

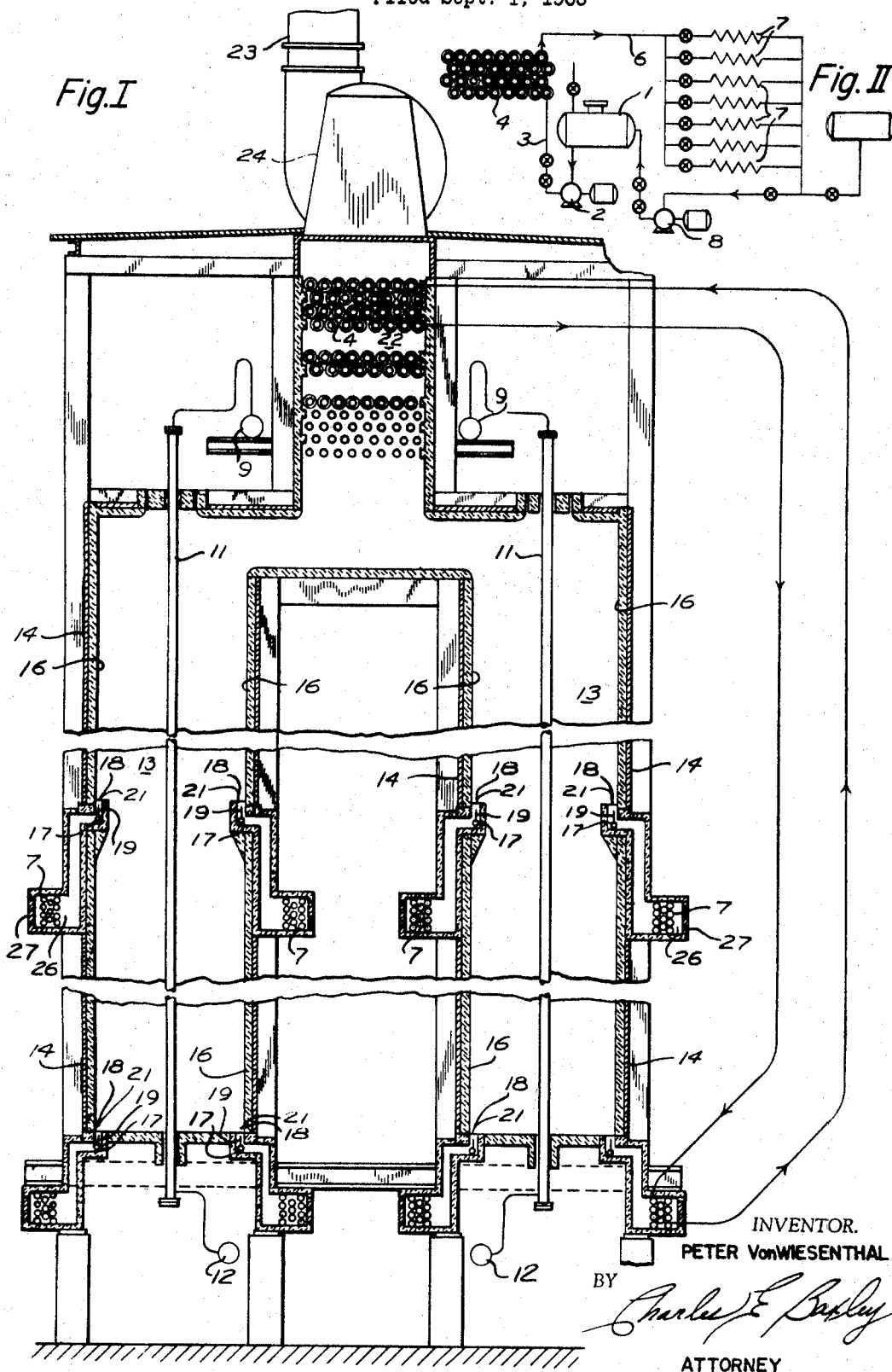
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APPARATUS FOR HIGH-TEMPERATURE CONVERSIONS

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APPARATUS FOR HIGH-TEMPERATURE CONVERSIONS

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1 Claim

ABSTRACT OF THE DISCLOSURE

This disclosure teaches cycling of a heat-transfer liquid to upgrade thermal efficiencies in high temperature furnaces. The liquids contemplated for this service are eutectic mixtures of potassium and sodium salts, eutectic mixtures of diphenyl and diphenyloxide, o-dichlorobenzene, tetrachlorobiphenyl compounds, aromatic oils and the like. Heat is recovered in convection tubes and is used to preheat combustion air so that fuel consumption is deduced and smaller furnace sizes are made possible. Circulation of the heat-transfer fluid is conveniently handled in pipes.

This disclosure contemplates high-temperature endothermal conversions. The invention resides in a tube furnace and related process by which high efficiency for such reactions is attained.

A number of commercially important endothermal conversions proceed at appreciable speeds only when elevated temperatures are reached. For example, the steam pyrolysis of vaporous hydrocarbons to produce olefins is normally conducted at temperatures of 1100° to 1600° F. Catalytic reforming in the presence of hydrogen to improve octane normally proceeds at temperatures in the vicinity of 900° F. In the case of catalytic steam reforming of hydrocarbons to produce hydrogen and carbon monoxide, temperatures in excess of 1000° F. are normally required. Since each of these processes are endothermal and occur at appreciable rates only with elevated temperatures, tubular furnaces can be used to add heat continuously to the reactants in the tubes thereby maintaining or increasing these temperatures while the reactions proceed.

Unfortunately, however, the use of tubular furnaces to carry out high-temperature conversions as practiced heretofore has occasioned some difficulties as can be illustrated by consideration of typical conditions employed in a furnace in which catalytic steam reforming of methane to produce hydrogen and carbon monoxide is conducted. Typically, a light hydrocarbon is preheated to a temperature of about 1000° F. and is introduced together with steam into catalyst-packed, vertical tubes disposed in the furnace chamber to be heated by burning a fuel. In order to supply the heat of reaction and to attain an outlet temperature in excess of 1500° F., tube wall temperatures above 1600° F. are maintained and the hot combustion products leave the furnace chamber at about 2100° F. Under these conditions the efficiency of the furnace is only about 40% from the standpoint of utilization in the reaction of the heat released by the combustion of the fuel. To obtain reasonable efficiency, the hot combustion products from the furnace chamber are flowed through a convection section of the furnace to preheat the gas feed and to generate steam. Thereafter the combustion products are vented via a stack. To make use of the steam thus generated, steam must generally be the principal source of power in the associated plant thereby precluding in some instances the use of electric motors for pumps, compressors, etc. Where large supplies of steam are not needed the operation of reformer furnaces for hydrogen

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production has frequently been deemed commercially impractical.

Another approach toward improving thermal efficiency was to recycle combustion gases in order to preheat combustion air. This approach was frustrated by cumbersome and expensive ductwork. Even when a regenerative-type air preheater was considered, the ductwork still was elaborate.

The present invention uses a heat-transfer fluid in a combustion-air-preheating system to step up furnace efficiency. The heat-transfer fluid receives heat in a convection section of the furnace. The heat-transfer fluid is easily piped to the vicinity of the burners where it gives up its heat to incoming combustion air. By this expedient ductwork is practically avoided, furnace chambers can be reduced in size by from ten to thirty percent and fuel requirements are reduced.

These and other features will appear more fully from the accompanying drawings wherein:

FIGURE I is an elevation view in section of a reformer furnace according to this invention.

FIGURE II is a schematic flow diagram depicting a heat-transfer system in accordance with this invention.

As best seen in FIGURE II, a heat-transfer fluid stored in drum 1 is circulated by pump 2 via line 3 to convection coil 4 for heating. The heated fluid is circulated via line 6 through air-preheat coils 7 and is returned by means of pump 8 to drum 1.

Heat-transfer fluids for the service here contemplated may be selected from among readily available commercial products such as eutectic mixtures of potassium and sodium salts, eutectic mixtures of diphenyl and diphenyloxide, o-dichlorobenzene, aromatic heat transfer oils tetrachlorobiphenyl compounds and the like. Information on the selection and application of these heat transfer fluids is contained in such publications as "Aromatic Heat Transfer Oils," a technical bulletin of Socony Mobil Oil Company, "Dowtherm Handbook," Form 125-276-60 by Dow Chemical Company; "Hitec Heat Transfer Salt," Bulletin A-15821 of E. I. Du Pont de Nemours & Co., Inc. and "Therminol Fluid Heat Systems" by Monsanto Company. Some of the design criteria which must be considered in the selection of a suitable fluid include cost, operating temperature ranges, freezing point, toxicity and stability.

To produce a mixture of H₂ and CO in the furnace shown in FIGURE I, a hydrocarbon (such as methane or propane) along with a suitable oxidant such as H₂O and/or CO₂ is coursed downward from inlet manifolds 9 through furnace tubes 11 which are filled with a granular catalyst such as nickel oxide to outlet manifolds 12 all in a manner well known to those familiar with the art.

Temperatures in excess of 2000° F. are desirable in furnace chamber 13. Toward this objective elongated settings 14 are provided with side walls 16 which are relatively close to tubes 11. Linear burners 17 are arranged in elongated troughs made of tile and disposed along side walls 16 so that the combustion gases from these burners wash side walls 16 to heat them to uniform incandescence so that substantially the entire surfaces of these side walls act as heating elements.

It is important that impingement of flames onto catalyst filled tubes 11 be avoided, so combustion of the gaseous fuel is contained from burner tips 19 to the upper extents 21 of troughs 18.

At the heart of this invention is the recovery of heat from combustion gases for use in air preheating. Combustion gases are drawn from furnace chamber 13 through convection section 22 and are subsequently vented through stack 23 all by means of induced draft fan 24. Convection coil 4 serves to raise the temperature of the heat-

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transfer fluid. Air-preheat coils 7 are positioned in air-inlet passages 26 which open by way of screens 27 to the atmosphere.

It will be understood by those skilled in furnace design that wide deviations may be made from the shown embodiment without departing from the main spirit of invention as set forth in the claims.

What is claimed is:

1. A furnace suitable for a high-temperature endothermal reaction and comprising
 - an elongated box-like setting having parallel side walls and enclosing a furnace chamber therein,
 - a source of fuel and a source of air,
 - the setting defining a plurality of air-inlet passages communicating in flow series with the source of air to receive combustion air therefrom,
 - a plurality of linear burners each operatively connected with the source of fuel and positioned in one of the air-inlet passages and arranged along both of the side walls in at least two tiers thereof for heating said side walls to incandescence and for supplying hot combustion gases to the furnace chamber,
 - at least one row of furnace tubes mounted in the furnace chamber approximately midway between the side walls,
 - means for coursing a hydrocarbon stream through at least one of the furnace tubes for noncontact heating by the combustion gases,

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the setting defining a convection section arranged to receive the combustion gases from the furnace chamber,
 at least one convection coil mounted in the convection section,
 at least one air-preheat coil mounted in the air-inlet passage,
 means for circulating a heat-transfer liquid in turn through the convection coil and then through the air-preheat coil.

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