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 STONE & WEBSTER ENG CORP \*WO 8700-081-A

27.06.85-US-749869 (15.01.87) B01j-08/06 C01b-03/02

Synthesis gas prodn. by connecting reforming - of hydrocarbon(s) and steam, using core assembly filled with particulate solid catalyst, heated by indirect heating fluid

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E(31-A1) H(4-E4, 4-F2E) J(4-E1) N(6)

shell enclosure, the passageway surrounding the tubular conduits of the core assembly.

#### ADVANTAGE

Synthesis gas is produced with improved thermodynamic efficiency by using high temperature waste heat more advantageously in the convective reformer device, so reducing the size and fuel consumption of the primary reforming furnace in steam reforming processes. In particular, the natural gas consumption for the production of ammonia is decreased in the order of 6MM BTU/MT.

#### EMBODIMENTS

The core assembly also includes baffling means for enhancing the velocity of the heating fluid. Most of the inside surface of the outer shell enclosure is lined with insulation material which retards heat loss and allows the use of carbon steel for the outer shell enclosure, with stainless steel tubular conduits for the feed mixture tubes containing the catalyst, there being 250-1000 such tubular conduits. The orifices in the lower ends of the catalyst tubes are constricted sufficiently to retain the particulate solid catalyst

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Hydrogen-rich gas is produced by the convective reforming of a feed mixt. of hydrocarbons and steam in a device which comprises

(a) an outer shell enclosure consisting of two end portions, a cylindrical main body portion, and separate inlet and outlet conduits for a heating fluid, each of which conduits include perforated distribution plates for delivering the heating fluid uniformly to and from

(b) a core assembly consisting of separate inlet and outlet conduits at opposite ends for the passage of the feed mixture, the conduits extending through the outer shell, and a number of tubular conduits open to the feed mixture flow and containing a particulate solid catalyst for the feed mixture, such that the outer enclosure and core assembly are separated by a passageway for the heating fluid communicating with the heating fluid inlet and outlet in the outer

while ensuring a uniform flow of feed mixture. The outer shell enclosure includes one or more access points for loading and unloading catalyst.

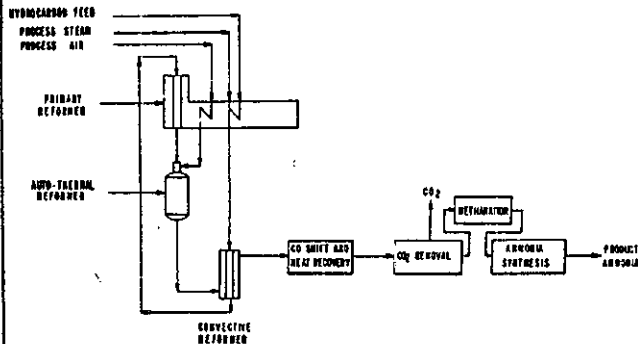
### STEAM REFORMING SYSTEM

The reforming of hydrocarbons into a hydrogen-rich gas comprises, in series, (a) a convective reformer device having indirect heat exchange to partially reform the hydrocarbons and steam; (b) a steam reforming furnace having a radiant section, reforming tubes in the radiant section, and means for producing radiant heat for the further reforming of effluent from (a); (c) an auto-thermal reformer for fully reforming the effluent from (b); (d) a conduit for transferring the partially reformed effluent from (a) to (b); (e) a conduit for transferring the effluent from (b) to (c); and (f) a conduit for transferring the fully reformed effluent from (c) to (a), to supply the heat of reaction for the partial reforming of the hydrocarbon-steam mixture.

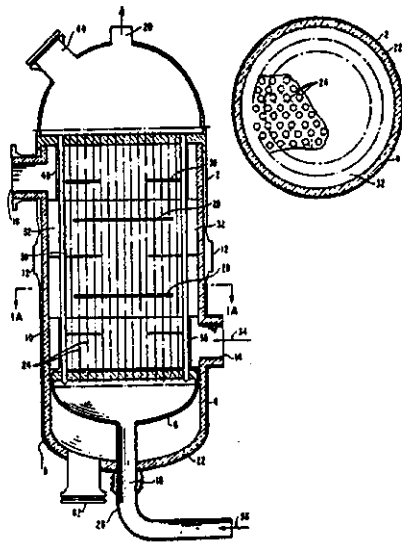
### CONVECTIVE REFORMER

The reformer (2) comprises inlet distribution annulus (14) and outlet collection annulus (16), containing perforated distribution plates (38,40), to direct heating fluid into core assembly (6) and evenly around tubes. Baffle sets (28,30) increase velocity of fluid entering (14) and passing around

tubes. Tubes (24) are sufficiently constricted in orifice size to retain catalyst while ensuring even flow of feed gas stream (36) to tubes. Manways (42,44) permit access to inside of convective reformer. (27pp1684RKMHDwgNo1,2/6). (E) ISR: US3532472 US3147084 US4256783 US4352341 US3278452 US4162290



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