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HIGH TEMPERATURE CONDUIT

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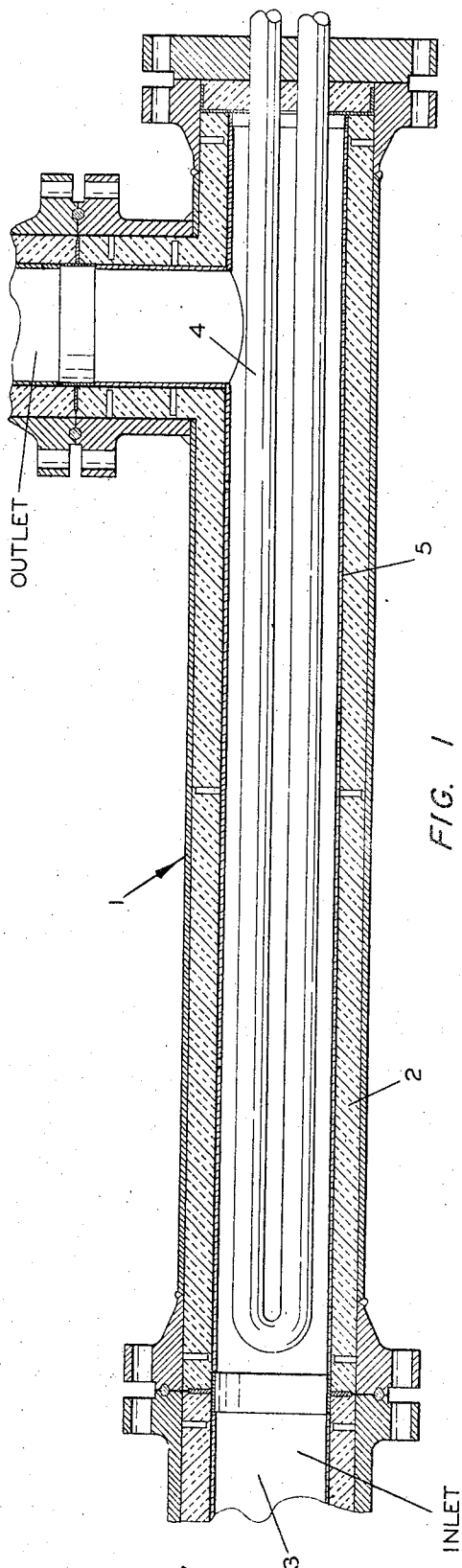


FIG. 1

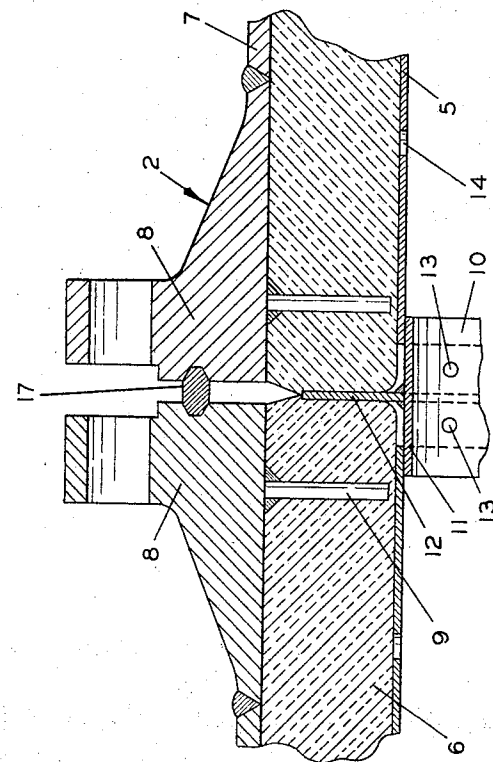


FIG. 2

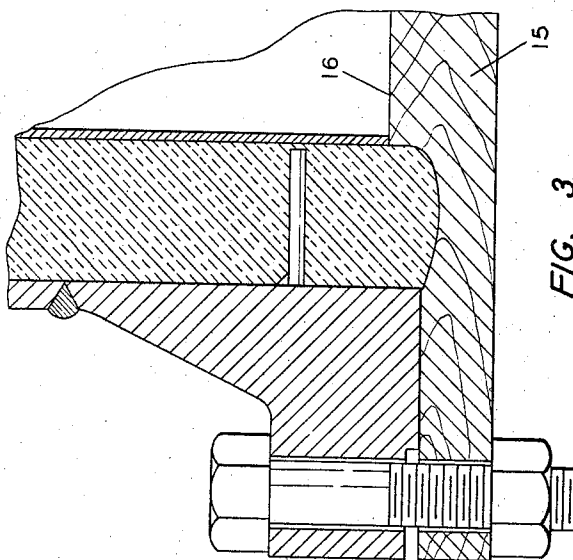


FIG. 3

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HIGH TEMPERATURE CONDUIT

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2 Claims. (Cl. 138—64)

This invention relates to conduits and containers of composite form for utilization of gases or vapors under conditions of extreme high temperature.

More specifically, my invention consists of a three-element structure comprised of: (1) a thin-walled and unpressured inner conduit formed of a material resistant to corrosion or oxidation by extremely hot gases; (2) a concentric outer shell of ordinary structural material such as low-carbon steel, for example, which will satisfactorily bear the pressure stresses as long as the temperature of the shell is not excessive, and (3) a layer of suitable insulating material interposed between the two concentric shells to insure maintenance of the outer shell temperature below the allowable limit.

In the past, many alloy steels have been developed for use in high temperature applications, such as in steam superheaters, petroleum cracking stills etc. These alloys were developed to answer two specific problems. One problem is in the overcoming of rapid corrosion effect of high temperature steam and/or organic gases upon equipment constructed of the early common types of steel. The second advantage gained by the introduction of these special alloy steels was an improvement in tensile strength at elevated temperatures.

While the advantage of the special alloy steels is great in regard to corrosion resistance, the improvement in strength characteristic as compared to ordinary steels is not proportionate to the increased cost of the alloy materials. The result is that equipment for high temperature applications (where high pressures are usually corollary) is designed to employ either the alloy materials at great money expense, or the ordinary steels at a lesser expense but a still considerable one and with the disadvantage of great bulk in the structure.

In my improved construction, the expensive corrosion-resistant alloy materials may be used sparingly with maximum benefit. The stress-bearing portion of the structure is protected from both high temperatures and corrosive action, so that the less costly common steels can be used without undue sacrifice with respect to strength, bulk or cost of the equipment to be fabricated. A further advantage is realized in that less heat is lost from the system per unit of time, with the dual effect of conserving the heat energy and minimizing the discomfort to be inflicted upon the operating personnel, as well.

A particular application for which my improve-

ment has great utility is in a process for treating hydrocarbons, wherein it is necessary to cool the effluent from a reaction vessel from 1500° F. down to about 850° F., at a sustained pressure of approximately 100 pounds per square inch. The required cooling is carried out in a heat exchanger in which the hot gaseous material is passed around a number of pipes containing water (steam) as a coolant. The gases to be cooled contain various hydrocarbon vapors, and often an appreciable quantity of sulphur, in which latter case the corrosive action is especially severe.

On the basis of results obtained in an experimental cooler incorporating my improved construction, the indicated cost of the cooling unit and adjacent piping for a commercial application would be but a fraction of that which would be incurred in constructing the unit in conventional fashion, or if available commercial heat exchangers were to be modified for the purpose.

A principal object of my invention is to provide a relatively inexpensive structure for the handling of extremely hot gases and vapors.

A more specific object is to make practical the use of ordinary carbon steels for the stress-bearing members in an application where the conditions of temperature and corrosion have heretofore required the use of more expensive special alloy steels.

A further object is to reduce the effect of differential expansion in the stressed portions of piping systems by holding the maximum temperature of those parts well below the values obtaining in the case of conventional structures in the same high-temperature service.

It is an object to reduce the amount of heat lost to the atmosphere in a system of the sort herein described, with a consequent increase in the amount of useful by-product heat recovered in the cooling system.

Another object is to provide, in a unit of the nature to be described, full protection against corrosive attack with a minimum expenditure of special corrosion-resistant alloy.

The advantages and true nature of my invention will be readily comprehended by consideration of the following description and claims.

In the drawing, Figure 1 shows an apparatus for which my invention is particularly well adapted. Figure 2 is a detail of my improvement, and Figure 3 illustrates a convenient manner in which the insulating material may be applied.

Referring to Figure 1, the numeral 1 refers

generally to a cooling chamber whose outer walls are to be formed in accordance with my invention, which is described in greater detail hereinafter. The conduit 2 is to contain the hot gases entering at 3 from a catalytic cracking chamber, not shown. The gases are passed in heat exchange relationship with tubes 4, after which they exit through the outlet to recycle through the system, or other disposition. The tubes 4 contain a circulating cooling medium. In the specific application at hand, I prefer to use water of condensate quality for the coolant, in which case cooling of the gases is accompanied by the generation of steam in the coolant tubes, producing usable by-product power for use in a turbine, for example. The gases enter the cooler at a temperature of approximately 1500° F., and exit at a temperature of approximately 850° F. A pressure of approximately 100 pounds per square inch is maintained in the conduit 2.

In Figure 2, which shows the detail about one wall of a flanged joint in the conduit 2, the numeral 5 indicates a tubular liner which may be made of 17% chromium steel, for example, or of any other material which is suitably resistant to corrosion at the temperatures to be encountered in a specific application. A layer of insulation material 6 is placed on the outward side of the corrosion resistant liner. The outer shell 7 is formed of ordinary carbon steel pipe or tubing of standard pipe size and weight. Conventional weld-type flanges 8 are provided at the termini of successive joints of pipe, and are fitted with frangible gaskets 17 of copper or soft iron which provide a pressure-tight joint.

Spacer pins 9 of alloy steel (same material as liner 5) are welded to the wall of the outer shell 7 and others are welded to the inner liner 5. The arrangement of these pins may be any of an almost infinite number of possible combinations. I prefer to attach at least three of these pins to the outer shell at each end, spaced equally about the circumference and also at least three attached radially to the liner 5 at its longitudinal midpoint. It is understood that in no case will the liner be tied to the outer case by welding both ends of any pin. All pins attached to the liner are free from the outer case, and vice versa. The result of this method of assembly is that the liner is spaced symmetrically within the outer shell and is well supported at the center and ends, yet the inner and outer tubes can expand and contract longitudinally in an independent manner.

At each joint in the inner lining 5 is provided a seal ring 10 of similar material which serves to provide an expansion joint for the liner. The seal ring has the form of a band, or short cylindrical section 11 which fits closely within the ends of the liners 5. Appended to the band 11 is a radial surface 12 which interposes between the abutting ends of the insulation layers. The cross-sectional shape of the seal ring is thus in T-form.

Pressure-equalization vents may be provided in the seal rings, as at 13, or in the alloy liners as at 14. The purpose of such vents is to assure equalization of pressure across the walls of the liner 5 so that the liner will not be required to bear the stress which would otherwise be generated by pressure of the pipe content. These vents are not always absolutely necessary, due to the fact that the liner joints will leak sufficiently to equalize the pressure. However, if the pressure within the pipes were to rise suddenly, leakage at the liner joints could not be depended upon to

relieve the resultant pressure stress adequately and rupture of the liner would be likely to occur. Therefore, it is preferable to provide the vents to take care of sudden rises in pressure which might occur.

Illustrated in Figure 3 is a convenient method of fabricating my improved pipe structure. Having at hand the carbon steel outer tubes with flanges attached, a wooden block 15 is turned on a lathe to the general shape shown in Figure 3 and is bolted to the flange at one end of the pipe as illustrated. The inner liner having been inserted from one end and brought to position, (determined by surface 16) the tube assembly is upended on the wooden form and insulation poured into the annular space between the tubes. After filling, another wood former may be placed on the remaining open end to form the insulation to like contour.

While many different types of insulating material are suitable for the purpose, I prefer to use one of the castable or moldable types which are placed in a wet condition and which upon drying or curing, attain a consistency at least rigid enough to retain a molded shape upon removal of the wood forms. The insulating material, when dried out, should have sufficient porosity to allow leakage of pressure from the vents of the inner liner toward the outer shell 7. Non-permeable insulators can be used, however, by providing suitable vent passages through the insulating layer. Such materials are commercially available, and no claim to the material per se is made herein.

The specific castable or moldable insulating materials that I have found most suitable in practicing this invention are "Panelag," "Insulag" and "Sil-O-Cell C-3". These are trade names. Quigley Co., 56 West 45th Street, New York city, states "Panelag" is good for temperatures up to 1700° F. while "Insulag" is good up to 2000° F., and that either one when mixed with water forms a plastic cement material which hardens into an insulating block. Johns-Manville Co., 292 Madison Ave., New York city states "Sil-O-Cell C-3" is a coarse granular form of calcined diatomaceous silica, which mixed with water forms a plastic cement which hardens into a block good for temperatures up to 2000° F. The exact composition of "Panelag," "Insulag" and "Sil-O-Cell C-3" are secrets, but they are sold by said companies in the open market with directions as to the amount of water to be added and the mixing procedure.

"The Refinery Catalog 1942," Gulf Publishing Company, Houston, Texas, lists suitable insulating cements on pages 96, 116, 239, 414, 449, 479, 508, 535 and elsewhere. A mixture of roughly 50% asbestos fibre and 50% Portland cement mixed with just enough water to make it plastic is also suitable, but is not preferred.

Having formed the insulation in the above manner, the wood forms 15 are removed and the seal rings 10 are inserted. The completed composite pipes are now ready for installation and the flanges 8 are bolted in the conventional manner for this purpose.

In operation, the unit illustrated by Figure 1 is connected to the discharge line from a thermal or a catalytic cracking furnace, for example. The high temperature products enter the cooling unit at 3, and after passing in heat exchange relationship with the tubes 4, exit from the cooler at a reduced temperature. The tubes 4 contain a

circulating coolant such as water (in which case steam is generated) or other suitable coolant. In some cases it is desirable to use an inert material for the coolant, such as CO₂, for example, to reduce the oxidizing tendency on the interior of the cooler tubes 4.

The temperature within the inner conduit 5 may be as high as 1500-2000° F. at the inlet. The outer case 7 is protected against this extreme temperature by the insulation 6, thus maintaining the temperature in this locality low enough that the carbon steel will not be materially weakened. The thin alloy steel liner 5 is of a composition capable of withstanding the extreme internal temperature, and serves to protect the insulating material 6 from mechanical damage by the gas stream, which at times may have a high velocity.

The inner and outer shells 5 and 7 are free to expand or contract independently of each other, and stresses in these members are thereby minimized. Continuity of the liner is maintained by the overlapping seal rings 10. Pressure on the interior of the liner 5 is equalized due to venting through the openings 13, so that no gas-stream pressure stresses are imposed on the liner.

It is understood that while the drawings and descriptive matter of this specification illustrate a specific example wherein my invention is of

particular benefit, other obvious applications can be made. The scope of my invention is, therefore, subject only to the limitations of the appended claims.

I claim:

1. A conduit for high temperature fluids comprising an imperforate stress-bearing shell, a perforate temperature resisting liner contained therein, a moldable heat insulating material between said outer member and the liner, spacer means welded to the outer member at the ends of the pipe, and further spacer means intermediate the ends of the pipe welded to the inner liner, all of said spacer means being imbedded in the moldable insulating layer.

2. A conduit for high temperature fluids comprising an imperforate stress-bearing shell, a perforate temperature resisting liner contained therein, a moldable heat insulating material between said outer member and the liner, spacer pins of the same material as the liner member welded to the outer member at the ends of the pipe, and further spacer pins intermediate the ends of the pipe welded to the inner liner, all of said spacer pins being imbedded in the moldable insulating layer.

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