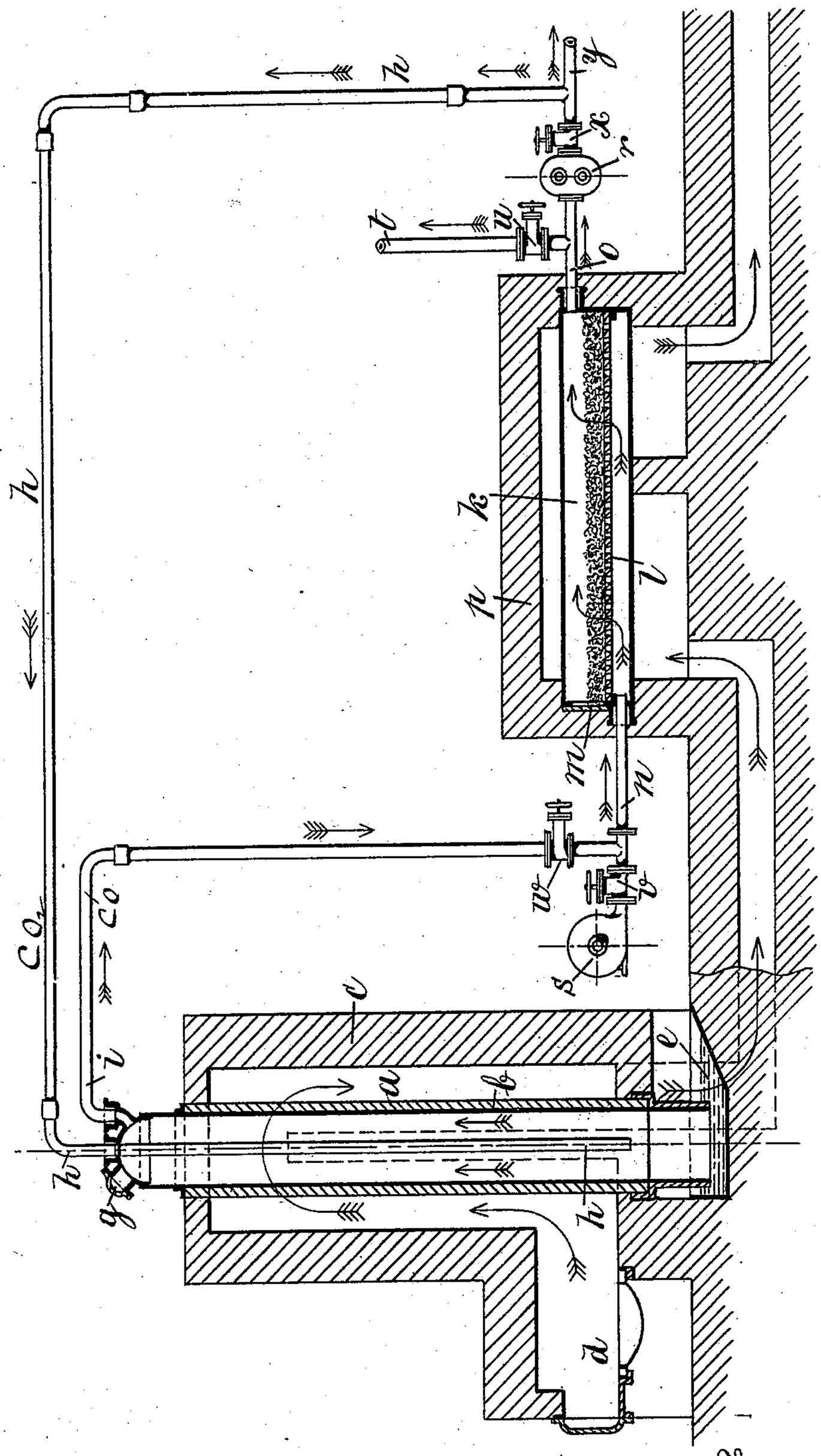
(No Model.)

H. LANE & J. PULLMAN.

MANUFACTURING CARBONIC ACID GAS.

No. 556,991. Patented Mar. 24, 1896.



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UNITED STATES PATENT OFFICE.

HOWARD LANE, OF BIRMINGHAM, AND JOHN PULLMAN, OF LONDON, ENGLAND.

MANUFACTURING CARBONIC-ACID GAS.

SPECIFICATION forming part of Letters Patent No. 556,991, dated March 24, 1896.

Application filed November 30, 1894. Serial No. 530,456. (No specimens.) Patented in England July 3, 1893, No. 12,995; in Germany November 4, 1893, No. 77,150, and in France November 4, 1893, No. 233,843.

To all whom it may concern:

Be it known that we, HOWARD LANE, engineer, residing at Corporation Street, Birmingham, in the county of Warwick, and JOHN PULLMAN, manufacturer, residing at Greek Street, Soho, London, in the county of Middlesex, England, subjects of the Queen of Great Britain, have invented certain new and useful Improvements in Manufacturing Carbonic-Acid Gas, (for which we have obtained Letters Patent in England, No. 12,995, dated July 3, 1893; in Germany, No. 77,150, dated November 4, 1893, and in France, No. 233,843, dated November 4, 1893,) of which the following is a specification.

The object of our invention is to economically and rapidly obtain carbonic-acid gas.

To carry our invention into effect, we pass atmospheric air through a retort or chamber containing heated carbon, thus producing carbonic-oxide gas, which is then passed through a second heated retort or chamber containing a metallic oxide by which the carbonic oxide is converted into carbonic acid. The latter is then carried back to the retort containing a carbon, where it is considerably increased in volume, the reactions being $CO_2+C=2CO$ and $2CO+O_2=2CO_2$. A part (constituting the surplus) of the carbonic-acid gas thus obtained is passed to a gas holder and washer, and can then be utilized in any desired way, while the remainder is passed back to and through the first retort, where it is again converted to carbonic oxide, the latter being once more returned to the second retort and passed through the heated metallic oxide in the latter, and the increased volume being again converted to carbonic-acid gas, a part of which is carried off to be used, while the remainder again returns to the first retort, and so on, as long as may be desired. When the metallic oxide becomes reduced to a metallic state by giving up its oxygen to the carbonic oxide, we pass a current of air through it until it has become sufficiently reoxidized, and the process is then continued as already described.

The accompanying drawing is illustrative of the apparatus (shown in longitudinal section) which may be used in carrying our improved process into effect.

a is a vertical retort or chamber of fire-clay lined with a wrought-iron tube *b*. This retort is set in a brickwork chamber *c* and is heated by a furnace *d*. The lower end of the retort is open and dips into a water pan or vessel *e*, so arranged that ashes and refuse from the retort may be removed without stopping the work.

The upper end of the retort *a* is provided with a cover or cap, having a door *g* through which the retort can be charged, an inlet-pipe *h* passing through the cover and centrally down nearly to the bottom of the retort *a*. An outlet-pipe *i* is also arranged from the top of the retort. The retort is charged, as required, with charcoal, coke, or other suitable carbonaceous material, upon the purity of which that of the resulting gas will depend.

In a convenient position in the neighborhood of the retort just described is arranged a second retort or chamber *k*. This chamber is fitted with a sufficient number of perforated fire-brick trays *l*, upon which is placed oxide of copper or of other suitable metal in a finely-divided state.

The retort *k* is provided with a manhole and door at *m*, by which access can be had to its interior, and with an inlet-pipe *n*, entering below the trays *l*, which carry the oxide, and an outlet-pipe *o* above the latter. The retort is set in a fire-brick chamber *p* and is heated by the waste heat from the retort first described, or by other suitable means.

The outlet-pipe *o* from the retort *k* is connected with the inlet-pipe *h*, descending through the center of the retort *a*, and the outlet-pipe *i* of the latter is connected with the inlet-pipe to the retort *k*, and in a suitable part of the circuit of pipes thus formed is inserted a blowing apparatus *r* of any suitable kind—such, for instance, as what is well known as a "Root's" blower—capable of operating upon hot gases, its object being to cause the constant circulation of the gases produced through the different parts of the apparatus. An ordinary fan *s*, or other equivalent apparatus for dealing with large quantities of air,

is also arranged in connection with the inlet-pipe *n* into the lower part of the second or oxidizing furnace *k* described, or in other suitable position, so that when required air can be driven through the metal upon the trays *l* for the purpose of reoxidizing it. A pipe *t* communicating with the open air is arranged upon the delivery-pipe *o* from the second retort. Regulating-valves are shown—one, *u*, upon this pipe *t*, just described, one, *v*, upon the delivery-pipe of the fan *s*, one, *w*, upon the pipe *i*, communicating from the upper part of the retort *a* to the lower part of the retort *k*, and one, *x*, upon the delivery-pipe from the upper part of the retort *k* to the pipe *h*, descending to the lower part of the retort *a*—which valves can be opened and closed, according to the different parts of the process which is being carried on.

The circulating-pump *r* and the fan *s* described are driven by steam or any convenient power.

The improved process of manufacturing carbonic-acid gas, is as follows: The first retort *a* is filled with carbon and the trays *l* in the second retort *k* with copper oxide or scale or other suitable metallic oxide. The valves *v* on the delivery from the fan *s*, and *u* upon the pipe *t*, communicating between the delivery-pipe *o* of the furnace *k* and the open air, are closed and the other valves opened. The circulating-blower *r* is then set in motion and both retorts *a* and *k* are heated, the first to a bright red and the second to a low red heat. The entire system in this condition contains atmospheric air—that is to say, a mixture of nitrogen and oxygen gases. The oxygen combines with the carbon and is converted to carbonic-acid gas in the lower part of the retort *a*, and as it rises is further converted to carbonic-oxide gas. The resulting mixture of carbonic oxide and nitrogen gases is passed by the action of the circulating-blower *r* from the upper part of the retort *a* and into the lower part of the second (or oxidizing) retort *k*, and passing up through the copper oxide the increased volume of carbonic oxide becomes converted to carbonic acid, the relative proportion of nitrogen being lessened. A part of the gas is allowed to pass away through the pipe *t* at the commencement of the process of manufacture, instead of being delivered through the pipe *y* leading to the gas-holder. The remainder of the mixture is forced back to and through the first retort *a*, the carbonic acid being again converted to carbonic oxide, and thence to the second retort *k*, where the carbonic oxide is again converted to carbonic acid and the relative proportion of nitrogen is again considerably reduced.

It will be seen that after a very short time the contents of the system become, without exterior aid, carbonic oxide, and practically pure carbonic acid, the volume of which is increased every time the gases circulate through the retorts, the surplus so produced passing off continuously to the gas holder and washers.

In order to prevent the presence of nitrogen at the commencement of the process the whole system may be charged with carbonic-acid gas before commencing. After the process has continued for a certain time the metallic oxide in the second retort *k* becomes reduced to a state approaching metallic, insufficient oxygen remaining in it to oxidize the carbonic oxide coming from the retort *a*. When this is the case, it is necessary to cease the manufacture and to close the valves in the circulating-pipes, those (*v* and *u*) communicating with the fan *s* and with the pipe *t* leading to the open air being opened, and the fan being set in motion air is passed through the contents of the trays in the retort *k*, the oxygen gas reoxidizing the metal in the trays and the nitrogen passing away into the open air or being conducted away and utilized if preferable. As soon as the reoxidation of the copper is complete or has proceeded sufficiently far, the two open valves are closed and the others opened. The circulating-blower *r* is then restarted and the process of manufacture of carbonic-acid gas resumed. The nitrogen gas remaining in the second retort may be blown out through the pipe *t*.

Instead of suspending the process of manufacture, as described, in order to reoxidize the copper in the second retort *k*, it is preferable that the number both of the first and second retorts should be multiplied, so that the manufacture of the gas can be continued without intermission, the alternate use and reoxidation of the contents of the second retorts being arranged so as to be progressive, one series being in action while the contents of the other one are in course of being reoxidized.

A regenerator of the well-known ordinary construction may be interposed between the fan *s* and the valve *v*, which connects the latter with the second retort *k*, as described, so that the entering air for reoxidizing the copper becomes heated by means of the outgoing gas passing to the open air, as above described, or by the products of combustion passing from the furnace to the retorts; also the retorts themselves (where the manufacture is on a large scale) may be heated by well-known systems of gas firing and regeneration. The contents of the first retort may be heated by passing air intermittently through the retort, which is thus heated internally instead of externally. By using external heat, however, the process can be carried on continuously.

By this invention carbonic-acid gas is obtained very economically, the process being simple and the apparatus being inexpensive, easily worked, and not liable to get out of order.

What we claim, and desire to secure by Letters Patent of the United States, is—

1. The continuous process for producing

carbon dioxide in a closed circuit, which consists in passing some carbon-dioxide gas already formed through heated carbon, causing the dioxide to become converted into an increased volume of monoxide, in subjecting this monoxide to an oxidizing agent, whereby it is changed into dioxide, in carrying off the increase in volume of gas, carrying the residue of dioxide in the circuit back through the carbon again forming monoxide of an increased volume, reoxidizing the monoxide, carrying off the excess of dioxide, and so on, substantially as described.

2. The continuous process for producing carbon dioxide in a closed circuit which consists in passing air through heated carbon converting the said air into carbon monoxide and nitrogen, in subjecting this mixture to the action of an oxidizing agent and converting the same into carbon dioxide and nitrogen, in passing the latter mixture through heated carbon forming a mixture composed of the same volume of nitrogen but an increased volume of carbon monoxide, in reoxidizing this carbon monoxide, in carrying off the excess of this mixture of gases, and passing the residue in the circuit back through the carbon forming an increased volume of carbon monoxide, reoxidizing this, and carrying off the excess of volume of the resultant mixture, and so on, the percentage of nitrogen in the closed circuit being decreased at every step until finally a practically pure carbon dioxide is obtained, substantially as described.

In testimony whereof we have hereunto set our hands in the presence of witnesses.

HOWARD LANE.
JOHN PULLMAN.

Witnesses as to Howard Lane:
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Witnesses as to John Pullman:
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