

C. P. HIDDEN.
FURNACE.

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1,348,175.

Patented Aug. 3, 1920.

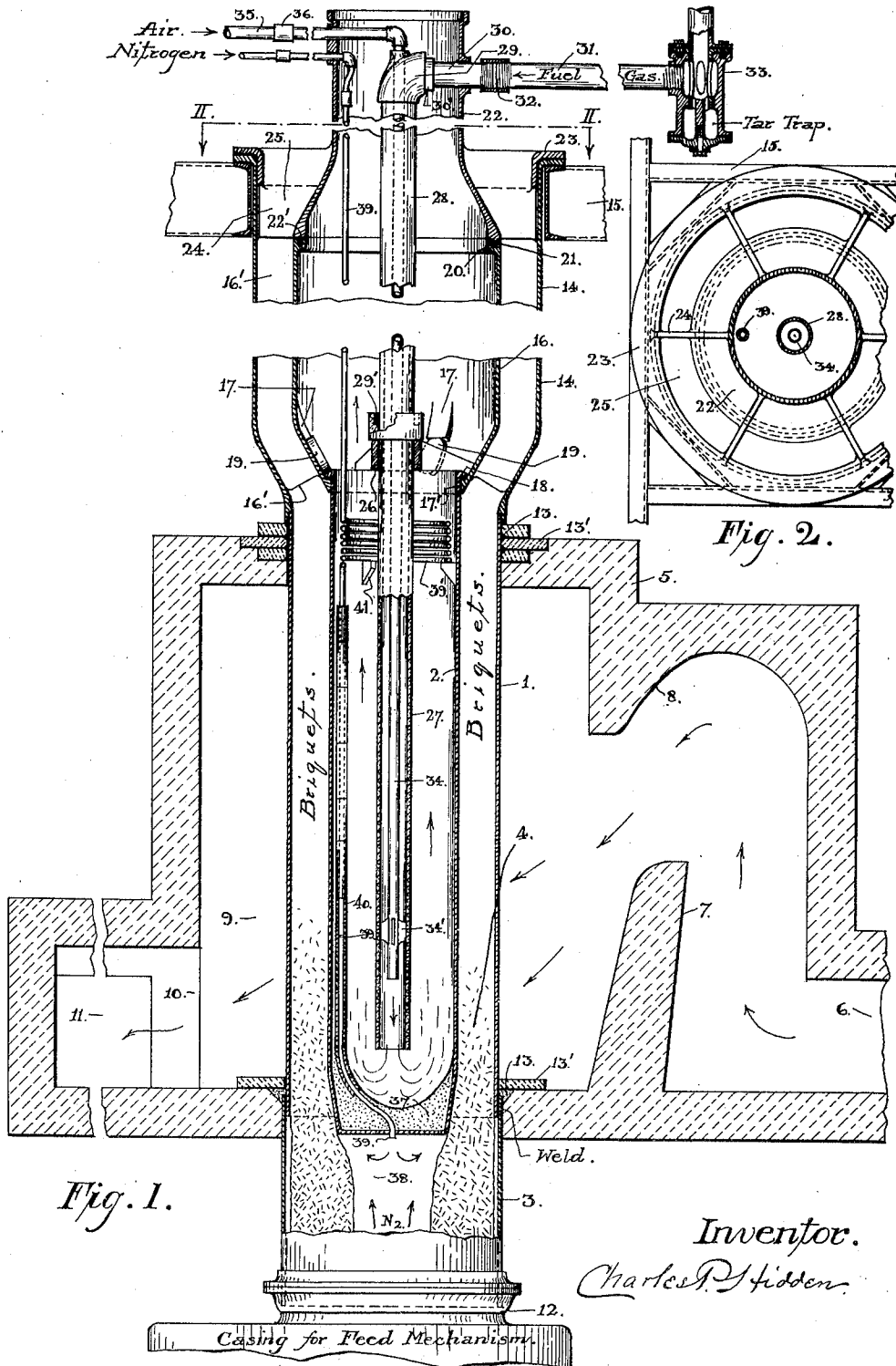


Fig. 1.

Fig. 2.

Inventor.

Charles P. Hidden.

UNITED STATES PATENT OFFICE.

CHARLES P. HIDDEN, OF PROVIDENCE, RHODE ISLAND, ASSIGNOR TO NITROGEN PRODUCTS COMPANY, A CORPORATION OF RHODE ISLAND.

FURNACE.

1,348,175.

Specification of Letters Patent.

Patented Aug. 3, 1920.

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To all whom it may concern:

Be it known that I, CHARLES P. HIDDEN, a citizen of the United States, residing at Providence, in the county of Providence and State of Rhode Island, have invented certain new and useful Improvements in Furnaces, of which the following is a specification.

This invention relates to furnaces for the effectuation of nitrogen fixation processes and the like; and more especially concerns a furnace for the conversion of such materials as sodium carbonate into sodium cyanid; the fixed nitrogen in the latter being preferably obtained from free or atmospheric nitrogen, during the operation.

In the patent to John E. Bucher No. 1,120,682, dated December 15, 1914, there is disclosed a process for fixing atmospheric nitrogen in the form of the cyanid of an alkali metal, such as sodium; and in certain of its more limited aspects, the herein described furnace may be regarded as an improvement upon that described by said Bucher in said patent.

The present invention has for one of its objects the provision of means for increasing the output from a given furnace; while permitting effective cyanization of the charge.

Another object is to so construct the apparatus as to permit of its being readily assembled and disassembled. These and other objects of my invention will be hereinafter referred to and the novel combinations of means and elements whereby said objects may be attained, will be more particularly pointed out in the claims appended hereto.

In the drawing, which forms a part hereof, I have somewhat diagrammatically exemplified a preferred construction; but as I am aware of various changes and modifications which may be made herein without departing from the spirit of my invention, I desire to be limited only by the scope of said claims, broadly considered in the light of my disclosure.

Referring to the drawing:

Figure 1 is a vertical section of the furnace; the section being taken on the axis of the retort; and

Fig. 2 is a partial detail section taken on line II—II of Fig. 1.

As shown in the drawing, the retort preferably comprises two shells; the outer shell being designated 1, and the inner one, 2.

Shell 1 may be made of iron pipe of relatively large diameter; *e. g.*, 30 inches or more. Telescoped over its lower end and preferably securely welded thereto is a pipe section 3 of somewhat larger diameter; which for convenience hereinafter will be referred to as the cooling section; in that as the descending columnar charge is received thereinto, it is cooled, in part by radiation and in part by relatively cool nitrogen currents, as hereinafter described.

The inner section 2 is desirably at least 10 or 12 inches smaller in diameter than section 1; so that there is left an annular space between the opposed walls of these sections, 5 or 6" thick, or more, adapted for the reception of the charge 4.

Section 2 is somewhat thimble-shaped and may be formed of iron, but is preferably of heat resistant alloy, such as one made of a suitable mixture of nickel, iron and chromium, or the like; and in some cases I also prefer to make the outer cylinder 1 of such material.

These concentric shells or cylinders are mounted vertically in a suitable furnace, which may conveniently be of the muffle type. The brick work of the furnace has been designated 5 and comprises a conduit 6, through which the heating gases may be introduced, these gases preferably being caused to impinge against a wall 7, and thence they pass into contact with a section 8 of the brick work, which is so formed as to co-act with the wall 7, to deflect the flames or hot gases more immediately into contact with the lower end of retort section 1; the object being to heat this lower end somewhat more highly than is the upper end of said retort. Thus, the lower end of the retort may be heated to a temperature, for example, of 1050° C., while the upper end may be heated to 1000° C., or somewhat less. The gases emerging from the conduit 6 pass through the chamber 9 in which the retort is disposed, and emerge via a conduit 10; whence they pass through a flue 11.

The lower end of the cooling section 3 is received into a part of the casing 12 for the feed mechanism, which mechanism removes the cyanized and relatively cooled charge from the retort. As this mechanism forms no part of the present invention, a portion only of the casing for the same has been shown,

The orifices in the brick work through which extend the sections 1 and 3 are sealed gas tight in any suitable manner, as for example by means of kieselguhr packing 13, and slabs 13' of firebrick, or the like.

The upper end of the outer section 1, preferably engages the base or lower end of a hopper-like casting 14, and the weight of this latter may conveniently be sustained by a suitable framework 15, as shown.

Into the hopper 14 is inserted a casting 16, provided with a plurality of ribs 16', which extend radially outward and have their outer edges shaped to adapt them for reception into the hopper 14. The lower ends of these ribs have their edges sloped, as shown, so that the casting 16 is firmly supported in and by the hopper 14.

Upon the interior wall of the casting 16 are a plurality of lugs 17, and the lower extremity of said casting is provided with an interior annular flange 17', which in cross section forms a substantially hooked shaped element, adapted for engagement with the out turned flange 18 at the upper end of retort section 2.

The inverted thimble 2 hence depends from the casting 16 and in order to prevent the charge in the furnace from displacing the thimble out of axial alinement with the cylindrical section 1,—in the event of some irregularity in the feed of the charge,—flat oval blocks 19 may be driven in beneath the lugs 17, so as, in effect, to wedge the flange 18 down against the hook-like interior flange at the lower end of the casting 16.

The advantage of this construction resides in the fact that these blocks 19 may be readily knocked out of place after the retort has been partly disassembled, in order to separate the casting 16 from the section 2. If bolts, or the like were employed to secure these parts together, then, owing to the heat to which they are subjected, it would at times be found exceedingly difficult to remove such bolts.

The upper end of the casting 16 is provided with an interiorly directed flange 20, which is preferably annularly recessed for the reception of kieselguhr or the like, as at 21; to provide a seal.

Above the casting 16 is an inverted funnel-shaped member 22, the lower extremity of which is provided with an outwardly directed flange 22' which is received into the kieselguhr 21, to complete the seal above referred to.

The weight of the member 22, may be sustained in part by the casting 16; but is preferably principally carried more directly by the framework 15, through the intermediacy of a flanged ring 23, which is integrally united to the member 22 by ribs 24. These latter are of the same number as ribs 16',

and desirably register therewith, so that the briquets fed into the hopper-like space 25, at no time encounter an obstruction to their downward movement. In other words, the space 25 is really an annulus which is divided into compartments by radially directed partitions 24, as shown in Fig. 2.

I have described how the cylindrical section 1 is exteriorly heated by combustion gases in the muffle furnace, and shall now consider the preferred mode of interiorly heating thimble-section 2 of the retort.

A spider 26 is introduced into the casting 16 and the extremities of its legs may rest directly upon the flange 18 of the thimble 2. This spider is centrally apertured for the reception of a pipe 27, which depends there-through and preferably extends down, well toward the bottom of the thimble. Pipe 27 may be formed of such an alloy as that above mentioned, or it may be formed of fused silica, or the like.

The upper end of pipe 27 is enlarged for the reception of a pipe 28, provision being made as by means of an annular recess 29, for the insertion of suitable sealing material, such as kieselguhr or the like.

Pipe 28 is secured to an elbow 29, to the other end of which, preferably through the intermediacy of a reducing flange 30', is connected a short pipe section or nipple 30, which extends laterally out through the wall of the member 22.

Fuel gas may be introduced into the pipes 28 and 27 from a pipe 31, which may be coupled to the nipple 30 by means of a sleeve 32.

To facilitate removal of the retort from the furnace, pipe 31 may, if desired, be mounted so that it may be swung aside or swiveled out of the way, after which sleeve 32 may be disengaged from the nipple 30; the casting 33 being pivotally connected to the pipe 31 and also, desirably, constituting a trap for any tar, or the like, present in the fuel gas.

In the interior of pipes 28 and 27, is a smaller pipe 34, through which air is admitted; this pipe extending up through the elbow 29 and, by suitable connections, thence projects laterally through the wall of member 22. It may receive air from a pipe 35, to which it may be coupled by a sleeve 36.

The pipe 34 may be provided with laterally directed lugs 34', to space it from pipe 27.

The combination of pipes 27 and 34, forms in effect an inverted Bunsen burner, the flame from which is directed downwardly toward the bottom of the thimble section 2. To preserve this part of the retort from excessive heating, I prefer to fill the lower extremity of said section 2 with suitable heat-resistant material 37,

which may be introduced in plastic condition and molded into the shape shown.

The flames emerging from the lower end of pipe 27, are deflected by the heat-resistant material 37 and thence travel upwardly in contact with the inner wall of thimble 2, and heat the latter at its lower extremity to approximately 1050° C.; the upper end being somewhat less highly heated, in correspondence with the mode of heating section 1, above described.

I have found it desirable, although by no means essential, to introduce hot nitrogen into the space 38, directly below thimble 2, and this nitrogen may be introduced via a pipe 39, which extends down through member 22 and casting 16, into the thimble, in which latter said pipe is preferably coiled as at 39', for a portion of its length.

This pipe may be formed of alloy, or if made of iron, it is preferably protected at least the lower extremity thereof, by annuli 40 of alundum, or the like, while the coil 39' may be supported upon brackets 41, welded to the inner wall of the thimble.

The lower extremity of pipe 39 may project through a small aperture in the bottom of section 2; this aperture being sealed around said pipe, by the material 37 afore-said.

The preferred mode of operating the furnace is as follows:

The material to be cyanized, preferably in the form of briquets and comprising intimately mixed sodium carbonate, finely pulverulent coke or other suitable carbonaceous material, and finely divided iron, is charged into the hopper 25 until the annular space between the retort sections 1 and 2, and, of course, any space therebelow, have been substantially filled. The briqueted charge also preferably extends up to the top of the ring 23.

The retort meanwhile, and indeed preferably previously, has been heated interiorly as well as exteriorly; the latter by means of the combustion gases emerging from the conduit 6, which traverse the chamber 9 and pass thence into the flue 11, as above described; while fuel gas is admitted through pipe 31 and pipes 28 and 27 and in the latter is mixed with air, under suitable pressure, admitted through pipe 34. The fuel gas will be, of course, under a pressure corresponding to that of the air, and the gaseous mixture will, by the time that it is delivered from the end of pipe 27, be highly heated and very effective combustion can hence be obtained; whereby to heat the inner retort section or thimble 2 up to the indicated temperatures.

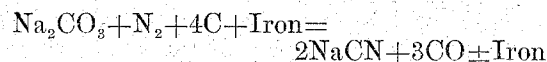
Nitrogen passing through pipe 39 will, of course, be highly preheated and will emerge into the space immediately below the section 2; at which point it will encounter a current

of nitrogen ascending from the feed mechanism casing. This latter nitrogen is hot, by reason of its having encountered the descending charge of cyanized briquets, after the furnace has been in operation a reasonable time; but it is by no means as highly heated as is the nitrogen which emerges from pipe 39. It is, in fact, sufficiently cool to chill the fused material in the descending briquet mass; this material comprising molten cyanid and sodium carbonate. When briquets containing this molten mixture are thus exposed to the nitrogen current at a point where the temperature of the latter is below the eutectic point of the mixed cyanid and soda-ash or sodium carbonate, this mixture solidifies and in so doing, becomes for a time quite adhesive or tacky.

If at such time, a portion of the retort wall is in contact with briquets, the cyanid content of which is therefore just in the act of setting or solidifying; such briquets will tend to adhere to the retort wall with which they are brought into contact and will hence tend to impede the progress of the charge through the retort.

It is for this reason that the inner section or thimble 2, has the bottom thereof so shaped as to, in effect, abruptly remove its wall from possible contact with the descending charge, at a point a short distance above where the charge begins to set and hence to become tacky, as above described.

In other words, the descending briquets, while passing down between the cylindrical walls of retort sections 1 and 2, and while exposed to the intense heat to which they are subjected, are more or less plastic and as the cyanid is formed therein according to the equation:



it normally is molten and after a fashion acts as a lubricant. After a given portion of the charge becomes cyanized, however, and descends below the level of the floor of the furnace, it begins to cool and by the time that it reaches the level of the bottom of the thimble 2, it is very nearly ready to set or harden, if it is located in the vicinity of said thimble. It, however, does not set until it has cleared the lower end of the section 2 and hence the mass of briquets will normally flow inwardly, or more or less radially, for a short distance, as indicated in Fig. 1; reducing somewhat the diameter of the space 38 within the briquet column.

At times this inward flow of the briquet mass, on account of heat conditions, may even be such as to cause the cavity 38 to assume either the form of an inverted cone; or of an inverted truncated cone.

The warm but not excessively hot nitro-

gen which also flows up from the feed mechanism casing alongside of the inner wall of the cooling section 3, is not materially admixed with hot nitrogen from the pipe 39; and hence the outer briquets, or those more nearly adjacent to the section 1, will tend to set sooner than those in the interior of the charge. The cooling section 3 is offset from the bottom of the section 1, to permit these briquets, thus in contact with the section 1 as they approach the lower end of the latter, to become tacky and set, out of contact with both said section 1 and the cooling section or wall 3.

I have thus made provision both upon the outer side of the briquet column and upon its interior, to insure against restriction of the movement of the charge downwardly through the annular retort, by reason of any adhesion of portions of the charge which are cooling to portions of the walls of the retort. As a result, the charge in the form of a hollow column, will move steadily downward into the feed mechanism casing; while fresh material, in the form of uncyanized briquets may be loaded into the compartmented space 25, from time to time, as needed.

The advantage of thus introducing hot nitrogen in the manner described, via pipe 39, or its equivalent, is that while the nitrogen, as a whole, is not supplied at such a high temperature as to prevent proper setting of the briquets,—which would obviously interfere with the operation of the furnace;—nevertheless, this supplemental stream of highly heated nitrogen, raises the temperature of the entire flow of nitrogen, just as it is about to enter the heat zone of the annular charge, and thereby favors the cyanid-forming reaction.

If cyanid is formed to any considerable extent in the upper part of the retort, there is a tendency for much of this cyanid to volatilize and pass upwardly along with the ascending nitrogen and carbon monoxid, until it reaches a point at or near the top of the heat zone, where its temperature is lowered sufficiently to permit of the destruction of said cyanid with reformation of sodium carbonate.

This is so, because, at a temperature for example of 1000° C., even 15% of carbon monoxid in the nitrogen current, will practically prohibit cyanid formation; while a greater content of CO, at this temperature, even tends to reverse the reaction and hence to convert the cyanid back to sodium carbonate.

The content of carbon monoxid tends to steadily increase in the ascending gaseous current; because carbon monoxid is liberated wherever the cyanid is formed, and hence, by reason of the presence of a relatively high content of carbon monoxid in

the upper end of the heat zone, if the temperature be kept down, to, let us say, 1000° C., there is then little tendency for cyanid to form in said upper end.

If cyanid is not formed at this point, then the briquets will descend through this portion of the furnace with maintenance of substantially their entire content of sodium carbonate and as the lower end of the furnace is most highly heated, and as, also, there is a strong incoming current of pure nitrogen, and since, further, this incoming current, by reason of the added nitrogen supplied by pipe 39, is almost up to cyanid-forming temperature,—there is a very strong cyanid forming reaction effected in the lower quarter of the heat zone.

This cyanid, after having thus copiously formed, does not have sufficient time to distil off to any great extent, before it passes down into the cooling section of the furnace in which, of course, it is promptly chilled and can no longer be lost by distillation.

On account of difficulties in connection with the feed mechanism, especially when using an exterior shell of large diameter, it is highly desirable to construct the double-walled retort in such fashion that the inner section or shell thereof depends into the outer section; while the means for supplying heat to said interior section, preferably similarly depends or extends into the space within said inner shell, substantially as shown.

By thus using an exterior shell of large diameter and providing therein a thimble or its equivalent, capable of co-acting therewith to afford an annular space, the thickness of which is not excessive,—it is possible to obtain an output from a single furnace, far in excess of that possible where a simple pipe-like retort is employed; since, obviously, the cross-sectional area of the annular charge-receiving space may be made many times that of the corresponding area of a simple pipe of a diameter in any way well adapted to the process.

Not only is the output increased thus materially by the disposition of the charge in the form of a hollow column of large diameter; but, further, the thickness of this column, measured radially, may be such as to permit of a rapid heating of the briquets most remote from the sources of heat. To be able thus promptly to elevate to reaction temperature, substantially all parts of the charge passing through that part of the heat zone of the retort, where it is desired that the cyanid-forming reaction shall occur, greatly favors the obtainment of a higher percentage yield of cyanid in the product, on account of the reduction of distillation of cyanid in the heat zone, in the manner above described.

It will hence be seen that there is a pe-

cular inter-action between the various elements of the described furnace, which favors effective cyanization of the charge, as a whole; while also permitting treatment of a relatively large volume of material in a single continuously operating apparatus.

Finally, while I have described a furnace, the inner and outer walls of the retort in which are heated by combustion gases, I do not wish to be limited by such a mode of heating; said mode being merely preferred by reason of its simplicity and general availability.

Having thus described my invention, what I claim is:

1. A furnace for fixing nitrogen which comprises two concentrically disposed retort sections, one within the other, the common axis of said sections being substantially vertical, means to heat the exterior section, auxiliary means to heat the interior section, means to receive material which descends through the annular space between said sections, said material having the form of a hollow column and said receiving means having provisions for cooling said column both interiorly and exteriorly while preventing adhesion of the charge to any part of the retort during the cooling operation, said cooling provisions including means to direct a relatively cool stream of nitrogen into contact with the lower end of said column.

2. A furnace for fixing nitrogen which comprises two substantially vertical retort sections, one within the other, means to heat the exterior section, auxiliary means to heat the interior section, means to receive material which descends through the annular space between said sections, said material having the form of a hollow column and said receiving means having provisions for cooling said column both interiorly and exteriorly while preventing adhesion of the charge to any part of the retort during the cooling operation, said cooling provisions including means to direct a relatively cool stream of nitrogen into contact with the lower end of said column.

3. A furnace for fixing nitrogen which comprises two substantially vertical retort sections, one within the other, means to heat the exterior section, auxiliary means to heat the interior section, means to receive material which descends through the annular space between said sections, said material having the form of a hollow column and said receiving means having provisions for cooling said column both interiorly and exteriorly while preventing adhesion of the charge to any part of the retort during the cooling operation, said cooling provisions including means to direct a relatively cool stream of nitrogen into contact with the lower end of said column, and means supple-

mental to the heating means aforesaid, for raising the temperature of the nitrogen, as a whole, just prior to its admission to the heat zone of said furnace.

4. A furnace for fixing nitrogen which comprises a retort which includes a cylindrical exterior section and a thimble in the interior of said section, said thimble being substantially co-axially located in said exterior section, means to heat said thimble interiorly and said section exteriorly, means to supply free nitrogen to the heated charge-receiving space between said thimble and section, and cooling means to receive said charge after treatment thereof in said space.

5. A furnace for fixing nitrogen which comprises a retort, the charge-receiving portion of which is substantially annular in cross section, said furnace including means to cool the charge emerging therefrom and provisions for effecting a vigorous nitrogen-fixing reaction in said retort only at the end of the latter which is adjacent said cooling means.

6. A furnace for fixing nitrogen which comprises a vertical retort, the charge-receiving portion of which is substantially annular in cross section, said furnace including means to cool the charge emerging therefrom and provisions for effecting a vigorous nitrogen-fixing reaction in said retort only at the end of the latter which is adjacent said cooling means.

7. A furnace for fixing nitrogen which comprises a retort, the charge-receiving portion of which is substantially annular in cross section, said retort including an exterior shell and a thimble substantially co-axially located within said shell, said furnace having means to heat one end of said shell to a higher temperature than the other, means to heat said thimble interiorly thereof, said thimble heating means having provisions for heating most highly the end of said thimble which is adjacent the most highly heated end of said shell.

8. A furnace for fixing nitrogen which comprises a vertical, gravity-fed retort, the charge-receiving portion of which is substantially annular in cross section, said retort including an exterior shell and a thimble substantially co-axially located within said shell, said furnace having means to heat the lower end of said shell to a higher temperature than the upper end thereof, means to heat said thimble interiorly thereof, said thimble heating means having provisions for heating most highly the lower end of said thimble, and provisions for cooling the charge substantially directly after said charge has been most highly heated in the space between said heated lower ends.

9. A furnace for fixing nitrogen which comprises a retort, the charge-receiving portion of which is substantially annular in

cross section, said retort including an exterior shell and a thimble substantially coaxially located within said shell, said furnace having means to heat one end of said shell to a higher temperature than the other, means to heat said thimble interiorly thereof, said thimble heating means having provisions for heating most highly the end of said thimble which is adjacent the most highly heated end of said shell, and provisions for cooling the charge upon its emergence from said retort substantially directly after said charge has been most highly heated in the space between said heated ends, said provisions including means for supplying gaseous nitrogen for contact with said charge.

10. A furnace for fixing nitrogen which comprises a vertical retort the charge-receiving portion of which is substantially annular in cross section, in combination with a hopper, the charge-holding portion of which is also substantially annular in cross section, means to supply nitrogen to said retort for passage therethrough up into said hopper, and means to heat said retort both interiorly and exteriorly thereof, so that the charge therewithin may simultaneously receive heat both from its exterior wall and its interior wall.

11. A furnace for fixing nitrogen which comprises a vertical retort the charge-receiving portion of which is substantially annular in cross section, in combination with a hopper, the charge-holding portion of which is also substantially annular in cross section, means to supply nitrogen to said retort for passage therethrough up into said hopper, and means to heat said retort both interiorly and exteriorly thereof, so that the charge therewithin may simultaneously receive heat both from its exterior wall and its interior wall, the portion of the charge which is in said hopper being also directly heated interiorly thereof by said means for heating the interior of said retort.

12. A furnace for fixing nitrogen which comprises a retort, the charge-receiving space of which is substantially annular in cross section in combination with a hopper for delivering the charge to said space, said hopper being separably connected to said retort to permit disassembling of said retort and its hopper, means to supply nitrogen to said retort and means to supply heat to said retort, so that said heat may pass into the charge in said space both from the exterior and interior walls thereof.

13. A continuous furnace for fixing nitrogen in the form of an alkali metal cyanid, which comprises a downwardly feeding, substantially vertical retort, the charge-receiving space of which is substantially annular in cross section, said retort having off-

sets at substantially the lower end of its heated portion, located to free from contact with the descending charge, those parts of the retort walls which are immediately below the respective offsets, means to interiorly heat said charge, means to exteriorly heat said charge, and means to cool said charge both interiorly and exteriorly, to solidify the cyanid formed, substantially directly after those portions of the charge which contain said cyanid, clear said offsets.

14. A continuous furnace for fixing nitrogen in the form of an alkali metal cyanid, which comprises a downwardly feeding, substantially vertical retort, the charge-receiving space of which is substantially annular in cross section, said retort having offsets at substantially the lower end of its heated portion, located to free from contact with the descending charge, those parts of the retort walls which are immediately below the respective offsets, means to interiorly heat said charge, means to exteriorly heat said charge, and means to cool said charge both interiorly and exteriorly, to solidify the cyanid formed, substantially directly after those portions of the charge which contain said cyanid, clear said offsets, said cooling means including provisions for supplying to said retort gaseous nitrogen to be fixed therein, said nitrogen being relatively cool and adapted to solidify said cyanid.

15. A continuous furnace for fixing nitrogen in the form of an alkali metal cyanid, which comprises a downwardly feeding, substantially vertical retort, said retort having offset portions directly below the lower end of its reaction zone, said offset portions being located to free from contact with the descending cyanized charge, those parts of the retort walls which are immediately below said offset portions, means to heat said retort, means to supply relatively cool nitrogen to the cyanized charge to solidify the cyanid therein after said cyanized charge has passed down out of contact with said offset portions, and means to supply highly heated nitrogen to said charge for admixture with said relatively cool nitrogen after the latter has performed its function of solidifying said cyanid.

16. A furnace which comprises an exterior retort section, a hopper-forming part above said section, co-acting hopper-forming means within said part, a thimble depending from said means and extending down into said exterior section, and means to heat said thimble interiorly and said section exteriorly, thus heating from both within and without, the charge in the space between said exterior section and thimble.

17. A continuously feeding furnace which comprises an exterior retort section, an in-

terior retort section, means to introduce the charge to be treated in said furnace, into the upper portion of the space between said sections, means to heat said exterior section
5 exteriorly and said interior section interiorly, to supply heat to said space both from within and without the same, provisions to cool the charge upon its emergence from said heated space, and provisions
10 to prevent adhesion of said charge to either of said retort sections while said charge is being cooled.

18. A continuously feeding furnace for fixing free nitrogen in the form of an alkali metal cyanid, which comprises a retort
15 through which the charge to be cyanized continuously moves, means to heat said retort to establish a cyanizing zone therein, means to supply relatively cool nitrogen to
20 the cyanized charge as the latter moves out of said zone, to solidify the cyanid in said charge, means to supply highly heated nitrogen to said zone, for admixture with said relatively cool nitrogen, and means to pre-

vent adhesion of said cyanid to said retort, 25 while said cyanid is solidifying.

19. A furnace having a double-walled retort, the space between the double walls of which holds the charge to be treated, means
30 to direct a stream of highly heated gas against the exterior wall of said retort, and means to direct a stream of highly heated gas against the interior wall of said retort.

20. A furnace having a double-walled vertical retort, the space between the double
35 walls of which holds the charge to be treated, means to heat the exterior wall, whereby to exteriorly heat the charge in said space, and means, extending into the space within the inner of said walls, for
40 heating said inner wall, whereby to heat said charge interiorly thereof.

In testimony whereof I have affixed my signature, in the presence of two witnesses

CHARLES P. HIDDEN.

Witnesses:

HOWARD F. HYLAND,
ROGER N. LOBDELL.