

Jan. 24, 1950

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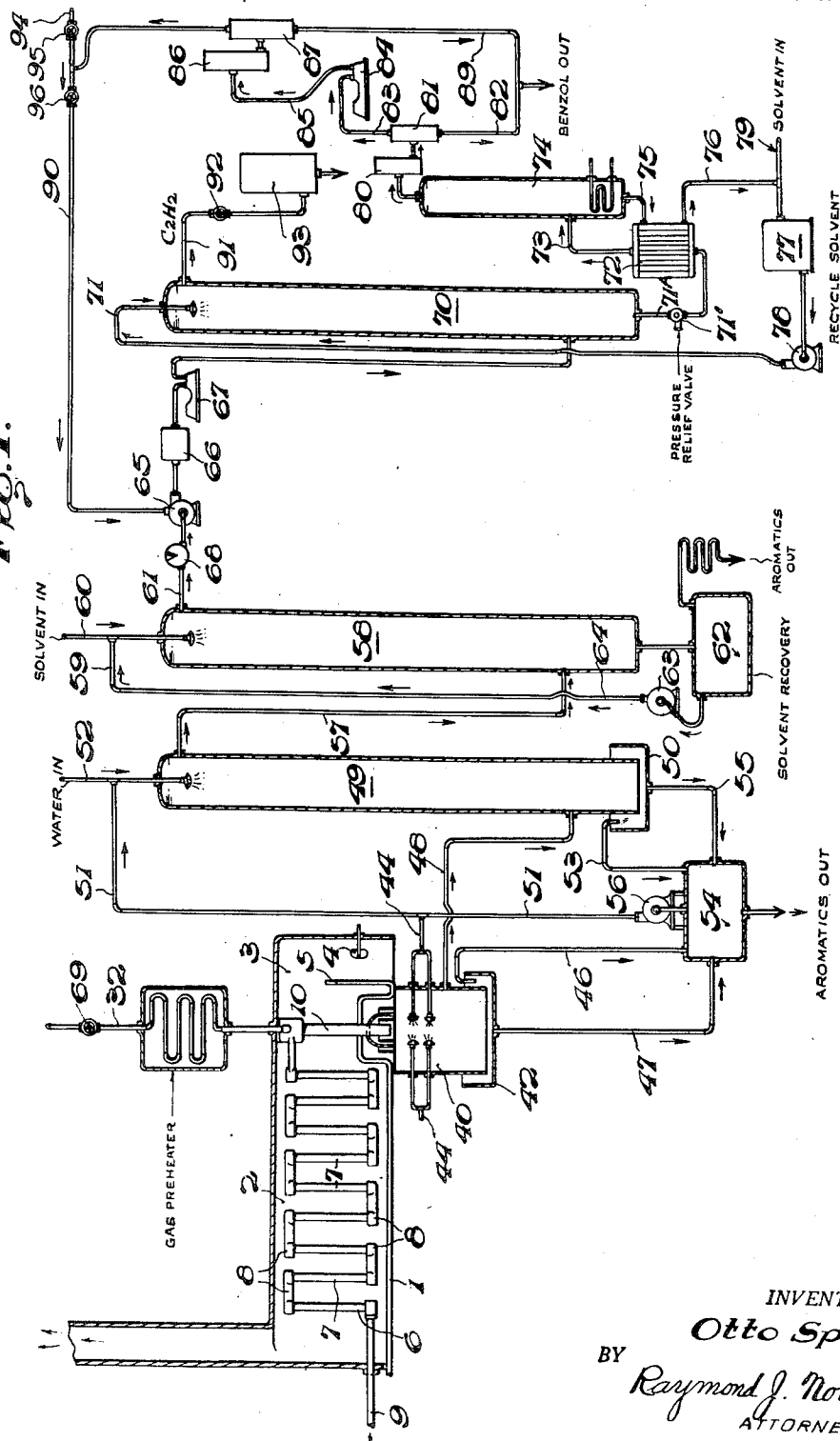
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APPARATUS FOR PRODUCING ACETYLENE

Filed June 15, 1944

2 Sheets-Sheet 1

FIG. 1.



INVENTOR.
Otto Spring
BY *Raymond J. Norton*
ATTORNEY

Jan. 24, 1950

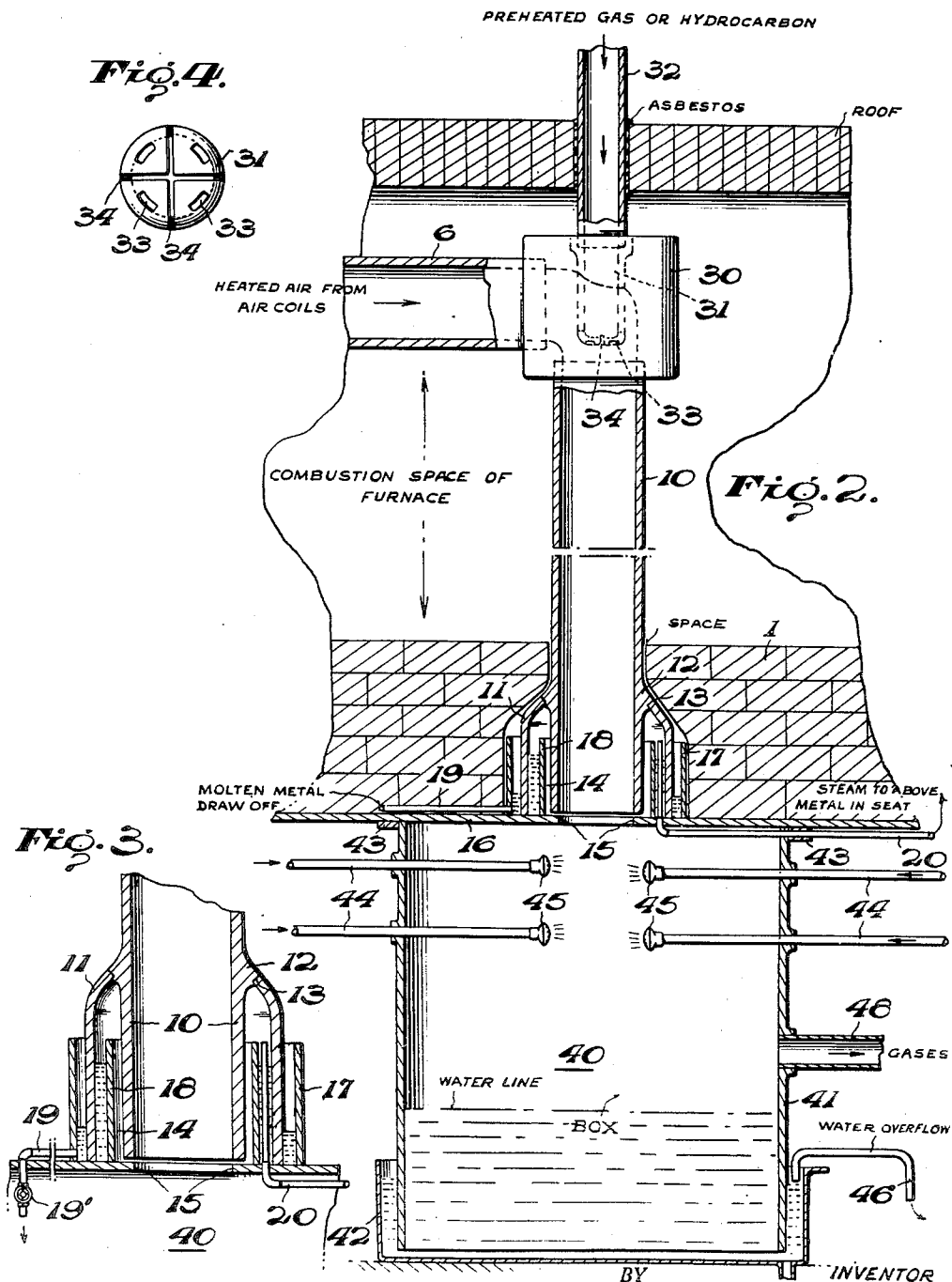
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UNITED STATES PATENT OFFICE

2,495,665

APPARATUS FOR PRODUCING ACETYLENE

Otto Spring, Okmulgee, Okla., assignor to Dan-
ciger Oil & Refining Company, Fort Worth,
Tex., a corporation of Texas

Application June 15, 1944, Serial No. 540,386

10 Claims. (Cl. 23—262)

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This invention relates to an improved method and apparatus for producing acetylene from hydrocarbons.

It has been proposed heretofore to produce acetylene from hydrocarbons, such as methane, by means of the electric arc, by direct thermal treatment of such hydrocarbons and by incomplete combustion of these hydrocarbons.

In comparison with the known methods of producing acetylene the present process has definite improvements. Its operating and construction costs are low, it is strictly continuous with long operating cycles of high efficiency and it is particularly adaptable to large scale operations.

One method of producing acetylene utilizing the process of partial combustion is described in U. S. Patent 1,940,209. However, the process described in such patent entails small scale operations. It has been found as a result of considerable experimentation that an attempt to produce acetylene on any substantial commercial scale, according to the disclosure of the patent, is fraught with considerable difficulty particularly with respect to achieving good yields and to designing an effective apparatus which will withstand the high temperatures involved.

As a result of extended research it has been found that the salient feature in the pyrolysis of hydrocarbons to acetylene is a complete or homogeneous and substantially instantaneous mixing of the hydrocarbons and air. If such a homogeneous mixing can be quickly effected the pyrolytic reaction is much more nearly quantitative and particularly if the reaction is carried out in a reaction zone so designed as to avoid loss of heat of reaction. Upon quickly quenching the reaction products decomposition of the initially formed acetylene is inhibited and high yields are secured.

Of still greater importance the provision of instantaneous homogeneous mixing enables the adaptation of this new method to large scale operations.

As will be seen hereinafter, improved results may be achieved when employing a novel design of conversion equipment and by utilizing special materials of construction in the furnace and reaction zones.

In order to enable a more ready comprehension of the invention there is shown in the accompanying drawings a typical illustrative embodiment of an apparatus for producing acetylene according to the invention in which:

Fig. 1 is a flow sheet of the process with the furnace structure in vertical section.

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Fig. 2 is an enlarged vertical section of the reactor shown in Fig. 1.

Fig. 3 is an enlarged vertical section of the lower portion of the reactor.

Fig. 4 is a plan view of the bottom of the gas inlet tube.

As will be seen from an inspection of the drawings the conversion unit comprises a suitable furnace 1 which includes a preheating section 2 and a combustion chamber 3 to which heat is supplied from the burner 4. The two sections are established by the bridge wall 5 which extends from the floor of the furnace upwardly a predetermined distance below the furnace roof.

As will be observed, within the furnace is mounted the continuous coil 6. This coil preferably is constructed of a suitable refractory material such as carbofrax (silicon carbide). The coil is constructed of standard interchangeable and readily replaceable units, namely, the tube sections 7 interconnected at the lower and upper ends by the return bends 8. These tubes may be of any suitable standard size, as for example, 4 inch internal diameter and 52 inches long. The joint between the tubes and the return bends are effectively sealed with any suitable cement. It is to be observed that the tubes are supported wholly on the floor of the furnace by the lower return bends and the upper return bends are spaced an appreciable distance from the roof of the furnace. With this type of construction the entire weight of the tubes is taken as a vertical compression load and the tubes are free to expand and contract in a vertical direction with change in temperature in the furnace, that is to say, no extraneous stresses are imposed on the tubes during thermal expansion.

The tube coil 6 is utilized for heating the air which is to be used for combustion of the hydrocarbons entering the reaction tube thereby providing the heat necessary to satisfy the negative heat of formation of acetylene. As shown, air is fed into the inlet end 9 of the coil and is discharged at any desired temperature to the upper portion of the reaction tube 10.

As shown, particularly in Fig. 2, the reaction chamber comprises an elongated tube which is preferably composed of the same material as the heating coil 6. With this type of construction, the difficulties of differential expansion of the air heating tubes and the reactor encountered in the case of ceramic air heating tubes and metallic reactor are obviated. The novel design of the reactor, as will be shown later, further assures freedom from differential stresses.

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The tube 10 is of any suitable size, as for example, about 52 inches long with an internal diameter of 4 inches. As will be seen hereinafter, the enlarged reaction chamber differs radically from the reaction chamber heretofore proposed. The latter comprised tubular or slot-shaped units of very restricted cross-section, i. e., of the order of from 2 mm. to 10 mm. The advantages of an enlarged reaction chamber over one of such restricted cross-section are striking particularly in an operation in which a large volume thruput is practically a prerequisite to commercial operation.

The lower portion of the tube, as will be noted, is of special design by reason of which numerous advantages are secured. As will be seen, the lower portion of the tube essentially is a double wall construction. The inner wall is formed by the lower portion of the tube itself. The second outer spaced wall 11 is established by the bell-shaped carbofrax section that is cast into the tube at the section 12. The bell-shaped flange may be scored as at 13 so as to provide a joint or weakened section at which any break would preferentially occur. It is particularly to be observed that the lower end of the bell-shaped flange projects below the horizontal plane of the end of the tube. Thus, when the tube is placed on a flat or plane surface it is wholly supported through the flange and the end of the tube itself is subjected to no supporting stresses.

As will be seen from an inspection of Fig. 2, the double wall structure of the end of the tube is designed so as to provide an hermetic seal between the intensely hot reaction tube and the cool quench box. This is accomplished by the association of the lower end of the tube with a liquid well structure 14 mounted on the top of the quench box. The furnace floor is cut away, as at 15, to provide a circular opening. The well structure includes the steel plate 16 which rests upon and is secured to the furnace floor adjacent the aperture in the furnace floor. This plate is provided with the spaced cylindrical sections 17 and 18 which are cast, welded or otherwise secured to the plate 16. The external flange 17 is tapped to receive a draw-off line 19 controlled by valve 19' through which molten metal may be withdrawn prior to shut down. As will be seen, the plate also serves as the top of the quench box and seals off the furnace from the box.

When the reactor tube is assembled in the furnace the bell flange 11 fits between and is spaced from the flanges 17 and 18. An effective pressure seal is established by introducing a low fusion point alloy such as Woods metal into the tubular well established by the flanges 17 and 18. Since this material remains molten during the operation of the furnace the reaction tube is effectively sealed off from the furnace and the atmosphere and, hence any desired pressure conditions within limits of the depth of the molten metal may be maintained in the tube.

It has been found that after operation of the unit if the molten metal constituting the seal is allowed to solidify in contact with the bell flange, breakage of the latter often occurs. This may readily be avoided and an increased life of the tube insured by withdrawing the molten metal through the line 19 at the time of shut down.

It has also been found that under the temperatures of operation there is a tendency of the metal of the liquid seal to oxidize. This may

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be avoided by inserting tube 20 through the metal pool. This tube is connected to a steam line and steam is bled into the space above the level of the liquid to form a blanket which inhibits oxidation of the metal. In the place of steam other inert gases such as flue gas or nitrogen may be used to prevent the oxidation of the sealing metal.

As noted previously, the end of the tube 10 is spaced an appreciable distance above the plate 16 so that however much it expands it does not contact the plate and therefore is not placed under any stress. This is of particular importance for this end of the tube is subjected to the maximum temperature of this operation and at such temperature its tensile properties are poor. By supporting the tube through the medium of the outside flanges 11 a longer operative life of the tube is insured.

As described previously, the air heating coil 6 communicates directly with the reaction tube 10. This connection, as shown, comprises the L 30 which is of the same material as the heating coil and the reaction tube. These joints are sealed with a suitable cement.

The upper face of the L connection is cored to receive the novel mixing unit 31. This unit, as shown, is connected with the line 32, through which preheated hydrocarbon gas is fed.

As intimated previously, the function and design of the mixing unit 31 is of paramount importance in the process and constitutes one of the main features that differentiates the present method from prior operations.

As has been explained, it had been thought by prior investigators in this field, an effective reaction of the type contemplated could be achieved only in a reaction chamber of drastically restricted cross-section. But it has now been found that these drastic mechanical limitations need not at all be imposed. As a result of extensive experimentation and test it has been ascertained that the essential factor in effecting the reaction and insuring high yield is the assurance of a homogeneous and instantaneous mixing of the hydrocarbon gas and heated air. This can be effectively accomplished by subdividing the gas stream into a plurality of small streams as it enters the air stream. The function of the unit 31 is therefore to effect this subdivision so that the preheated hydrocarbon gas is dispersed through and intimately admixed with the heated air to insure instantaneous mixing. It has been ascertained that when such instantaneous homogeneous mixing is achieved a reaction chamber of relatively substantial size may be utilized. For example, operations have been conducted, according to the invention, in which a reaction chamber 24 inches long and 1.5 inches internal diameter has been employed with eminently satisfactory results. It was ascertained that the yields so obtained were at least as good as those obtained with reaction slots of restricted cross-section. Furthermore, better results from an operation standpoint were experienced.

The subdivision of the gas stream into a series of small cross-section streamlets at the point of contact with the air stream may be effected by a number of specifically different units. The important factor in the design of the mixing unit is that the apertures in the mixer shall be as small as is practicable. In operations which have been conducted mixing units were employed having a plurality of orifices which were $\frac{1}{8}$ inch in diameter or width. It has been ascertained that the width

of the orifice should not exceed substantially $\frac{3}{4}$ inch. The size of the several orifices and their relative position should be such that the length of time necessary for the air stream to travel to the center of the gas stream should not be more than approximately 10% of the time the reaction gases remain or are retained in the reaction zone.

It will be appreciated then, that the design of the mixing element 31 may be widely varied. The orifices may be of any desired configuration within the dimensional limits expressed above. The orifices, for example, may be simple, circular apertures, elongated slots and the like. The unit shown in Figs. 2 and 4 which has been employed very successfully, comprises a tubular member having the closed bottom portion 32 of about $1\frac{1}{2}$ inches in diameter. This is formed with the peripheral slots 33 which are approximately $\frac{1}{8}$ inch in width and about $\frac{1}{2}$ inch or more long. The bottom portion is also formed with the intersecting transverse slots 34 of the same width as the curved peripheral slots 33. Obviously, as noted, the openings may be of any other desired shape. The bottom of the mixing unit 31 may also be in the form of a hemisphere through which a plurality of circular holes of small diameter are bored. These holes or apertures may also be positioned in the vertical walls of the mixing unit close to the bottom.

As will be seen in Fig. 2, the mixing unit 31 projects into the air stream as the latter enters the upper end of the reaction tube. At this point instantaneous and homogeneous mixing of the gas and air takes place.

Due to the fact that the mixing unit 31 projects into the hot air stream which latter is at a temperature above the cracking temperature of the gas it is necessary to take special precautions to prevent cracking of the gas and consequent accumulation of carbon adjacent the surface of the mixer, since such carbon accumulation would soon clog the orifices. This carbon accumulation can be avoided by controlling the temperature of the entering gas stream to a point sufficiently low to preclude such cracking. This temperature will vary depending on the conditions of a particular operation, more especially on the temperature of the air stream. For example, in a typical operation where the air stream is at a temperature of 2250° F. it is necessary to carry the gas stream at a temperature of about 950° F. or below, to avoid carbon accumulation.

A long series of tests have established that when instantaneous and homogeneous mixing is insured at the point of contact of the gas and air streams a very high yield of acetylene is obtained when employing lower temperatures than heretofore required and but little carbon is produced. This latter feature is a particularly important feature since it minimizes or eliminates the necessity of periodically burning out the accumulated carbon as was required under prior practices thus commensurately increasing the operating efficiency of the apparatus. Furthermore, as will be appreciated, the reduction in carbon formation greatly simplifies the subsequent steps of collecting and concentrating the acetylene-containing gas.

The reaction gases formed in the reaction zone are drastically quenched whereby their temperature is decreased to 212° F. or below. This is accomplished in the quench unit 40 shown in Fig. 1. As there shown, the unit is comprised of the top plate 16, which serves as the support for the reaction tube 10, the side walls 41 and the open

base 42. The base 42, in effect, is a container for the accumulation of liquid and seals the quench unit. The quench box may be of any desired shape and is shown herein as comprising the cylindrical wall of steel or other suitable material. This may be provided with a separate or integral flange 43 which is bolted, welded or otherwise secured to the plate 16 so as to form a pressure-tight seal.

The quench unit is provided with a plurality of water lines 44 each with a spray head 45. The spray heads, as will be noted, are positioned along the axis of the effluent reaction gas stream and serve to quickly reduce the temperature of the gas to below the boiling point of water. This water spray also serves to solidify, aggregate and carry down higher aromatics of the type of anthracene. These being heavier than water collect at the bottom of the water seal. This deposit may be periodically removed and passed to container 54 through line 47 for recovery of the valuable hydrocarbons.

In a typical operation the quench box should be approximately five times the diameter of the reaction tube. The height of the water seal at the base of the quench tank, as will be understood, may be varied. In normal circumstances a vacuum of between about $\frac{1}{2}$ and 1 inch of mercury is maintained in the quench tank. Under these circumstances the water within the cylinder 40 will rise to a height of approximately 1 foot above the level of the overflow line and the water in box 42 may be several inches deep. The base of the quench tank is provided with the water overflow line 46 which discharges to the tank 54.

The cooled reaction gases are withdrawn from the quench tank through the line 48 which is positioned well above the water level therein. The gases are discharged from line 48 to a lower section of a cooling and scrubbing tower 49. This tower, like the quench box, is provided with a water seal base 50. The gases passing upwardly in the tower are contacted with a countercurrent spray of water admitted to the top of the tower through recycle line 51 and from water make-up line 52.

The water accumulating in the base of the tower continuously overflows through line 53 and passes to a settling tank or decanter 54. The settle sludge, containing solidified aromatic constituents, may be periodically or continuously withdrawn through line 55 to decanter 54 from which it may be withdrawn and treated in any desired manner to recover the valuable constituents. Water from the settling tank is picked up by pump 56 and recycled through line 51 to the top of tower 49 to contact the incoming gas. Similarly, water from tank 54 is forced by pump 56 through line 44 to be sprayed into the quench box.

The cooled and partially scrubbed gas is withdrawn from the upper part of tower 49 and is passed through the line 57 to the lower portion of the solvent scrubbing tower 58. In this tower the gases are contacted with a downwardly flowing stream of a solvent admitted through line 59. Make-up solvent may be admitted from a source of supply through line 60. The solvent employed is one which has a selective affinity for certain of the more volatile aromatics, such as naphthalene. The scrubbed gas passes out of the top of the tower through line 61 for further treatment to be described. The solvent accumulating in the base of the tower is continuously passed to the aromatic recovery stage 62 and the

stripped solvent is recycled to the top of the tower through pump 63 and line 64. With many solvents which may be used in this tower an appreciable quantity of acetylene may be extracted. If it is desired to recover this quantity the overhead material distilled off from the solvent may be fractionated to separate the acetylene which may be returned to the system, as for example, to the intake side of blower 65.

The gases which are scrubbed in tower 58 pass overhead through line 61 and are forced by blower 65 through the surge tank 66 to the compressor 67. This blower also functions to draw the air through the preheating tubes by operating at such a rate as to establish a slight vacuum on the quench box. The proportion of air entering the reaction tube is established by metering the total volume of reaction gases passing to blower 65 by means of an orifice meter 68 placed in line 61. As will be appreciated, the gas entering the reaction tube is measured by means of an orifice meter 69 placed in the gas line 32 before the preheater. By means of the compressor the gas is compressed to any desired degree and the compressed gas is fed continuously to a lower section of the solvent scrubbing tower 70. Gases passing upwardly through the tower 70 are scrubbed with a limited quantity of a selective solvent which has a selective affinity for the contained aromatics and other substances boiling higher than acetylene. This solvent, which may be a gas oil is fed to the top of the tower through line 71.

It will be appreciated that when employing a solvent, as the scrubbing medium in tower 70, not an inconsiderable amount of acetylene will be dissolved in the solvent. In large scale operations it is desirable to recover such acetylene from the extract. This may be done in any suitable manner, as for example, in a recovery cycle such as is shown in Fig. 1. As there shown, the solvent accumulating in the base of tower 70 is passed continuously through line 71A controlled by valve 71' through the heat exchanger 72 and thence through line 73 to the bubble tower 74. In the bubble tower the extract phase is heated to evolve the lighter constituents such as benzol and acetylene. The stripped solvent accumulating in the base of the tower passes through the line 75, through heat exchanger 72, wherein it is utilized to preheat the extract passing to the bubble tower, and thence through line 76 and surge tank 77. From the surge tank the stripped solvent is picked up by pump 78 and recycled to the top of the tower. Make-up solvent may be introduced into the cycle at any desired point, as for example, through line 79.

The material distilled off from the solvent in tower 74 is passed through the cooler 80 and thence to the separator 81. A condensate consisting essentially of benzol is withdrawn from the bottom of the separator through line 82. The uncondensed fraction containing acetylene and other gases is passed overhead through line 83 to the compressor 84. The compressed gas is then passed through line 85 to the condenser 86 and separator 87. In separator 87 any residual benzol is withdrawn as a condensate through line 89 and is passed, together with the fraction from separator 81 to storage. The overhead fraction from separator 87 is passed through line 90 to the intake side of compressor 65 and returned to the system, or under conditions where gaseous impurities therein would harm subsequent reactions or products, the overhead prod-

uct is passed to operations where such impurities are harmless through line 94. Valves 95 and 96 may be operated to permit such alternate flow.

The scrubbed gas discharged from the top of the tower 70 passes through line 91 and pressure control valve 92 to any suitable treating unit 93. This exit gas, as will be noted, has been freed of carbon and aromatics and consists of acetylene and some ethylene diluted with other gases, such as N_2 , CO, CO_2 , H_2 and the like. In ordinary operations the gas contains 4% or more of acetylene. This may be further treated by any suitable method to produce more concentrated acetylene or it may be treated directly to produce derivatives of acetylene. For example, the acetylene-containing gas may be treated in unit 93 to hydrate the acetylene to acetaldehyde by contacting the dilute gas with a suitable catalyst such as mercuric sulphate in sulfuric acid.

As an alternate method this gas issuing from tower 70 may be passed through a solvent extractor in which a sufficient amount of a suitable solvent is used to extract substantially all of the acetylene. The acetylene gas recovered from this unit may be hydrated in unit 93 to produce acetaldehyde or otherwise treated to produce any desired acetylene derivative.

While one embodiment of the present process and apparatus has been given, variations may be introduced which will in no way alter the essence of such process and apparatus. For instance, the air used in the process may be preheated before being introduced in coil 6 by heat exchange with hot furnace gases passing up the stack, by constructing furnace with a double wall and causing the air to traverse the space between the walls or by means of an auxiliary furnace. Furthermore, if desired, a blower may be disposed in line 9 acting as a source of positive pressure on the air being introduced into the system, so as to give assurance that the required quantity of air is introduced without increasing the vacuum on the quench box above the desired level.

In some circumstances it may be desirable to protect the lower portion of the reactor 10 from the direct heat of the furnace. This may be accomplished by providing a layer of insulation of, for instance, high temperature brick.

While the reaction tube 10 is shown as disposed within the furnace 2, thereby preventing heat losses from within the tube, it is perfectly permissible to dispose the reaction tube in a separate furnace. This variation is effective under circumstances where it is desired to control the temperature obtaining within the reactor at a level substantially different from the temperature in the main furnace.

The furnace may be constructed without the bridge 5 with the result that better advantages of radiant heat from the flame from burner 4 would be obtained.

The improved results accruing from the use of the described method and apparatus can more readily be appreciated from a consideration of typical operations carried out in the described apparatus. In one operation propane was utilized as the hydrocarbon gas charge. The gas was preheated to $950^\circ F.$, was fed at the rate of 308 cu. ft. per hour together with air preheated to $2200^\circ F.$ Upon analysis it was found that the yield of acetylene was 35% by volume of the feed gas.

In another operation a preheated gas having a gravity of .77, comprised essentially of methane and ethane was fed to the reactor at the rate of

458 cu. ft. per hour together with preheated air at the rate of 1153 cu. ft. per hour. Analysis of the cooled effluent gas showed a yield of 17.3% of acetylene by volume of the feed gas.

In another operation a preheated gas of .643 gravity was fed to the reaction chamber at the rate of 508 cu. ft. per hour and was intimately mixed with preheated air fed at the rate of 1108 cu. ft. per hour. The furnace temperature was 2250° F. Analysis of the cooled effluent gas disclosed a yield of 13.5% of acetylene by volume of the feed gas.

In another typical operation preheated gas of .750 gravity was fed to the furnace at the rate of 470 cu. ft. per hour and was homogeneously mixed with preheated air fed at the rate of 1150 cu. ft. per hour. In this operation the furnace temperature was 2250° F. Analysis of the cooled exit gases showed a yield of 16.9% of acetylene by volume of the feed gas.

In yet another run preheated gas of .734 gravity was fed through the mixer to the furnace at the rate of 475 cu. ft. per hour and was intimately admixed with preheated air fed in at the rate of 1150 cu. ft. per hour. The furnace temperature was 2400° F. Analysis of the cooled gaseous effluent disclosed a yield of 17.4% acetylene by volume of the feed gas.

It will be observed that the described process embodies many novel features which are specifically and respectively correlated to insure improved results. The apparatus shown is designed so as to insure the optimum reaction conditions which conduce to satisfactory commercial yields. The unit described insures the desirably high degree of preheat of the air which is best attained by employed refractory tubes as the preheating structure. This high degree of heat insures a rapid combustion of that portion of the hydrocarbon charge which is necessary to attain the temperature required for the ultimate reaction leading to the formation of acetylene. As explained, the provision of the novel mixing unit insures the difficultly attainable homogeneous and instantaneous mixing of the gas and air streams thus assuring high yields with thru-puts large enough for profitable commercial operation. The expedient of positioning the reaction chamber directly within the furnace further facilitates to desired reactions in that heat loss from the zone of reaction by radiation from the exterior of the reaction chamber is positively precluded. The mounting of the reaction tube within the furnace in turn is made possible only by establishing an effective pressure seal between the quench box and the interior of the furnace such as is effectively done by the novel liquid seal described.

It is to be observed also that the structure of the quench unit, although eminently simple, insures unobvious results. As has been explained, the use of a water spray permits a drastic reduction in temperature of the gases while using the cheapest coolant, namely, a recirculating stream of water. The use of an open base or pan at the bottom of the quench unit also contributes materially to the overall efficiency of the process. With this type of a structure, i. e., using an open water seal the solid material which appears as such during quenching is allowed to accumulate in a unit from which it may, if desired, be readily removed. Again, the use of the open liquid seal as the pressure retention medium at the base of the tower serves, in a sense, as an effective buffer to take up or compensate for quench va-

riations or changes in the degree of negative pressure in the tank.

As will be appreciated, these several novel features of operation and structure are each intimately correlated and conduce to a simplified effective operation.

While a preferred embodiment of the invention has been described it is to be understood that this is given didactically to illustrate the underlying principles of the invention and not as limiting the useful scope of the invention to the particular illustrative embodiment.

I claim:

1. In an apparatus of the class described comprising a furnace, a tubular ceramic reaction chamber positioned vertically within and openly through the furnace, said chamber being formed at the base portion with a flange laterally spaced from the tubular body of the chamber, said flange being of greater length than the tubular body; a quench tank positioned exteriorly of the furnace and below the reaction chamber, said tank having an apertured top portion, communicating with the chamber a pair of spaced upwardly projecting flanges secured to the upper surface of said top portion of the quench unit, the said laterally spaced flange of the reaction chamber extending between the said upwardly projecting flanges on the quench unit and abutting the top portion of the quench tank to establish a sealed expansible joint and to support the chamber in position on the quench unit and means to distribute a cooling liquid in the quench tank and in contact with gases entering said tank from the reaction chamber.

2. An apparatus according to claim 1 in which the space between the upwardly projecting flanges on the quench tank contains a liquid sealing means.

3. An apparatus according to claim 1 in which the space between the upwardly projecting flanges on the quench tank contains a molten heat resistant sealing means.

4. In an apparatus of the class described comprising a furnace, a refractory, ceramic, vertically positioned tubular reaction chamber within and opening through the furnace, a metallic quench tank positioned exteriorly of the furnace and directly below the reaction chamber means to directly support the chamber on the tank, means to establish a pressure tight seal between the quench tank and the reaction chamber, said seal means comprising a pair of short concentric pipe sections attached to the top of the quench tank and projecting into the furnace and a flange on the reaction chamber extending within the circular slot formed by the said concentric pipes.

5. A reaction chamber for the production of acetylene by the incomplete combustion of hydrocarbons which comprises a furnace, an elongated refractory tube positioned vertically within and opening through the furnace, and a bell-shaped flange cast into the lower portion of the tube and extending below the lower end of the tube to support the tube, said bell-shaped flange being provided with a weakened portion at which any fracture would preferentially occur.

6. A reaction chamber for the production of acetylene by the incomplete combustion of hydrocarbons which comprises a furnace, an elongated refractory tube positioned vertically within and opening through the furnace, said tube being formed at the base portion with a concentric flange of greater length than the body of the

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tube and adapted to serve as the supporting means for the tube.

7. An apparatus for producing acetylene by incomplete combustion of hydrocarbons which comprises a furnace, a reaction chamber of refractory ceramic material positioned vertically within and opening through said furnace, a gas line and air line connected with the upper end of the chamber, said gas line having a plurality of small openings into said chamber, means constructed and arranged to mix the gas and air as they enter the upper end of the reaction chamber, a tank positioned exteriorly of the furnace and below the said reaction chamber, means for supporting the reaction chamber thereon, the lower end of said chamber being in open communication with said tank, distributing means in said tank for providing contact between gases passing from the lower end of said chamber to said tank and cooling liquid supplied to said distributing means a sealed expansion joint between the chamber and tank comprising a pair of concentric short pipe sections mounted on the top of the tank so positioned that the vertical reaction chamber extends within the circular slot formed by the aforementioned pipes, said sealing means providing a sealed joint at said support thereby sealing said chamber and tank from said furnace and exterior atmosphere to establish a pressure-type seal between the tank, the furnace and the reaction chamber.

8. An apparatus in accordance with claim 7

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in which the space between the said concentric pipes containing molten metal.

9. An apparatus in accordance with claim 7 in which the space between the said concentric pipes containing a molten metal and in which means are provided to withdraw molten metal from between the flanges.

10. An apparatus in accordance with claim 7 in which the space between the said concentric pipes containing molten metal and in which means are provided to establish a non-oxidizing atmosphere above the molten metal.

OTTO SPRING.

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