April 27, 1965

K. OECHSLIN

HEAT EXCHANGER

3,180,406

Filed July 31, 1963

2 Sheets-Sheet 1

Fig. 1

Fig. 3

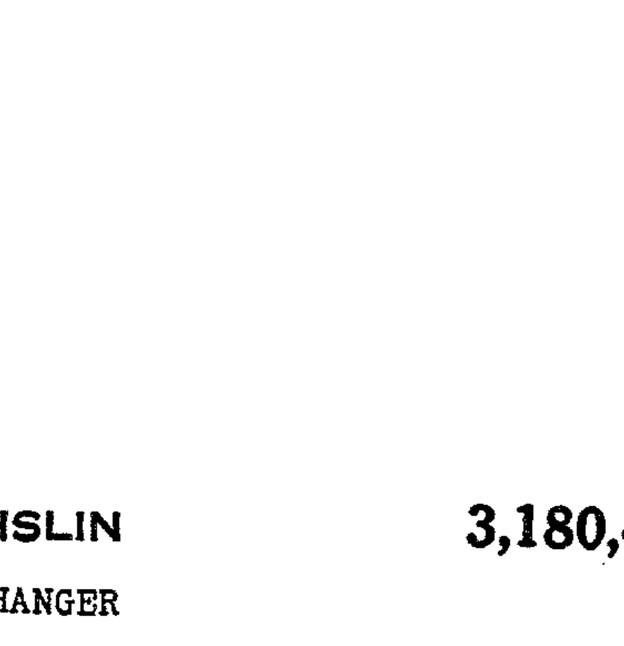


Fig. 4

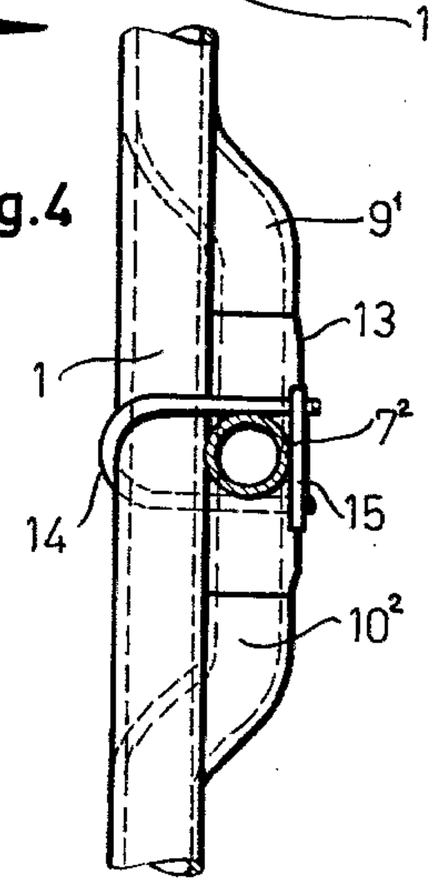


Fig. 2

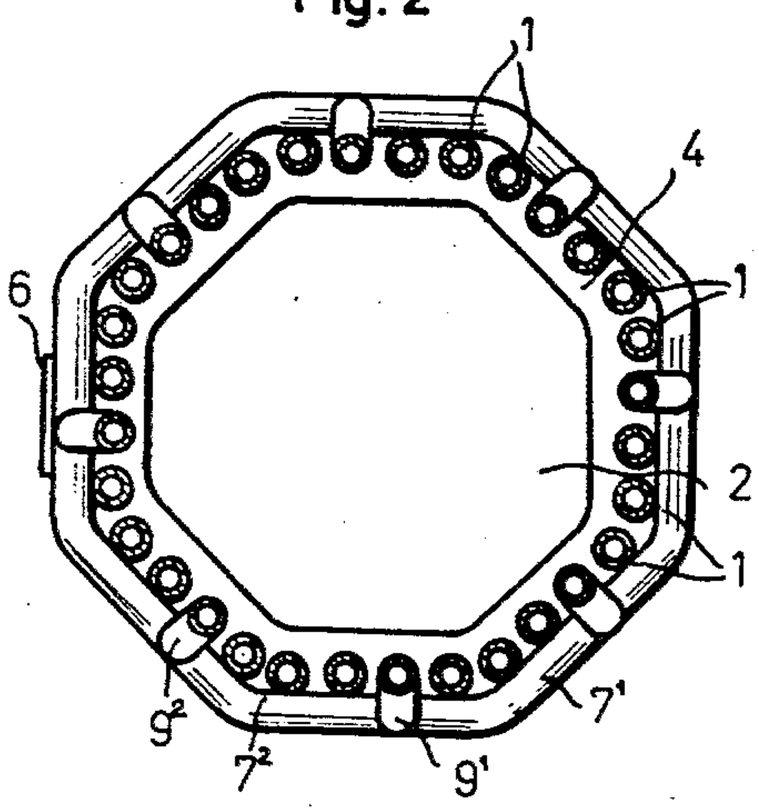
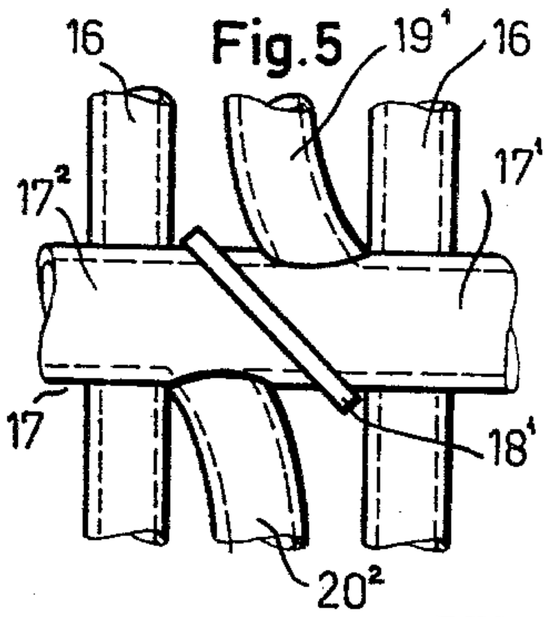


Fig. 5



INVENTOR.
Konrad Oechslin

BY Dodge and Son

Attorneys

April 27, 1965

K. OECHSLIN

HEAT EXCHANGER

3,180,406

Filed July 31, 1963

2 Sheets-Sheet 2

Fig.6

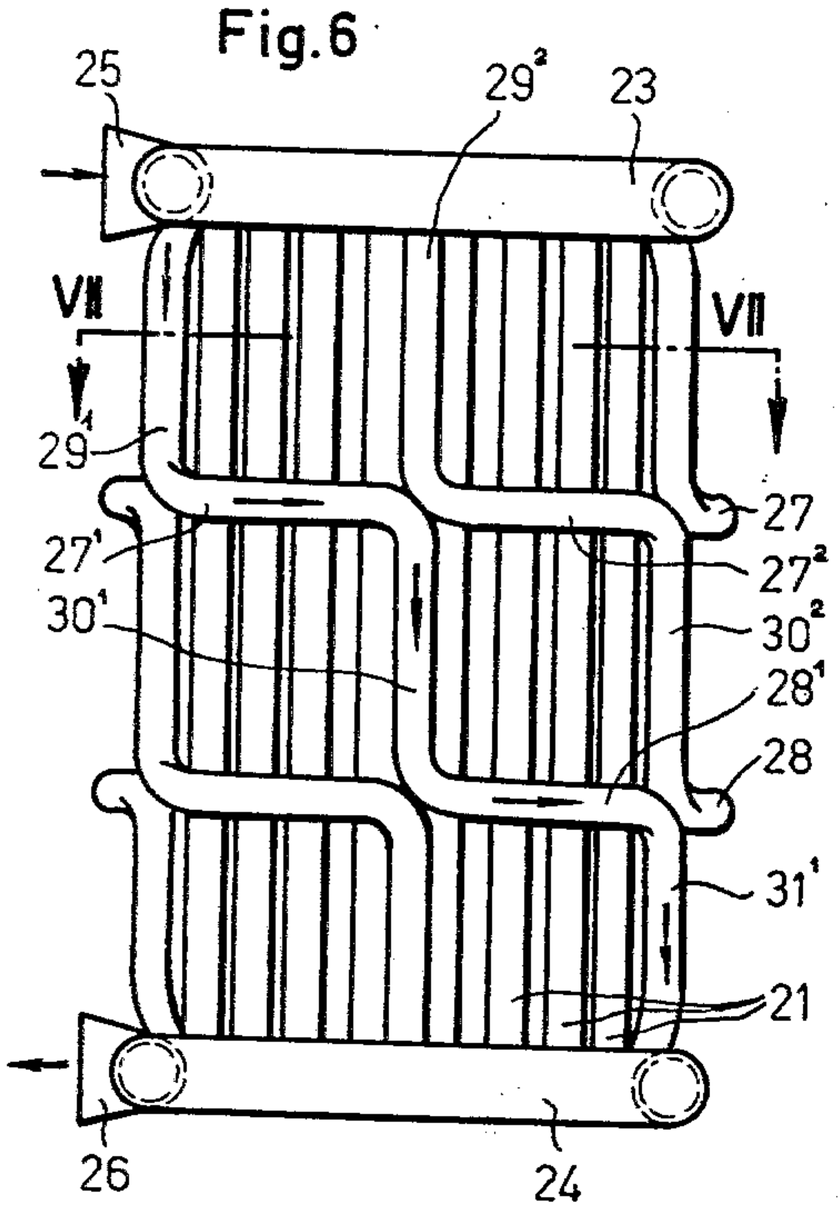


Fig.8

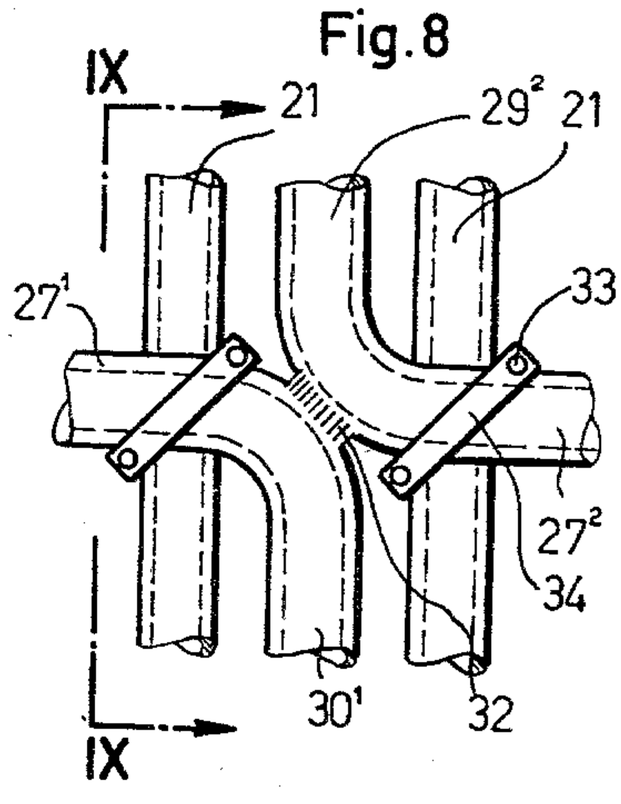


Fig.9

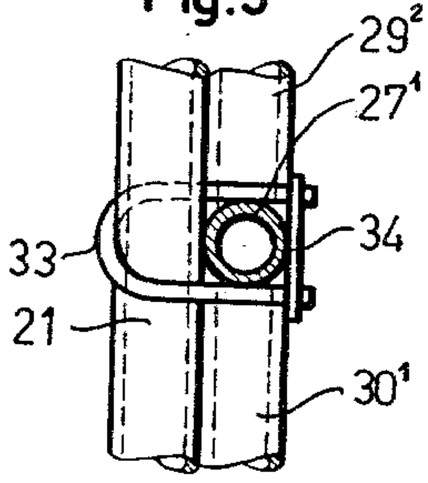


Fig.7

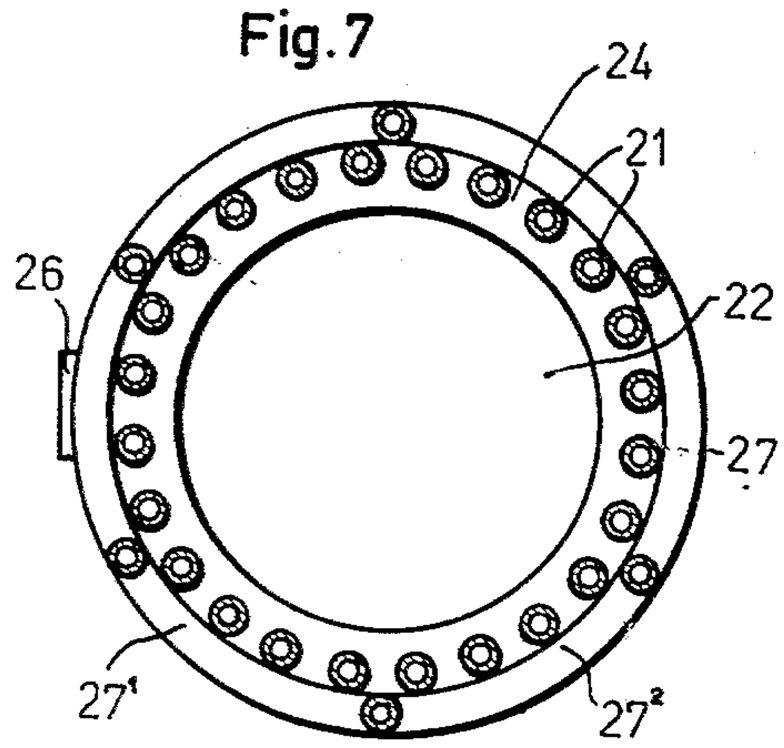


Fig.10

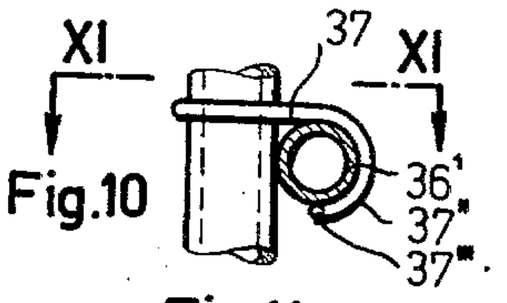
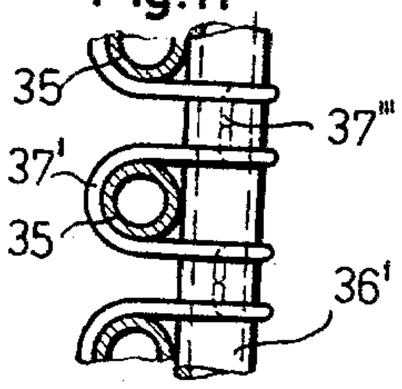


Fig.11



INVENTOR.
Konrad Oechslin
BY
Dodge and Dorn
Attorneys

United States Patent Office

3,180,406

Patented Apr. 27, 1965

3,180,406
HEAT EXCHANGER

Konrad Oechslin, Zurich, Switzerland, assignor to Escher Wyss Aktiengesellschaft, Zurich, Switzerland, a corporation of Switzerland

Filed July 31, 1963, Ser. No. 299,056
Claims priority, application Switzerland, Sept. 3, 1962, 10,457/62
6 Claims. (Cl. 165—144)

This invention relates to heat exchangers such as a gas heater which comprises a row of a plurality of straight heater tubes through which the gas to be heated flows and which are arranged to encircle a combustion chamber and are connected at one end to an annular distributing header situated in a plane disposed substantially perpendicularly to the heater tubes, and at the other end to an annular collecting header situated in a plane parallel to the plane of the distributing header, there being provided at least one tubing ring which is situated in a plane substantially parallel to the planes of the distributing and collecting headers and to which the heater tubes are fixed.

In such gas heaters, it has been necessary hitherto to provide special supply conduits to the tubing rings in order to enable a cooling medium to be supplied to the said rings. Furthermore, the quantity of coolant has had to be regulated in dependence on the load of the gas heater and the conditions prevailing in the combustion chamber, in order to protect the tubing rings against excessively high thermal stressing.

It is the aim of this invention to obviate these disadvantages. In a gas heater of the kind described initially, according to the invention a smaller number of stiffening tubes is distributedly arranged around the combustion chamber, each tube substantially consisting of at least two tube sections extending parallel to the heater tubes and at least one interposed tube section extending circumferentially of the combustion chamber. The one ends of these stiffening tubes are connected to the distributing header and the other ends to the collecting header so as to allow throughflow of a part of the gas to be heated. The circumferentially extending tube sections of the consecutive stiffening tubes are fast connected to one another so as to form the tubing ring or rings to which the straight heater tubes are fixed. Examples of embodiment of the subject of the invention are illustrated in a simplified manner in the drawings, wherein:

FIGURE 1 is a view of a gas heater,

FIGURE 2 is a sectional view on the line II—II of FIGURE 1,

FIGURE 3 is a view of a fragment of FIGURE 1 on a larger scale,

FIGURE 4 is a sectional view on the line IV—IV of FIGURE 3,

FIGURE 5 is a fragmentary view corresponding to FIGURE 3 but relating to another form of embodiment,

FIGURE 6 is a view of a further form of embodiment of the gas heater,

FIGURE 7 is a sectional view on the line VII—VII of FIGURE 6,

FIGURE 8 is a view of a part of FIGURE 6 on a larger scale,

FIGURE 9 is a sectional view on the line IX—IX of FIGURE 8,

FIGURE 10 is a sectional view corresponding to FIGURE 9 through a further form of embodiment, and

FIGURE 11 is a sectional view on the line XI—XI of FIGURE 10.

The gas heater shown in FIGURES 1 to 4 comprises a plurality of straight heater tubes **1** which are arranged

parallel to one another. These as viewed in cross-section are arranged in the form of a closed, polygonal row of tubes, which encircles a combustion chamber **2**. The heater tubes **1** are connected at one end to an annular distributing header **3** and at the other end to an annular collecting header **4**. In the heater tubes, a gas, e.g. the gaseous working medium of a thermal power plant, preferably air, is heated which enters the distribution header **3** through an inlet pipe **5**, flows through the heater tubes **1** and passes out from the gas heater again through the collecting header **4** and an outlet pipe **6**. The gas heater may be surrounded by a tubular wall of masonry (not shown).

The heater tubes in operation are subjected over their entire length to considerable thermal stressing and, therefore, have to be held at specific intervals so that as far as possible they cannot bend in any direction.

For this purpose, for example two tubing rings **7** and **8** are provided to which the heater tubes **1** are fixed. The distributing header **3**, the collecting header **4** and the tubing rings **7** and **8** are situated in four planes which are parallel to one another and are at right angles to the heater tubes. The tubing rings **7** and **8** are formed of individual tube sections 7^1 to 7^8, and 8^1 to 8^8 respectively. Each segment of the tubing ring **7** is connected at one end to one of tube sections 9^1 to 9^8 connected to the distributing header **3** and disposed substantially parallel to the heater tubes **1**, and at the other end to one of tube sections 10^1 to 10^8 which are arranged substantially parallel to the heater tubes **1** and are connected to the collecting header **4**. Correspondingly, each tube section of the tubing ring **8** is connected at one end to one of tube sections 11^1 to 11^8 connected to the distributing header **3**, and at the other end to one of tube sections 12^1 to 12^3 connected to the collecting header **4**. The staggered tube sections 9^1, 10^1 form with the interposed tube section 7^1 a stiffening tube 9^1–7^1–10^1 which allows throughflow of a part of the gas to be heated. The same applies to the remaining tube sections 7^2 to 7^8 or 8^1 to 8^8 of the tubing rings **7** and **8** together with the adjoining tube sections 9^2 to 9^8, 10^2 to 10^8, 11^1 to 11^8 and 12^1 to 12^8, respectively.

As FIGURE 3 shows more particularly, there is welded in between the tube sections 7^1, 7^2, 9^1 and 10^2 a connecting element **13** which consists of two pipe bends and two ducts **13″** and **13‴** separated by a partition wall **13′**, the duct **13″** leading from the tube section 9^1 to the tube section 7^1, and the duct **13‴** from the tube section 7^2 to the tube section 10^2. In the same way, all the other tube sections of the tubing ring are connected to one another and to their associated supply and discharge tubes for the throughflowing gas.

As FIGURES 3 and 4 show, the heater tubes **1** are fixed with clamps **14** to the tube sections of the rings **7** and **8** respectively. The clamps **14** each engage about a heater tube **1** and stiffening tube section situated perpendicularly thereto, and are welded to straps **15**. The straps **15** are arranged at that side of the heater tubes which is remote from the combustion chamber **2**.

The tubing rings **7** and **8** and the connecting elements **13** are situated outside the octagonal row of heater tubes. In FIGURES 1 and 2, the clamps **14** and straps **15** are not illustrated, in order to leave the drawings easy to read.

As FIGURE 4 shows more particularly, the tube section 9^1 near the point at which it is welded to the connecting element **13** situated outside the row of heater tubes, comprises a bent portion and is subsequently disposed between consecutive heater tubes, thus forming part of the heater tube row and acting as one of the heater tubes. The tube section 10^2 illustrated in the figure and

all the other tube sections for the supply and discharge of the throughflowing gas are constructed in the same way.

The tubing rings 7 and 8, the supply tube sections 9 and 11 and the discharge tube sections 10 and 12 which are connected securely to one another by the connecting elements 13, together form a mechanically stable framework which bends to only very inconsiderable extents even under considerable thermal stressing, and provides secure support for the combustion chamber tubes.

Each segment of the tubing rings 7 and 8 form with the supply and discharge tubes connected to its ends a through flow path for the gaseous working medium from the distributing header to the collecting header, as indicated by arrows in FIGURE 1. Thus, the same medium flows through the ring segments as flows through the heater tubes 1, the tube sections for the supply and discharge of the medium acting as heater tubes. Thus there is no longer any need for additional supply conduits to be taken through the masonry about the gas heater in order to introduce a coolant to the tubing rings. The gas flowing through the rings has the same temperature as the gas flowing through the heater tubes. Therefore, the said rings are stressed in the same way as the heater tubes, and it is no longer necessary for the cooling of the tubing rings to be adapted to varying conditions when the gas heater load varies.

Since the distance over which the gas to be heated has to travel in flowing through the ring segments of the tubing rings 7 and 8 is longer than the distance through the heater tubes 1, the rings 7 and 8 are cooled rather less intensively. But this is compensated for by the fact that the rings 7 and 8 are situated outside the circle of heater tubes and are therefore less strongly heated than the latter tubes.

The fragmentary view which is shown in FIGURE 5 and corresponds to part of FIGURE 3 shows a detail of another form of embodiment of a gas heater. This has a plurality of heater tubes 16 disposed parallel to one another. Arranged in a plane perpendicularly to the said tubes is a continuous tube 17 which is sub-divided by partition walls 18^1, 18^2 . . . into tube sections 17^1, 17^2 . . . Each of the tube sections forming the ring 17 has welded to its opposite ends staggered sections 19 and 20, respectively, the tube sections 19 being connected to a distributing header and the tube section 20 to a collecting header. In order to avoid zones with stagnant gas the partition walls 18^1, 18^2 . . . are arranged at an inclination to the axes of the tube sections forming the ring 17. The heater tubes 16 are fixed by means not shown in the drawings to the tubing ring formed by the continuous tube 17.

The continuous tube 17 sub-divided into the ring segments or tube sections 17^1, 17^2 . . . has a larger diameter and a correspondingly greater wall thickness than the heater tubes 16 and the supply and discharge tube sections 19 and 20. The result of this is greater strength for the tubes which serve to support the combustion chamber tubes.

The tube sections for the supply and/or discharge of the throughflowing gas may also be of greater dimensions than the heater tubes.

The partition walls 18^1, 18^2 . . . which serve to subdivide the tube 17 may also be omitted if the supply and discharge tubes are connected to the tube 17 at equal spacings and in alternation to one another. This arrangement ensures, without the use of partition walls, a uniform distribution of the gas flow and therefore uniform cooling of the tubing ring.

The gas heater shown in FIGURES 6 to 9 has a row of a plurality of heater tubes 21 which are arranged parallel to one another. They are arranged, as viewed in cross-section, in the form of a closed, circular ring, so as to encircle a combustion chamber 22. The heater tubes 21 are connected at one end to an annular distributing header 23 and at the other end to an annular collecting header 24. In the heater tubes 21 may be heated a gaseous working medium of a thermal power plant which enters the distributing header 23 through an inlet pipe 25, flows through the heater tubes 21, and issues from the gas heater through the collecting header 24 and an outlet pipe 26.

Provided for fixing the combustion chamber tubes are two tubing rings 27 and 28 which consist of individual tube sections 27^1 to 27^6, and 28^1 to 28^6 respectively. The distributing header 23, the collecting header 24 and the rings 27 and 28 are situated in four planes which are parallel to one another and are arranged at right angles to the combustion chamber tubes 21.

The tube section 27^1 of the tubing ring 27 and the tube section 28^1 of the tubing ring 28 form together with a supply tube section 29^1 connected to the tube section 27^1 and to the distributing header 23, with an intermediate tube section 30^1 connecting the two tube sections 27^1 and 28^1 and with a discharge tube section 31^1 connected to the tube section 28^1 and to the collecting header 24, a through tube through which a part of the gaseous working medium flows. The path of the working medium is indicated by arrows in FIGURE 6. The other tube sections of the tubing rings 27 and 28, the other intermediate tube sections 30, supply tube sections 29 and discharge tube sections 31 are constructed in the same way as parts of continuous tubes which lead from the distributing header 23 to the collecting header 24 and are traversed by working medium.

The individual tube sections of the tubing rings 27 and 28 are connected securely to one another by a weld seam 32, as FIGURE 8 shows more particularly.

Provided for fixing the heater tubes 21 to the tube sections forming the tubing rings 27 and 28 are tube clamps 33 which surround a heater tube 21 and a tube section of the tubing ring 27 in each case and are welded with fixing straps 34. In FIGURES 6 and 7 the clamps 32 and the straps 34 have been omitted, in order to leave the figures easier to read.

The stiffening tubes consisting of the tube sections forming the tubing rings 27 and 28, the supply tube sections 29, the intermediate tube sections 30 and the discharge tube sections 31, are arranged outside the row of heater tubes 21, which encircles the combustion chamber. As a result, they are heated less strongly and this compensates substantially for the fact that they are cooled less intensively in comparison to the heater tubes, owing to the longer path of travel for the working medium.

Instead of using clamps 33 with straps 34, the heater tubes can be fixed to the tube sections forming the tubing rings by other means e.g. hooks, such as are shown in FIGURES 10 and 11. Each of the illustrated hooks 37 has a portion 37′ looping about the heater tube 35, and a portion 37″ which partially engages about a tube section 36^1. In order to space the individual heater tubes 35, the hooks 37 are provided with projections 37‴ which are disposed in the direction of the axis of the tube sections forming the tubing ring and which abut against one another.

What is claimed is:

1. A tube bundle for use in a heat exchanger comprising

(*a*) a substantially circular series of straight, mutually parallel tubes;

(*b*) a toroidal distributing header lying in a plane substantially perpendicular to said tubes, one end of each tube being connected to said header;

(*c*) a toroidal collecting header lying in a plane substantially perpendicular to said tubes, the other ends of the tubes being connected to the collecting header;

(*d*) a plurality of stiffening tubes fewer in number than said straight tubes distributedly arranged between said headers,

(*e*) each stiffening tube including

(1) end sections parallel with the straight tubes, each end section connected to a corresponding header, and

(2) at least one intermediate tube section substantially parallel with said headers and extending circumferentially of the straight tubes,

(*f*) said intermediate sections being connected end to end with one another to form a closed ring,

(*g*) said straight tubes being fixed to said ring.

2. The tube bundle defined in claim 1 in which said end sections are disposed between consecutive straight tubes.

3. The combination defined in claim 1 in which for the connection of the circumferentially extending tube sections of two consecutive stiffening tubes a connecting element is provided which consists of two pipe bends, each of them being welded-in between adjoining tube sections of the consecutive stiffening tubes.

4. The combination defined in claim 1 in which the said ring formed by the circumferentially extending tube

sections consists of a continuous tube having partitions for subdividing its interior into individual sections.

5. The combination defined in claim 1 in which at least the circumferentially extending tube sections of the stiffening tubes have a larger internal diameter than the straight tubes.

6. The combination defined in claim 1 in which at least the circumferentially tube sections of the stiffening tubes are situated outside the series of straight tubes.

References Cited by the Examiner

UNITED STATES PATENTS

1,782,430	11/30	Kelly et al.	126—109 X
2,797,667	7/37	Patterson	122—240

FOREIGN PATENTS

504,062	7/51	Belgium.

CHARLES SUKALO, *Primary Examiner.*