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12/19/2001 - 08:23:45

(12) **Patent:** (11) **CA 312244**

(54) APPARATUS FOR MANUFACTURING CARBON MONOXIDE

(54) APPAREIL A FABRIQUER DU PROTOXYDE DE CARBONE

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(73) (Country):	**PHILIPP SCHILLING**
(71) (Country):	
(74)	
(45)	**June 9 , 1931**
(22)	
(43)	
(52)	**23/395**
(51)	**N/A**
	No
(30)	**None**
	N/A
	Unknown

*** Note: Data on abstracts and claims is shown in the official language in which it was submitted.

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This invention relates to the manufacture of carbon monoxide and more particularly refers to improvements in apparatus for the efficient production of carbon monoxide gas of high purity.

Carbon monoxide gas is a basic element in the production of various substances such as formic acid, acetic anhydride and phosgene. Like in all processes of manufacture, the cost of the finished product is, of course, a factor of paramount importance; in the matter under consideration this factor is closely allied to the purity of the carbon monoxide and also to its original cost of production, since as is well known the purer the monoxide gas the quicker and more complete the reaction, giving rise to the formation of fewer intermediate compounds.

In another application for patent, entitled Process of Manufacture of Carbon Monoxide, United States Serial No. 371,963, Canadian Serial No. 353,284, I have described and claimed a process of manufacture of carbon monoxide, resulting in a product of great purity which can be obtained at relatively low cost.

The purity of the product and its efficient production are the direct result of the manner in which the reaction giving rise to the carbon monoxide takes place in the generator used. Carbon monoxide gas is generally produced by admitting pure oxygen within a mass of coke brought up to white heat, said coke being placed in a suitable generator equipped with means for insuring a continuous supply of coke without admitting air to the generator and without stopping the operation of the furnace.

However, the very high reaction temperatures used, give occurrence to a number of difficulties in the operation of these generators and also entail heavy maintenance costs due to the necessity of consequently renewing linings, nozzles, etc.

The heavy formation of slag in the furnace also entails the necessity of frequent removals, so that the operation of the furnace must be interrupted from time to time and a diminished output results.

In carrying out processes of manufacture heretofore known, it is customary to admit the oxygen gas to the nozzle directly as generated in a generating plant. The generating plant may be of any suitable type and may produce oxygen by the electrolytic process, or else it may preferably consist of an air liquefying apparatus in which oxygen gas may be isolated by fractional distillation.

Oxygen gas is thus admitted to the carbon monoxide generator at a pressure which is only slightly above the atmospheric, and as a result the temperature of combustion within the generator, although high, is not high enough to sublime the entire ash contents of the coke; so that as stated, a heavy formation of slag results.

My process is based upon the fact that if oxygen is supplied to the generator through a narrow nozzle, at a relatively high velocity resulting from the fact that the oxygen is previously submitted to the action of pressure, the ensuing reaction which may be compared to that taking place in a welding or cutting burner, occurs very energetically, producing a very high temperature which is however, localized and therefore does not affect the furnace linings.

At the same time, the reaction temperature is such that with a normal composition of the coke, the entire ash becomes sublimed and is carried away with the gas, no sintered or molten slag remaining in the generator. This feature constitutes a very material advantage over methods and apparatus heretofore in use, because by virtue of the same the necessity of removing slag is entirely eliminated.

The primary object of the present invention is to provide a novel and improved apparatus for the manufacture of carbon monoxide gas, whereby a gas having a high degree of purity can be produced at relatively low cost.

Another object is to provide an apparatus of the character specified whereby the production of gas having a high degree of purity may be uninterruptedly maintained for considerable periods.

A further object of the invention is to provide in apparatus for the manufacture of carbon monoxide, means for delivering the oxygen gas to the carbon monoxide generator at a suitable relatively high pressure, such as will result in the production of localized extremely high temperatures within said generator.

A still further object is to provide, in apparatus for the manufacture of carbon monoxide, means for compressing and delivering to the generator oxygen gas under a suitable pressure, means being also provided for adjusting said pressure and maintaining it at a predetermined relatively uniform degree.

Other objects and advantages of the present invention will more fully appear as the description proceeds and will be set forth and claimed in the appended claims.

An apparatus embodying my invention is illustrated by way of example in the accompanying drawings in which:

Fig. 1 is a diagrammatic plan of a plant for carrying out my invention; and

Fig. 2 is a view in elevation partly sectioned of a type of generator which may be used in connection with my invention.

My process is carried out in a wrought iron generator which is maintained at a relatively low temperature by water cooling. The generator is first charged with a small amount of charcoal on top of which coke is added. The fuel is then ignited and the generator manhole is closed, after which pure oxygen is supplied through a nozzle so that it will react with the carbon content in the coke producing carbon monoxide gas. The charging of the generator is done from the top by a special charging apparatus which makes it possible to supply additional coke from time to time without stopping the process. The oxygen supply should be well regulated because if the supply is too abundant, carbon dioxide might be produced together with carbon monoxide.

The amount of the filling charge depends on the gas temperature. With a generator burned low, the gas temperature should not exceed 130° Celsius but under normal conditions of operation the temperature should be about 60 to 70° Celsius. The oxygen pressure can be regulated automatically as will be understood. The dimensions of the generator may be very small in comparison with the output, therefore the cost of the apparatus is proportionately low.

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Referring to Fig. 1, 10 designates a source of supply of oxygen gas, for instance, a gas tank or a distillation column of an air liquefying plant, and 11, 11' designated two generators which may be selectively or collectively connected to said source of supply. Between the source of supply 10 and generators 11, 11', is interposed a compressor 12, which is connected to the source of supply by a suction line 13 and to the generators by a delivery line 14. At a certain point 15, the delivery line 14 is split into two branch lines 16, 17 leading to generators 11, 11', respectively, said branch lines being controlled by valves 18, 19.

The compressor which is driven in any suitable manner, for instance by means of an electric motor 20, withdraws oxygen gas from the source of supply 10 and compresses it, delivering it under pressure to the generators, as will be understood. The pressure at which the oxygen gas is thus delivered is not less than one-half atmosphere and may reach in practice up to 5-7 atmospheres, because with the increased pressure, the yield of the generator or generators will be increased.

The pressure at which the oxygen gas is delivered can be regulated and maintained by means of a pressure relief valve 21, which is inserted at some point along the delivery line 14 and which is preferably connected by a return line 22, to the source of supply 10.

By virtue of this arrangement, if the pressure of the oxygen gas delivered by the compressor is higher than that for which the relief valve 21 is set, this pressure is reduced accordingly, and the excess oxygen is returned to the source of supply through line 22.

As stated, through the concentration of the flame in the cutting arc, such high temperatures are produced that the ash evaporates and is sublimed and carried away with the gases, these being produced at a pressure sufficient to thus carry away the sublimed ash in its entirety.

As the gas leaves the generator it is conveyed to one of the units of a specially constructed two unit filter in which the ash and flue dust admixed with the gas are retained.

For instance, in the drawing it is seen that the generator 11 is connected at one side to a filter unit 23, by a pipe line 24 controlled by a valve 25, and is similarly connected at the other side with a filter unit 23' by a pipe line 24' controlled by a valve 25'. One of the filter units is always connected with the generator while the other one is disconnected. As soon as the connected unit is filled with ash and flue dust, the gas supply is switched to the other unit.

In this manner, the operation is not interrupted and the first filter unit may be cleaned at once and made ready for the next step.

In a similar manner generator 11' is connected at one side to a filter unit 26 by a pipe line 27, controlled by a valve 28 and is connected at the opposite side ~~max~~ to another filter unit 26' by a pipe line 27', controlled by a valve 28'. The exhaust outlets of filter units 23, 26 are connected in parallel by a common pipe line 29 to a receiver 30 which delivers the filtered gas to a prepurifier 31.

This apparatus consists of a tower provided with several compartments; the carbon monoxide gas enters this tower at the bottom, travels through the different compartments and leaves it at the top after having been freed of the greater part of the impurities, such as the small amount of dust which may have been carried past the filter and the sulphur and other constituents of the gas.

In a similar manner, the exhaust outlets of filter units 23', 26' are connected in parallel by a common line 29' to a receiver 30' which in its turn delivers the filtered gas to a prepurifier 31'.

Upon leaving the prepurifier, the gas is subjected to an after purification process and therefore the outlets 32, 32' of the prepurifiers are connected by a common line 33 to the afterpurifier 34. The gas entirely purified and absolutely free from dust issuing from the afterpurifier is led to a dry cleaner 36, and the dry gas can then directly be used for the production of formates in autoclaves together with caustic soda for the further production of formic acid by subsequent treatment with sulphuric acid, or else the gas may be stored in a storage tank and later used for the manufacture of formic acid, acetic anhydride, or phosgene.

It will be observed that the continuity of the operation can be maintained for long periods because although only one afterpurifier and one dry cleaner are used, the gas generated in either or both can be switches from one filtering and prepurifying group to the other.

The generator itself, shown in Fig. 2, is of a well known type, and consists of a wrought iron structure comprising a combustion chamber 37 surrounded by a cooling jacket 38 supplemented by a cooling water tank 39 underneath the bottom of the combustion chamber. The combustion chamber extends upwardly to form a funnel like structure terminating at the top with a charging hopper 40 through which the fuel charge may be introduced. The hopper is separated from the top of the combustion chamber by two vertically spaced slide valves 41, 42, separated by an intermediate chamber 43. At the top of the combustion chamber are provided two diametrally opposed gas outlets 44, 45 which are connected to filters 23, 23', by pipe lines 24, 24' controlled by valves 25, 25' as previously stated. A relief outlet 46 controlled by a valve 47 is also provided for each line 24, 24', 27, 27'. One or more manholes 48 may be provided through the side of the combustion chamber for the purpose of cleaning and inspection, also for starting the operation of the generator. The temperature of the gas issuing from the generator may be checked from time to time by means of a thermometer installed in each gas discharge line.

The oxygen gas under pressure flowing through line 16 controlled by valve 18 is admitted to the nozzle 50 which extends vertically through the water tank 39 and has its tip opening at the bottom of the combustion chamber. The action of the nozzle may be controlled in the usual manner by means of a valve operated by a hand wheel 51 or in any other suitable manner.

Carbon monoxide produced by means of the apparatus described has a degree of purity as high as 98-99% and never lower than 96% according to the kind of coke used as against a purity of 90-92% obtained by other processes.

The following is a typical test report on runs made according to my process in an apparatus of the type described.

Time of operation:- 30 and 50 hours.

Analysis of the Coke used:-	I:	II:-
Water	4.0%	1.3%
Ash	8.0%	8.2%
Carbon	85.9%	88.4%
Residual Gas	1.5%	1.8%

The Residual Gas contained with #I:- 31.1 vol% H and 2.5 vol% CH_4
#II:- 30.6 " " " 1.5 " "

Sizes of the Coke used.....1.4 - 2.4 inch

Composition of the CO-Gas produced:-

CO....98.5%, CO2..... -.5%, H2.... -.9% O2..... --.--

Coke Consumption K/g per hour	O2-Consumption cbm/p.hour	Pressure Atm.	Temperature of the CO-Gases (Exit)
27	22.5	1.6 - 2	60 - 130 Deg C
30	25.2	"	" - " "
35	29.4	"	- " "

Dust Content of Gases when leaving the Generator....36 g/cbm
Dust Content of the Gases after purification..... nil
Analysis of the dust:- C....14.80%, SiO2...34.08%, Fe2O3..15.60%, Al2O3..16.12%
CaO..9.79%, MgO...3.02%, S....6.60%

These satisfactory results are mainly due to the novel arrangement of carbon monoxide generating and purifying plant, described in combination with means for delivering to the generator oxygen under pressure from a suitable source of supply. It is obvious that the structural details of the apparatus and its general arrangement may vary to a certain extent from those shown without departing from the inventive idea; the drawings will therefore be understood as being intended for illustrative purposes only and not in a limiting sense. Accordingly, I reserve the right to carry my invention into practice in all those ways and manners which may enter, fairly, into the scope of the appended claims.

I claim:-

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1. - In apparatus of the class described, the combination, with an oxygen source of supply, and a carbon monoxide generator provided with a combustion chamber and a nozzle leading thereto, of means interposed between said source of supply and said nozzle, for withdrawing oxygen from said source of supply, compressing it, and supplying it under pressure to said nozzle.

2. - In apparatus of the class described, the combination, with an oxygen source of supply, and a carbon monoxide generator provided with a combustion chamber and a nozzle leading thereto, of means interposed between said source of supply and said nozzle, for withdrawing oxygen from said source of supply, compressing it, and supplying it under pressure to said nozzle, and means for regulating the pressure at which said oxygen is so supplied to said nozzle.

3. - In apparatus of the class described, the combination, with an oxygen source of supply, and a carbon monoxide generator provided with a combustion chamber and a nozzle leading thereto, of means interposed between said source of supply and said nozzle, for withdrawing oxygen from said source of supply, compressing it, and supplying it under pressure to said nozzle, and means automatically regulating the pressure at which said oxygen is so supplied to said nozzle.

4. - In apparatus of the class described, the combination, with an oxygen source of supply, and a carbon monoxide generator provided with a combustion chamber and a nozzle leading thereto, of means interposed between said source of supply and said nozzle, for withdrawing oxygen from said source of supply, compressing it, and supplying it to said nozzle at a predetermined pressure, and a relief valve preventing said pressure from exceeding a predetermined maximum value.

5. - Apparatus for the manufacture of carbon monoxide, comprising an oxygen source of supply, a generator provided with a combustion chamber and a nozzle leading thereto, and a compressor interposed between said source of supply and said nozzle.

6. - Apparatus for the manufacture of carbon monoxide, comprising an oxygen source of supply, a generator provided with a combustion chamber and a nozzle leading thereto, a compressor interposed between said source of supply and said nozzle, and means for regulating the pressure at which said oxygen is delivered by said compressor.

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7. - Apparatus for the manufacture of carbon monoxide, comprising an oxygen source of supply, a generator provided with a combustion chamber and a nozzle leading thereto, a compressor interposed between said source of supply and said nozzle, and means for regulating the pressure at which said oxygen is delivered by said compressor, and for returning the excess oxygen to said source of supply.

8. - Apparatus for the manufacture of carbon monoxide, comprising an oxygen source of supply, a generator provided with a combustion chamber and a nozzle leading thereto, a compressor interposed between said source of supply and said nozzle, and a relief valve interposed between the delivery end of said compressor and said source of supply.

9. - Apparatus for the manufacture of carbon monoxide, comprising an oxygen source of supply, a generator provided with a combustion chamber and a nozzle leading thereto, a compressor interposed between said source of supply and said nozzle, and means for filtering and purifying the gas generated in said generator.

10. - Apparatus for the manufacture of carbon monoxide, comprising an oxygen source of supply, a generator provided with a combustion chamber and a nozzle leading thereto, a compressor interposed between said source of supply and said nozzle, means for regulating the pressure at which said oxygen is delivered by said compressor, and means for filtering and purifying the gas generated in said generator.

11. - Apparatus for the manufacture of carbon monoxide, comprising an oxygen source of supply, a generator provided with a combustion chamber and a nozzle leading thereto, a compressor interposed between said source of supply and said nozzle, means for regulating the pressure at which said oxygen is delivered by said compressor, and for returning the excess oxygen to said source of supply and means for filtering and purifying the gas generated in said generator.

12. - Apparatus for the manufacture of carbon monoxide, comprising an oxygen source of supply, a generator provided with a combustion chamber and a nozzle leading thereto, a compressor interposed between said source of supply and said nozzle, means for receiving and purifying the gas generated in said generator, and a filter interposed between said generator and said receiving and purifying means.

13. - Apparatus for the manufacture of carbon monoxide, comprising an oxygen source of supply, a generator provided with a combustion chamber and a nozzle leading thereto, a compressor interposed between said source of supply and said nozzle, means for regulating the pressure at which said oxygen is delivered by said compressor, means for receiving and purifying the gas generated in said generator, and a filter interposed between said generator and said receiving and purifying means.

14. - Apparatus for the manufacture of carbon monoxide, comprising an oxygen source of supply, a generator provided with a combustion chamber and a nozzle leading thereto, a compressor interposed between said source of supply and said nozzle, a relief valve interposed between the delivery end of said compressor and said source of supply, means for receiving and purifying the gas generated in said generator, and a filter interposed between said generator and said receiving and purifying means.

15. - Apparatus for the manufacture of carbon monoxide, comprising an oxygen source of supply, a generator provided with a combustion chamber and a nozzle leading thereto, a compressor interposed between said source of supply and said nozzle, a filter connected to said generator, a prepurifier, an afterpurifier, and a receiver interposed between said filter and said prepurifier.

16. - Apparatus for the manufacture of carbon monoxide, comprising an oxygen source of supply, a generator provided with a combustion chamber and a nozzle leading thereto, a compressor interposed between said source of supply and said nozzle, a filter connected to said generator, a prepurifier, an afterpurifier, a dry cleaner, and a receiver interposed between said filter and said prepurifier.

17. - Apparatus for the manufacture of carbon monoxide, comprising an oxygen source of supply, a generator provided with a combustion chamber and a nozzle leading thereto, a compressor interposed between said source of supply and said nozzle, means for regulating the pressure at which said oxygen is delivered by said compressor, a filter connected to said generator, a prepurifier, an afterpurifier, and a receiver interposed between said filter and said prepurifier.

18. - Apparatus for the manufacture of carbon monoxide, comprising an oxygen source of supply, a generator provided with a combustion chamber and a nozzle leading thereto, a compressor interposed between said source of supply and said nozzle, means automatically regulating the pressure at which said oxygen is supplied to said nozzle, a filter connected to said generator, a prepurifier, an afterpurifier, and a receiver interposed between said filter and said prepurifier.

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19. - Apparatus for the manufacture of carbon monoxide, comprising an oxygen source of supply, a generator provided with a combustion chamber and a nozzle leading thereto, a compressor interposed between said source of supply and said nozzle, means automatically regulating the pressure at which said oxygen is supplied to said nozzle, a filter connected to said generator, a prepurifier, an afterpurifier, a dry cleaner, and a receiver interposed between said filter and said prepurifier.

20. - Apparatus for the manufacture of carbon monoxide, comprising an oxygen source of supply, a generator provided with a combustion chamber and a nozzle leading thereto, a compressor interposed between said source of supply and said nozzle, a relief valve interposed between the delivery end of said compressor and said source of supply, a filter connected to said generator, a prepurifier, an afterpurifier, a dry cleaner, and a receiver interposed between said filter and said prepurifier.

× Philipp Schilling

...s. for the Manufacture of Carbon Monoxide.

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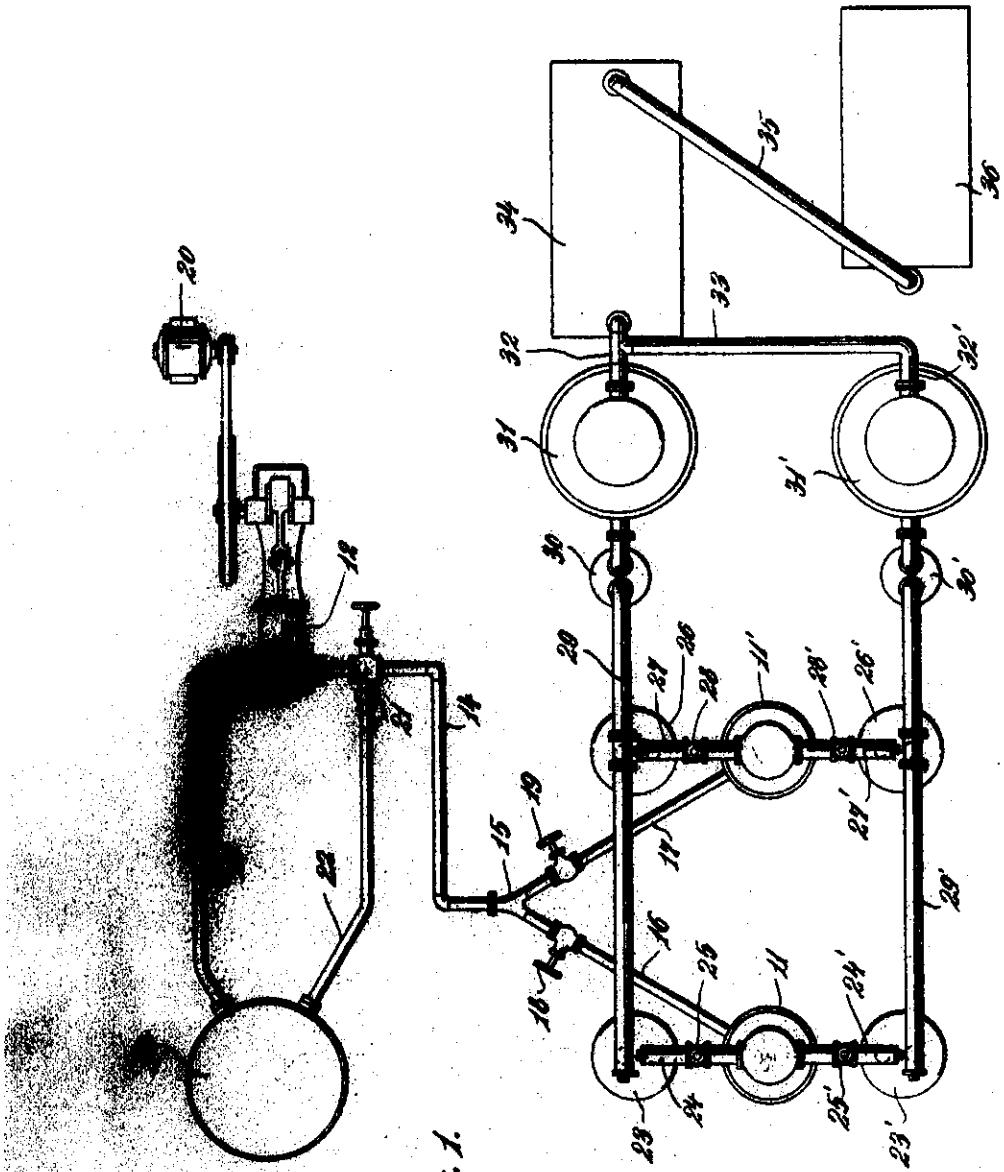

Fig. 1.

Certified to be the drawing referred to in the specification hereunto annexed.

New York, N. Y., U.S.A. January 28 1930

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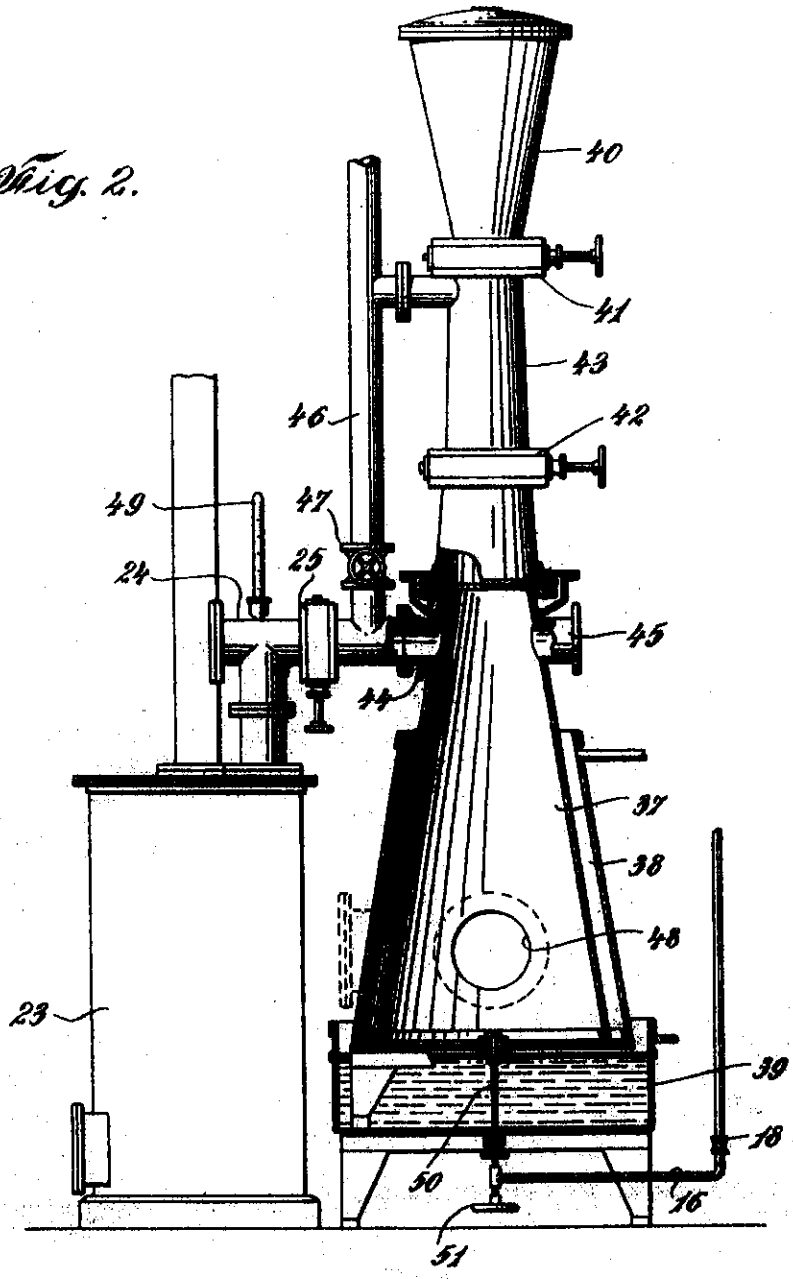
Fig. 2.



INVENTOR

Certified to be the drawing referred to in the specification hereunto annexed.

Philipp Schilling

by Guido W. Tesch

New York, N.Y., U.S.A., January 28 1930

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