Jan. 6, 1970 E. J. DICKSON 3,488,040

PIPE SHEATHING TILE

Filed Feb. 13, 1968

FIG. 3

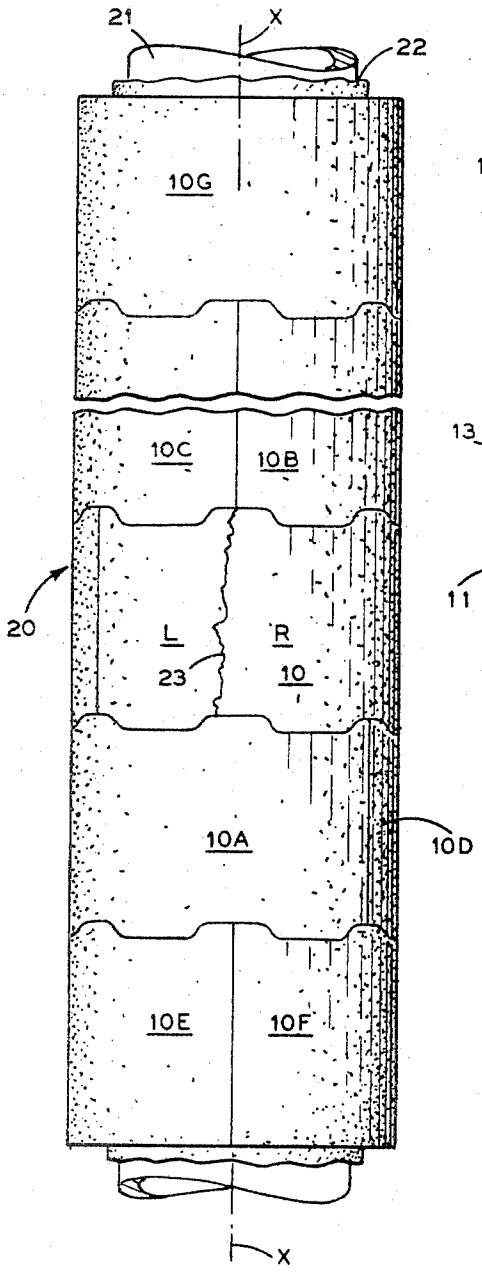


FIG. 2

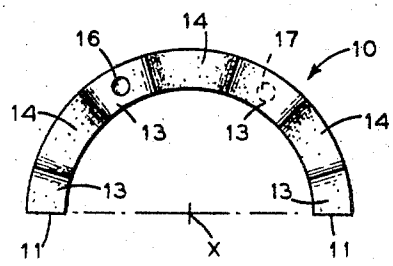


FIG. 1

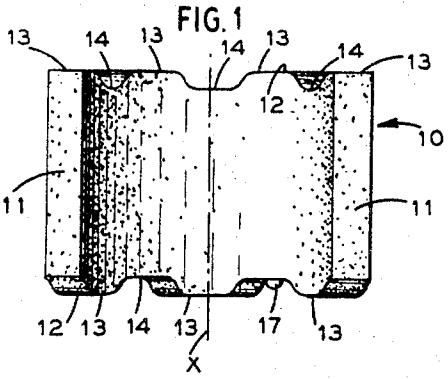
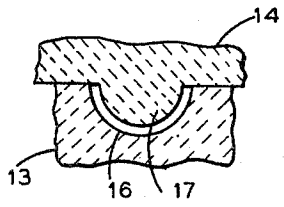


FIG. 4



INVENTOR.
Edwin J. Dickson

BY

ATTORNEY

United States Patent Office

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PIPE SHEATHING TILE

Edwin J. Dickson, Augusta, Ga., assignor to The Babcock & Wilcox Company, New York, N.Y., a corporation of New Jersey

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ABSTRACT OF THE DISCLOSURE

A pipe sheathing tile structure which can be assembled from multiple courses of modular tiles stacked in an axial direction to form an extended hollow sheath circumferentially enclosing a pipe, and wherein the individual tiles are provided with radially tapered male and female parts circumferentially distributed in an alternating sequence along either one or both axial ends of the tile, each set of male and female parts being arranged to interlock with a corresponding set of matching female and male parts of an endwise adjoining tile. The interlocking radially tapered end parts allow for thermal expansion and contraction between adjoining tiles and prevent drop-out of tile pieces in the event of cracking.

Background and summary of the invention

This invention relates in general to tile which can be assembled into hollow sheathing structures for encasing pipes, columns, rods and other lineally extending members which must be protected from a high temperature environment, such as that commonly encountered in furnaces and heat treating chambers.

More particularly, the invention is directed to a tile sheath structure which can be assembled from multiple courses of modular tiles stacked in an axial direction to form an extended hollow sheath circumferentially enclosing the pipe or other member to be protected.

In the prior art, numerous tile shapes have been used to build up hollow sheath structures, as for example, those shown by U.S. Patents No. 338,512 to Gilman, No. 2,435,362 to Morton, No. 2,884,879 to Corriston, and No. 3,055,651 to McCullough. One of the basic problems presented in the construction of tiled hollow sheath structures that are to be exposed to high temperature is that of preserving a continuous circumferential enclosure when tile cracking occurs. With most prior art tile shapes, in mortarless or dry-set sheath structures, tile cracks result in drop-out of tile pieces, leaving an opening exposing the pipe to the action of hot gases. Although if cracking itself could be completely eliminated, the pipe exposure problem would no longer exist, under present day furnace and hot chamber operating conditions, it is practically impossible to guarantee that none of the many tiles making up the pipe sheath will not, over an indefinitely long service period, experience any cracking, either from thermally induced stresses, changes in material properties, or from accidental damage.

The invention provides a hollow sheathing structure made up from multiple courses of modular tiles which can be progressively stacked in an interlocking arrangement without the need for any mortar. The individual tiles are provided with radially tapered male and female parts that are circumferentially distributed in an alternating sequence along either one or both of the axially facing ends of the tile. In the case of tiles which are to be laid in terminal courses, only one set of male and female parts is provided, and this set is on the inside axial end of the tile, i.e. the end which is to adjoin another tile. On intermediate tiles which interconnect with adjoining tiles at

both axial ends, two sets of male and female parts are provided, one set per end. In joining consecutive courses of tiles, the male and female parts associated with the tiles of one course interlock with respectively corresponding female and male parts of the tiles of the other course. By using interlocking male and female parts that are radially tapered, such portions of the tiles as become separated in the event of cracking are retained in their original sites.

These male and female parts are preferably dimensioned so as to establish predetermined clearances between interlocking male and female parts of adjoining tiles so as to permit limited radial direction movement between such adjoining tiles. This allows for normal thermal expansion and contraction between tiles and prevents build-up of stresses which could cause cracking.

Expediently, the tiles are made in the form of semi-circular cylindrical segments, so that a pair of laterally adjoining tiles constitutes a single course and forms a complete hollow cylindrical sheath section of axial length corresponding to the distance between the interlocking parts bearing ends of the tiles. Of course, non-circular cylindrical or polygonal prismatic segment tile configurations can be used if desired, for the purpose of forming tiled sheaths with oval or polygonal cross-sections. By using tiles in the form of cylindrical segments extending each for one-half or less of the total sheath circumference, two or more tiles can be easily installed to form each course of a circumferentially closed sheath, around a pipe or column which need not have any free end, as would be necessary for installing full cylindrical tiles.

The interlocking parts of the tiles are preferably arranged such that the tiles making up each course of the sheath can be circumferentially staggered between adjoining courses. This is expediently done by providing on a male part associated with one end of the tile, and also on a female part associated with the other end thereof, a three-dimensionally contoured surface portion, one surface portion being convex, and the other being concave. These two surface portions are generally complementary to each other, and are circumferentially spaced-apart to key the tile for interlocking engagement with a pair of endwise adjoining similar tiles in a circumferentially staggered relation thereto corresponding to the circumferential spacing between the convex and concave surface portions. In this way, the tiles of each consecutive course can only be interlocked when positioned in the proper staggering relation.

It is therefore an object of the invention to provide a tiled sheathing structure that can be assembled from multiple courses of tiles to form a lineally extended hollow sheath around a pipe, column or similar member.

Another object of the invention is to provide a tiled sheathing structure as aforesaid which can be assembled without mortar from modular tiles having tapered parts which interlock with corresponding tapered parts on endwise adjoining tiles.

A further object of the invention is to provide a tile having an interlocking part configuration which when assembled into a sheathing structure as aforesaid, is capable of retaining in their original situs, such tile portions as become separated upon cracking.

A further object of the invention is to provide a tile as aforesaid having interlocking parts dimensioned to allow a limited degree of radial direction movement between adjoining tiles.

Still another object of the invention is to provide a tile having means to key it for assembly in staggered relation to tiles of adjoining courses.

Other and further objects of the invention will become apparent from the following detailed description and accompanying drawing.

Brief description of the drawing

In the drawing:

FIG. 1 is a longitudinal view of a tile made in accordance with a preferred embodiment of the invention;

FIG. 2 is an end view of the tile shown in FIG. 1;

FIG. 3 is an elevation view of a hollow sheathing structure assembled from tiles of the type shown in FIGS. 1 and 2;

FIG. 4 is a detail view in section, of the adjoining portions of two typical interlocking tiles in the structure of FIG. 3, as taken within the outlined region IV therein.

Description of the preferred embodiments of the invention

In FIGS. 1 and 2, there is shown a basic modular tile **10** having a generally semi-circular cylindrical segment configuration, a pair of opposite lateral edges **11** generally coincident with a radial plane through a reference axial direction line X and a pair of opposite axially facing ends **12**.

Along each of the ends **12**, the tile **10** has a plurality of male parts **13** and a plurality of female parts **14** circumferentially distributed in an alternating sequence. These male parts **13** and female parts **14** are radially tapered with respect to the axial line X, and are disposed for interlocking engagement with corresponding and matching female parts **14** and male parts **13** respectively of similar endwise adjoining tiles **10A**, **10B**, **10C**, **10D** as shown in FIG. 3.

The tiled hollow sheathing structure **20** in FIG. 3 is assembled from a plurality of modular tiles **10**, **10A–10G** of the type shown in FIGS. 1 and 2, all of which are disposed in interlocking engagement with one another and are arranged in multiple courses stacked along the axial line X. The tiles **10E** and **10F** making up the lowermost course, and the tile **10G** together with another tile (not shown) which is hidden behind tile **10G** and with said tile **10G** makes up the uppermost course, have interlocking parts **13**, **14** distributed only around one end, i.e., in each case the inside end, for the reason that these uppermost and lowermost courses are terminal courses.

By reason of the semi-circular cylindrical configuration of the tiles **10**, **10A–10G**, two tiles make up each course to form a sheath structure **20** that extends along line X and completely encloses it circumferentially.

A pipe **21** or similar member can be enclosed by the sheath structure **20**, and any radial spacing between the outside of pipe **21** and the inside surface of the sheath **20** can be filled with a layer of compacted insulation **22**, if desired. It should be recognized however that the tile may be made of a material that is both heat resistant and has insulating properties.

The use of radially tapered male and female parts **13** and **14** to interlock the tiles of adjoining courses has the advantage of retaining in their original sites, such portions of any tile which become separated in the event of cracking.

For example, if a crack **23** should develop as shown in tile **10**, such tile **10** would become divided into a right hand portion R and left hand portion L. The portion R would still have male and female parts **13** and **14** interlocked with some of those of tiles **10B** above and tiles **10A** and **10D** below. Should some force be exerted to pull the portion R radially outward, the male parts **13** of tiles **10B**, **10A** and **10D** would bear against the female parts **14** remaining with tile portion R to prevent such outward withdrawal thereof.

If a force were applied to push the tile portion R radially inward, the male portions **13** thereof would bear against the female portions **14** of tiles **10B**, **10A** and **10D** to prevent any inward displacement of said portion R.

Likewise, the left hand tile portion L would be restrained against both inward and outward movement by the interlocking action of its male and female parts **13** and **14** with those of tiles **10C** and **10A**. It should be noted that the tile portions R and L are retained in their original situs without any assistance from the pipe **21** or its insulation layer **22**.

In the assembly of sheath **20**, it is preferable that the tiles of adjoining courses be laid in a circumferentially staggered order so that the lateral edges **11** of the tiles in one course do not line up with those of the tiles in the next course on either end. For purposes of example, in FIG. 3, the tiles of adjoining courses are shown as being staggered 60 degrees apart, but any suitable staggered spacing can be chosen, the variation in staggering range being limited by the circumferential arc length of the tiles and the spacing and number of male and female parts in the end of the tile. With semi-circular tiles, a 0 degree to 180 degree stagger range is available, whereas if the tiles were made as 90 or 60 degree cylindrical segments, then only 0 to 90 degrees, and 0 to 60 degrees of stagger respectively would be available.

It should be noted that the invention does not inherently require that the tiles **10**, **10A–10G** be limited to circumferential lengths of 180 degrees or less, or that all of them be equal in circumferential length. For example any given course could be made up of cylindrical segment tiles totalling 360 degrees in arc length, but with one tile greater than 180 degrees arc length, and one or more other tiles less than 180 degrees arc length. However, the tiles **10**, **10A–10G** are expediently all equal in arc length so that the sheath **20** can be assembled with modular tile shapes, and the arc length of the basic modular tile **10** is preferably kept at 180 degrees or less so as to allow all tiles to be shipped around any pipe **21** and insulation cover **22** up to the full inside radius of the tile.

To facilitate assembly of the tiles **10**, **10A–10G** in the intended 60 degree staggering order, the basic tile **10**, which is identically representative of the intermediate tiles **10A**, **10B**, **10C**, **10D** is provided with a three-dimensionally contoured surface portion **16** on a predetermined one of its upper end **12** male parts **13**, and a three-dimensionally contoured surface portion **17** on a predetermined one of its lower end **12** female parts **14** as shown in FIGS. 1, 2 and 4. The surface portion **16** is concave and the surface portion **17** is convex and dimensioned to be generally complementary to surface portion **16**. Both surface portions **16** and **17** are generally centered in the thickness of tile **10** between the inside and outside curved surfaces thereof, and are spaced apart circumferentially by an arc length distance of 60 degrees, which corresponds to the intended staggering distance.

Although the surface portions **16** and **17** are shown as being approximately hemispherical, it should be noted that any other combination of compatible shapes, not necessarily geometrically complementary, can be used, provided that the intended purpose of keying the tiles in adjoining courses for assembly in the proper staggering order can be realized.

As can be readily appreciated from FIGS. 1–3, the tiles provided with such surface portions **16** and **17** cannot be laid into complete interlocking engagement with any tile of an adjoining course except when positioned in the proper stagger spacing, in which case the convex surface portion **17** of one tile will be received by the concave surface portion **16** of the other tile.

In general, the number of male and female parts **13** and **14** provided per tile end **12** can be selected as desired, and as such number increases, the greater is the degree of tile piece drop-out protection afforded, because in the event of multiple crack formation, the possibility of having any separate tile portion without at least some fraction of a male part **13** plus some fraction of a female part **14** decreases.

From FIGS. 1 and 2, it can be noted that the tile **10** has along its upper end, a first male part **13** of 15 degrees arc length, a first female part **14** of 30 degrees arc

length, a second male part **13** of 30 degrees arc length, a second female part **14** of 30 degrees arc length, a third male part **13** of 30 degrees arc length, a third female part **14** of 30 degrees arc length, and a fourth male part **13** of 15 degrees arc length, counting along the tile circumference from the left edge **11** to the right edge **11**. Along its lower end **12**, tile **10** has a first female part **14** of 15 degrees arc length, a first male part **13** of 30 degrees arc length, a second female part **14** of 30 degrees arc length, a second male part **13** of 30 degrees arc length, a third female part **14** of 30 degrees arc length, a fourth male part **13** of 30 degrees arc length, and a fourth female part **14** of 15 degrees arc length, counting circumferentially between the edges **11** from left to right. In both cases, the beginning and last male or female parts in each set are one-half the arc length of the others. Thus, in the assembly of the sheath structure **20**, adjoining edges **11** of tiles in the same course will be centered between a full 30 degree female part **14** of a tile in one adjoining course, and between a full 30 degree male part **13** of a tile in the other adjoining course, as exemplified by the tiles **10B** and **10C**, **10A** and **10D**. Actually, when two semi-circular cylindrical tiles such as **10C** and **10B** are laid together, their adjoining 15 degree arc length male and female parts **13** and **14** in effect are combined to present at each end an alternating sequence of 30 degree male and female parts around the full 360 degrees circumference of the tile course established by the pair of tiles **10C** and **10B**.

Preferably, the male and female parts **13** and **14** associated with the various tiles **10**, **10A–10G** used in the sheath **20** are dimensioned to establish predetermined clearances between interlocking parts **13**, **14** of adjoining tiles so as to permit limited radial directional movement between such adjoining tiles. This allows for thermal expansion between tiles and prevents build-up of stresses which may cause cracking. Likewise the surface portions **16** and **17** are dimensioned to provide sufficient clearance between each convex surface portion **17** and the concave surface portion **16** which receives it, so that there will be no interference between such surface portions **16** and **17** at any relative tile displacement permitted by the clearances between the male and female parts **13** and **14**.

From the foregoing description, it will be readily understood by the artisan that the specific geometrical shape of interlocking parts **13** and **14** and surface portions **16** and **17** illustrated for purposes of example in the drawing can be varied. For example, instead of providing the combination of a concave surface portion **16** on a male part **13**, and a convex surface portion **17** on a female part **14**, a concave surface portion **16** could be provided on a female part **14** along with a convex surface portion **17** on a male part **13**.

For high temperature applications, the tiles **10**, **10A–10G** are preferably made of a refractory material, and can be formed by casting. Since sharp corners and edges give certain practical problems in casting, the male and female parts **13** and **14** are preferably rounded as shown in the drawing.

It should be noted that the invention does not absolutely require that the tiles **10**, **10A–10G** be made of refractory material in all cases, and if desired they can be made of any other material suitable for their intended service environment, such as for example, metal, glass or plastic. If desired, the male and female parts **13** and **14** can be machined or otherwise formed so that their radially tapered surfaces are planar instead of sloped and rounded as shown in the drawing.

From the foregoing, it will be appreciated by the artisan that the invention is susceptible of numerous obvious modifications and variations to suit the needs of particular applications.

What is claimed is:

1. A tiled structure which comprises a plurality of tiles disposed in interlocking engagement with one another and arranged in multiple courses stacked along a predetermined axial direction line to form an extended hollow sheath circumferentially enclosing said axial direction line, each of said tiles having a plurality of male parts and a plurality of female parts circumferentially distributed in an alternating sequence along at least one axially facing end of the tile, said male and female parts of each tile having matching radially tapered configurations accommodating the joining together by movement along said axial direction line of endwise adjoining tiles and restraining such adjoining tiles and portions thereof from separation by radial movement relative to each other, whereby in the event of tile cracking the resulting fragments are retained in their original situs.

2. A tiled structure according to claim **1** wherein the male and female parts of said tiles are dimensioned to establish predetermined clearances between interlocking male and female parts of adjoining tiles to permit limited relative radial direction movement between such adjoining tiles.

3. A tiled structure according to claim **1** wherein each tiled course includes a plurality of tiles, each tile extending circumferentially over a predetermined segment of the total sheath circumference, and wherein the tiles of adjoining courses are positioned in circumferentially staggered relationship.

4. A tiled structure according to claim **3** including a plurality of tiled courses wherein each tile has at each of two opposite axially facing boundaries a plurality of said male parts and a plurlity of said female parts circumferentially distributed in an alternating sequence.

5. A tiled structure according to claim **3** wherein a predetermined one of the male and female parts associated with one tile of each pair of interlocking tiles in adjoining courses has a three-dimensioned surface portion contoured for matching engagement with a three-dimensionally contoured surface portion of a corresponding one of the female and male parts associated with the other of said pair of tiles to establish a predetermined circumferential staggering distance between tiles in adjoining courses.

6. A tiled structure according to claim **5** wherein a predetermined male part associated with each pair of interlocking tiles in adjoining courses has a concave surface portion positioned for matching engagement with a convex surface portion of a predetermined female part associated with the other of said pair of tiles.

7. A tile having a plurality of male parts and a plurality of female parts circumferentially distributed in an alternating sequence along at least one axially facing end, said male and female parts having matching radially tapered configurations accommodating the joining together by movement along a predetermined axial direction line of an endwise adjoining tile and restraining such adjoining tiles and portions thereof from separation by radial movement relative to each other.

8. A tile according to claim **7** wherein said tile has a cylindrical segment configuration.

9. A tile according to claim **7** wherein said tile has a semi-circular cylindrical segment configuration.

10. A tile according to claim **7** wherein said tile has a plurality of male parts and a plurality of female parts circumferentially distributed in alternating sequences along each of two opposite ends, the male and female parts at each end being radially tapered and disposed for interlocking engagement with matching female and male parts respectively of an endwise adjoining tile to form therewith a hollow sheath extending along said axial direction line.

11. A tile according to claim **10** wherein a predetermined male part associated with one of said ends and a

predetermined female part associated with the other of said ends both have a three-dimensionally contoured surface portion, one of said surface portions being convex and the other surface portion being concave and circumferentially spaced-apart from said convex surface portion to key said tile for interlocking engagement with a pair of endwise adjoining similar tiles in a circumferentially staggered relation thereto corresponding to the circumferential spacing distance between said convex and concave surface portions.

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JOHN J. CAMBY, Primary Examiner

U.S. Cl. X.R.

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