United States Patent

Bo

[15] **3,664,413**

[45] **May 23, 1972**

[54] COLLECTION HEAT EXCHANGERS FOR GASEOUS FLUIDS IN GENERAL, PARTICULARLY HEATERS OF BURNING AIR FOR STEAM HEATERS IN MARINE AND LAND INSTALLATIONS

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[73] Assignee: **Ansaldo Meccanico-Nucleare S.p.A.,** Genoa, Italy

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[21] Appl. No.: **875,313**

[30] **Foreign Application Priority Data**

May 31, 1969 Italy 7079 A/69

[52] **U.S. Cl.** **165/4,** 165/5, 165/9

[51] **Int. Cl.** **F28d 17/04**

[58] **Field of Search** 165/4, 9

[56] **References Cited**

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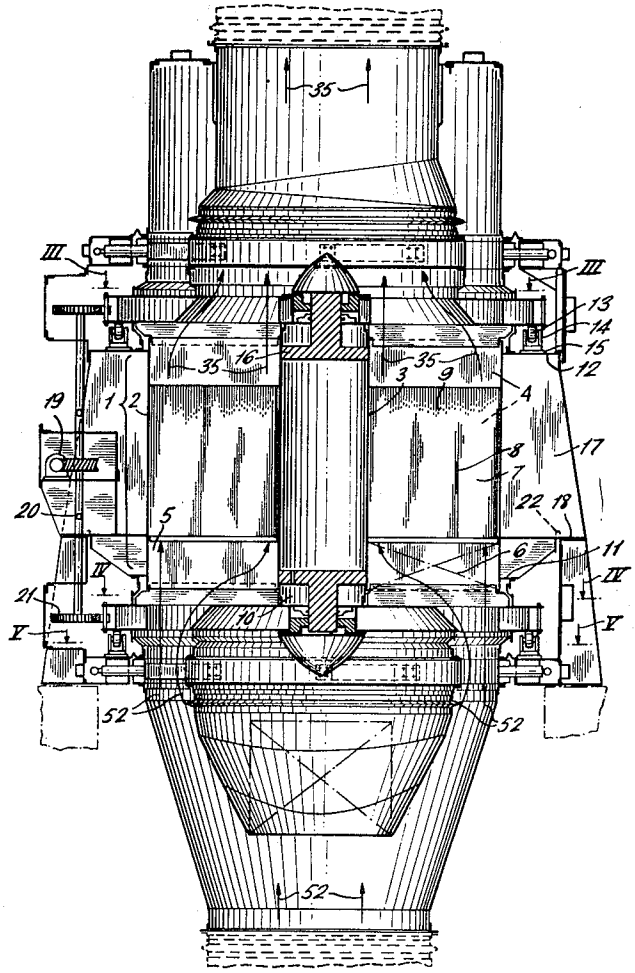
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Primary Examiner—Albert W. Davis, Jr.
Attorney—Robert E. Burns

[57] **ABSTRACT**

A regenerative heat exchanger of the type used in heating air for furnaces by the heat of gaseous combination products comprises a stationary cylindrical casing divided by flat radial walls into a plurality of like compartments. Regenerative material occupies central portions of the compartments while leaving distribution spaces at opposite ends. The cylindrical casing is disposed between two stationary concentric pipe connections at opposite ends of the casing for supplying, transporting and discharging the air and combustion products respectively. Valving of the gas and air successively to the several compartments containing the regenerative material is effected by circular flat plates disposed at opposite ends of the cylindrical casing and between the casing and the pipe connections. Each plate has at least one port for each of the gaseous fluids disposed facing the respective pipe connection. The plates are rotatably supported and are driven in synchronism with one another. Sealing means is provided between the plates, cylindrical casing and pipe connections.

12 Claims, 28 Drawing Figures

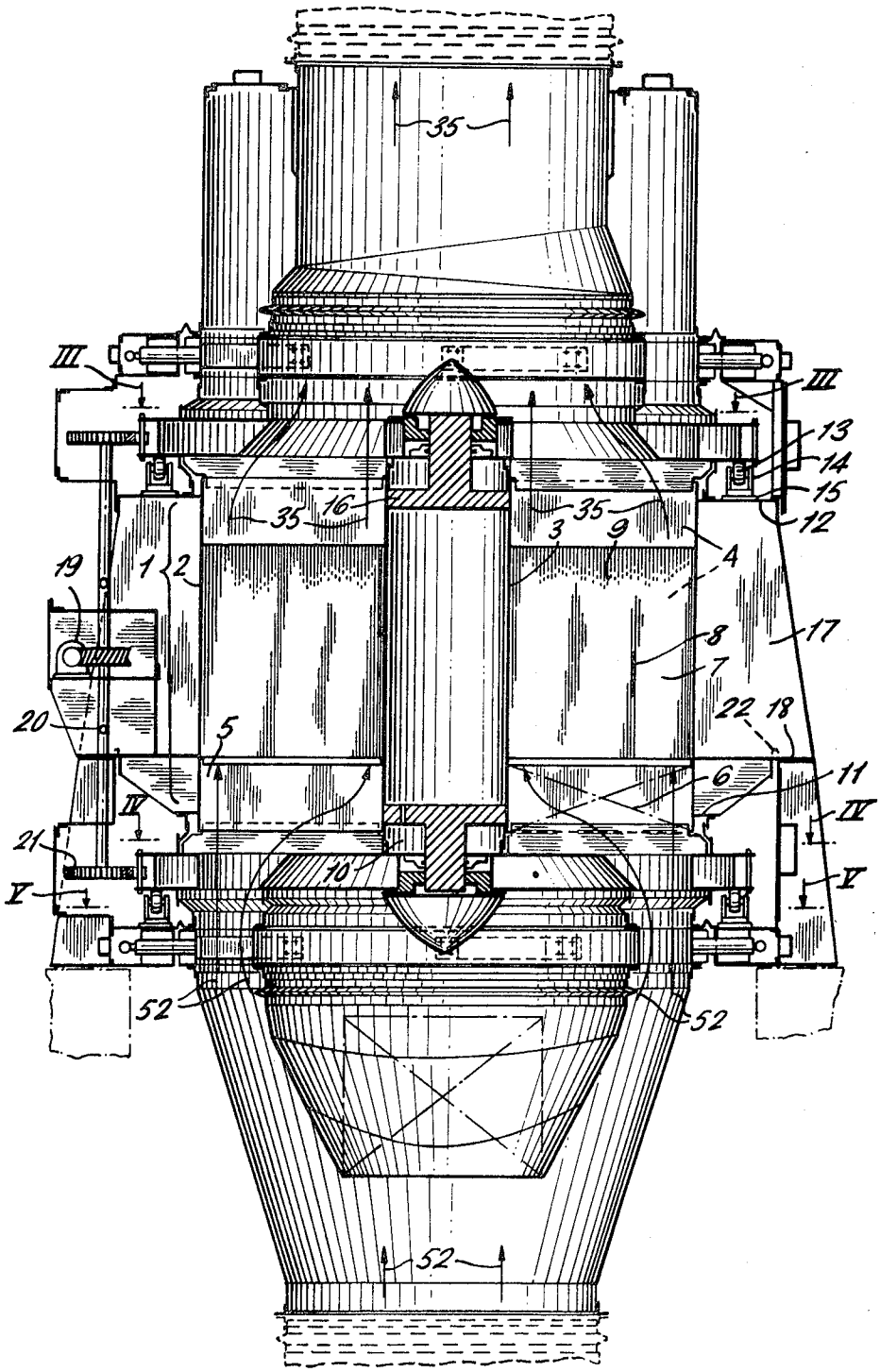


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SHEET 01 OF 10

FIG. 1.



SHEETS - SHEET 1 - S.N. 875,313 - Inventor: BO - By: Robert E. Burns
Attorney

FIG. 2.

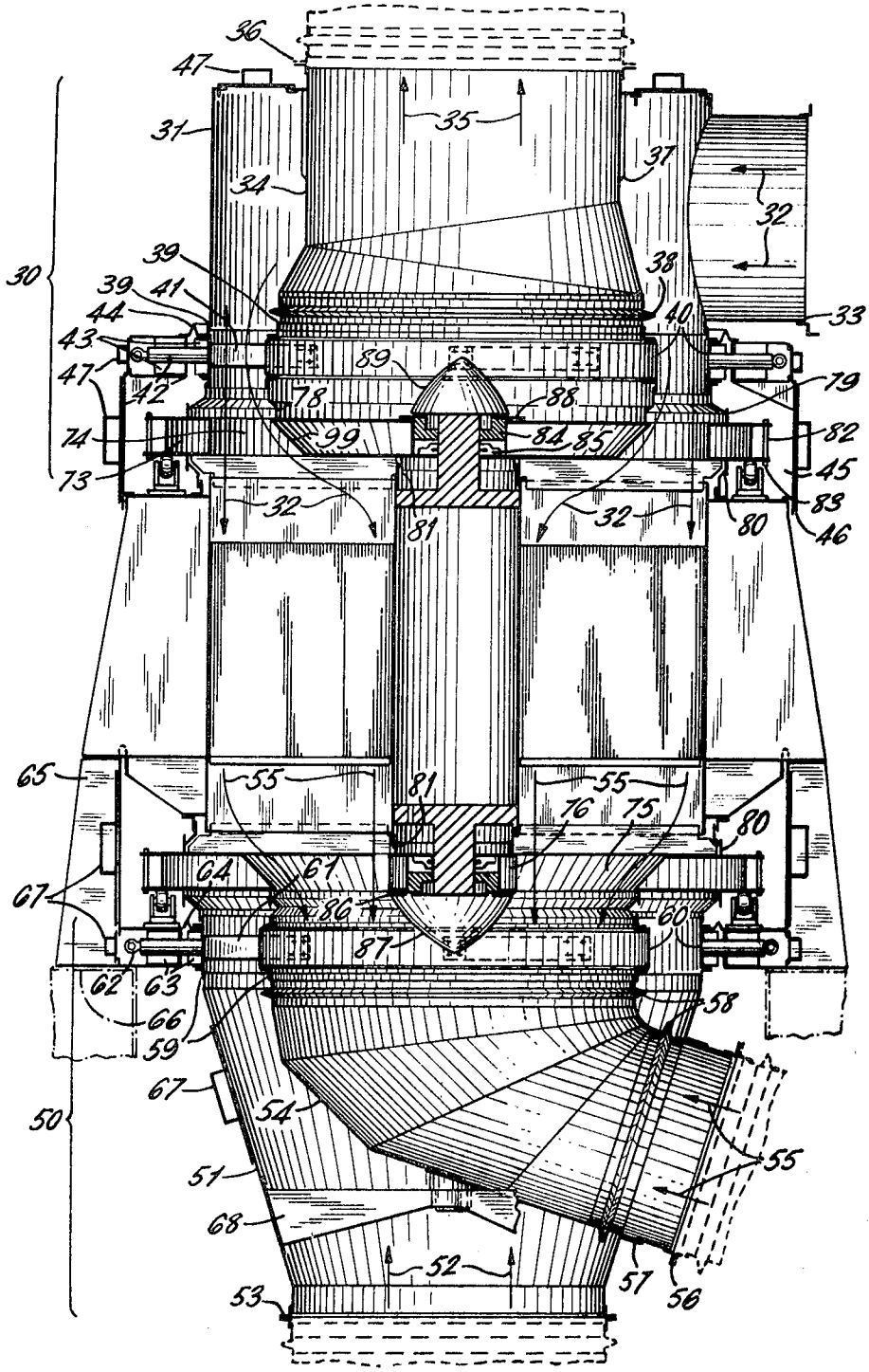

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FIG. 3.

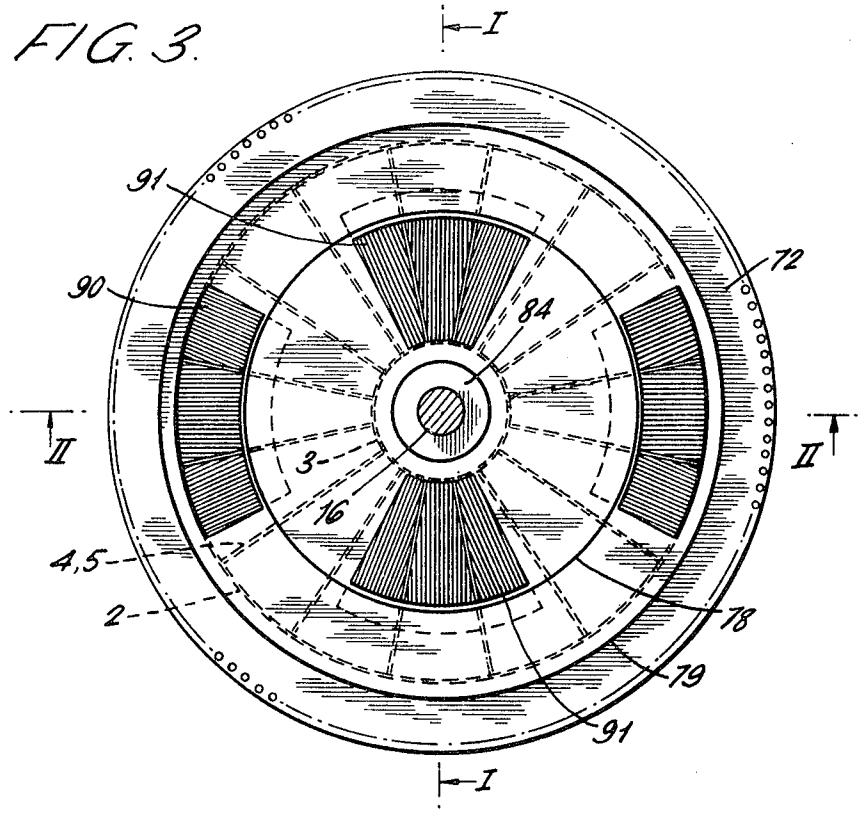

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FIG. 4.

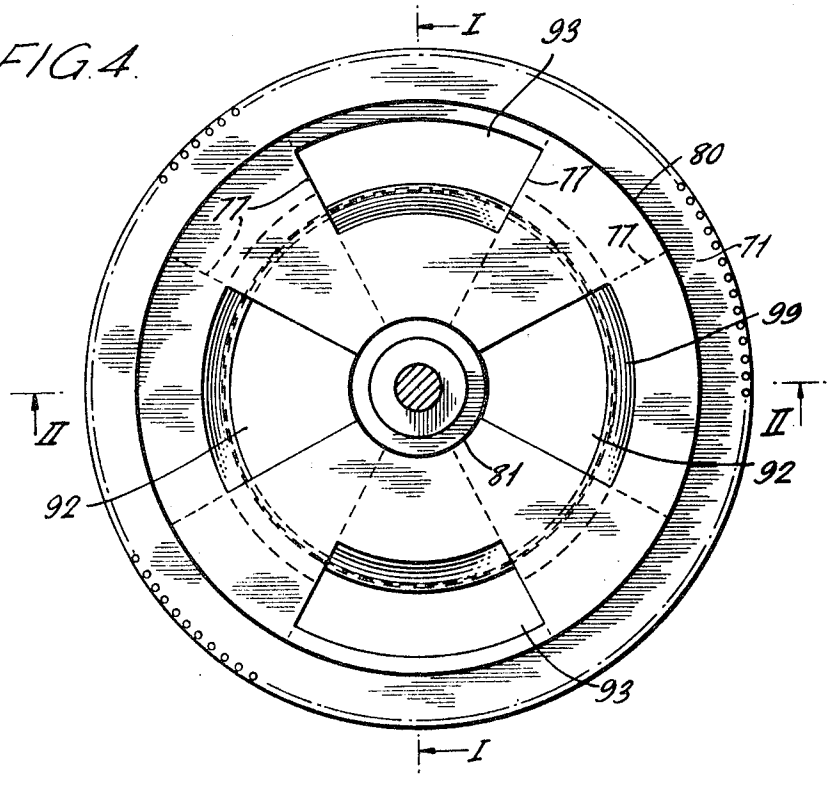

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FIG. 5.

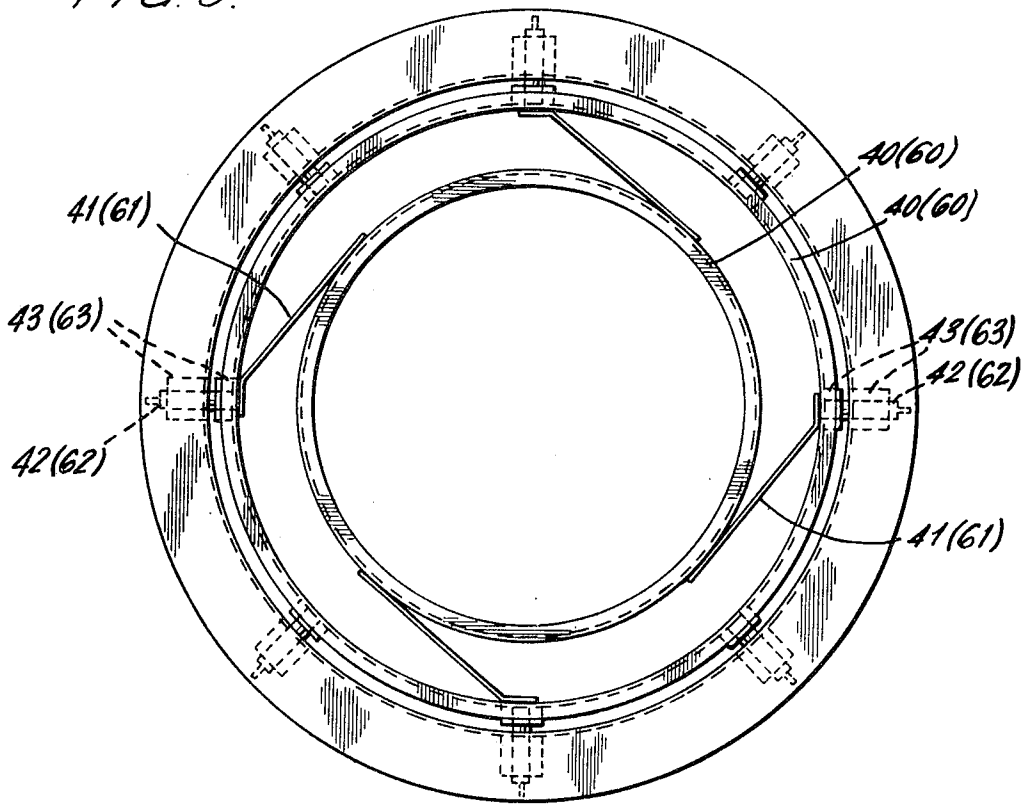

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FIG. 6.

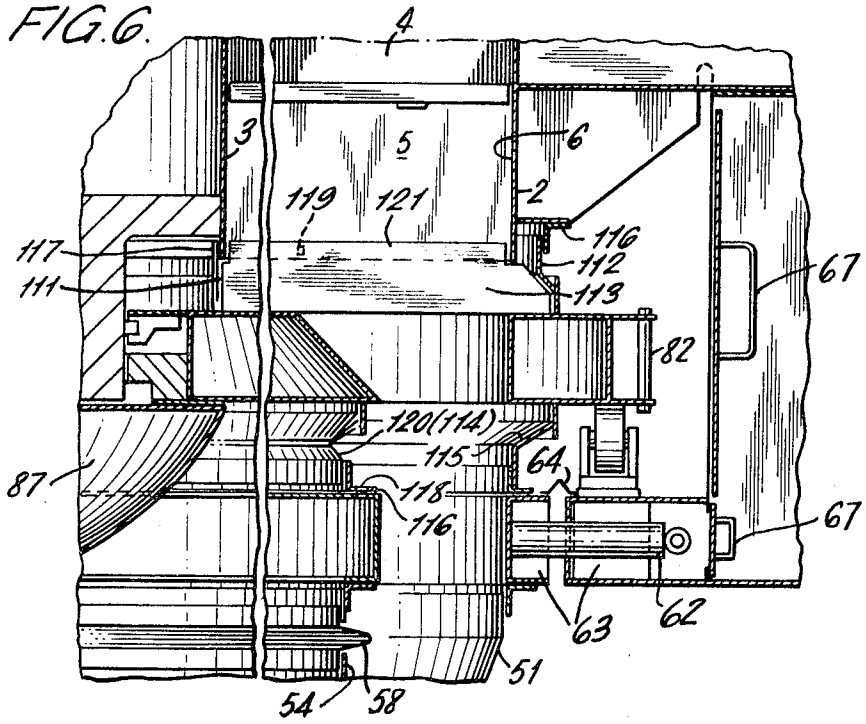

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FIG. 7.

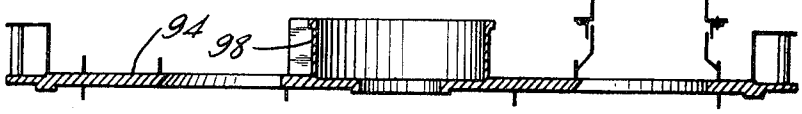


FIG. 8.

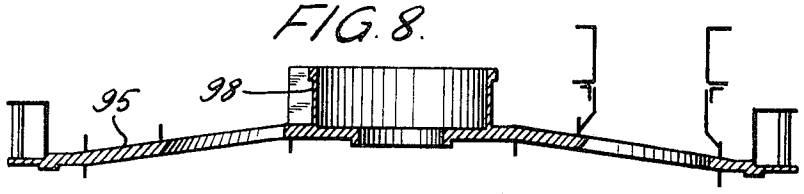


FIG. 9.

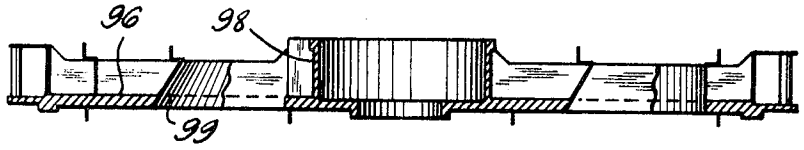
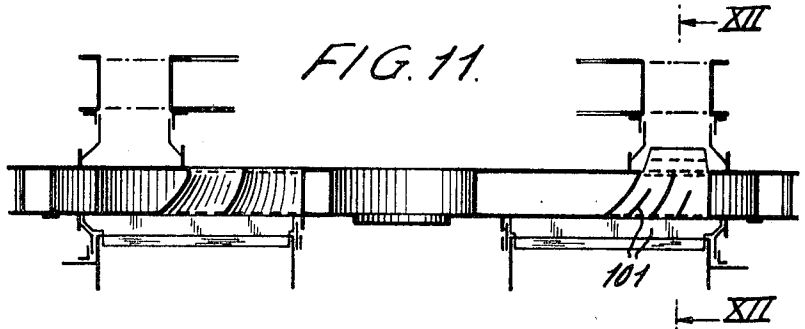


FIG. 10.



FIG. 11.



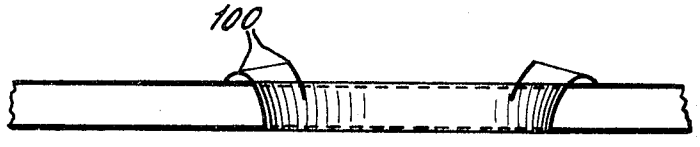


FIG. 12.

FIG. 13.

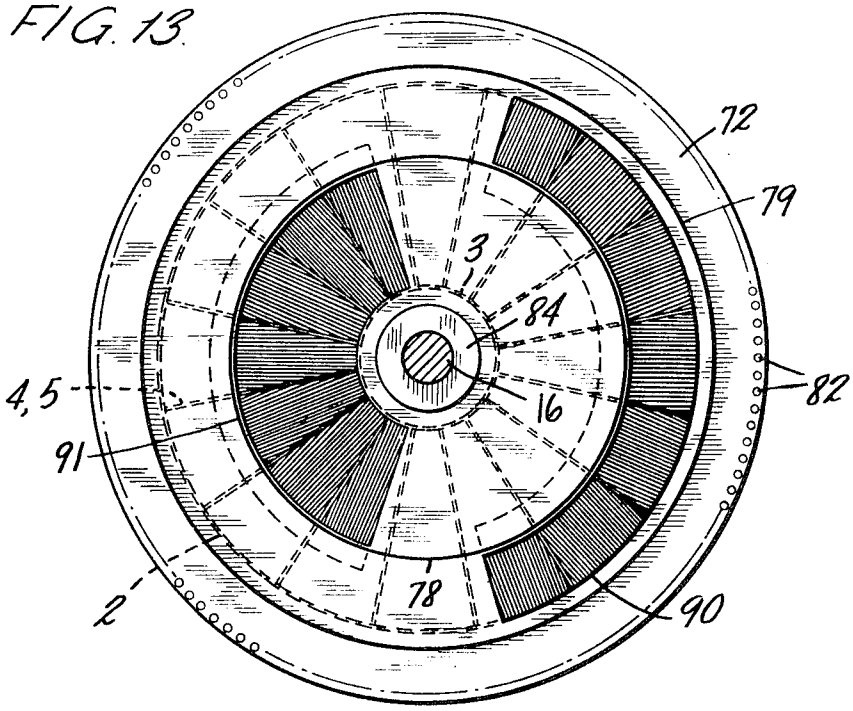


FIG. 14.

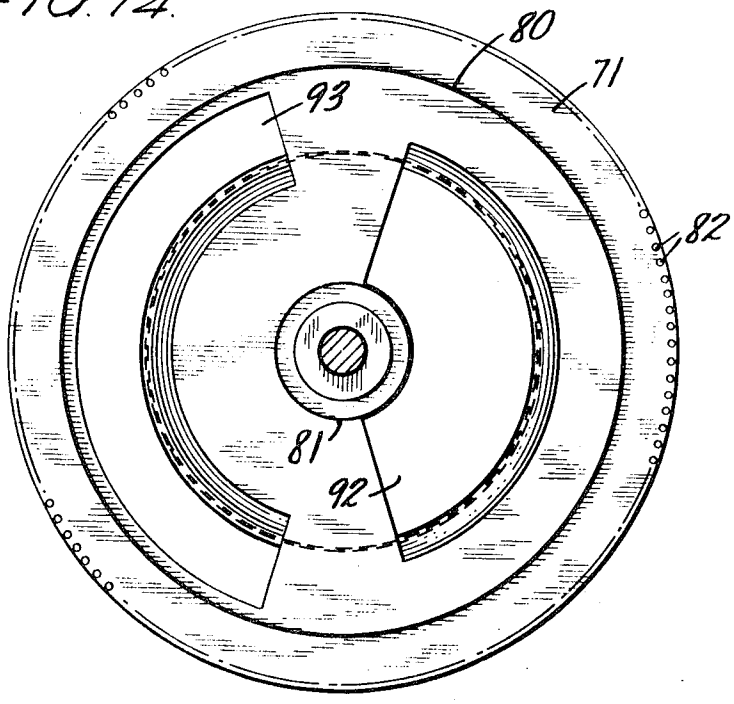


FIG. 16.

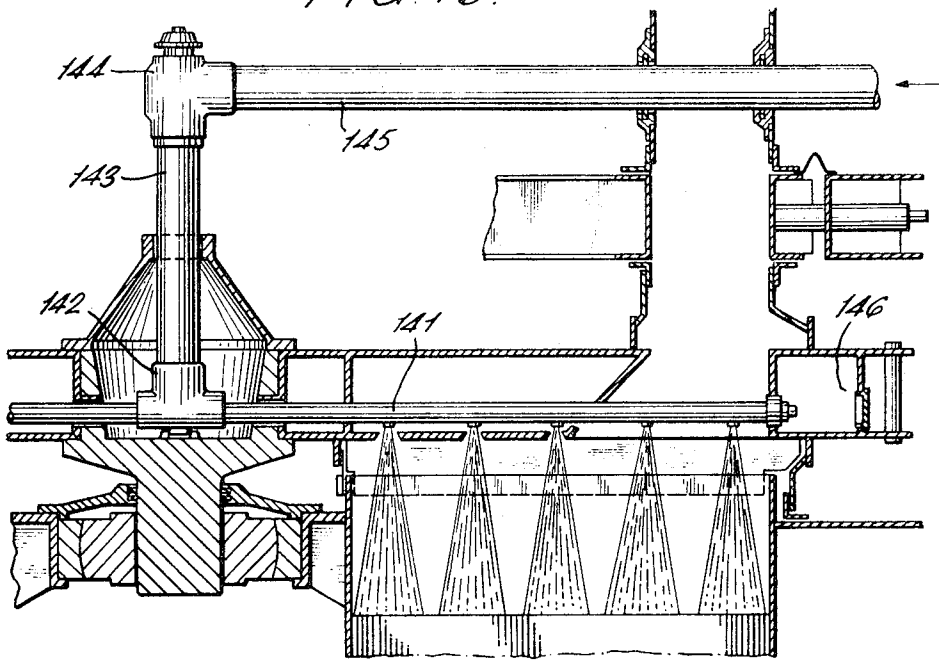


FIG. 15.

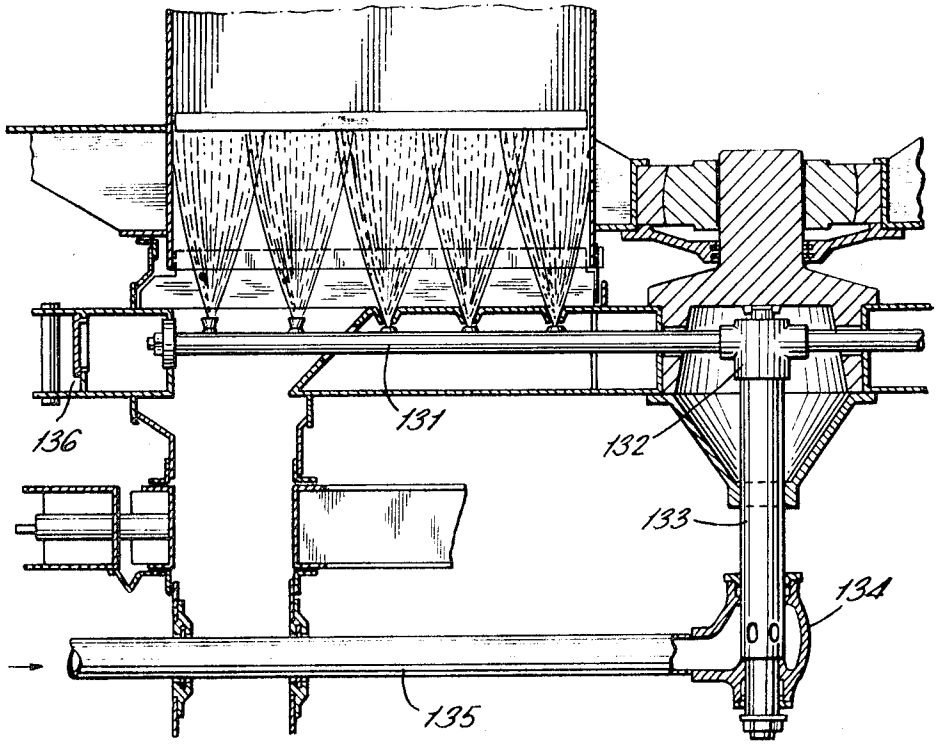


FIG. 17.

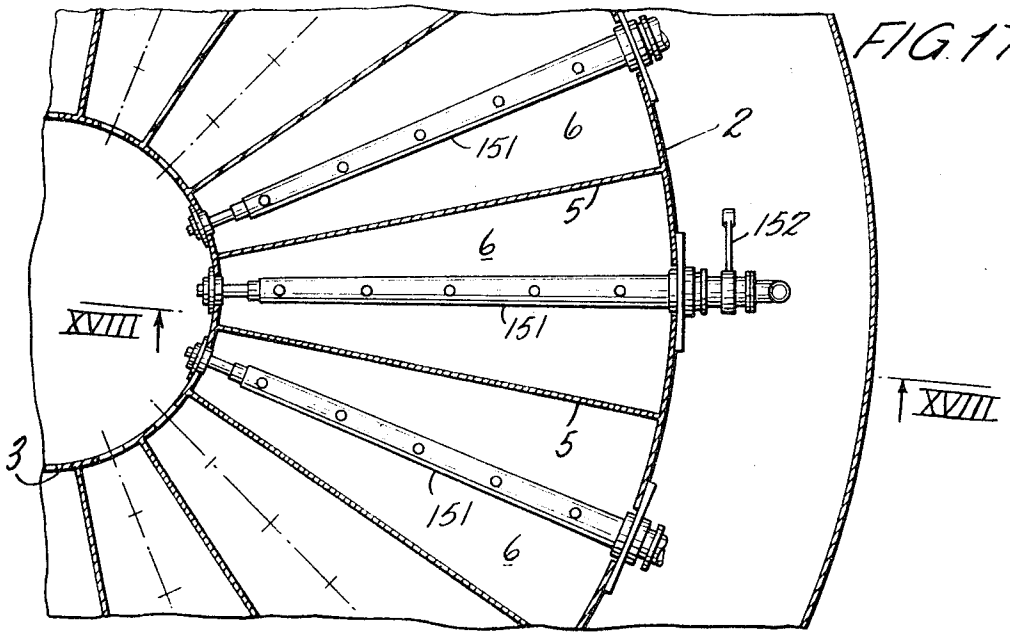


FIG. 18.

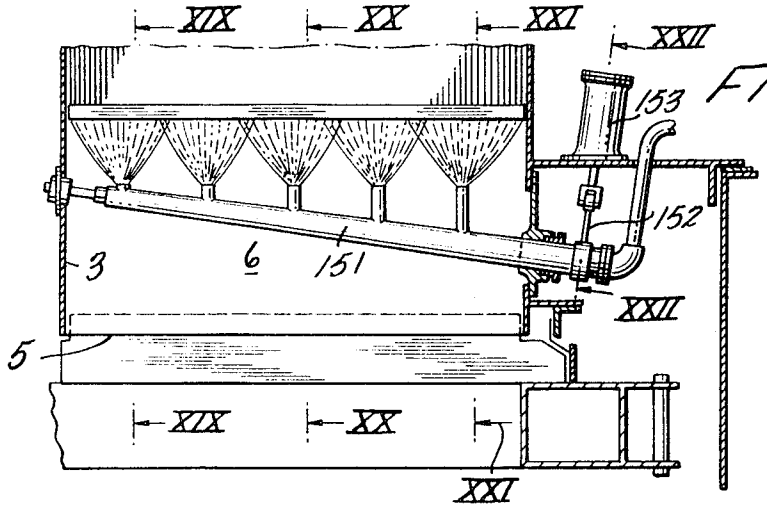
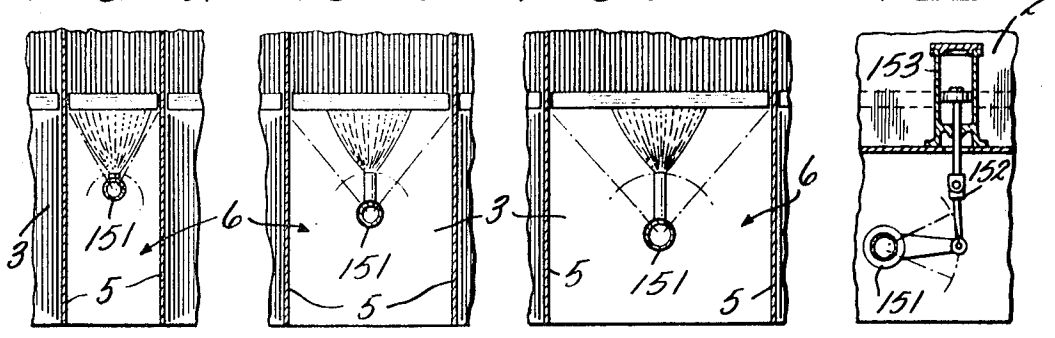


FIG. 19. FIG. 20. FIG. 21. FIG. 22.



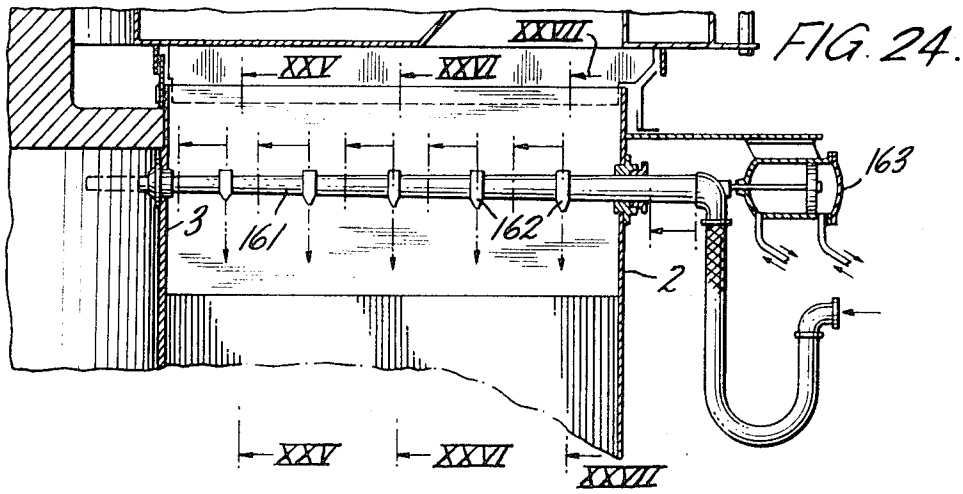


FIG. 24.

FIG. 23.

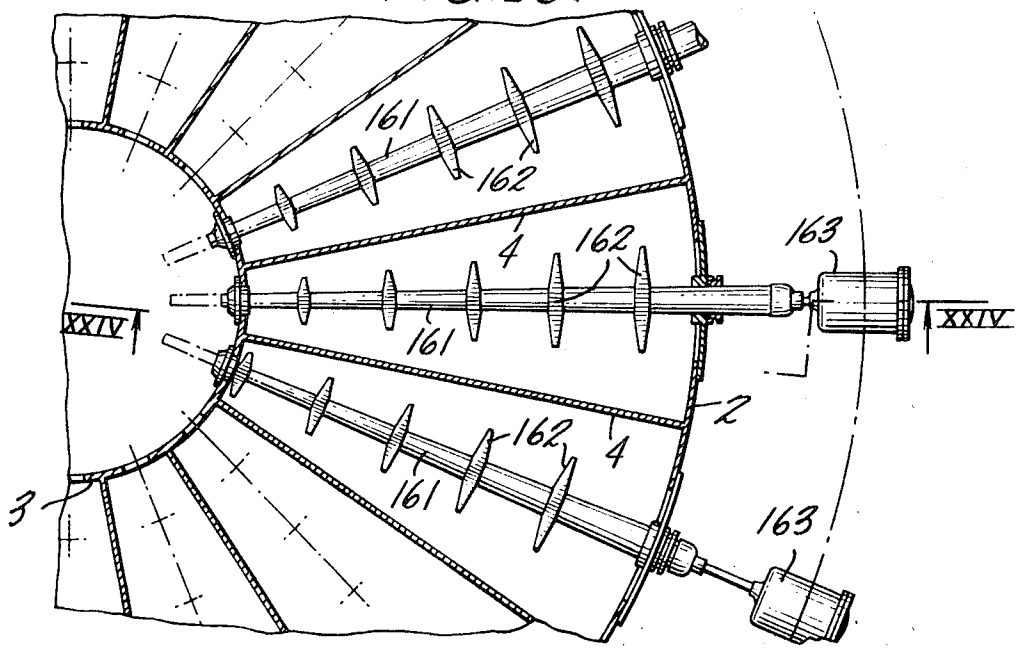


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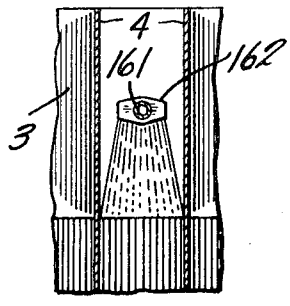


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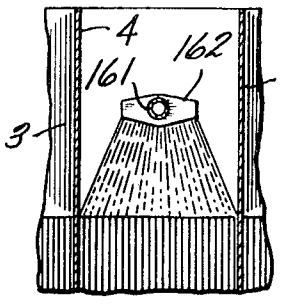


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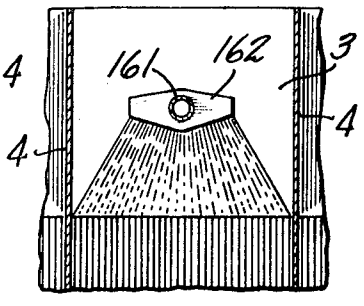
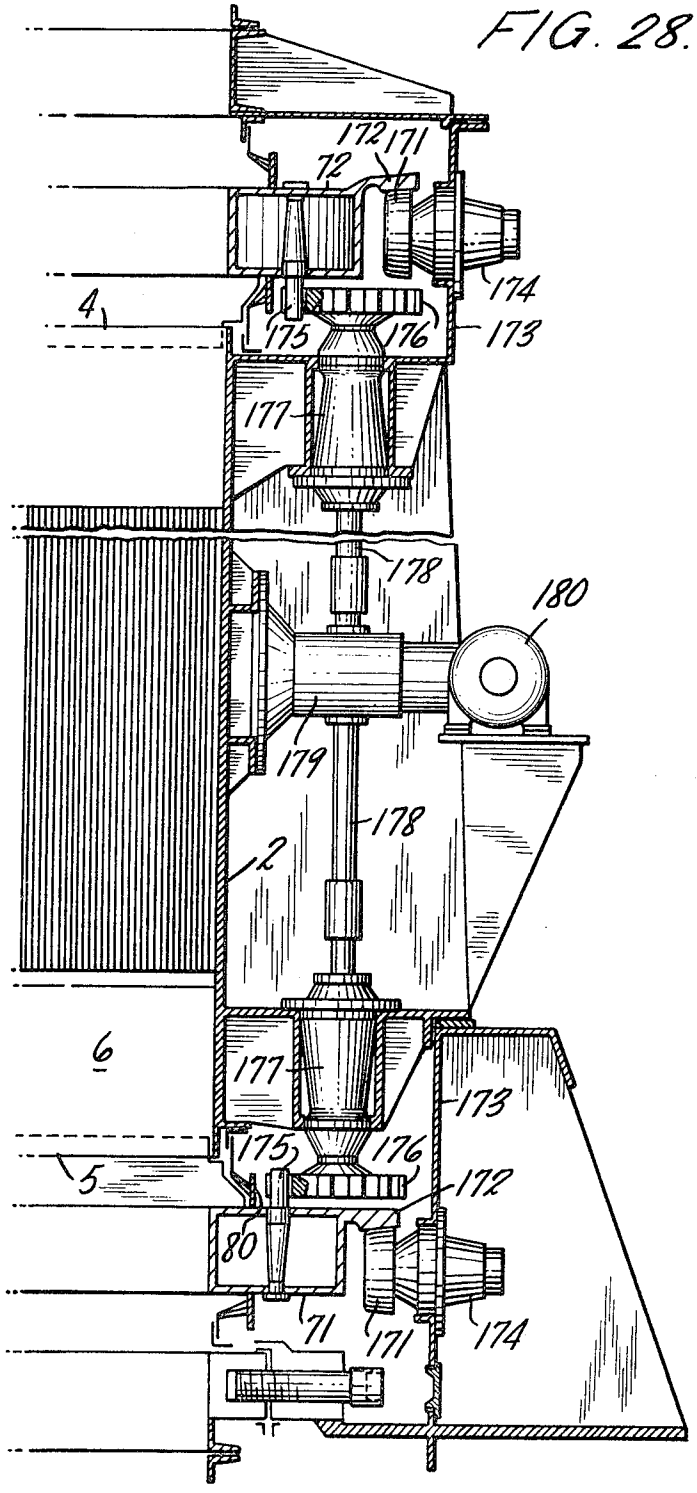


FIG. 28.


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COLLECTION HEAT EXCHANGERS FOR GASEOUS FLUIDS IN GENERAL, PARTICULARLY HEATERS OF BURNING AIR FOR STEAM HEATERS IN MARINE AND LAND INSTALLATIONS

BACKGROUND OF INVENTION

The present invention concerns heat exchangers for the thermal recovery between the combustion products and the burning air for steam boilers in marine propelling installations or land thermoelectrical plants, through cyclic accumulation and transfer of heat by a suitable material.

Two types of heat exchanges with opposed technical and constructive solutions are well known and used,i.e.:

a) a type comprising rotating parts consisting of a cylinder containing thermally active material in laminar or cellular form, said cylinder is to be passed through axially by the heat exchanging and has a horizontal or vertical rotation axis; while all the other parts comprising the fluid distributing and collecting pipes, the pipes feeding said fluids to the four outside connection ports or conduits,as well as the casings,frame and the like are stationary;

b) another type comprising rotating parts consisting of the inner distributing,collecting and transporting pipes, with a horizontal or vertical rotating axis; while all the other parts, from the cylinder containing an active material to the casing and frame, are stationary.

The requirements, difficulties,advantages and performances of each of said types are well known. As a matter of fact,it is to be considered for type a) the stiffness and balancing of the cylinder containing the active material, the remarkable weight thereof and the mechanical parts for the rotary motion; while for type b) the structurally unfavorable shape and the considerable size of the inner rotating pipes for distributing,transporting and collecting the fluids.

SUMMARY OF THE INVENTION

The main object of the present heat exchanger, which is of the type with stationary heat accumulating material,is to further separate in two parts the inner movable elements which are necessarily tridimensional: a first practically bidimensional part provided with a rotary motion and reduced,under a constructive point of view, to flat (or slightly curved) discs and provided with ports symmetrically distributed according to a particular geometric arrangement for progressively distributing and collecting the fluids; a second tridimensional stationary part in the geometrically simplest form, for the inner transport of the fluids; said rotating part having preferably a vertical rotating axis.

Said rotating part consists of two fluid distributing and collecting discs which are specularly arranged, statically balanced and of reduced mass and weight. Said discs are guided by a central pivot and carried by a crown of peripheral rollers, are actuated by an outer motoreducer with a pinion engaging a peripheral rack of theirs, are freely expansible and not subject to deformation dangerous for the fluid seals and mechanical operation, finally they guarantee a sure and long performance with a limited and easy maintenance. There are no problems in the choice of the kind and quality of the thermal exchange active material, as the latter is housed in the stationary part.

For said qualities and forms the exchangers according to the present invention are particularly suitable for marine propelling installations as well as for land thermoelectric plants. Further advantages will appear in the description of the exemplified embodiment, as for instance the possibility of selecting for the discs the number of ports which is more convenient to meet the laws of heat transmissions with respect to the heat exchanging material used.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings show by way of example only a preferred embodiment of the object of the present invention.

FIG. 1 shows a simplified meridian section of the heat exchanger set taken on the line I—I in FIG. 3.

FIG. 2 shows the a simplified meridian section taken on the line II—II,which is orthogonal to the preceding one, of the heat exchanger set.

FIGS. 3 and 4 show cross sections taken on the line III—III and IV—IV in FIG. 1 respectively corresponding to the upper and lower rotating distributing discs.

FIG. 5 shows cross section taken on the line V—V in FIG. 1 showing a precision centering system for the ends of the coaxial conduits with respect to the distributing discs.

FIG. 6 is a portion of FIG. 1 showing (on an enlarged scale) a detail the sliding seals between rotating distributors and stationary parts.

FIGS. 7 to 11 show, in meridian section at an angle of 90° and then rotated to a single plane, various constructive kinds of rotating distributing discs and in particular: FIG. 7 shows a distributing disc in the form of a simple flat plate, FIG. 8 shows a disc in the form of a simple curved frusto-conical plate,FIG. 9 shows a disc in the form of a simple ribbed flat plate with nozzles at the ports, FIG. 10 shows a disc in the form of a double flat plate and with a cellular structure provided with inner ribs, the passage ports being provided between the plates with surrounding walls, and FIG. 11 shows the disc of FIG. 10 with the ports having outlined nozzles provided with diverging and converging direction blades.

FIG. 12 shows a mean cylindrical section of said nozzles on the line XII—XII of FIG. 11.

FIG. 13 shows a modification concerning the upper distributing disc,which consists of having a single opening or port in each of the two circular crowns each distributing disc being divided in two by means of a separating cylindrical rib.

FIG. 14 shows the same modification for the lower distributing disc.

FIG. 15 shows the blowing of air and/or steam in phase with the flow of fumes in the exchanging material mass.

FIG.16 shows the washing of said mass in phase with the air flow.

FIG. 17 is a partial plan showing a modification in said blowing. FIG. 18 is a section on the line XVIII—XVIII in FIG. 17. FIGS. 19 to 22 are sections taken on the lines XIX—XIX to XXII—XXII in FIG. 18.

FIG. 23 is a partial plan showing a modification in said washing. FIG. 24 is a section on the line XXIV—XXIV in FIG. 23. FIGS. 25 to 27 are sections taken on the lines XXV—XXV to XXVII—XXVII in FIG. 24.

FIG. 28 shows a modification in the carrying and drawing of the distributing discs.

DESCRIPTION OF THE INVENTION

With reference to the cylindric intermediate body shown in the figures,numeral 1 denotes the cylindric intermediate body (stationary in the exchanger), 2 an outer cylindric casing,3 an inner cylindric casing, 4 complete flat meridian walls,5 a part projecting from the pack of the complete meridian walls,6 a radial chamber for the fluid distribution and collection, 7 reduced and not-projecting meridian walls,8 intermediate and not-projecting coaxial cylindric walls,9 a thermally active filling material, 10 a housing for a stationary pivot for centering a distributor disc, 11 an outer lower crown, 12 an outer upper crown, 13 curved discs for disc peripheral support,said discs being provided with an axis and a bearing,14 demountable supports for said discs, 15 levelling plates of the curved discs for disc peripheral support, 16 a stationary pivot for centering the distributing disc,17 a resting foot, 18 a sliding abutment, 19 a motoreducer,20 joints of said motoreducer, 21 pinions of said motoreducer, 22 seal bellows.

With reference to the upper head shown in the figures, numeral 30 denotes the upper head (stationary in the exchanger),31 an outer casing receiving fresh air, 32 an upper inlet flow for the fresh air (arrows), 33 a connection flange for the outer conduit of fresh air, 34 an inner casing receiving cold fumes,35 an upper outlet flow for the cold fumes (arrows), 36 a connection flange of the fume conduit to the chimney, 37 an elastic connection between the outer and the inner

casings, 38 a sprung body, 39 connection flanges of casings 31 and 34 to C-shaped sections, 40 concentric C-shaped section, 41 sheets for centering,radially guiding and supporting the inner C-shaped section, 42 pivots for centering,radially guiding and supporting the outer C-shaped section, 43 bushes receiving pivots 42, 44 a seal bellows, 45 cylindric supports for the upper head, 46 connection and abutment flange for supporto 45 on the cylindric body 1, 47 check and service doors.

With reference to the lower head shown in the figures,numeral 50 denotes the lower head stationary in the exchanger,51 an outer casing receiving the hot fumes,52 a lower inlet flow for the hot fumes (arrows),53 a connection flange for the hot fume outer conduit,54 an inner casing receiving hot air, 55 a lower outlet flow of the hot air (arrows),56 a connection flange for the hot air outer conduit to the burners, 57 elastic connection between the outer and inner casings, 58 sprung bodies,59 connection flanges for casings 51 and 54 to C-shaped sections, 60 concentric C-shaped sections, 61 sheets for centering,radially guiding and supporting an inner C-shaped section, 62 pivots for centering,radially guiding and supporting an outer C-shaped section, 63 bushes receiving pivots 62, 64 a seal bellows, 65 an abutment seat for the cylindric body and lower head, 66 abutment plane for said seats 65, 67 check and service doors, 68 a support for the inner casing.

With reference to the distributing discs shown in the figures, numeral 70 denotes rotating distributing discs, 71 a lower rotating distributing disc, 72 an upper rotating distributing disc,73 an outer cellular crown, 74 a cellular crown, 75 an inner cellular crown provided with ports, 76 an inner crown, 77 a cellular cross connecting 73 and 76, 78 a sealing severing outer cylindric rib, 79 a sealing complementary outer cylindric rib, 80 a seal inner cylindric rib on casing 2, 81 a seal inner cylindric rib on casing 3, 82 a peripheral rack provided with pivots,83 a hardened path for roller rolling, 84 a guide (and possibly also thrust) bearing, 85 seal of said guide bearing,86 an engagement and seal flange for the lower disc of the guide bearing, 87 a suitable shaped cover integral with the lower disc of the guide bearing, 88 an engagement flange of the upper disc of the guide bearing, 89 a gland and a suitably shaped stationary cover for the upper disc of the guide bearing, 90 a fresh air inlet of the upper distributing disc, 91 cold fume outlets of the upper distributing disc, 92 hot air outlets of the lower distributing disc, 93 hot fume inlets of the upper distributing disc, 94 simple flat plate with reinforced thickness of the distributing disc shown in FIG. 7, 95 a simple frusto-conical shield-like plate of the distributing disc shown in FIG. 8, 96 a ribbed simple flat plate with nozzle of the distributing disc shown in FIG. 9, 97 double flat plate with cellular structure of the distributing disc shown in FIG. 10, 98 a bearing cylindric housing (see FIGS. 7, 8 and 9), 99 nozzle-like contour walls of the ports (see FIGS. 9 and 10), 100 starting blades for fluodynamic flow on the converging side, 101 starting blades for the fluodynamic flow on the diffusor side.

With reference to the seals between the distributing discs and the stationary parts shows in FIG. 6, numeral 111 denotes sheet seals between the disc and the inner cylindric casing 3, 112 sheet seals between the disc and the outer cylindric casing 2, 113 sheet seals between the disc and the projecting meridian walls 5, 114 sheet seals between the disc and the inner C-shaped section 40, 115 sheet seals between the disc and the outer C-shaped section 40, 116 circular portions of angular sections for seals 112,114 and 115, 117 circular portions of flat sections for seals 111, 118 radial buttonholes for adjusting the radial clearance on the radial section 116, 119 axial buttonholes for adjusting the axial clearance on seals 111,112,113,114 and 115, 120 a variant to seal 114 with multiple sealing, 121 straight flat sections for seals 113.

With reference to the blowing apparatus shown in FIG. 15, numeral 131 denotes a radial blower of air and/or steam, 132 a three-way connection with a central pivot,133 a turnable axis pipe, 134 a stationary connection with two glands; 135 a stationary feeding pipe, 136 a closure plug.

With reference to the washing apparatus shown in FIG. 16, numeral 141 denotes a washing radial pipe, 142 a three-way connection with a central pivot, 143 a turnable axial pipe, 144 a stationary connection with two glands, 145 a stationary feeding pipe, 146 a closure plug.

According to a preferred embodiment of the invention, said heat exchanger comprises:

- a cylindric intermediate body 1 which is stationary and provided with supporting feet (FIGS. 1 and 2),
- an upper head 30 and a lower one 50 (FIGS. 1 and 2),
- two rotating distributing discs 71 and 72 (FIGS. 3 and 4),
- seals between the distributing discs and the stationary parts (FIG. 6),
- blowing and washing apparatus (FIGS. 15 and 16).

Said cylindric body is stationary and consists of two concentric cylindric casings 2 and 3 with a vertical axis, between said two casings being placed the material 9 which in a first time receives heat from the fumes and then transfer said heat to the burning air. Said material receiving and giving heat may be of corrugated metal sheet, ceramic material, refractory material and the like. Said material is distributed within the cylindric body except for the two ends of said body.

Flat diaphragms 4 and 5 are radially arranged between the two cylindric casings, the lying plane of said planes coinciding with the axis of the cylindric body. Said diaphragms end at the ends of said cylindric body and each of them has a sealing (radial) strip 113 which brushes with the radial side the horizontal plane of the distributing disc. The inner cylindric casing 3 and the outer one 2 have at their ends cylindric seals 111,112 which brush the cylindric surfaces 80,81 projecting from the disc. Therefore, at the two ends of the cylindric body,between the two cylindric casings, there are a plurality of gas-tight chambers 6 which serve for the radial distribution and collection of the gaseous fluid and thus are called distributing and collecting chambers. The number of said chambers is the same as that of the diaphragms.

A crown 12 bearing roller carrying blocks 14 is provided on the upper outer portion of the cylindric casing. Said roller carrying blocks and the relevant rollers 13 are all equal and interchangeable with each other and with those arranged on the support seats 65. The roller carrying crown may be the upper portion of the support feet.

The axis of said rollers is radial and normal to the axes of the cylindric body and their surface is curved in order to avoid the different peripheral speeds. The rollers arranged on crown 12 carry the upper distributing disc 72, while the rollers arranged on the support seats carry the lower distributing disc 71. The weight of the material receiving and giving heat is carried by the two cylindric casings and the diaphragms. The whole cylindric body is carried through the support feed 17 by said support seats. The latter are fixed on the metal structure of the ship or the foundation plates of the land thermal plant. A sliding contact 18 may be provided, particularly in case of large sizes,between the support feet and the seat, so as to allow a regular expansion of the cylindric body. To this end, crowns 11 and 12 and every circumferential rib existing on the outer casing,may have radial cuts so as to allow a regular expansion of the cylindric body.

Inside the inner cylindric casing and at its two ends there are two housings 10 receiving two pivots 16, said pivots serving as a guide for the two distributing discs. Said cylindric body may consist, for constructive reasons, of several portions which are then assembled by welding. After the complete welding or,for encumbrance reasons,after the welding of the portions forming the cylindric body an extension annealing is performed.

Therefore, the necessary mechanical operations are the following:

- boring housings 10 at the two ends of the inner cylindric casing;
- levelling upper brackets 12 and lower ones 11 arranged outside the cylindric casing and the supports feed 17 (the upper brackets carry besides the seals the roller carrying blocks); said levelling ought to be normal to the boring of said chambers;

drilling said two housings so as to fasten the guide pivots to the two distributing discs;

performing bores in order to fasten the sections carrying seals **116,117,121**,

levelling and drilling inorder to fasten the motoreducer.

The cylindric body according to the example described works as follows: the cold air enters from the top at the outside and exits on the bottom at the inside; the fumes enter on the bottom at the outside and exit from the top at the inside. Two adjacent diaphragms and two cylindric arcs of the casings, one inner and the other outer, form a tight conduit for the gaseous fluid. The center of said conduit, as above said, is filled with material absorbing and giving heat, while at the two ends there are the distributing chambers. Therefore,each conduit is passed through first by the fumes from the bottom outside to the top inside and then by the buring air from the top outside to the bottom inside; the losses are thus independent of the passage direction (upward or downward). The above operation may be reversed.

The upper head **30** and the lower one **50** function for conveying and collecting the fluids, their performances are equal.

In case of special uses,said heat exchangers may keep the conduits of said two heads coaxial for lengths corresponding to the plant requirements,as a matter of fact,it is to be noted that the longer are the coaxial portions of the conduits of said two heads, the more efficient will be the heat exchanger.

Going back to describing the preferred example, it is to be noted that the upper head is carried by the intermediate cylindric body **1** through the cylindric support **45**, while the lower head is carried by the support seats **65**. Said seats carry the intermediate cylindric body as well as the roller carrying blocks **13,14** and **15** which on their turn carry the lower distributing discs **71**.

Both heads,though being free of expanding, must keep always concentric to the rotary distributing discs both in the permanent operation and above all in the transistory operation.

For such two reasons, i.e. free expanding and concentricity,the following particularities have been provided.

Pivots **42** and **62** serve for centering, radially guiding during expansion,supporting the heat weight, by using bushes **43** and **63**, between supports **45** and the benches **65** and the outer C-shaped sections **40** and **60**.

The outer C-shaped section supports the outer conduit **31** and **51** and part of the inner conduit.

An elastic connection **37** and **57** is provided at one end between the outer conduit and the inner one, while at the the other end a connection by means of sheets **41** and **61** is provided between the C-shaped concentric inner and outer sections **40** and **60**.

Said tangentially arranged sheets allow the centering, radially guiding during expansion and supporting of the C-shaped inner section with respect to the outer one.

It is to be noted that the weight supported by said sheets is limited and consists exactly of the weight of the C-shaped inner section more a portion of the bellow thrust.

In the lower head there is a support **68** bearing the weight of the inner casing; at the two ends of said inner casing there are arranged two sprung bodies **58** absorbing the differential axial and radial expansions.

In the upper head the weight of the inner casing is supported by a joint **37**,while the sprung body **38** absorbs the axial differential expansions. In said upper head are further provided small doors **47** which may serve too for replacing the thermally active material **9**.

The construction of said heads doen not cause particular difficulties.

The C-shaped sections must be sufficiently circular and after the curve must be sufficiently co-planar; that may be as well obtained even without using any tool-work.

Bushes **43** and **63** must be fixed during assembling, taking due consideration of the reference circumferences drawn on the wings of the C-shaped sections. Said circumferences will also provided with the seal fixing bores.

The arrangement of said heads in the example described is the following:

Upper head :the inner conduit serves as outlet of cold fumes;

Upper head :the outer conduit serves as inlet of air;

Lower head :the inner conduit serves as outlet of hot air;

Lower head :the outer conduit serves as inlet of hot fumes.

This arrangement may be also reversed.

The rotary distributing discs **71** and **72** are the characteristic feature of the apparatus, they are two and arranged at the two ends of the cylindric intermediate body **1**. Operatively, they may be in form of flat plates for the smaller devices,while for the larger ones they are in form of a cellular bearing structure disc.

In the described example, a cellular cross **77** consisting of four radial cells connects the outer cellular crown **73** to the inner cellular crown **76**, obtaining so a symmetric and sufficiently strong structure.

Such discs have on their periphery a rack **82** consisting of cylindric pivots locked by two split pins. Two cylindric concentric ribs **78** and **79** receiving the brushing of the seals of(inner and outer)conduits, are welded on the disc face opposite said heads. Two cylindric concentric ribs **80** and **81** receiving the brushing of the seals of the (inner **3** and outer **2**) cylindric casings are welded on the disc face opposite the cylindric body.

The disc faces opposite the cylindric body are brushed by the seals bolted on the diaphragms.

The upper disc **72** is carried by the rolls resting on the upper outer crown **12**, while the lower disc **71** is carried by the rolls resting on the support benches **65**.

Said discs in their inner portion, coaxial to the cylindric body, are provided with a bearing **84** dismountable in more pieces,and a circumferential seal **85**.

In the lower disc, the axial displacements of said bearing are prevented by a seal and abutment flange **86**; and in order to improve the gaseous fluid flow a cover of suitable shape **87** may be mounted integral with said disc.

In the upper disc, the axial displacements of said bearing are prevented by a flange **88**, while a gland and a cover of suitable shape **89** may be mounted on the upper guide pivot **16**.

The gland for the upper disc may be necessary in the exchangers arranged on ships.

In the cellular structure of the discs a series of small bores in a position suitable for obtaining the air discharge is provided.

Each distributing disc has four openings,two diametrally opposed inner openings and two diametrally opposed outer openings, the latter two being further dephased of 90° with respect to the former two. Said openings are in form of an arc of circular crown. The inner diameter of the circular crown of the outer openings is larger for about 100 mm than the outer diameter of the circular crown of the inner openings; and that in order to permit welding the seal severing outer cylindric rib **78** on the face opposite the conduits.

The discs concerned are to be mounted on the cylindric body in a position dephased of 90°; for that it is however necessary that the rack pins are in a number which may be divided by four. In order to assure the synchronism between the two discs, it is necessary to mark before the assembling on each disc the position of two pins engaging at the same time the upper and lower pinion **21** of the motoreducer. Said motoreducer **19** is arranged and suitably insulated on the outside of the outer casing of the cylindric body, it causes the rotation of the two distributing discs.

The number of turns of the discs may vary from one to five turns per minute,depending on the size.

The operations of the distributing discs are the following:

1. Welding;
2. Expansion annealing;
3. Plate grinding;
4. Boring of bearing housing;
5. Seal cylindric rib turning;
6. Clean flattening of the roller support plane according to the preceding operations;

7. Rack pin boring.

The assembling sequence of the heat exchanger may be the following:

1. Supports benches **65**;
2. C-shaped sections **60**;
3. Lower rollers, lower seals and conduits;
4. Lower distributing disc;
5. Intermediate cylindric body with lower seals,heat absorbing and giving material;
6. Upper rollers, seals, upper distributing disc;
7. Upper cylindric support **45**;
8. C-shaped sections **40**;
9. Upper seals and conduits;
10. Motoreducer;
11. Adjusting of seal axial and radial clearance;
12. Soot blowers,washing device,non-conducting and plating.

The sealing elements for gaseous fluids between the distributing discs and the stationary portions, as shown in FIG. **4**,consists of flexible thin sheets of fume corrosion resisting steel like Corten or other steels suitable to the kinds of gaseous fluids used. In the described example the sheet seals **111,112,113,114,115** are provided with axial buttonholes for adjusting the axial clearances.

The sheet seals **112,114,115** are fixed on circular portions **116** of angular sections. Seals **111** are fixed on circular portions **117** of flat sections. Seals **113** are fixed on straight flat sections **121**. The angular sections **116** are provided with radial buttonholes for adjusting the radial clearance.

Said thin sheets consist of at least two overlapping leaves with dephased axial cuts; further, said sheets are suitably shaped so as to perform a continuous and sufficiently elastic brushing.

From what above and by watching at the drawings, it will be noted that besides sheets **113**, the seal is obtained by the relative brushing of cylindric surfaces; sheets **113** brush on the flat surface of the distributing discs.

The height of the cylindric ribs **78,79,80,81** gives a sufficient guarantee to the differential expansion in axial sense. The radial differential expansion is counterbalanced by the elasticity of the seals and the calculated cold positioning.

As for the blowing and washing apparatus as shown in FIGS. **15** and **16**,it is to be noted that the blowing apparatus consists essentially of two radial blowers **131** inserted radially from outside into the lower distributing disc and screwed into the three-way joint **132**. Said joint is positioned and fixed to the disc by means of a central pivot. From said joint extends the axial turning pipe **133** which, integral with the distributing disc, ends at the stationary joint **134** provided at the two ends with two glands. The closure plug **136** serves for closing the passage bore after assembling or servicing radial blower. The feeding stationary pipe **135** conveys to the stationary joint the steam and/or air for the blowing. Said blowing is performed during the normal operation and in phase with the fume flow.

What above is valid too for the washing apparatus, with the following differences: the apparatus is arranged in the upper disc and the washing operation is performed preferably with the heater excluded from the thermal cycle,washing in phase with the air flow and discharging the water through the air discharge conduit.

With reference to the constructive variations, in FIGS. **7** to **12** are shown several types of distributing discs, the choice of the type depends essentially on the size of the heater and the fluodynamic efficiency which is to be achieved. In FIGS. **13** and **14** there are shown variations at the upper and lower distributing discs illustrated in FIGS. **3** and **4**. In FIGS. **17** to **22** is shown a variation in the blowing apparatus; said variation consists of a blower pipe **151** arranged radially in each lower stationary distribution chamber. Said blower is made oscillating angularly during the blowing operation through a lever system **152** and a pneumatic cylinder **153**. The blowing sequence in phase with the fumes is controlled by the disc rotation. In FIGS. **23** to **27** is shown a variation in the washing apparatus; said variation consists of a washing radial pipe **161** arranged in each upper stationary distribution chamber and having nozzles **162**. Said radial pipe is made to reciprocate radially during the washing operation through a pneumatic cylinder **163**. The washing sequence may be controlled by the disc rotation. In FIG. **28** is shown a variation in the support and driving drawing of the lower and upper distributing discs **71,72**. The curved and conical rollers **171**, supporting the disc by means of a slightly conical guide **172**, are step mounted on a flanged support **173** having the two bearings **174** for rollers lubricated and reachable from outside. In the driving system, the rack consists of step working pivots **175** engaged by a pinion **175** rotatably supported by a bearing **177** and connected by a shaft **178** and a gear ax **179** to a drive motor **180**.

What we claim is:

1. A regenerative heat exchanger of the type utilizable in heating air for furnaces by the heat of gaseous combustion products and operating through cyclic accumulation and transfer of heat by means of a regenerative material, comprising a stationary cylindrical casing, median flat walls dividing said casing into a plurality of like compartments, regenerative material occupying central portions of said compartments with distribution spaces at opposite ends of each compartment, two stationary concentric pipe connections at each of opposite ends of said cylindrical casing for the separate inlet, transport and discharge of said air and said combustion products, valve means comprising two circular distributor plates rotatably mounted respectively at opposite ends of said cylindrical casing between said casing and said pipe connections respectively, each said plate having at least one port for said combustion products and at least one port for said air, each port being disposed in the annular zone facing the respective pipe connection, sealing means between said cylindrical casing, plates and pipe connections and means for rotating said two plates in synchronism with one another.

2. A heat exchanger as claimed in claim **1**, characterized in that the rotatably mounted circular flat plates each have a double circular flat wall ribbed inside to provide a cellular structure.

3. A heat exchanger as claimed in claim **1**, wherein said sealing means comprises elastic sealing strips projecting from the end edges of the meridian flat walls at the opposite ends of said casing, so as to slide with the inner faces of the rotatably mounted circular flat plates, the inner faces of said rotatably mounted circular flat plates being provided, on their outer periphery, with a first annular rib projecting towards the regenerative material casing, whose outer cylindrical wall is provided on its two ends with projecting elastic sealing strips which slide against said annular rib, facing the regenerative material casing, of said rotatably mounted circular flat plate inner face.

4. A heat exchanger as claimed in claim **1**, wherein the outer face of each rotatably mounted flat circular plate is provided with a peripheral annular rib and with an intermediate annular rib which divides the surface of the corresponding rotatably mounted circular flat plate into two concentric areas with substantially equivalent surface; wherein the edges of each of the two concentric pipe connections, facing said circular flat plates, are provided with projecting elastic sealing strips, so as to slide with said two annular ribs provided on the outer face of the rotatably mounted circular flat plates.

5. A heat exchanger as claimed in claim **1**, wherein the two rotatably mounted flat circular plates comprise, on each of the two concentric zones, their outer faces divided into a pair of openings in the form of an arc of circular crown, which are defined by two radial sectors and two circular arcs; said openings being in each pair equal and diametrically opposite, further, in each rotatably mounted circular flat plate, said pair of openings of a concentric zone being squaring with the opening pair of the other concentric zone, finally said two rotatably mounted flat circular plates being arranged in the exchanger dephased for 90°, so as to have, in axial correspondence, said openings of different type.

6. A heat exchanger as claimed in claim **1**, the two rotatably mounted circular flat plates are provided at their center with a

sliding radial carrying bearing; said rotatably mounted circular flat plates being further provided at their outer periphery with a stiffening crown, a circular support resting on a crown and formed of curved rollers with idle radial axis for supporting said rotatably mounted circular flat plates, and a driven circular rack with cylindrical pins at a constant tangential pitch for the synchronous rotation of said two rotatably mounted circular flat plates.

7. A heat exchanger as claimed in claim 1, wherein said two rotatably mounted circular flat plates are connected by a torsionally rigid tubular axis arranged in a central space provided on the regenerative material casing, a circular rack with cylindrical pins for the rotation of said two rotatably mounted circular flat plates, and a driven pinion for driving said rack.

8. A heat exchanger as claimed in claim 3, wherein the sliding seals, with elastic sheets, are arranged with a clearance and flexibility against a wall.

9. A heat exchanger as claimed in claim 5, wherein the portions carrying the elastic sealing strips are fastened in place by screws through holes in order to avoid the necessity of major disassembly.

10. A heat exchanger as claimed in claim 7, wherein the polar uniformity of the radial clearance from a cold to a hot condition of the above-cited sliding sheet seals is assured with the necessary exactness by centering a system of the inner conduits with respect to outer conduits of the combustion products and heated air, said system consisting of a series of tangential elastic sheets fixed between the crowns of sections closer to the sliding radial seals, and being completed by a generally symmetric connection in the outlet area for said inner conduits through the outer conduits, with the addition of radial auxiliary ribs.

11. A heat exchanger as claimed in claim 1, wherein each said distributor plate is double and comprises spaced plates connected by walls around said ports.

12. A heat exchanger as claimed in claim 1, wherein said distributor plates are provided with guide blades associated with said ports to direct the gaseous fluids flowing through said ports.

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