(No Model.) 3 Sheets—Sheet 1.

# T. B. FOGARTY.

## METHOD OF AND APPARATUS FOR PRODUCING CYANIDES AND AMMONIA.

No. 500,651. Patented July 4, 1893.

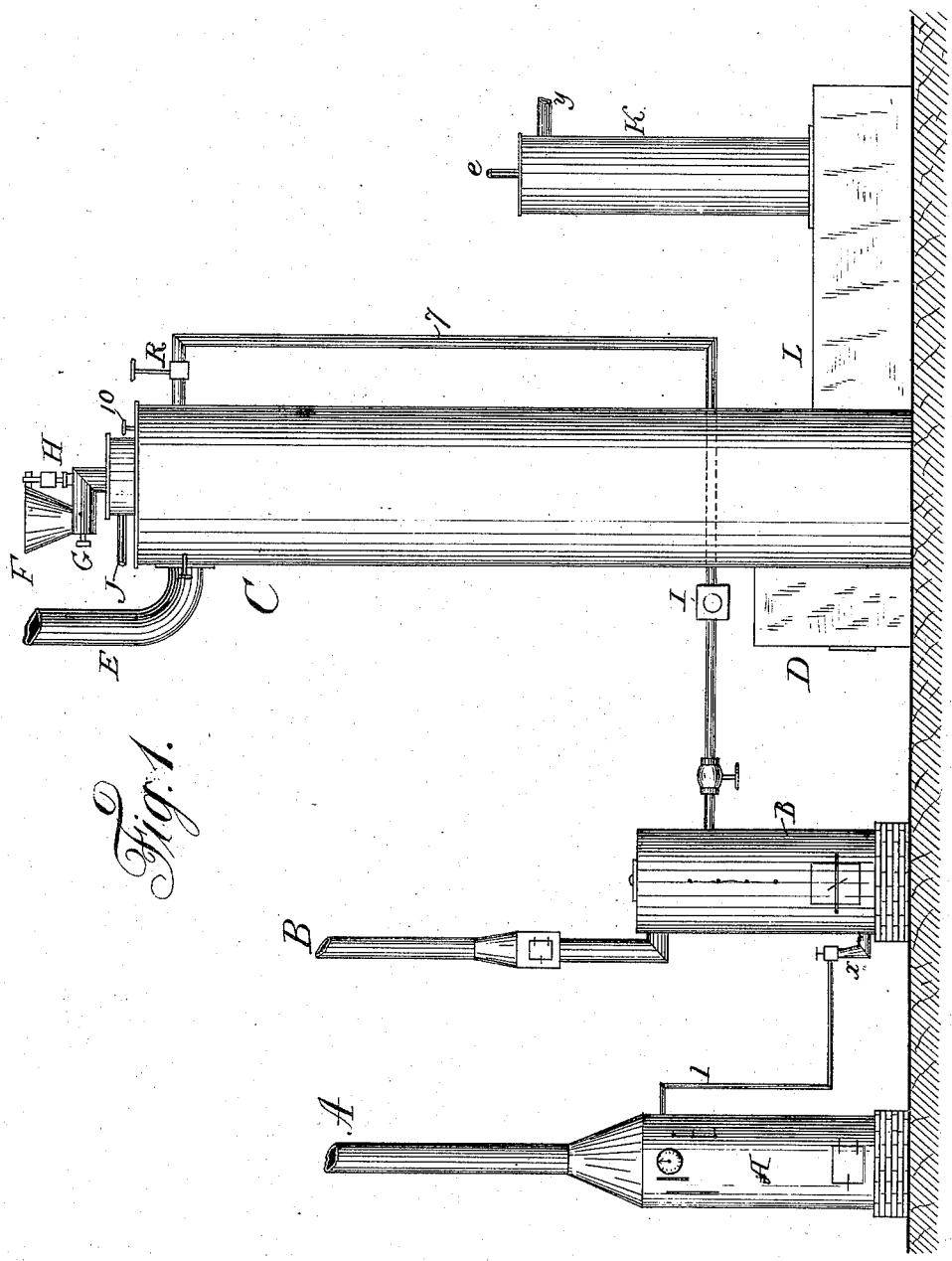



Fig. 1.

WITNESSES:

Wm. R. Hutton

Leo Fox Rosenberg

INVENTOR

Thomas B. Fogarty.

By Porter & Freeman

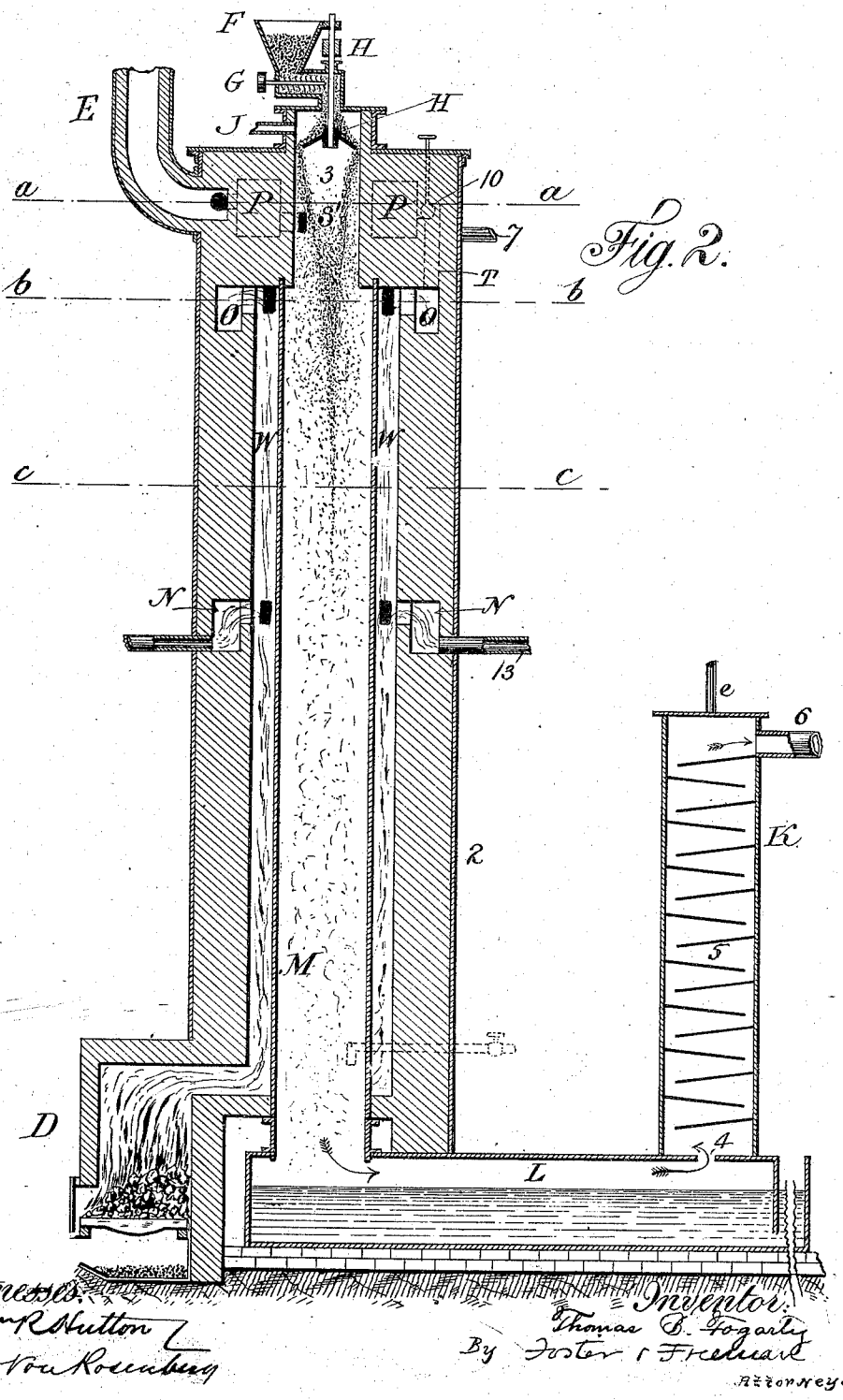
Attorneys.

(No Model.) 3 Sheets—Sheet 2.

# T. B. FOGARTY.

## METHOD OF AND APPARATUS FOR PRODUCING CYANIDES AND AMMONIA.

No. 500,651. Patented July 4, 1893.




Witnesses:
Wm. R. Hutton
Leo Von Rosenberg

Inventor:
Thomas B. Fogarty
By Foster & Freeman
Attorneys.

(No Model.) 3 Sheets—Sheet 3.

# T. B. FOGARTY.

## METHOD OF AND APPARATUS FOR PRODUCING CYANIDES AND AMMONIA

No. 500,651. Patented July 4, 1893.

Fig. 3.

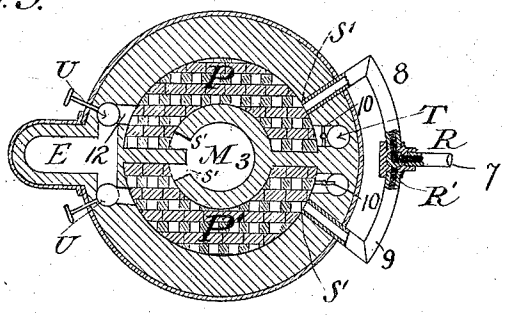



Fig. 4.

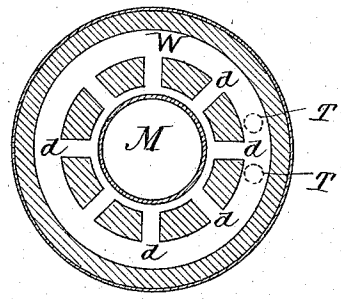
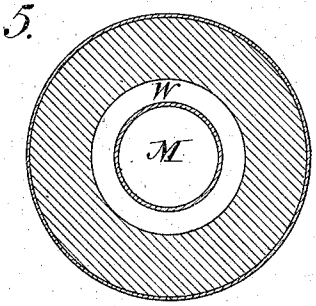



Fig. 5.




WITNESSES:

Wm. R. Hutton

Leo Fox Rosenberg

INVENTOR

Thomas B. Fogarty

By Dexter & Freeman

Attorneys.

# UNITED STATES PATENT OFFICE.

THOMAS B. FOGARTY, OF LONG ISLAND CITY, ASSIGNOR OF ONE-TWENTIETH TO ESEK COWEN, OF NEW YORK, N. Y.

## METHOD OF AND APPARATUS FOR PRODUCING CYANIDES AND AMMONIA.

SPECIFICATION forming part of Letters Patent No. 500,651, dated July 4, 1893.

Application filed March 26, 1891. Renewed January 16, 1892. Again renewed October 11, 1892. Serial No. 448,560½. (No model.)

*To all whom it may concern:*

Be it known that I, THOMAS B. FOGARTY, a citizen of the United States, residing at Long Island City, in the county of Queens and State of New York, have invented certain new and useful Improvements in Methods of and Apparatus for Producing Cyanides and Ammonia, of which the following is a specification.

The object of my invention is to produce with rapidity, certainty and at a comparatively small expense cyanides and ammonia and to this end I make use of the means and apparatus hereinafter fully set forth, said apparatus being illustrated in the accompanying drawings, in which—

Figure 1 is a vertical elevation of said apparatus. Fig. 2 is a vertical sectional elevation, enlarged, showing the furnace retort and washer; and Figs. 3, 4, and 5 are transverse sections respectively upon the lines *a*, *b*, *c*, Fig. 2.

The most valuable forms of combined nitrogen are cyanogen and its salts, and ammonia, and for this reason I have devised a method and means whereby to obtain these products cheaply and rapidly.

As is well known it is extremely difficult to effect practically and upon a commercial scale the combination of nitrogen and carbon—the elements of cyanogen—or to form free cyanogen even at extremely high temperatures; but, that when an alkali or alkaline earth be present cyanogen may be readily produced from free nitrogen and carbon, a cyanide or cyanate being formed which in turn may be decomposed by steam producing ammonia, oxides of carbon and free hydrogen. Efforts have frequently been made to thus produce cyanides synthetically, but the results have, so far as I am aware, in no case been practically successful owing chiefly to the extremely negative characteristics of the elements necessary to be combined, the difficulty of maintaining the apparatus at the intense heat required, and of maintaining other conditions incompatible with high temperature; and the wear and tear of the apparatus.

With the view to overcoming the above difficulties and to simplify the synthesis of cyanogen, its salts and products at a reduced temperature I make use of a process by which the chemical changes and reactions result in harmonizing the maintenance of the combining temperature with that of the other necessary conditions of the process.

While I can make use of various forms of apparatus in carrying out my improved process I prefer that illustrated in the drawings, in which—

A represents a steam generator, which may be of any suitable construction; B, a gas generator, of any suitable construction; C, a furnace for the production of cyanides; L, a tank and K a washer.

The generator or steam boiler A, is of any suitable construction and has a capacity equal to the production of the amount of steam required.

Steam from the boiler A, passes through an injector *x*, by means of which or of any other suitable form of pump, jet, aspirator or exhauster a suitable volume of steam and air is forced, or drawn through an incandescent volume of carbonaceous or hydro-carbonaceous fuel contained in a generator B, the oxygen of the steam and air combining with the incandescent carbon of the fuel to produce carbonic oxide and carbonic acid, while the hydrogen and nitrogen are set free, and the general result being combustible gas containing a large volume of nitrogen. A suitable generator gas may be also produced by similarly passing air, unmixed with steam, through the incandescent fuel in the generator B, forming a generator or producer gas of which the well known Siemens producer gas is an excellent type. In this case the boiler A, may be dispensed with. Through the combination of its oxygen with the carbon of the incandescent fuel in the generator B, as just described, the nitrogen of the air is thus rendered practically free from oxygen, and is reduced to a condition suitable for the production of cyanides, a large volume of fuel gas being simultaneously produced.

The details of construction of the furnace C, are best shown in Figs. 2 and 5, which illustrate said furnace as consisting generally of an elevated stack of fire brick or other refractory material. Said stack has a feed opening 3, at the upper end and is expanded below the latter to receive the retort M, also of suitable

refractory material, the chamber W, between the retort and the stack communicating with a fire-place D, the lower end of the retort communicating with the top of the tank L, containing a suitable supply of water and an outlet opening 4, affording a communication between the tank L and the washer K, which may be of any approved construction, but as shown is provided with a series of alternating plates forming a circuitous passage. The gaseous matter passes from the washer K, to the pipe 6, and the wash water passes into the washer through the pipe *e*. At the top of the stack and preferably at such an elevation above the retort as not to be detrimentally affected by the heat of the latter is arranged a hopper F, having a feeder G, in the form of a revolving screw, and a distributer H, in the form of a revolving disk, which receives the matter fed from the hopper by the screw and distributes it equally through the opening 3, into the retort. Where the hopper, feeder and distributer may be exposed to any excessive heat they are made of suitable refractory material.

The pipe 7, extending from the generator B, communicates at the upper end and with two branches 8, 9, leading to two super-heaters P, P′, at the upper part of the stack, a valve R′, in a casing R, serving to direct the gases alternately to one super-heater or the other, said gases after passing through either super-heater flowing through a port S′, into the inlet opening 3, and passing thence to the retort. Ports T, T, communicating with a circumferential chamber O, around the top of the retort permit the gases from the chamber W, to pass alternately to the super-heaters P, P′, accordingly as said ports are controlled by valves 10, 10, and other ports U, U, controlled by valves 12, 12, afford communication between the super-heaters and the chimney E. In the stack and around the inner chamber W, is a chamber or series of chambers N, with which communicates one or more pipes 13, leading from a reservoir or other source of supply of air or combustible gas, or of both.

Assuming that the stack has been heated to a sufficient temperature by the products of combustion, from the fire-place D, and that one of the super-heaters P or P′ has also been heated by said gases which have just been directed into the other super-heater communication is opened between the generator B, and the heated super-heater, the gases from the generator B, are caused to flow through the heated super-heater and out through the opening *s′*, into the feed-opening 3, and there meeting the material falling from the feeder pass downward therewith through the retort M. These gases will usually consist of a mixture of hydrogen, oxides of carbon, and nitrogen, the last named being in the proportion of about sixty per cent. and will probably vary in composition within certain limits according to the temperature and process of distillation or source and material from which they are obtained. Simultaneously with the introduction of the super-heated generator gases into the retort M, as just described, I introduce through the pipe J, into the feed opening 3, a suitable volume of hydro-carbon gas or vapor or a mixture of both which mixes with the generator gas passing through the retort. The hydro-carbon gases or vapors thus introduced, or, as usually happens, a mixture thereof may be derived from any suitable source. They may be obtained from the destructive distillation in closed vessels of bituminous coal or shale or of tar or oil, or other suitable hydro-carbonaceous matter. Ordinary coal or carbureted water gas, or natural gas may also be used with advantage, inasmuch as they are largely composed of hydro-carbon gases. Also, by means of the feeder G, I feed into the retort from the hopper F, a suitably adjusted volume of pulverized alkali or alkaline earth which passes downward through the retort in a state of intimate mixture with, and in the company of the generator and hydro-carbon gases. I do not, however, confine myself to the process of introducing the alkali into the retort in a pulverized state, for under certain conditions it may be advantageously introduced in the form of vapor, in which case the hopper may be dispensed with and a pipe for the introduction of the vapor may be substituted. In passing through the externally heated retort M the hydro-carbon gases and vapors thus introduced will be subjected to a high temperature which causes them to undergo various decompositions and syntheses according to their natures and characteristics. Thus when hydro-carbon gases and vapors are subjected to a high temperature in a closed vessel they tend to resolve themselves into their elements and finally do so, but by a gradual succession of changes, each successive change producing new substances more condensed or richer in carbon, and free hydrogen. This process is technically called "cracking" and finally results in the complete dissociation of the hydro-carbons into free carbon and hydrogen; and such changes suffice to supply the retort M, liberally with olefiant gas and acetylene, and also with nascent carbon and hydrogen all of which are the forms and compounds of hydrogen and carbon best suited for use in the synthesis of cyanogen and for the subsequent production of ammonia.

The synthesis of acetylene from its elements absorbs sixty-four thousand calories for its molecular weight, one and one-half times as much as cyanogen itself and it is consequently endowed with remarkable chemical energy, while the nascent hydrogen and carbon produced by the process of dissociation are in a state most highly favorable to the synthetical production of cyanides and cyanates.

By passing the generator gases through the super-heaters I impart to them a high temperature before they are admitted to the re-

tort, and thus effect a desirable economy by utilizing the waste heat of the escaping furnace gases; also, in proportion as I superheat the generator gases, I render it easier to maintain the temperature of the retort and, thus, contribute materially to its efficiency. As the gases enter the retort they are intimately mingled with the alkali or alkaline salt or earth from the hopper F, falling through the retort and traveling in the same direction with the gases themselves. At the same time the hydro-carbon gases and vapors undergoing the synthesis and decomposition before described, and being thereby presented to the atoms of nitrogen and alkali in a constant succession of chemically energetic and nascent conditions and in a state of intimate admixture, present innumerable points of contact and give rise to the following reactions resulting in the production of cyanogen and its salts, and ammonia:

First. Acetylene combines directly with nitrogen and produces hydro-cyanic acid, thus:

$$C_2H_2+N_2=2HCN.$$

Second. Acetylene combines with alkaline carbonates, oxides and hydrates, as for example:

$$Na_2CO_3+2C_2H_2+N_2=3CO+2Na, CN+2H_2.$$

Third. Nascent carbon combines with nitrogen and alkaline carbonates, oxides and hydrates, as for example:

$$Na_2CO_3+4C(nascent)+N_2=3CO+2NaCN.$$

Fourth. Nascent hydrogen combines directly with nitrogen producing ammonia, thus:

$$3H_2(nascent)+N_2=2NH_3.$$

Around these metamorphoses revolves a train of intermediate, analogous, and secondary reactions, all of which tend and gravitate to, and rest upon the common basis of the intense chemical energy and strong affinities of olefiant gas and acetylene and in a less degree of nascent carbon and hydrogen. Among these reactions may be included the analogous results obtained in the use of other alkalies as potassium, and the carbonates, oxides, and hydrates of the alkaline earths, calcium, barium, and strontium, all of which are available in a greater or less degree.

Among the products of my process will be a large amount of excellent fuel gas which may be used for heating the retort or otherwise.

When ferro-cyanides are the principal object of manufacture the cyanides produced may pass to the tank L, where part of them will be decomposed producing ammonia and fuel gases, the remainder being converted by means of suitable iron salts or oxides into ferro-cyanides which are utilized in any well known way.

When ammonia is the product chiefly sought for the cyanides may be decomposed before passing into the tank L, by means of a regulated volume of steam admitted at a point above the bottom of the retort to a pipe shown in dotted lines. This will decompose the cyanides, producing ammonia and its carbonates and fuel gas.

The production of the cyanides raises the temperature at the lower part of the retort but without any detrimental effect as far as regards the cyanides themselves, but causing loss and inconvenience when the production of ammonia is desired, the high temperature decomposing the nascent ammonia into its elements. To avoid this I feed from the hopper F, such an excess of carbon as will decompose a similar excess of steam producing a volume of water gas that will absorb or take up the heat sufficiently to reduce the temperature of the resulting gases to a degree suitable for the production and preservation of ammonia.

Without limiting myself to the precise processes or succession of processes, actions, and reactions described or to the exact form and arrangement of apparatus shown, I claim—

1. The process herein described of producing cyanides and ammonia, consisting in producing a gas consisting chiefly of oxides of carbon, free hydrogen and nitrogen, passing the same into and through a suitable retort maintained at a high or incandescent temperature, passing simultaneously through the same retort and in the same direction as the before described gas, suitable volumes of hydro-carbon gas or vapor and of alkali or alkaline earth or vapor, decomposing the hydro-carbon gas or vapor by heat into acetylene and free carbon and hydrogen, and causing these to combine with nitrogen and alkali and to produce alkaline cyanides, ammonia, and fuel gas, substantially as described.

2. The process herein described of producing alkaline cyanides and ammonia consisting substantially in causing nitrogenous gas, hydro-carbon gases and vapors and a suitable alkali to pass together in the same direction through an incandescent retort whereby the hydro-carbons are decomposed into simpler and elementary bodies which combine with nitrogen and alkali and produce alkaline cyanides, ammonia and fuel gas, substantially as described.

3. The hereindescribed process of producing alkaline cyanides and ammonia consisting in introducing highly heated nitrogen into a highly heated retort through which acetylene and nascent carbon and hydrogen are passing, together with an alkali or alkaline earth or vapor, whereby the acetylene, carbon, hydrogen and alkali are caused to combine with the nitrogen and the hydro-carbons are cracked producing alkaline cyanides and ammonia, substantially as set forth.

4. In an apparatus for producing alkaline cyanides, a retort combined with a supplementary combustion chamber N, N and means for supplying the latter with gas, constructed and operated, substantially as described.

5. In an apparatus for producing alkaline cyanides, the combination of the retort furnace D, supplementary chamber N, N, and superheaters, substantially as described.

6. The hereindescribed process of producing alkaline cyanides and ammonia consisting in introducing incandescent nitrogen into an incandescent retort in which acetylene and other hydro-carbon gases and vapors are being cracked and through which such hydro-carbon gases and vapors and nascent carbon and hydrogen are passing together with an alkali or alkaline earth or vapor, causing the acetylene, nascent, carbon and hydrogen and alkali to combine with the nitrogen and to produce alkaline cyanides, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

THOMAS B. FOGARTY.

Witnesses:
LEWIS CONDICT,
CLARENCE KING.