

Jan. 15, 1963

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3,073,769

PROCESS FOR MAKING ACETYLENE

Filed July 7, 1960

3 Sheets-Sheet 1

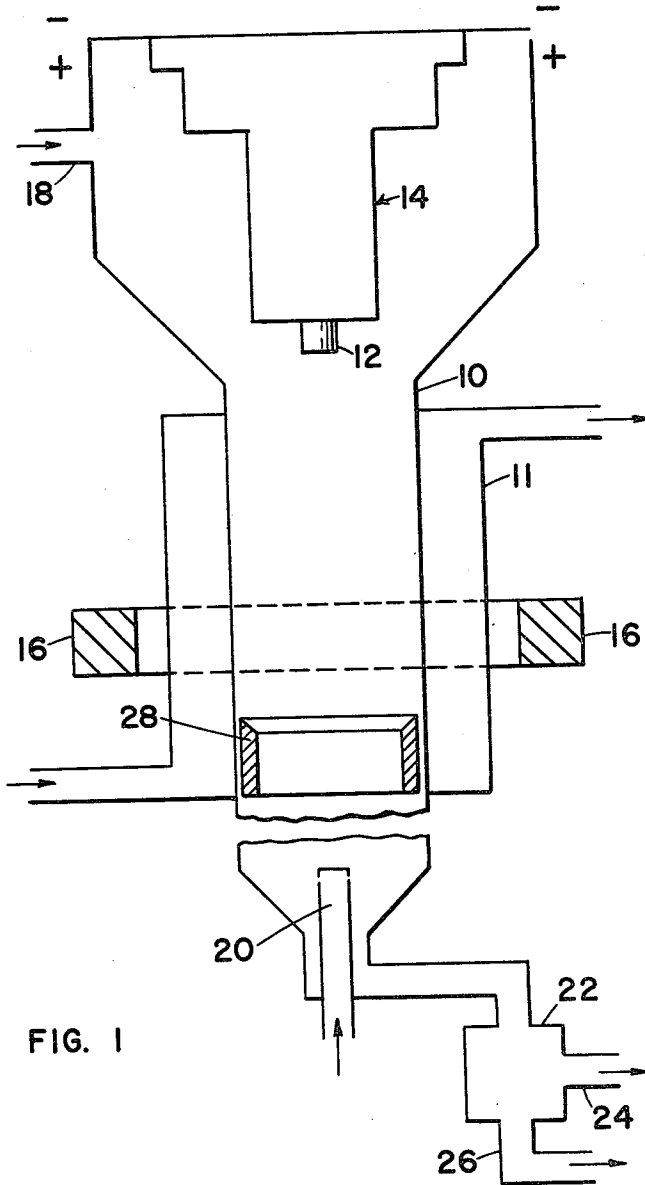


FIG. 1

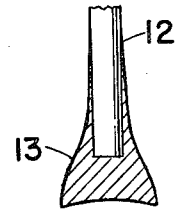


FIG. 2

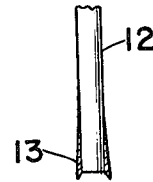


FIG. 3

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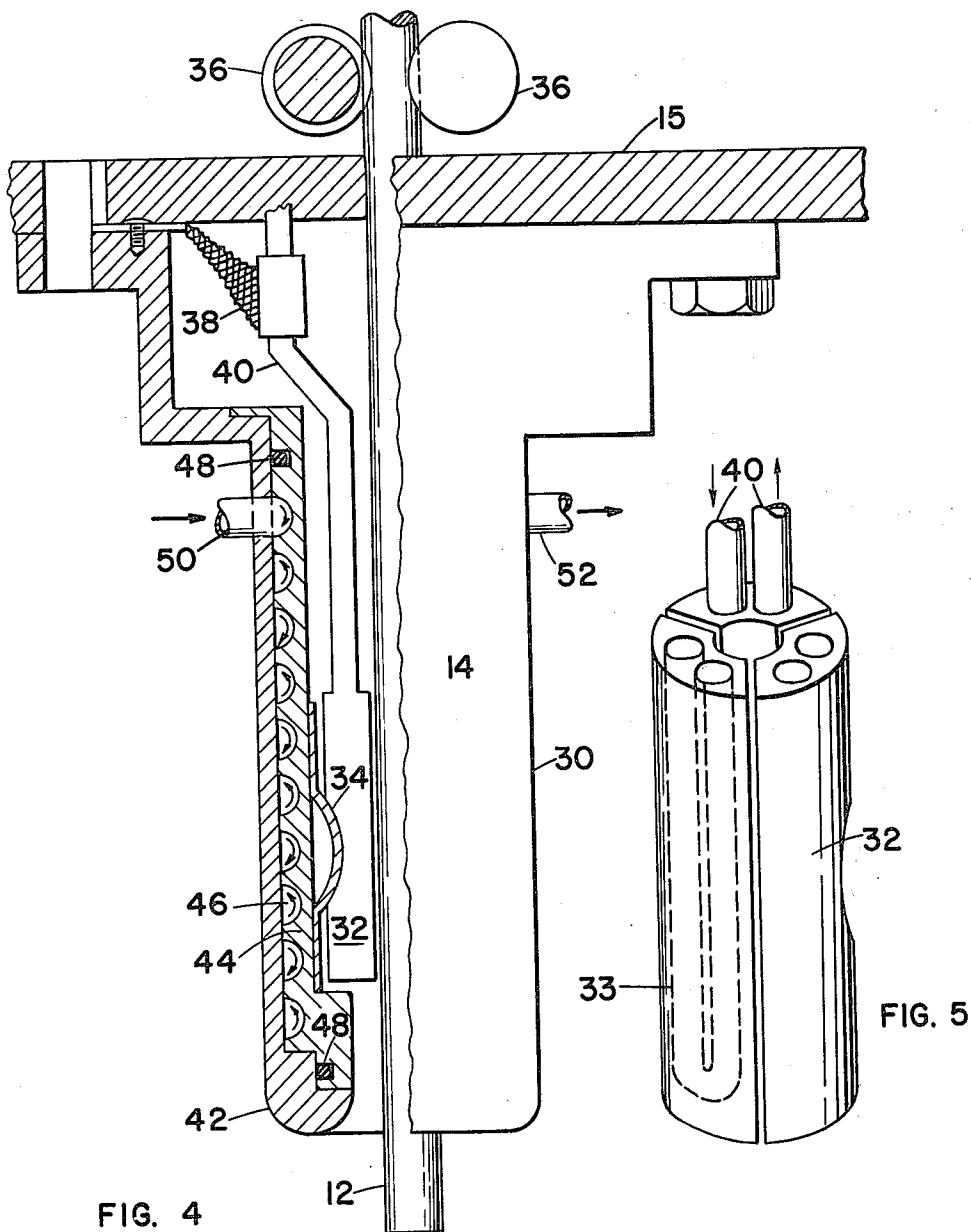


FIG. 4

FIG. 5

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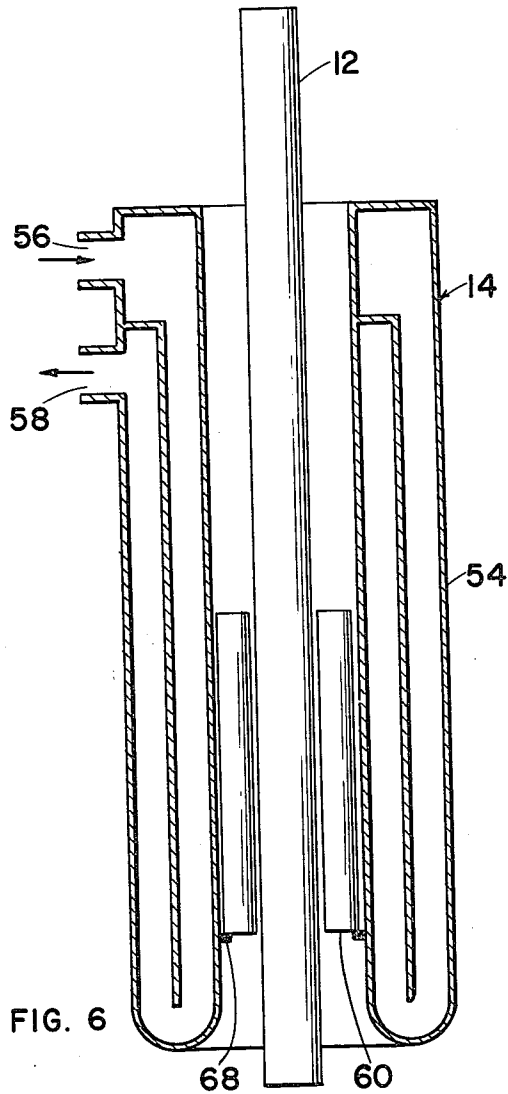
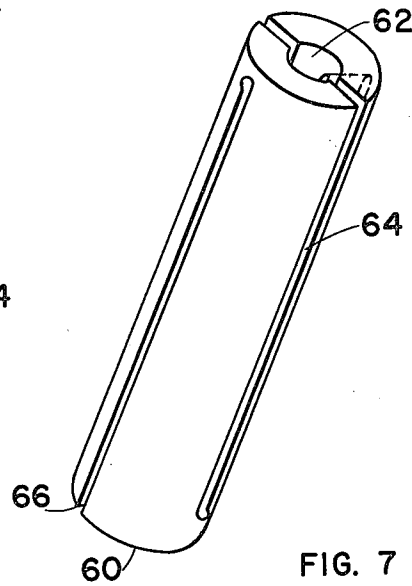
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3 Sheets-Sheet 3



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1

3,073,769

PROCESS FOR MAKING ACETYLENE

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Filed July 7, 1960, Ser. No. 41,329

6 Claims. (Cl. 204—171)

This invention relates to the process for making acetylene by the pyrolysis of hydrocarbons in an electric arc furnace and more particularly to a method of operating the process so as to avoid undesirable accumulations of carbon whereby the furnace can be operated continuously over substantial periods of time.

Baumann and Stadler in U.S. Patent 2,013,996 disclose the production of acetylene by passing a hydrocarbon gas through an electric arc formed between a solid rod-like cathode extending within a coaxially aligned hollow cylindrical anode. In U.S. Patent 2,074,530, Baumann, Stadler and Scholling disclose the formation of acetylene by passing a hydrocarbon gas through a magnetically rotated electric arc. In such processes, there is simultaneously formed substantial amounts of carbon. Particularly in a furnace of the character shown in U.S. Patent 2,013,996, deposits of carbon form on the electrodes and in a short time grow so as to shorten and soon entirely close the gap between them. The carbon deposit on the anode is loose and brittle and can be removed mechanically. The carbon deposit on the cathode is strong, firmly adherent, and cannot be readily removed.

It has been found that, even if the apparatus of U.S. Patent 2,013,996 is operated with a magnetically rotated electric arc, the formation of the strong, firmly adherent carbon deposits on the cathode cannot be prevented for any material length of time, whereby it becomes necessary to frequently interrupt the operation for removal of the enlarged end of the cathode or replacement of the cathode.

It is an object of this invention to provide a process for making acetylene by the pyrolysis of hydrocarbons in an electric arc furnace which obviates the difficulties heretofore encountered. Another object is to provide such a process whereby the objectionable accumulation of carbon deposits on the cathode is avoided and the process can be operated continuously over long periods of time. Other objects are to advance the art. Still other objects will appear hereinafter.

The above and other objects may be accomplished in accord with this invention wherein acetylene is made by the pyrolysis of a hydrocarbon in an electric arc furnace having a carbon cathode in the form of a round rod, a coaxially aligned elongated cylindrical metal anode extending beyond the end of the cathode and having an internal diameter greater than the diameter of the cathode, and a rotating electric arc formed from the tip of the cathode and striking the anode in a zone beyond the tip of the cathode, which process comprises passing the hydrocarbon in a gaseous stream under a pressure of at least 2 inches of mercury absolute through the furnace past the cathode tip through the rotating electric arc, exposing the end portion of the cathode to the gaseous stream over a length corresponding to from about 2 to about 5 times its diameter, strongly cooling the shank of the cathode above said end portion to a temperature below about 1100° C., applying a direct electric current to the cooled shank of the cathode to form and maintain the electric arc, adjusting the strength of said current within the safe current-carrying capacity of the cathode in accord with the gas pressure and the diameter of the cathode to provide a current of at least about 1400 amperes per inch of cathode diameter at

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which the cathode tip burns off steadily at a rate of at least 2 inches of length per hour and the diameter of the cathode is maintained substantially constant, and advancing the cathode into the furnace at the rate at which it is consumed so as to maintain said exposed end portion at a length of from about 2 to about 5 times its diameter.

It has been found that, by employing an electric arc furnace having the specified structure and form of electric arc and by simultaneously cooling the shank of the cathode strongly to a temperature below about 1100° C., and exposing only a short length thereof to the gaseous stream, it is possible to adjust the strength of the electric current to control the deposition of carbon on the cathode so that only a thin layer of carbon is deposited on the exposed side of the cathode and such deposit is continuously removed along with a corresponding thin layer from the face of the tip; thereby preventing objectionable deposits of carbon on the cathode. In other words, by so cooling the shank of the cathode, exposing only a short length thereof to the gas stream, and regulating the current in accord with the diameter of the cathode and the pressure of the gas in the furnace, in the manner above set forth, the rate of volatilization or burn-off of the carbon is adjusted so that there is no increase in the dimensions of the cathode tip after the thin layer of carbon on the side thereof has been established.

In the absence of the strong cooling of the shank of the cathode, or if a length thereof significantly more than about 5 times its diameter is exposed to the gas stream, carbon deposits tend to build up on the side and on the tip of the cathode, and cannot be readily prevented. This deposit is thickest nearest the tip and grows out from it, forming a tulip-shaped or mushroom-shaped structure of hard compact carbon of much greater diameter than the original tip. Such deposit requires increases in current for continued operation, and the deposit grows more and more rapidly until the operation has to be interrupted for replacement of the cathode. Once a carbon deposit of this kind has been well started, it is practically impossible to remove it by the volatilizing action of the current because the greatly increased current required for such volatilization must be carried through the relatively small shank of the cathode and causes the shank to become so hot as to volatilize the carbon in the center thereof with resultant explosion of the cathode.

This invention may be best understood by reference to the accompanying drawings in which:

FIGURE 1 is a diagrammatical view in vertical cross-section of an electric arc furnace of the type employed in the process of this invention;

FIGURE 2 is a vertical cross-sectional view of the end portion of the cathode 12 showing the carbon deposit 13 which forms when the conditions of the present invention are not employed;

FIGURE 3 is a vertical cross-sectional view of the end portion of the cathode 12 showing the carbon deposit 13 which is formed when the conditions of the present invention are employed;

FIGURE 4 is a side view of a preferred form of a cathode holder assembly (and adjacent portions of the furnace) with the left half of the assembly shown in vertical cross-section;

FIGURE 5 is a side view of the contact shoes which form part of the cathode holder of FIGURE 4;

FIGURE 6 is a diagrammatical view in vertical cross-section of another form of cathode holder; and

FIGURE 7 is a side view of the expansible contact shoe which forms part of the cathode holder of FIGURE 6.

Referring to FIGURE 1, the electric arc furnace comprises a metal shell 10 having an enlarged upper portion to accommodate the cathode holder and to permit the introduction of the hydrocarbon feed gas, and a lower elongated cylindrical anode portion which is externally cooled by a water jacket 11. The cathode 12 is made of carbon and is in the form of a round rod passing downwardly through the top of the furnace and coaxially aligned with the cylindrical anode portion of the furnace. The anode portion of the furnace extends downwardly a considerable distance below the tip of the cathode and has an internal diameter greater than the diameter of the cathode so as to provide a gap for the electric arc.

The size of the furnace, particularly of the cathode, the anode and the arc gap will vary widely depending upon the scale of operation which it is desired to employ, particularly upon the volume of hydrocarbon gas stream to be treated, the voltage available, and economic considerations. The principles of construction and operation of arc furnaces are well known to those skilled in the art. See for example U.S. Patent 2,929,771 of Landis et al.

The shank of the cathode 12 is frictionally held in a cathode holder 14 which is internally cooled so as to provide the strong cooling for the shank of the cathode. The holder 14 also contains electrical connections for connecting the shank of the cathode 12 to a source of direct electric current (not shown).

A vertically adjustable, annular electromagnet 16, which is operated by direct current, is placed about the cylindrical anode portion of the furnace and is concentric therewith. Such electromagnets are conventional for inducing the rotation of the arc struck between the cathode and the anode at from about 2,000 to about 20,000 revolutions per second, depending on the field strength employed, as shown, for example, by Baumann et al. in U.S. Patent 2,074,530. The electric arc will be drawn out or deflected downstream so that it is formed entirely from the tip of the cathode and strikes the anode in a zone beyond the tip of the cathode, partly by the action of the gaseous stream and partly by the action of the electromagnet 16, in the manner and in accord with the principles disclosed by Landis et al. in U.S. Patent 2,929,771. Thereby, the point at which the arc is in contact with the cathode (the cathode spot) moves, under the influence of the magnetic field, in circular or cycloidal paths which cover its whole surface, and the cathode tip tends to "burn off" uniformly and retains an approximately flat surface. Also, during operation, the arc does not strike the anode in a single circumferential line, but fluctuates over a zone of some width. The zone, in which the electric arc strikes the anode, may be adjusted vertically by adjusting the position of the electromagnet along the anode, by adjusting the field strength of the electromagnet, or by a combination of both such adjustments, in the manner known to the art. Usually, the angle of the arc (the line from the center of the cathode tip to the median of the zone over which the arc strikes the anode) will be about 45° or less with the axis of the cathode, preferably about 15° to about 23°, but may approach 90°.

An inlet 18 in the upper enlarged portion of the furnace is provided for the hydrocarbon feed gas, so that it flows downward past the tip of the cathode 12 and through the rotating electric arc where it is pyrolyzed to acetylene, hydrogen, and by-products. The gaseous reaction mixture then flows to the bottom of the cylindrical portion of the furnace where it passes through a quenching spray of water introduced through pipe 20 provided with spray apertures in its upper end, and then to entrainment tank 22 in which the water is separated from the gas. The gaseous reaction products pass out through conduit 24 to storage or to a system for recovering the acetylene and other valuable products contained therein. The separated water is discharged through conduit 26.

The cylindrical anode portion of the furnace conventionally is provided with a scraper 28 which is in the form of an annular knife closely fitting the inner wall of the anode and which is movable vertically within said cylindrical portion of the anode to dislodge carbon deposits formed on the internal walls of the anode.

The furnace will also be provided with one or more sight glasses (not shown) positioned so that the cathode tip, the arc, and other portions of the furnace can be observed directly and the operation thereof followed and adjusted as required. Conveniently, such sight glasses usually will be in the form of conventional T-tubes set in the wall of the furnace and closed by a sight glass and light filters.

FIGURES 4 and 5 illustrate a preferred form of holder assembly 14 for the cathode, which assembly is disclosed and claimed in my copending application, Serial No. 42,669, filed July 13, 1960. This holder assembly is attached to the top wall 15 of the furnace and comprises a generally cylindrical casing 30 which is internally cooled with a circulating fluid, is made of electrically conducting material and is insulated over its outer exposed surface by a ceramic coating. It contains contact shoes 32 made of electrically conducting material and internally cooled with a circulating fluid passing through U-shaped passages 33. The concave inner surfaces of the shoes 32 frictionally engage the cathode 12. Springs 34, between the outer surfaces of the shoes and the inner surface of the casing 30, press the inner surfaces of the shoes against the cathode. Two opposed grooved wheels or sheaves 36 positioned outside of the furnace are adjusted to press against the sides of the upper portion of the cathode so as to grip it firmly. These sheaves 36 are connected to means (not shown), such as reduction gears and a variable speed motor, so as to advance the cathode into the furnace through the holder 14 at an adjustable controlled rate so that the end portion of the cathode always protrudes a predetermined distance beyond the lower end of the holder 14.

Flexible electrical leads 38 connect each of the shoes 32 with a source of direct electric current through the hollow extensions 40 of the shoes through which the cooling fluid for the shoes is circulated.

The casing 30 of the cathode holder is conveniently formed of two parts, an outer shell 42 and an inner shell 44. The inner shell 44 is provided with channels 46 in its outer surface which form with the inner wall of the shell 42 a passage through which cold water or other cooling fluid is circulated. O rings 48 seal the casing 42 and the shell 44 together and prevent leakage of the cooling fluid. The channels 46 are in the form of a double-thread spiral, that is the passage runs spirally from the top to the bottom where it reverses its direction and returns spirally to the top, parallel to the downward passage. The cooling fluid enters the spiral channels 46 through inlet 50 and leaves through the outlet 52.

It will be understood that, while the specific form of cathode holder shown in FIGURES 4 and 5 has been found to be most efficient and is preferred, other forms of cathode holders, which provide strong cooling for the shank of the cathode and protect it from contact with the hydrocarbon gas stream, may be used.

FIGURES 6 and 7 show an alternative, less preferred form of cathode holder and cooling means 14. This cathode holder comprises a hollow cylindrical outer shell 54, provided with an inlet 56 and an outlet 58 for the circulation of a cooling fluid, and an expansible contact shoe 60. The contact shoe is in the form of a copper cylinder, sized to fit loosely in the shell 54, and having a central bore 62 slightly smaller in diameter than the cathode 12. The contact shoe is also provided with four slots arranged 90° apart and extending through the wall of the shoe. Two opposing slots 64 extend from the top almost to the bottom of the contact shoe. The other two opposing slots 66 extend from the bottom almost to the top of the con-

tact shoe. When the cathode is inserted, the cathode shoe expands somewhat by widening of the slots, such expansion being limited by contact of the outer surface of the contact shoe with the inner cylindrical surface of the shell 54. Thereby, there is formed a firm resilient sliding fit of the cathode in the contact shoe and a firm fit of the contact shoe in the shell 54. A retaining ring 68 is provided to prevent the contact shoe from sliding downward out of the shell 54. The cathode holder will be supported from the top of the furnace, the shell 54 or the contact shoe 60 will be connected with a source of direct electric current, and means for advancing the cathode through the holder will be provided, similarly to the structure of FIGURE 4. The structure of FIGURES 6 and 7 provides good physical support and protection for the cathode, and the resilient contact between the parts is sufficient for good conduction of the electric current to the cathode and good cooling of the shank of the cathode.

The cathode 12 will be adjusted so that the lower end portion thereof will extend beyond the lower end of the holder 14 for a length corresponding to from about 2 to about 5 times the diameter of the cathode, preferably about 4 times its diameter, said end portion being exposed to the hydrocarbon gas stream. If the exposed end portion of the cathode is materially less than 2 times its diameter, it tends to shatter during operation of the furnace because of the sharp temperature gradient imposed. If the exposed end portion of the cathode is materially more than 5 times its diameter, carbon deposits on its side at a rate faster than it can be readily volatilized and forms a tulip-shaped structure 13 such as that shown in FIGURE 2 of the drawings.

The electric current, applied to the cathode, will be direct current and will have the voltage required to form an electric arc between the cathode and the anode, as is well known in the art. A cooling fluid will be passed through the jacket 11 and through the cooling fluid passage or passages of the cathode holder. Any suitable cooling fluid may be employed. However, for reasons of economy, convenience and efficiency, water will ordinarily be used as the cooling fluid.

The hydrocarbon stream will be composed essentially of a hydrocarbon or a mixture of hydrocarbons which are conventionally employed for the manufacture of acetylene by pyrolysis in an electric arc. Such hydrocarbons are represented by methane, ethane, propane, butane, ethylene, propylene, butylene, gasoline, kerosene fractions, and the like. Such hydrocarbons may be diluted with an inert gas, such as hydrogen. Usually, methane or natural gas will be employed, preferably diluted with hydrogen. The gas stream, passing downwardly through the electric arc, acts in cooperation with the magnetic field to deflect the arc downstream and assists in causing the arc to be formed entirely from the tip of the cathode.

The hydrocarbon stream will be introduced through the inlet 18 and will flow through the furnace under a pressure of at least 2 inches of mercury absolute. At present, it appears that the gas pressure usually will be in the range of from 2 to about 16 inches of mercury, and preferably from 2 to about 10 inches. Higher gas pressures may be used, such as those known to the art to be suitable in the manufacture of acetylene by the pyrolysis of hydrocarbons in an electric arc, e.g. up to about 250 pounds per square inch gauge.

The strength (amperage) of the electric current applied to the cathode is adjusted in accord with the pressure of the feed gas and with the diameter of the cathode to provide a current of at least about 1400 amperes per inch of cathode diameter at which the cathode tip burns off (volatilizes) steadily at a rate of at least 2 inches of length per hour and the diameter of the cathode is maintained substantially constant. The minimum current required is easily determined experimentally for any cathode and pressure. At the preferred gas pressure of from about 2 to about 10 inches of mercury absolute, it has been found that the current required for continuous suc-

cessful operation is from about 2,000 to about 1,700 amperes for each linear inch of cathode diameter. At higher gas pressures, the required minimum current is progressively less, being about 1,480 amperes per inch of cathode diameter at a pressure of from about 15 to about 16 inches of mercury absolute. Since the burn-off of the cathode tip is due to the volatilization of the carbon thereof, it is apparent that the cathode spot has a temperature above 3,500° C., i.e. the temperature at which carbon volatilizes or sublimates. Thus, the current must be sufficient to produce a cathode spot temperature above 3,500° C., approaching 4,000° C.

The maximum current strength which can be applied is the maximum safe current-carrying capacity of the cathode, that is, the maximum current that the particular cathode can carry without shattering due to the thermal stresses set up therein, or without exploding due to internal volatilization of carbon. The safe current-carrying capacity of carbon cathodes varies with the structure and process of manufacture and is well known to the art or can be readily determined experimentally. Usually, the current employed will be somewhat above the minimum required, e.g. that at which the cathode tip burns off steadily at a rate of about 6 inches of length per hour. If the current is insufficient to provide the required rate of burn-off of the cathode tip above set forth, carbon deposits will build up on the end of the cathode in the manner shown at 13 of FIGURE 2, even with the limited exposure of the end portion of the cathode and the strong cooling of the shank of the cathode hereinbefore specified. The burn-off of the cathode tip and/or the build-up of carbon on the cathode can be readily observed visually during the operation of the furnace, and the current can be adjusted as required.

A furnace, of the structure shown in FIGURE 1 of the drawings, has been used, employing cathode holders of the structure shown in FIGURES 4 to 7. In such furnace, the cylindrical anode portion had an internal diameter of 3.5 inches and the electromagnet was positioned so that the top thereof varied from about 2 to about 10 inches below the tip of the cathode. Cathodes of various sizes ranging from 0.188 to 0.5 inch were used, and the exposed end portions of the cathodes were varied from about 2 to about 5 times their diameters. The furnace was operated successfully, without objectionable build-up of carbon on the cathode, employing gas pressures varying from 2 to 26.4 inches of mercury absolute, and currents varying from about 1,480 to about 3,200 amperes per inch of cathode diameter with burn-off of the cathode tip at rates varying from 2 to over 12 inches of length per hour. Representative operations are described in more detail in the examples given herein-after.

In order to more clearly illustrate this invention, preferred modes of practicing it, and the advantageous results to be obtained thereby, the following examples are given.

Example 1

The furnace of FIGURE 1, with the cathode holder of FIGURES 6 and 7 of the drawings, is used in which the cylindrical anode portion is 3.5 inches in internal diameter and the cathode is 0.5 inch in diameter. The furnace is operated at a pressure of 9.4 inches of mercury absolute and a current of 1,000 amperes and 335 volts. The current to diameter ratio of the cathode is thus 2,000 amperes per inch of diameter. Under these conditions, the temperature at the cathode spot approaches 4,000° C. and the carbon volatilizes. The electromagnet is placed so that the arc strikes the anode about 4 inches below the tip of the cathode, the line from the center of the cathode tip to the median of the zone where the arc strikes the anode is at an angle of about 23° with the axis of the cathode. The arc rotates at 8,000 revolutions per second. The feed gas is methane at 120 lbs. per hr., giving a product gas containing 18% of acetylene by

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volume. The cathode, which extends 2 inches beyond the end of the cathode holder, is advanced at a rate of about 6 inches per hr. so that the 2 inches is constantly exposed and remains free of any deposit of carbon except for a thin coating which forms on the hot shank of the cathode near the tip and is caused by the contact of the feed gas with the hot surface. As the end of the cathode evaporates, the adjacent part of this deposit is also "burned off." Thus, after the arc has been operated for a short time and the thin layer of carbon has formed on the side of the cathode, there is no further increase in its diameter. The cathode, when this steady state is reached, has the vertical cross-section shown in FIGURE 3 of the drawings. The cathode spot moves over the whole cathode tip and consumes it uniformly. The loose deposit of carbon on the anode is removed periodically with the scraper. Under these conditions, the furnace operates continuously without trouble from accumulation of carbon.

On the other hand, when the current is not great enough to give the temperature required for volatilizing the carbon, for example 800 amperes or a current to diameter ratio of 1600, the carbon (formed by pyrolysis of the feed gas) deposits, in hard compact form, on the end and nearby parts of the cathode and rapidly grows out both sideways and longitudinally, usually starting from the edge of the cathode tip and growing outward and downward in a curved path, forming "tulips" as shown in FIGURE 2 of the drawings. Such deposits first reduce the length of the arc and soon short circuit it. This thick deposit is not effectively removed even though the cathode spot is hot enough to evaporate carbon.

Example 2

The process of Example 1 is operated again at a current of 1,000 amperes, but the voltage is reduced to 200 volts by reducing the arc length. The operation is otherwise the same and the carbon does not accumulate on the cathode tip to an objectionable extent.

Example 3

The process of Example 1, employing the cathode holder shown in FIGURES 4 and 5, is operated at 15.6 inches pressure. The voltage is 330 volts and the corresponding current of 740 amperes, i.e. 1,480 amperes per inch of diameter, is enough to keep the cathode tip from increasing objectionably in size.

Example 4

The process of Example 1, employing the cathode holder shown in FIGURES 4 and 5, is operated, using a 0.25 inch diameter cathode extending about one inch from the cooled part, at 3.2 inches pressure and 200 volts. A current of 500 amperes (2,000 amperes per inch of diameter) is enough to keep the cathode tip from increasing materially in size and to assure continuous operation. The same results are obtained with a 0.188 inch diameter cathode at 375 amperes and with a 0.35 inch diameter cathode at 710 amperes (both about 2,000 amperes per inch of diameter).

The following examples illustrate operation under conditions which allow the cathode to increase in size to an objectionable extent and hence are not embodiments of the invention, and are given for purposes of comparison.

Example 5

The process of Example 1 is operated at a current of 1,020 amperes and 320 volts but with a 0.750 inch diameter cathode. The ratio of current to diameter is thus only 1360. After 14.5 minutes of operation, the length of the cathode is unchanged but the diameter at the tip has increased to 1.25 inches and increases rapidly thereafter.

Example 6

The process of Example 1 is operated at 900 amperes and 340 volts. The exposed length of the 0.5 inch diameter cathode is 4 inches instead of 2. The initial cur-

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rent to diameter ratio is 1800. In the first 10 minutes of operation, the cathode "burns off" 0.5 inch. At this time, the diameter of the tip has increased to 0.75 inch, giving a current to diameter ratio of 1200. At this point, "burn off" stops and "tulip" growth starts. After another 10 minutes of operation, the diameter of the tip has increased to 0.875 inch (current to diameter ratio 1030) and the length increased by 0.25 inch.

Example 7

When the process of Example 1 is operated at the same 1,000 amperes and 335 volts, with the only difference being that the cathode is not cooled, the results are similar to those in Example 6. That is, carbon forms rapidly for a considerable distance along the hot sides of the cathode and the diameter at the tip increases in spite of the "burn off." The current to diameter ratio accordingly decreases with the increase in diameter and soon is not enough even to burn off the carbon.

It will be understood that the preceding examples have been given for illustrative purposes solely and that this invention is not restricted to the specific embodiments described therein. On the other hand, it will be understood that the structure, size and relative sizes of the furnace, of the various parts thereof and of the related equipment; the materials; the conditions; and the techniques employed can be widely varied within the limitations and in accord with the principles set forth in the general description without departing from the spirit and scope of the invention. Also, the process and principles of this invention can be applied to the treatment or reaction of other organic compounds in a similar electric arc furnace which likewise involve the problem of objectionable build up of carbon deposits on a carbon electrode.

From all of the above, it will be readily apparent that this invention provides a novel process for treating hydrocarbons in a rotating electric arc whereby the objectionable accumulation of carbon deposits on the carbon electrode is prevented and the process can be operated continuously over extended periods of time without the interruptions previously required by such accumulations of carbon deposits. The process is simple and easy to operate and to control. Accordingly, it will be apparent that this invention represents a valuable advance in and contribution to the art.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. The process for making acetylene by the pyrolysis of a hydrocarbon in an electric arc furnace having a carbon cathode in the form of a round rod, a coaxially aligned elongated cylindrical metal anode extending beyond the end of the cathode and having an internal diameter greater than the diameter of the cathode and a rotating electric arc formed from the tip of the cathode and striking the anode in a zone beyond the tip of the cathode, which process comprises passing the hydrocarbon in a gaseous stream under a pressure of at least 2 inches of mercury absolute through the furnace past the cathode tip through the electric arc, exposing the end portion of the cathode to the gaseous stream over a length corresponding to from about 2 to about 5 times its diameter, strongly cooling the shank of the cathode above said end portion to a temperature below about 1100° C., applying a direct electric current to the cooled shank of the cathode to form and maintain the electric arc, adjusting the strength of said current within the safe current-carrying capacity of the cathode in accord with the gas pressure and the diameter of the cathode to provide a current of at least about 1400 amperes per inch of cathode diameter at which the cathode tip burns off steadily at a rate of at least 2 inches of length per hour and the diameter of the cathode is maintained substantially constant, and advancing the cathode into the furnace at the rate at which it is consumed so as to maintain said exposed end portion at a length of from about 2 to about 5 times its diameter.

2. The process for making acetylene by the pyrolysis of a hydrocarbon in an electric arc furnace having a carbon cathode in the form of a round rod, a coaxially aligned elongated cylindrical metal anode extending beyond the end of the cathode and having an internal diameter greater than the diameter of the cathode and a rotating electric arc formed from the tip of the cathode and striking the anode in a zone beyond the tip of the cathode, which process comprises passing the hydrocarbon in a gaseous stream under a pressure of from 2 to about 16 inches of mercury absolute through the furnace past the cathode tip through the electric arc, exposing the end portion of the cathode to the gaseous stream over a length corresponding to from about 2 to about 5 times its diameter, strongly cooling the shank of the cathode above said end portion to a temperature below about 1100° C., applying a direct electric current to the cooled shank of the cathode to form and maintain the electric arc, adjusting the strength of said current within the safe current-carrying capacity of the cathode in accord with the gas pressure and the diameter of the cathode to provide a current of at least about 1480 amperes per inch of cathode diameter at which the cathode tip burns off steadily at a rate of at least 2 inches of length per hour and the diameter of the cathode is maintained substantially constant, and advancing the cathode into the furnace at the rate at which it is consumed so as to maintain said exposed end portion at a length of from about 2 to about 5 times its diameter.

3. The process for making acetylene by the pyrolysis of a hydrocarbon in an electric arc furnace having a carbon cathode in the form of a round rod, a coaxially aligned elongated cylindrical metal anode extending beyond the end of the cathode and having an internal diameter greater than the diameter of the cathode and a rotating electric arc formed from the tip of the cathode and striking the anode in a zone beyond the tip of the cathode, which process comprises passing the hydrocarbon in a gaseous stream under a pressure of from 2 to about 16 inches of mercury absolute through the furnace past the cathode tip through the electric arc, exposing the end portion of the cathode to the gaseous stream over a length corresponding to from about 2 to about 5 times its diameter, strongly cooling the shank of the cathode above said end portion to a temperature below about 1100° C., applying a direct electric current to the cooled shank of the cathode to form and maintain the electric arc, adjusting the strength of said current within the safe current-carrying capacity of the cathode in accord with the gas pressure and the diameter of the cathode to provide a current of at least about 1480 amperes per inch of cathode diameter at which the cathode tip burns off steadily at a rate of from 2 to about 6 inches of length per hour and the diameter of the cathode is maintained substantially constant, and advancing the cathode into the furnace at the rate at which it is consumed so as to maintain said exposed end portion at a length of from about 2 to about 5 times its diameter.

4. The process for making acetylene by the pyrolysis of a hydrocarbon in an electric arc furnace having a carbon cathode in the form of a round rod, a coaxially aligned elongated cylindrical metal anode extending beyond the end of the cathode and having an internal diameter greater than the diameter of the cathode and a rotating electric arc formed from the tip of the cathode and striking the anode in a zone beyond the tip of the cathode, which process comprises passing the hydrocarbon in a gaseous stream under a pressure of from 2 to about 10 inches of mercury absolute through the furnace past the cathode tip through the electric arc, exposing the end portion of the cathode to the gaseous stream over a length corresponding to from about 2 to about 5 times its diameter, strongly cooling the shank of the cathode above said end portion to a temperature below about 1100° C., applying a direct electric current to the cooled shank of the cathode to form and maintain the electric arc, adjusting the strength of said current within the safe current-carry-

ing capacity of the cathode in accord with the gas pressure and the diameter of the cathode to provide a current of at least about 1700 amperes per inch of cathode diameter at which the cathode tip burns off steadily at a rate of from 2 to about 6 inches of length per hour and the diameter of the cathode is maintained substantially constant, and advancing the cathode into the furnace at the rate at which it is consumed so as to maintain said exposed end portion at a length of from about 2 to about 5 times its diameter.

5. The process for making acetylene by the pyrolysis of a hydrocarbon in an electric arc furnace having a carbon cathode in the form of a round rod, a coaxially aligned elongated cylindrical metal anode extending beyond the end of the cathode and having an internal diameter greater than the diameter of the cathode and a rotating electric arc formed from the tip of the cathode and striking the anode in a zone beyond the tip of the cathode, which process comprises passing the hydrocarbon in a gaseous stream under a pressure of from 2 to about 10 inches of mercury absolute through the furnace past the cathode tip through the electric arc, exposing the end portion of the cathode to the gaseous stream over a length corresponding to about 4 times its diameter, strongly cooling the shank of the cathode above said end portion to a temperature below about 1100° C., applying a direct electric current to the cooled shank of the cathode to form and maintain the electric arc, adjusting the strength of said current within the safe current-carrying capacity of the cathode in accord with the gas pressure and the diameter of the cathode to provide a current of at least about 2000 amperes per inch of cathode diameter at which the cathode tip burns off steadily at a rate of about 6 inches of length per hour and the diameter of the cathode is maintained substantially constant, and advancing the cathode into the furnace at the rate at which it is consumed so as to maintain said exposed end portion at a length of about 4 times its diameter.

6. The process for making acetylene by the pyrolysis of methane in an electric arc furnace having a carbon cathode in the form of a round rod which has a diameter of from about 0.18 to 0.5 inch, a coaxially aligned elongated cylindrical metal anode extending beyond the end of the cathode and having an internal diameter greater than the diameter of the cathode and a rotating electric arc formed from the tip of the cathode and striking the anode in a zone beyond the tip of the cathode, which process comprises passing the methane in a gaseous stream under a pressure of from about 9 to about 10 inches of mercury absolute through the furnace past the cathode tip through the electric arc, exposing the end portion of the cathode to the gaseous stream over a length corresponding to about 4 times its diameter, strongly cooling the shank of the cathode above said end portion to a temperature below about 1100° C., applying a direct electric current to the cooled shank of the cathode to form and maintain the electric arc, said current being of a strength to provide a current of about 2000 amperes per inch of cathode diameter at which the cathode tip burns off steadily at a rate of about 6 inches of length per hour and the diameter of the cathode is maintained substantially constant, and advancing the cathode into the furnace at the rate at which it is consumed so as to maintain said exposed end portion at a length of about 4 times its diameter.

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