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3,521,866

COKING APPARATUS TUBE CONSTRUCTION

Original Filed July 6, 1965

3 Sheets-Sheet 2

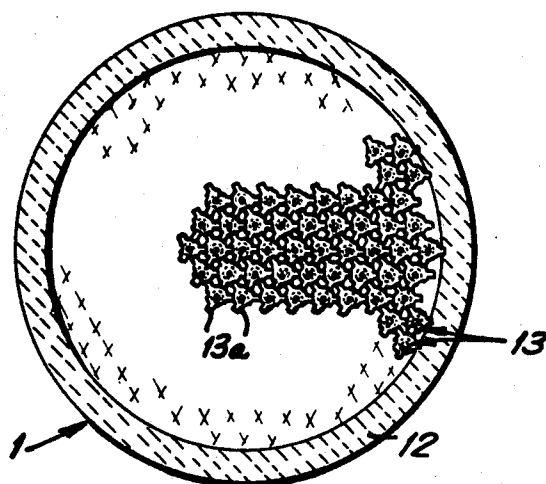


FIG. 2

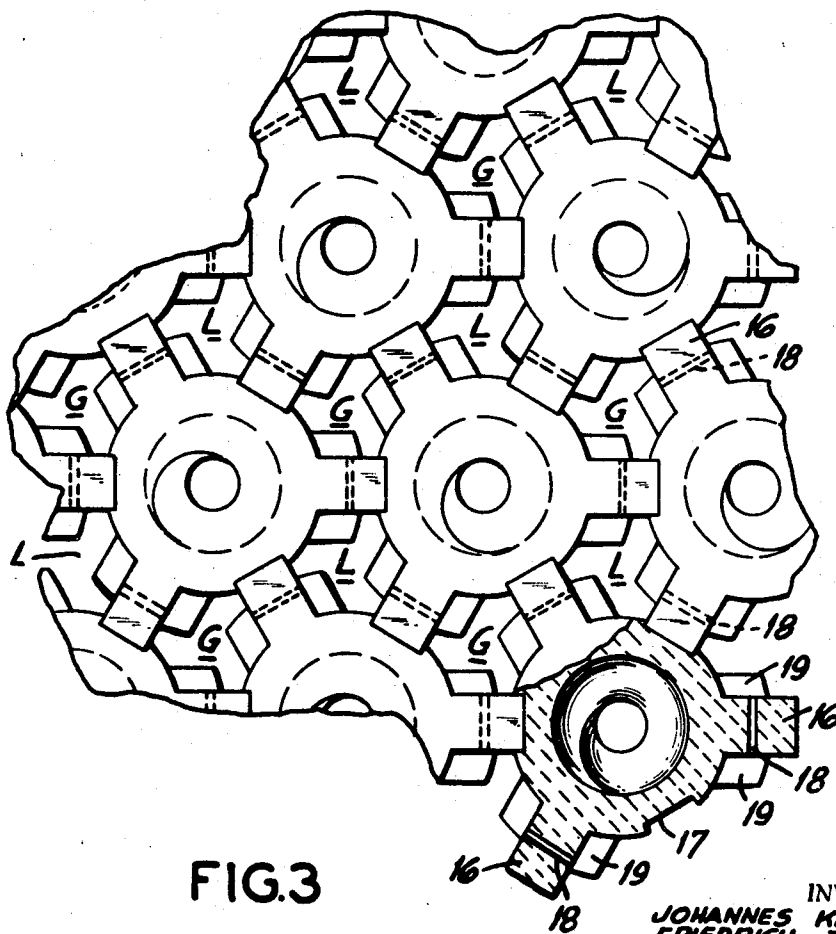


FIG. 3

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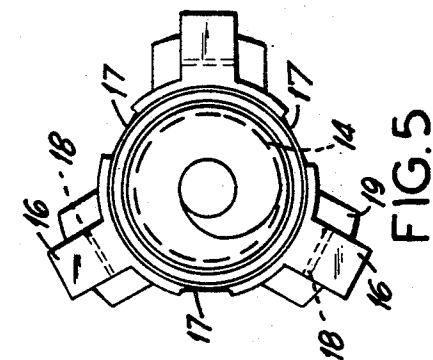


FIG. 5

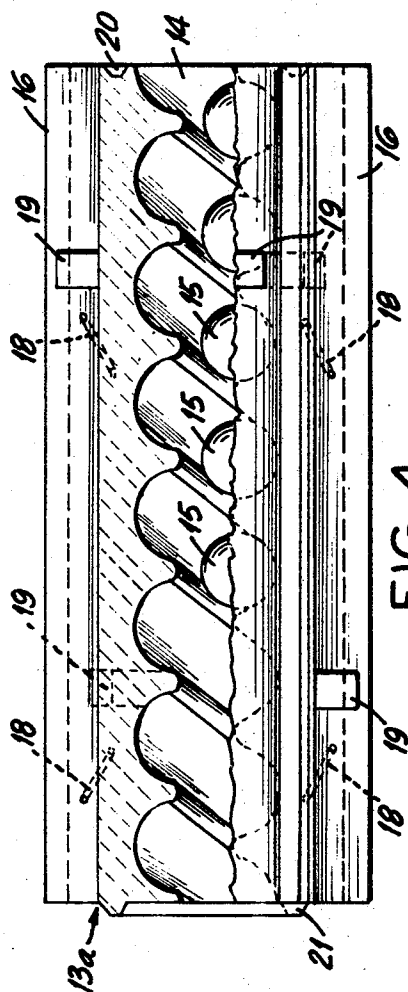


FIG. 4

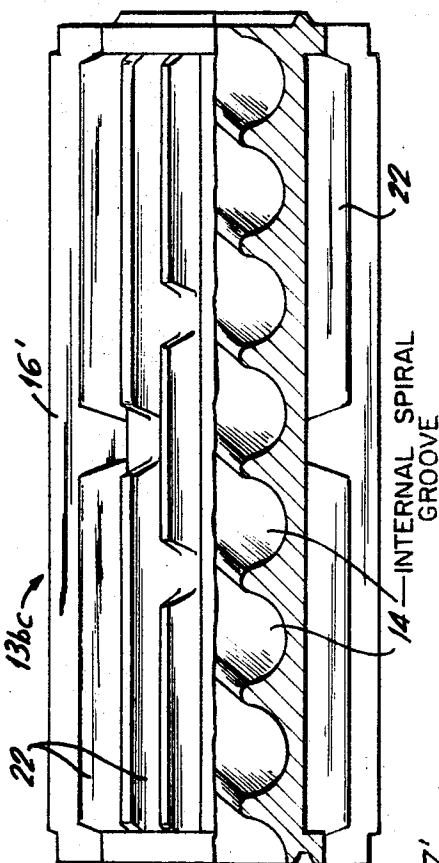


FIG. 7

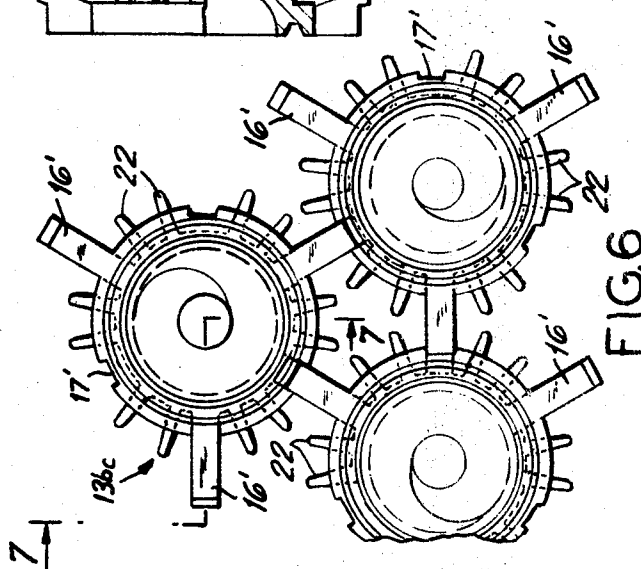


FIG. 6

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COKING APPARATUS TUBE CONSTRUCTION

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Original application July 6, 1965, Ser. No. 469,458, now Patent No. 3,461,037. Divided and this application Sept. 27, 1968, Ser. No. 794,812

Claims priority, application Germany, July 3, 1964,

St 22,347

Int. Cl. F27b 7/00

U.S. Cl. 263—32

3 Claims

ABSTRACT OF THE DISCLOSURE

A tube wall of ceramic material includes a groove on its interior which extends axially therealong in the form of a spiral, a projection is formed on the exterior of the wall along its length at at least three equally spaced locations around its periphery. Recesses are formed between adjacent projections so that a plurality of tubes may be arranged together with the projections of one engaged in the recesses of the next adjacent tube, the projections are such that a passage is defined therethrough. A baffle is arranged at fixed intervals along the length of the tube alongside the passage.

This is a division of application Ser. No. 469,458, filed July 6, 1965, now U.S. Pat. No. 3,461,037.

This invention relates, in general, to an apparatus for the coking of coal and, in particular, to a new and useful tube construction for effecting the same.

At the present time there are a number of methods which are available for the continuous coking of coal briquets for coal dusts, for example, the coal dusts or particles may be continuously directed into the top of a shaft furnace and coked. The coke is then discharged at the bottom. Direct (autogenous coking) or indirect heating is possible. Difficulties are encountered in the systems with respect to the permeability of the coal briquets to be coked to gases, for example, air and to escaping coke-oven gases, particularly when coking coal is used. Shaft furnaces are not generally applicable for such a process, particularly since their height must be adapted to the properties of the coal. Such adjustment definitely impairs the economy of such furnaces.

Coal briquets can also be coked in so-called tunnel furnaces through which they are conducted in piles or stacks on moving stands. Such known methods, however, have not been too successful in the industry for various reasons, particularly because the technical expenditure for the apparatus is too high.

It has also been attempted to carbonize coal in revolving tubular furnaces which are provided with air tubes, and while using fine grained coal, but this process permits only the obtaining of fine grained coke or coked breeze. Such a process has produced a generally inferior product.

It was found that coal briquets can be coked continuously from fine coal with or without the addition of binders by using a space-time yield which is greater than that of chamber coking.

Molded coke can be obtained therefrom if the coal is molded into the desired shapes (e.g. ball-shaped ellipsoid-shaped, barrel-shaped or cylindrical-shaped bodies) whose end faces may be either curved or flat. In accordance with the invention, such bodies may be heated in a slightly inclined tube which either rotates about its axis or in a direction parallel to its axis. The coal briquets perform a continuous rolling movement inside the tube and

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move down the inclined tube slowly from one end to the other.

In accordance with a feature of the invention, it has been found advantageous to control the continuous movement of the briquets by designing the tubes in their interiors in the manner of a large female thread or continuous spiral groove. When the tubes are rotated, the coal briquets are guided continuously and their path is prescribed by the outline of the groove in the tube.

Another feature of the process is that the heating of the briquets in such a tube can be effected either indirectly from the outside or by direct heat transfer, for example, by burning a part of the gases formed by the coal during coking (autogenous coking).

In a preferred construction for use with the method of the invention, it has been found desirable to combine a plurality of tubes into a nest of tubes which nest is arranged to rotate about a common slightly inclined axis. When using a nest of tubes, the tubes are provided with an outer jacket which is protected by insulation against heat losses. In a preferred construction, the tubes are provided in their interior with a continuous thread or groove having a cross section in the form of the briquet to be formed, for example, semi-circular, ellipsoidal, barrel-shaped or smooth.

In accordance with the invention, the apparatus for coking coal advantageously includes means for facilitating the orderly entrance of the coal briquets into the coking tubes at their upper ends which includes a feed hopper which is arranged to direct the briquets into the tubes. The tubes advantageously have an opening which is only slightly greater than the cross section of the coal briquets so that only one briquet can enter during a revolution of the tube. The tubes are preferably so designed that their female screw thread has a cylindrical core diameter which corresponds approximately to the cross section of the coal briquet.

In order to ensure the alternating entrance of the air into the gas ducts and the gas into the air ducts, which are advantageously formed as separated ducts between groups of tubes, baffles are arranged behind the openings in the direction of the flow of the combustion media in order to produce the necessary gradients for the desired flow conditions.

After combustion, the hot waste gases continue to flow upward from the heating zone to the preheating zone and the individual channels formed on the exterior of the tubes need no longer be sealed from each other. The gases are separated from the coal briquets which enter from the tops of the tubes and move through the interior of the tubes in heat exchange relationships. As the heating gases move upwardly around the exteriors of the tubes, the coal briquets move downwardly and arrive in a preheated state in the central coking zone. In this manner, it is possible to employ the sensible heat of the hot coke and that of the hot combustion gases for the coking process, and both the combustion media and the coal briquets arrive in a preheated state in the coking zone of the center of the tubular furnace.

The device is advantageously constructed with tube walls which correspond in materials and thickness to the temperature of the gases encountered. In the combustion zone proper, in which temperatures of 1000 to 1200° C. prevail, the tubes and the ducts are made of a ceramic material such as a refractory material. In the superposed preheating zone for the coal briquets and also in the cooling zone for the hot coke briquets, the tubes are advantageously made of a metal, for example, cast iron. The complete furnace construction advantageously includes a plurality of tubes which are joined end-to-end and which include lugs or projections advantageously pro-

jecting at spaced locations, for example, equally spaced locations 120° apart to provide for the formation of ducts for combustion gas and air flow between the exterior peripheries of adjacent tubes. The tubes are advantageously provided with complementary depressions which receive the projections or lugs of the next adjacent tube so that they may be fitted together in gas-tight relationship to provide the defined gas and air paths which are necessary.

In the central high temperature area, the tubes are advantageously made with a refractory lining but the tubes in the preheating and cooling zone may be made of a metal construction with walls much thinner than the ceramic tubes in the coking zone. By such a construction, it is also possible to provide ribs, needles or pegs on the outer zones to increase the outer surface of the tubes and the heat exchange capabilities thereof.

A further object of the invention is to provide an apparatus for the coking of coal which includes a furnace comprising a plurality of tubes arranged in a bundle with their axes inclined and each tube having a passage defined therethrough for the passage of a coal briquet and with the spaces surrounding the tubes defining a flow path for combustion media, which advantageously is directed over the tubes in a direction different to the advance of the briquets within the tubes.

A further object of the invention is to provide a furnace for the coking of coal which includes a tube bundle arrangement formed by a multiplicity of tubes each having a passage defined therethrough and a spiral groove of a configuration of a final coal briquet defined along the interior and wherein the tubes further include formations on the exterior which define together with additional tubes additional passages around the exterior of the tubes for combustion media.

A further object of the invention is to provide a furnace tube construction for a coking furnace.

A further object of the invention is to provide a furnace construction and a furnace tube construction which is simple in design, rugged in construction, and economical to manufacture.

The various features of novelty which characterize the invention are pointed out with particularity in the claims annexed to and forming a part of this application. For a better understanding of the invention, its operating advantages and specific objects attained by its use, reference should be had to the accompanying drawings and descriptive matter in which there are illustrated and described preferred embodiments of the invention.

In the drawings:

FIG. 1 is a partial side elevational and partial longitudinal sectional view of a coking furnace constructed in accordance with the invention;

FIG. 2 is a section taken on the line 2—2 of FIG. 1;

FIG. 3 is an enlarged partial and elevational view of the tube nest for the furnace of FIG. 1;

FIG. 4 is a partial side elevational and partial longitudinal sectional view of an individual tube;

FIG. 5 is an end elevational view of the tube indicated in FIG. 4;

FIG. 6 is a partial and elevational view of a nest of tubes of a nest of another embodiment of tubes; and

FIG. 7 is a section taken on the line 7—7 of one of the tubes indicated in FIG. 6.

Referring to the drawings, in particular, the invention as embodied in FIG. 1 comprises a continuous coking furnace generally designated 50 which includes an elongated hollow tube 1 which is rotatably mounted on a plurality of bearings 2 on foundation pillars 3 for rotation about an inclined axis. The tube 1 is rotated by means of a gear 4 which is secured to the exterior periphery of the tube and which is driven by a gearing 5 from an electric motor 6.

In accordance with the invention, the furnace is operated preferably to maintain a central combustion zone or heating zone *a* with a preheating zone *b* on one end and a cooling zone *c* on the opposite end.

Pre-pressed coal briquets are delivered along a conveyor 23 and directed into an open hopper 52 having a rotary drum seal 24 for the delivery of the briquets downwardly into a vertical feed pipe 8 which is mounted on a fixed support 54. A rotatable feed hopper 7 is connected to sealing elements 9 to the vertical feed pipe 8 and connects at its lower end to the tube 1 of the rotary furnace 50.

In accordance with the invention, the interior of the tubular furnace 1 is lined with an insulating layer 12 (FIG. 2) which may be a refractory material, for example, and a multiplicity of tubes generally designated 13 extend the full length of the interior of the tube 1 at least in the combustion zone *a*, the preheating zone *b* and the cooling zone *c*. In a preferred arrangement, the tubes 13 are arranged to extend with their axes parallel to the tube 1 and are arranged so that the exterior peripheries interengage to form a plurality of passages throughout the tube 1 for the combustion media. In this manner, the coking of pressed spherical coal briquets is provided by indirect heating and it is possible to recover released rich gas.

In the combustion zone *a*, it has been found preferable to arrange the tubes 13 in the manner indicated in detail in FIG. 2. At least for the combustion zone *a*, it is preferable that the tubes 13a be of a ceramic material, as indicated in FIGS. 4 and 5, whereas in the other zones, the preheating zone and the cooling zone *b* and *c*, the tubes may be of a type 13bc in FIGS. 6 and 7 which tubes are made of metal, preferably of heat resistant cast iron. Both the tubes 13a and the tubes 13bc have a helical or progressive groove 14 defined therethrough dimensioned to permit passage of coal pellets or briquets 15. The configuration of the grooves 14 is such that the coal pellets 15 can roll along the groove in an axial progression as the tubular furnace 1 is rotated. In the embodiment illustrated, the grooves are indicated to be rounded to accommodate spherical pellets, but, of course, they may be made of a configuration to accommodate cylindrical, ellipsoidal or other shaped pellets in a manner to permit the progression of the pellets through the tubes as the outside tube 1 is rotated.

In accordance with a feature of the invention, the tubes 13 are of a configuration such that their exteriors form separate passageways for the flowing of a separate fluid media, for example, the combustion media. For this purpose, each of the tubes is provided with three lugs 16 which project outwardly from the surface at equally spaced locations and also with three grooves 17 which are located between the lugs around the exterior surface. The lugs 16 of adjacent tubes fit into the grooves 17 of the other tubes as best indicated in FIGS. 2 and 3 and define, in the embodiment of the furnace illustrated, separate combustion media gas passages *G* and air passages *L*. In order to permit the combining of the combustion media gas and the air, slots 18 are provided which extend through the lugs 16 at various intervals in order to permit air to be alternately conducted from the air ducts *L* into the gas ducts *G* and inversely the gas from the gas ducts *G* into the air ducts *L*. The slots 18 are advantageously distributed over the entire length of the combustion zone *a* indicated in FIG. 1 so that the combustion takes place in steps similar to the well known heat ducts of horizontal chamber coke-ovens having great chamber heights. In this manner, it is possible to ensure uniform heating of the coking tubes over the required length. In order to obtain the necessary pressure gradients between the gas and the air ducts *G* and *L*, baffle plates 19 are arranged in the air ducts *L* immediately behind the slots 18 at the points where the air is to be directed into the gas ducts. In the same manner, baffle plates 19 are also arranged in the gas ducts at the point where the gas is to be introduced into the air ducts.

Each of the tubes 13, as best indicated in FIG. 4, is provided with an annular tongue 21 at one end and

an annular recess of corresponding dimensions 20 at the opposite end to permit a plurality of tubes to be assembled together in an axial direction using mortar to make the connection gas tight and permanent. Mortar is also applied in the assembly and the depressions 17 before the lugs 16 of the next adjacent tube are inserted. This results in a stable ceramic structure with ducts for the combustion media separated in a gas tight manner from each other and with gas-tight coking tubes for the movement and pelletization and coking of the coal briquets.

The metallic tubes 13_{bc} (FIGS. 6 and 7) are arranged in the part of the furnace where the operating temperature permits the use of a metallic tube part. The interior of these tubes, as indicated in FIGS. 6 and 7 correspond to the tubes 13_a with the exception that the walls are made thinner because of the change of material. In this embodiment, projections or lugs 16' are made of a different dimension and, in addition, the tubes are provided with ribs 22 to improve the heat transfer between the coal and the interior of the tube and the combustion media and waste heat.

The device operates by feeding the coal briquets from the conveyor 23 into the rotatable hopper 7 which rotates to bring the briquets up to a speed of rotation necessary for entering into the grooves 14 of the tubes 13 and traveling therealong in the preheating zone *b*. They are advanced along the axis of each tube until they finally issue from the tubes at the extreme end after passing through the combustion zone *a* and the cooling zone *c*.

In a preferred arrangement, the coal briquets are first heated in the preheating zone *b* in heat exchange with waste gases and then are delivered to the combustion zone proper *a* where they are heated to the coking temperature. The coked briquets then roll through the cooling zone *c* where they give off some of their heat to the combustion media which is flowing upwardly through the gas tubes *G* and they leave the tubes 13_c cooled to a temperature below their ignition temperature. A discharge chute 10 is connected to this end of the furnace tube 1 and is provided with a plurality of baffles 27 which are arranged in a position for directing the discharge briquets past a valve element 28 and into a container 29 through a valve element or gas gate 30 and onto a discharge conveyor 31.

In the construction indicated in FIG. 1, a provision is made for heating with poor gas, which can be obtained, for example, by mixing rich gas obtained in the process with a waste heat gas.

The combustion media gas is advantageously directed through a nipple 32 and defined in a fixed tube 33 and into a tube 34 which is rotatable within the fixed tube and connects from the tube 33 to a chamber 36 which interconnects at this end of the furnace all of the gas ducts *G* formed around the peripheries of the tubes 13. The tubes 33 and 34 are connected together by means of gas-tight rotary connections 35. The connecting chamber 36 is so designed that the gas ducts *G* connect into the chamber while the coking tubes 13 and the air ducts *L* extend through the chamber in a gas-tight manner.

The necessary combustion air is directed into a nipple or fitting 37 and through the preheating chamber 29 where it obtains heat from the coke briquets which are delivered thereto. The air is then directed outwardly through a fitting 38 to a conduit or pipe 39 and into a compartment space 40 formed in the tubular element 33. The space 40 communicates with a tubular element 41 which is rotatably mounted and connects at its other end into an air chamber 42. All of the air ducts 1 connect into the air chamber 42, but the tubes 13 extend through the air chamber in a gas-tight manner. At this location the lugs 16 and the grooves 17 are advantageously eliminated from the tubes 13 where they extend through the connecting chamber 42. The waste heat is eliminated through the connecting chamber 43 which is arranged around the tubes 13 at the heat of the preheat zone at the upper end of

the furnace 50. All of the air ducts 1 open into the chamber 43 and the waste gases are directed out through a connection 44. The rich gas which is produced can be withdrawn either through a connection 45 at the upper end of the vertical tube 8, or at a connection 46 at the discharge unit 10.

It should be appreciated that the grooves in the tubes 13 may be of any configuration and, for example, if barrel-shaped briquets are to be formed, then the groove is similarly formed. In some instances, helical guide plates are desirable in the groove formations.

If the heating of the coking in the coking zone *a* is to be effected with gases which cannot be preheated, for example, a rich gas, a residual gas from synthesis, natural gas, liquid gas or similar gas, these are fed approximately at the boundary surface between the cooling zone *c* and the combustion zone *a* through a connecting chamber for the gas ducts *G* which would be provided at such location. In such an installation, the gas ducts *G* which are provided in the cooling zone would be employed for preheating the air instead of for gas flow.

The revolving tubular furnace 50 can also be used for the so-called autogenous coking where the production of rich gas is eliminated. In such a case, the preheating zone *b* and the cooling zone *c* can be omitted. The air and gas ducts *G* and *L* can also be omitted. The coking tubes are then directly juxtaposed without any interval and the air supply is effected from the filling side and the withdrawal of the waste heat gases from the discharge side.

While specific embodiments of the invention have been shown and described in detail to illustrate the application of the inventive principles, it will be understood that the invention may be embodied otherwise without departing from such principles.

What is claimed is:

1. A tube formation, comprising a tube wall of a ceramic metal material formed with a groove on the interior extending axially therealong, a projection formed on the exterior of the tube wall at at least three equally spaced locations on the periphery thereof, a recess formed between each of the projections on the exterior of said tube, said projections being of a size to fit in the recesses for engagement of the projections in the recesses of an adjacent tube, means defining a passage extending through said projections, said tubes having an end formation with a projection at one end and with an opposite end having a recess to permit engagement of the projection of one tube in a recess of another tube for interengagement of the tubes, and a baffle defined at fixed intervals along the length of the tubes adjacent the bore through said projections, and a plurality of ribs defined at fixed intervals around the tube for the increased heat transfer through the walls thereof.

2. A tube formation, comprising a tube wall of a ceramic material formed with a groove on the interior extending axially therealong, a projection formed on the exterior of the tube wall at at least three equally spaced locations on the periphery thereof, a recess formed between each of the projections on the exterior of said tube, said projections being of a size to fit in the recesses for engagement of the projections in the recesses of an adjacent tube, means defining a passage extending through said projections, said tubes having an end formation with a projection at one end and with an opposite end having a recess to permit engagement of the projection of one tube in a recess of another tube for interengagement of the tubes, and a baffle defined at fixed intervals along the length of the tubes adjacent the bore through said projections.

3. A tube formation, comprising a tube wall of a metal material formed with a groove on the interior extending axially therealong, a projection formed on the exterior of the tube wall at spaced locations on the periphery thereof, a recess formed between each of the projections on the exterior of said tube, said projections being of a size

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to fit in the recesses for engagement of the projections in the recesses of an adjacent tube, said tubes having an end formation with a projection at one end and with an opposite end having a recess to permit engagement of the projection of one tube in a recess of another tube for interengagement of the tubes, and a baffle defined at fixed intervals along the length of the tubes adjacent the bore through said projections, and a plurality of ribs defined at fixed intervals around the tube for the increased heat transfer through the walls thereof.

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References Cited

UNITED STATES PATENTS

2,809,019	10/1957	Newton	-----	165—179	X
2,913,009	11/1959	Kuthe	-----	165—179	
3,401,923	9/1968	Bearce	-----	263—32	

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U.S. Cl. X.R.

165—179; 263—20