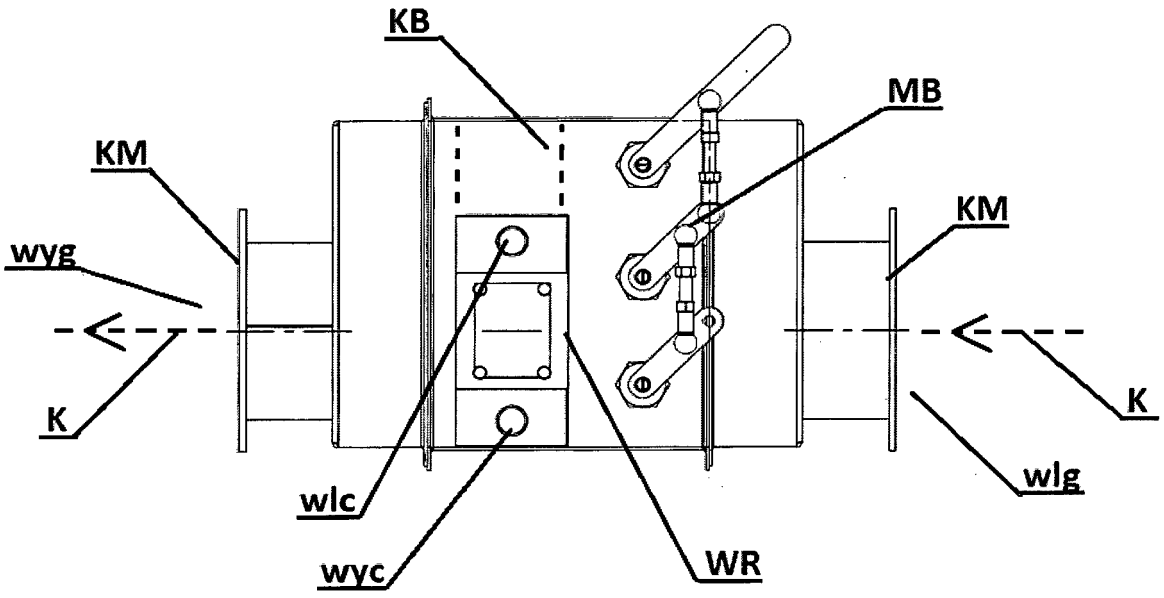

Fig. 6

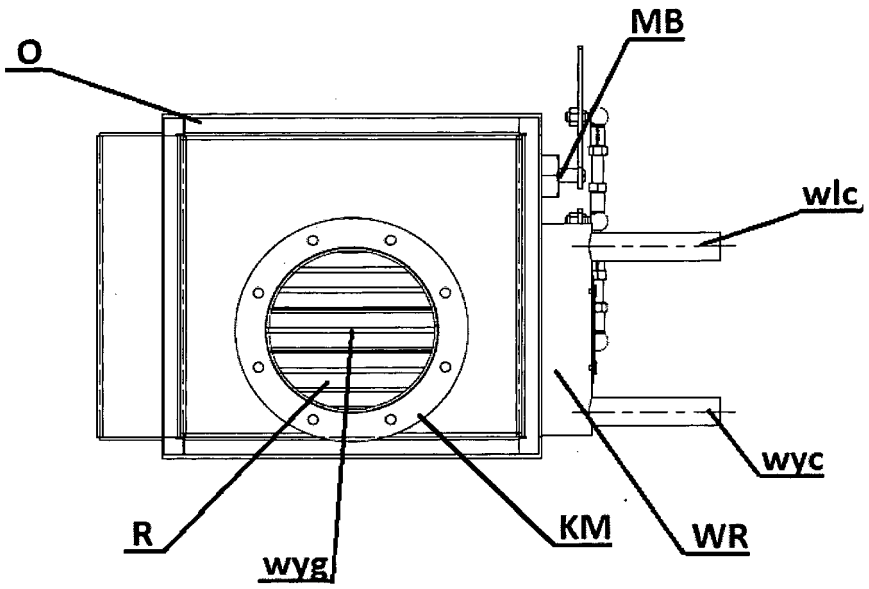

Fig. 7

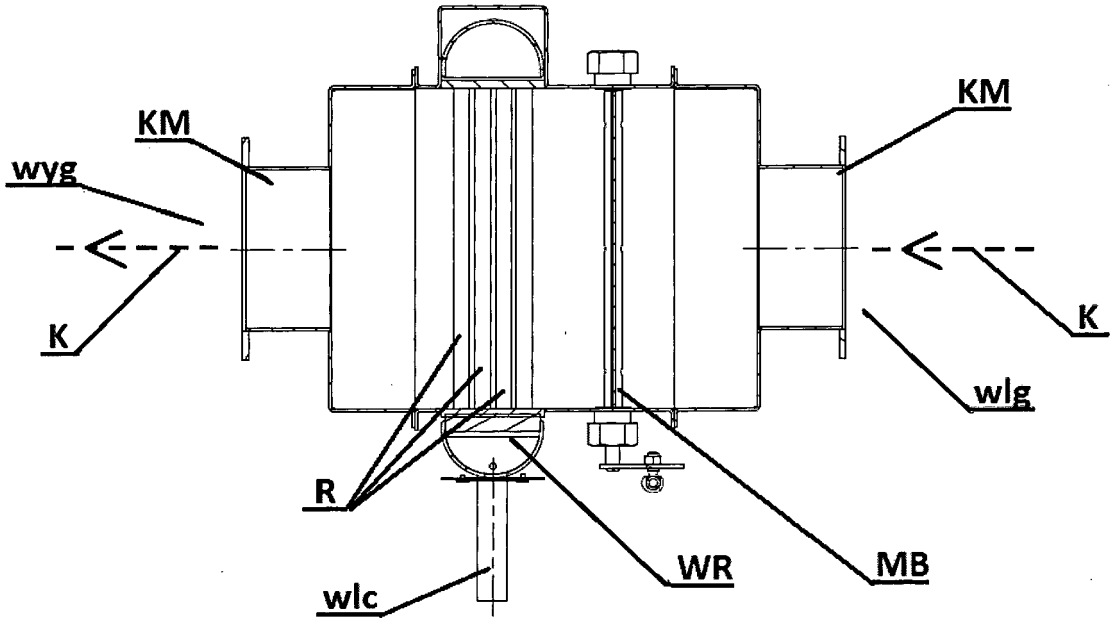

Fig. 8

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EUROPEAN SEARCH REPORT

Application Number
EP 16 46 0099

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	FR 2 356 494 A1 (BRETAGNE ATEL CHANTIERS [FR]) 27 January 1978 (1978-01-27) * figure 1 * -----	1-3	INV. F28F9/00 F28F9/16
X	DE 31 43 088 A1 (HOECHST AG [DE]) 11 May 1983 (1983-05-11) * figure 1 * -----	1-3	ADD. F28D7/16
X	US 4 323 115 A (STAFFORD DONALD C ET AL) 6 April 1982 (1982-04-06) * figure 1 * -----	1-3	
A	US 2004/226701 A1 (LOMAX FRANKLIN D [US] ET AL) 18 November 2004 (2004-11-18) * figure 2 * -----	1-3	

TECHNICAL FIELDS SEARCHED (IPC)

F28F
F28D

~~The present search report has been drawn up for all claims~~

Place of search	Date of completion of the search	Examiner
Munich	27 June 2017	Vassoille, Bruno

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

Europäisches Patentamt
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Application Number
EP 16 46 0099

CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing claims for which payment was due.

☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due and for those claims for which claims fees have been paid, namely claim(s):

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

☐ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

☒ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

1-3

☐ The present supplementary European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims (Rule 164 (1) EPC).

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LACK OF UNITY OF INVENTION
SHEET B

Application Number
EP 16 46 0099

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 1-3

   Relates to a shell-and-tube heat exchanger, whereby the tubes are glued to the tube sheets and a shell connected with screws.

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2. claims: 4-8

   Relates to a shell-and-tube heat exchanger having a by-pass channel and a control mechanism to let fluid flow through the by-pass channel.

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3. claims: 9, 10

   Relates to a method of protecting a heat exchanger with a coating.

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 16 46 0099

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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27-06-2017

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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