

## PATENT SPECIFICATION



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## COMPLETE SPECIFICATION.

## Improvements in or relating to Portable Gas Producers.

I, JEAN GOHIN, French citizen, of 35, Avenue de Paris, Choisy-le-Roi, Seine, France, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement :—

The invention relates to improvements in or relating to portable gas producers, more particularly adapted for use on heavy motor vehicles such as lorries, tractors and charabancs.

Such a producer should be light and strong, and it should be adapted for rapid ignition and starting. Further, it should be flexible in that it should respond immediately to the fuel demands of the engine for a wide variation of speed and torque. Other desiderata are automatic separation of ashes and clinker from the fuel, easy cleaning, and adaptability to any kind of fuel.

It has been proposed to reduce the weight and dimensions of producers for such applications by localising the fire zone in a small space, remote from the walls, since the ordinary type of producer with refractory lining and a large mass of hot fuel would be prohibitive in size and weight. The localisation was produced by injecting the air at high speed from a tuyere extending well into the bed of fuel, and by collecting the gas through a tube opposite the tuyere and also extending into the bed of fuel.

With such a producer, however, especially when the demand for gas is reduced from a high value, the tuyere nozzle is liable to fuse, and even with a constant demand it scales rapidly. This trouble has been met hitherto to some extent by making the tuyere very thick and heavy and by bringing the nozzle near the side of the producer casing. Even with these expedients it is necessary to confine the producer to use with fuel having a high moisture content/such as green wood.

In fixed producers that difficulty is overcome by the use of forge or cupola tuyeres which are completely water cooled, but such a solution is inapplicable for portable producers because of the excessive weight involved.

[Price 1s.]

According to the present invention the tuyere is effectively protected by providing it with a water cooled nozzle. This expedient makes it possible to adopt a variety of constructions, some of which are described in detail below. Moreover, any fuel may be used in such a producer, for example, charcoal, anthracite, coke, bituminous coal, lignite, green or dry wood, peat, briquettes.

More than one tuyere may be used, the air may be directed downwards or in an approximately horizontal direction, and the gas outlet may be through a single tube or preferably through a grate. In the case of fuel having a high content of volatile matter it is advantageous to use two tuyeres fairly near each other and a gas outlet between them. This constrains the volatile matter to pass through the fire zone, thus converting the hydrocarbons into fixed gases.

In some cases the water cooling system is a closed circuit system, a reservoir with fins serving to radiate the heat taken up at the nozzle. Preferably a non-freezing fluid is then used for cooling. In other cases the nozzle cooler acts as a steam generator, the steam being injected with the air or separately into the fire zone to produce a richer gas. It is advantageous then to interconnect the steam and air regulation to maintain the composition of the gas nearly constant.

Whatever variation of construction is adopted, however, high speed air injection is maintained, giving high local temperature and direct production of CO from the carbon in the fuel without an intermediate CO<sub>2</sub> stage, with fusing of the clinker, which flows away from the fire zone, and carrying off incombustible ash as dust in the gas current, from which it is separated at a suitable point.

The invention is illustrated by way of example in the accompanying drawings, in which figures 1, 2, 3 and 4 show different forms of producers in accordance with the present invention.

Figure 5 is a section on the line a—b (Fig. 4) of the annular reservoir.

Figure 6 shows a down-draught tuyere with its cooling arrangement.

Figure 7 shows a horizontal tuyere. Figures 8 and 9 show two tuyeres with removable nozzles in which one is a horizontal and the other a down-draught tuyere. Figure 10 shows an arrangement for automatically varying the proportion of steam to air. Figure 11 shows in elevation a producer provided with different improvements according to the invention. Figure 12 shows in detail the feed from the hydrator and water-vapour feed pipe through the heating chamber. Figure 13 is a modification of the method of introducing the water-vapour. Figure 14 is a modification of the arrangement allowing the use either of damp coal, wet or dry wood, lignite, etc. Figure 15 shows schematically an arrangement for maintaining the composition of the gas constant.

Figures 16 and 17 show two arrangements for separating the ashes and clinker by fusion, the grate being eliminated in the second case (small producers). Figures 18 and 19 show the forms of the isotherms as a function of the air speed, and Figures 20 and 21 show in section and plan respectively a producer more particularly for use with bituminous fuel.

Figures 1 and 2 show schematically two portable producers of the type according to the invention. They consist of a container C without a refractory lining and having usual charging orifices (their number and position being variable without departing from the spirit of the invention) and provided with a double bottom shaped as an inverted truncated cone, F. Underneath the outlet orifice is a fixed or movable grate G, for example, capable of oscillation about a shaft O or of suitable movement by any known arrangement.

The tuyere T in connection with the reservoir R blows down the axis of the orifice of the double bottom.

These two views differ only in respect of the position of the reservoir relative to the tuyere.

In Figure 3 are also shown the container C, double bottom F, movable grate G, and tuyere T. The reservoir R can hold a large volume of water; its position being concentric with the charging orifice, it assumes the shape of the container and is entirely within the latter.

This type of producer is particularly suitable for producing a mixed gas.

Cooling water is led to the tuyere nozzle by a tube  $t_1$  and circulates in the nozzle-ring c and returns through the tube  $t_2$  to the reservoir R owing solely to difference in density which exists between the ascending current of water mixed with vapour bubbles and the descending current. In proportion as the temperature

is raised at the tuyere nozzle, so the vapour formed there is greater in quantity and accumulates at the top of the reservoir R, the said vapour passing through a tube  $\theta$  to a point A in the tuyere T where it is mixed with the primary air. Communication between the reservoir R and the tuyere nozzle may also be obtained by a single tube as shown in Figure 4.

The proportioning of the water vapour in the primary air will be described later on.

The reservoir R is provided with a water gauge N which is easily seen by the operator so that he may see when it is necessary to supply water to the reservoir; a pipe and cock for this purpose would be placed within his reach.

Figure 4 shows an arrangement particularly suitable in the case where steam is not employed; the reservoir R is concentric with the charging orifice and is entirely screened from radiation from the fire zone, and further to assist cooling, fins increasing the surface of contact with the outside air are provided as shown in Figure 5. Figure 6 is a view of a down-draught tuyere of which the nozzle B is in the form of a ring; this ring is connected to the reservoir R, by pipes  $t_1$   $t_2$  the liquid entering  $t_1$  as shown by the arrow 1 and leaving  $t_2$  as shown by the arrow 2. The tube  $t_2$  penetrates a considerable distance into the reservoir R.

Further, any method of regulating can be used without departing from the spirit of the invention.

The reservoir R comprises a fusible plug D preventing abnormal rise in pressure.

Figure 7 shows a horizontal draught tuyere based on the same principle as that described above.

Figures 8 and 9 shown in section two tuyeres with removable nozzles of which one is for horizontal draught (Fig. 8) and the other for down-draught (Fig. 9) their construction is obvious from the figures without need of further explanation.

Figure 10 shows in detail the automatic control of the steam in relation to the air blown in. Air comes from the blower through the tuyere T by the path indicated by the arrows 4, 5; this produces a suction at the tube  $\theta$  where steam enters as shown by the arrow 3. A throttle valve  $r$  is arranged in an enlargement in the steam feed pipe; this enlargement A, open at its upper end, is placed at a constriction of the tuyere. The throttle permits of obtaining a regulation such that for a given discharge of air a proportional quantity of steam is taken; part of the steam passes through

the throttle, the excess going away through an opening arranged in the enlargement A. If the discharge of air varies, the suction in the chamber A also varies and the quantity of steam sucked in varies without the throttle being touched; the position of the throttle is set once and for all.

When the discharge of air ceases, there is no longer any draught in the chamber A and so the steam escapes into the atmosphere.

This arrangement is applied to the producer shown in Figure 3.

The heating surface of the generator, i.e., the surface of the tuyere in contact with the fire, is calculated so that the production of steam is sufficient for the greatest load. In fact, the greater the speed, the more intense is the fire, and thus the greater the production of steam, which avoids useless expenditure of water.

It should be noticed that for the tuyeres forming a steam generator, rain-water should be used and they should be provided with removable nozzles.

Over and above the general advantages set out at the beginning of the description, other advantages gained by using a tuyere forming a steam generator are:—

a) The gas is richer and burns better.  
b) The temperature is lower using mixed gas than using poor gas, and the producer is cooler.

c) The consumption of fuel is a little lower. The inconvenience of running with mixed gas in the customary manner, using injection of water by means of a drip feed which consists in the impossibility of effecting a good regulation of the discharge, is overcome. Actually the regulation is set once and for all, and takes place automatically because of injection of steam in quantity proportional to the air discharge. The producer G (Fig. 11) is a horizontal draught producer formed with a container without a refractory lining and provided with a cooled tuyere T of minimum size and weight. This tuyere T is in communication with a reservoir *r* for circulation of cooling water, the said reservoir being provided with fins and containing very little liquid (about a  $\frac{1}{2}$  litre for a tuyere of this type). The cooling liquid is a non-freezing liquid and may be, for example, water, to which is added glycerine or any other substance adapted to lower the freezing point sufficiently.

The reservoir *r* comprises a fluid-tight closure so as to prevent evaporation and thus rendering unnecessary any inspection or repair of the tuyere; it comprises a fusible plug, not shown, preventing

excess of pressure, such as may arise, for example, from the heating of the radiator with its fins by a flame.

The gas outlet is through a grate  $G_1$ , shaking or not; striking baffles *c* the gas gives up most of the dust it possesses. The baffles *c* are mounted upon a rod *a* so that they may be easily withdrawn, the grate may be fast with the baffles and withdrawn with them. The arrangement of the tuyere combined with the high speed of the current of air wholly avoids the formation of pockets. The heap of coal being consumed over a wide area at the bottom cannot therefore fail to fall. Moreover, owing to the grate being vertical, the sifting of fine particles of fuel is avoided; such sifting is produced by the vibration of the vehicle using a horizontal grate producer and prevents the use of very small coal or of briquettes, however coherent they may be, without heavy loss of fuel. A horizontal false grate slid over the tuyere to retain the superincumbent fuel allows the fused clinker to be easily removed. The distance between the air inlet and gas outlet being small the internal resistance in this producer is less than in other cases, which permits the use of slack which is not possible in most producers, not only on account of the loss through the horizontal grate but also on account of the excessive resistance caused by the thick layer of dust which the gases are obliged to traverse.

The producer may also be provided with what may conveniently be termed a small hydrator C (Fig. 12) automatically supplying water under suction from the engine or from a fan. This hydrator is similar in construction and operation to a carburetter.

Any change of conditions shows itself by a change of the partial vacuum D caused by the tuyere T; the discharge of water will be proportional to  $\sqrt{D}$  as also the discharge of air and consequently that of gas.

The automatic hydrator is thus in all ways comparable with an automatic carburetter for petrol which in fact it replaces; it has economic advantages over the carburetter which it is needless to explain.

The water may be introduced at different places, for example, it may simply be mixed with the air from the tuyere or vaporised by the heat of the gas and introduced either with the primary air at  $V_1$  (Fig. 13) or directly into the fire zone at  $V_2$  in countercurrent to the air injection as shown in Fig. 11.

In figures 11 and 12 the hydrator is at C; it is of constant level and is fed by

a water reservoir B, the water in this case under suction from the engine, comes down a pipe system S and circulates in the cooling chamber R in a direction

5 opposite to the gas from the producer.

A methodical contact is produced, the very hot gas meeting the superheated water which is almost in the state of a vapour whilst the gas already cooled is in  
10 contact with the water at ordinary temperature; the exchange of heat is thus effected in the most advantageous manner if the contact surface is multiplied by arranging the pipe system S as a coil or  
15 any other appropriate form.

At the end of this counter current progress the vaporised water is supplied to the fire zone  $V_2$  whilst the cooled gas enters a scrubber F comprising two stacks  
20 of filling material 3, 4. The scrubber is fed by a branch of the water circulation of the engine; for example, the water is sucked at the bottom of the radiator 2 by a pump 1 and driven to the layer  
25 3 of filling material; thence sucked by a pump 7 at the bottom of the scrubber through a filter 6 to be rid of impurities extracted from the gas and returned to the top of the radiator 2. The volume  
30 of the cylinder swept by the piston containing less heat with poor gas than with petrol, the radiator constructed for running with petrol suffices for cooling poor gas and absorbing the desired percentage of heat given out by the explosion.  
35

The gas after having traversed the layer 3 and met the atomised water, passes through the layer of filling material 4 which stops the finely divided water carried over mechanically.  
40

The gas leaves the scrubber at 5, it is then dry cool and free from impurities, that is to say, ready for use.

45 Although dry charcoal is the ideal fuel, for a producer made in accordance with this invention, it is advantageous to be able to use also at will damp coal, dry or green wood or even lignite peat, etc., but maintaining constant the CO  
50 content of the gas, a condition which is essential for the flexibility of the producer; it is only necessary for this purpose slightly to modify the producer as is shown in Fig. 14. Part of the gas flows  
55 (as shown by the arrows f) through the damp mass which gives up its volatile matter to the gas which is collected in a regular, homogeneous manner round the truncated cone 10.  
60

It is drawn by the ejector 13 through a condenser 11 which may be either a surface condenser as shown in the figure or a jet condenser fed by a branch of the  
65 sprinkler circuit of the washer above

described; and then enters a separator 12. The ejector 13 comprises the tuyere T of the type already described and a central pipe 14; under these conditions a suction is created at the end of the pipe 14  
70 which produces the gas current of which the discharge is controlled by means of a butterfly valve 15.

This arrangement may be used in the case of any producer with gas outlet at the bottom, to which it gives flexibility.  
75

Actually if in a producer which is not so furnished, damp coal, for example, be used, when the engine slows down the coal continues to give off an abundance of vapour which cools the hearth and increases unduly the  $CO_2$  content, the engine loses power and the control of air has to be constantly altered. With the arrangement which has been described  
80 nothing but dry coal ever arrives at the air tuyere; the content of CO and  $CO_2$  is constant, and the engine acquires an incomparable flexibility whatever be the degree of humidity of the fuel.  
85  
90

#### DIRECT PRODUCTION OF CO:

If the temperature of the hearth is relatively low, carbonic acid is formed which, giving up its heat to the layers of fuel which it traverses, raises them  
95 to a temperature sufficient partially to convert the  $CO_2$  to CO, according to the laws of equilibrium; if, however the speed of the air current striking the coal is large enough, at the point where the  
100 air contacts with the coal a very high temperature is produced and the formation of CO is instantaneous. However close to the air entry the gas is taken off, there is found in it practically only  
105 CO and nitrogen.

In order to start this phenomenon the speed of air should be much greater than that which suffices to maintain it in action. STARTING OF THE REACTION BY A HIGH  
110

#### PRESSURE FAN:

If it is desired to start the engine on petrol, the admission of air is reduced to obtain a speed sufficient for starting. When this is obtained, the partial  
115 vacuum at the tuyere is reduced to a minimum without passing such a value as will cause the reaction to stop.

The best method is to determine the limiting speed for maintenance of the  
120 reaction, then rigidly to couple the accelerator, the butterfly valve for secondary air and the valve needle for primary air in such a way that at no load this limiting air speed is exceeded by a small  
125 safety margin; this arrangement is shown in Figure 15, wherein T is the cooled tuyere, P a needle whose rod slides in a guide 4 and which is actuated by a screw V. 2 is the butterfly valve for  
130

secondary air and 3 the mixture admission valve or accelerator.

To start up, the needle P is actuated directly by the screw V, so as to diminish the section of the tuyere and to obtain the speed of air necessary to start the reaction of direct production of CO.

Owing to this arrangement constancy of the composition of the gas is obtained with a constant very small loss of charge. The clinker fuses and flows vertically downwards, leaving the fire zone which is more or less horizontal on account of the air jet being horizontal or only slightly inclined. The infusible ashes remain as dust, and are driven out by the gaseous current and deposited behind the vertical grate. The arrangement is shown in Figure 16. The fused clinker falls at 5. The ash dust is deposited at 6 behind the grate G<sub>1</sub>.

The horizontal grate must be eliminated since, in operation, a loss of fuel by sifting would ensue; a vertical or inclined grate therefore is used which may even be omitted in the case of small producers.

Figure 17 shows a small producer in which the grate is omitted. The fused clinker falls at 5 as before, but the infusible ashes collect as shown at 6<sup>1</sup> where there is an abrupt change of velocity. The ashes are shaken down to the base of the producer by the vibration of the vehicle, and must be cleared out more frequently than in the case of producers with a grate.

By this arrangement (Figs. 16 and 17), the producer can be used with slack which is practically useless in known producers.

Figures 18 and 19 show the form of the isotherms.

1) In running with CO<sub>2</sub> (slow air speed).

2) In running with CO (high air speed).

In the first case the producer becomes hot since the zone of fire is close to the walls; water escapes with the gas which is not cold. The coal, losing its water at the beginning, no longer contains sufficient and consequently it is necessary to add some to obtain a rich gas.

In the second case, the producer does not become hot; the dampness of the coal evaporates in proportion as the coal arrives at the narrow fire zone; the gas is given off dry and cold, and the walls, even when of unlined sheet metal, remain cold.

Figures 20 and 21 are respectively a section and plan of a producer more particularly adapted for use with bituminous fuel, the products of distillation before

reaching the outlet S are made to pass over a very high temperature zone where they are transformed into stable fixed gases.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. A portable gas producer adapted for localisation of the reaction zone away from the walls by means of air injection at high speed and having one or more tuyeres with water cooled nozzles.

2. A portable gas producer adapted for high speed injection through a tuyere with water cooled nozzle projecting a considerable distance into the mass of fuel.

3. A portable gas producer as claimed in claim 1 or 2 in which the volatile matter is constrained to pass through the fire zone.

4. A portable gas producer as claimed in claim 3 in which the gas outlet is situated adjacent to the air injection tuyere or tuyeres.

5. A portable gas producer as claimed in any of claims 1 to 4 in which the water cooling system of the nozzles is adapted to generate and supply steam to the producer.

6. A portable gas producer as claimed in claims 1 to 4 in which the nozzle cooling system is a closed circulation system with non-freezing cooling fluid.

7. A portable gas producer as claimed in claim 6 in which the water cooling system comprises a small reservoir with heat-radiating fins.

8. A portable gas producer as claimed in claims 1 to 5 comprising a hydrator or motor carburetter adapted to mix water automatically with the air supply.

9. A portable gas producer as claimed in claims 1 to 5 in which steam is drawn into the tuyere in proportion to the amount of air passing by means of the reduction of pressure caused by a constriction of the tuyere.

10. A portable gas producer as claimed in any of claims 1 to 5, in which water is injected into the fire zone in a spray counter-current to the air injection.

11. A portable gas producer as claimed in any of the preceding claims comprising a scrubber fed from a branch of the engine cooling system.

12. A portable gas producer as claimed in any of the preceding claims comprising an arrangement for obtaining uniform composition of gas by interconnecting the accelerator, the secondary air shutter and primary air valve, substantially as described.

13. A portable gas producer as claimed in any of the preceding claims comprising means substantially as described for eliminating clinker by fusion and infusible ash by entrainment in the gas supply.

14. A portable gas producer as claimed in any of the preceding claims in which the grate is dispensed with.

15. Portable gas producers constructed,

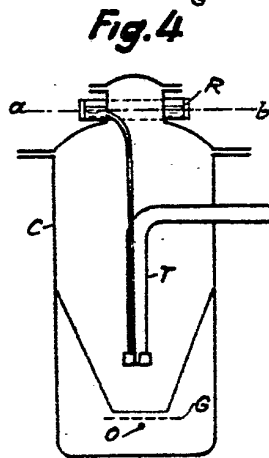
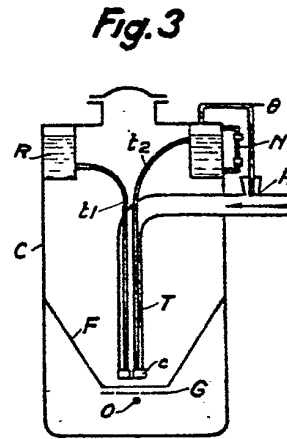
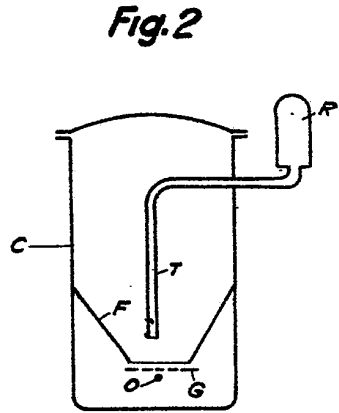
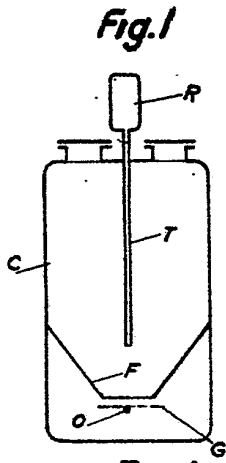
operating and arranged substantially as described with reference to the accompanying drawings.

Dated the 8th day of February, 1929.  
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W.C. 2.

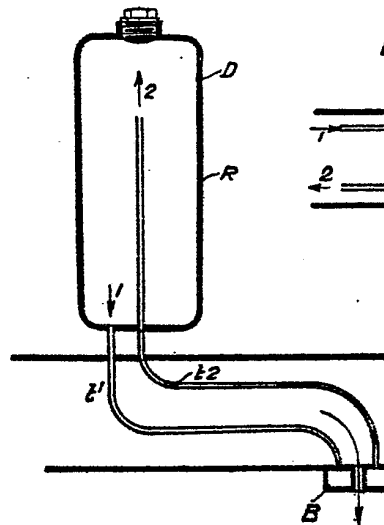
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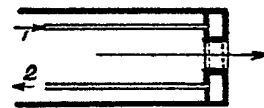
[This Drawing is a reproduction of the Original on a reduced scale.]



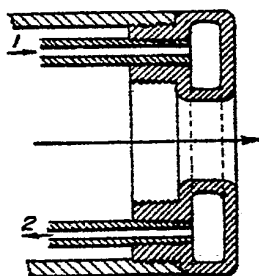
**Fig.6**



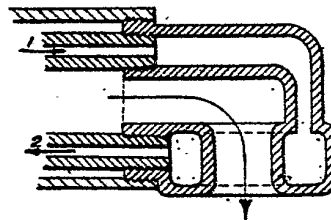
**Fig.7**



**Fig.8**



**Fig.9**



**Fig.10**

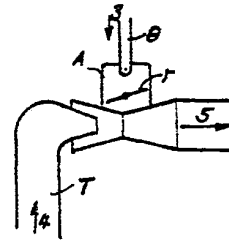


Fig. 11

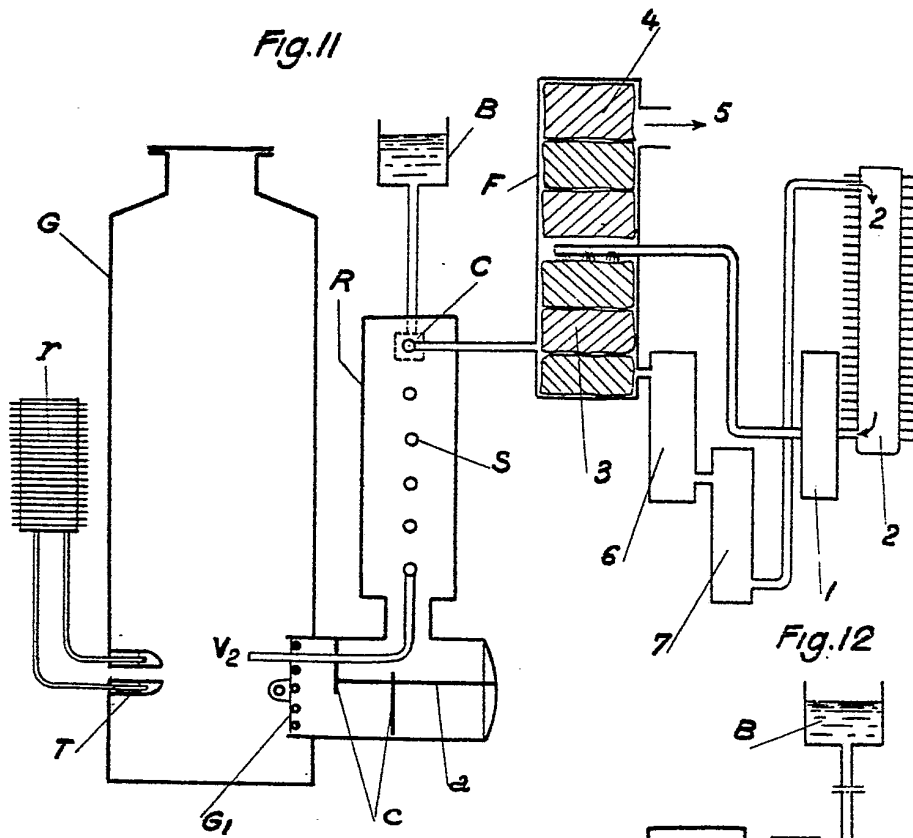


Fig. 12

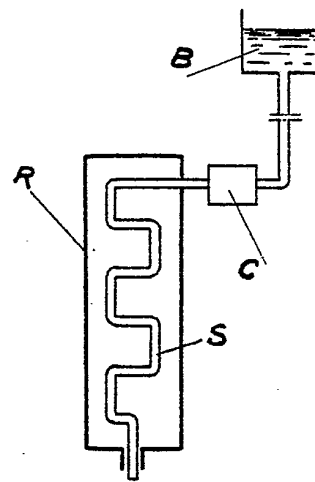


Fig. 14

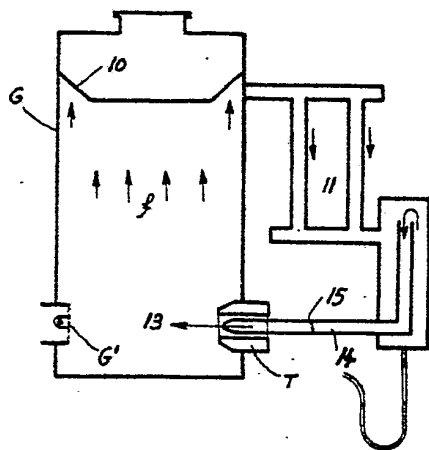
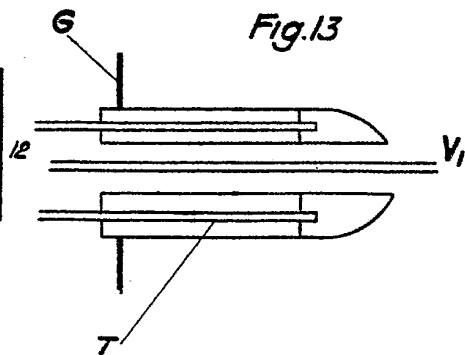
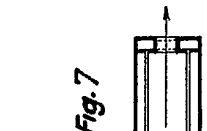
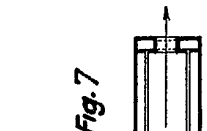
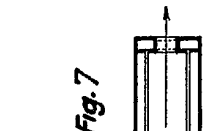
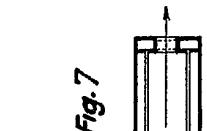
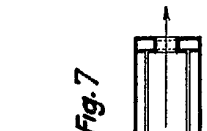
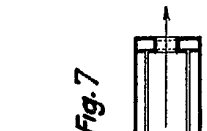
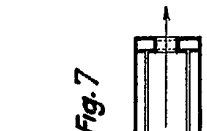
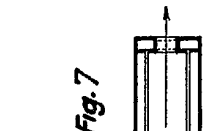
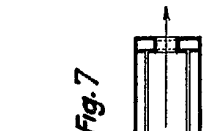
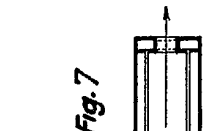
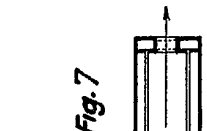
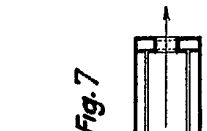
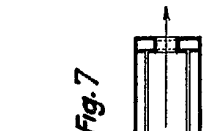
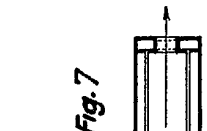
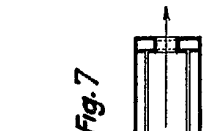
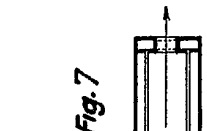
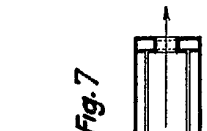
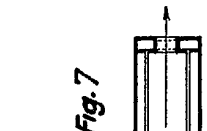
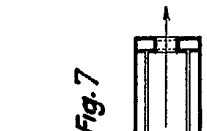
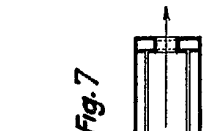
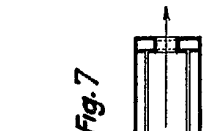
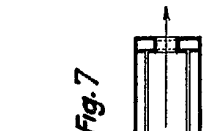
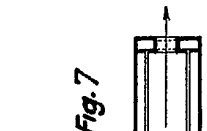
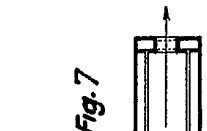
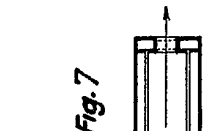
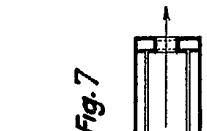
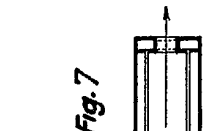
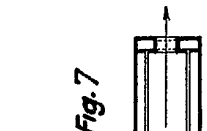
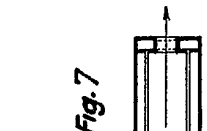
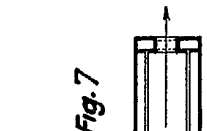
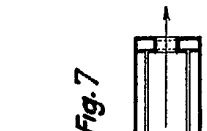
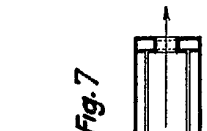
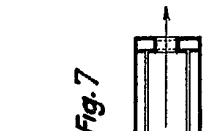
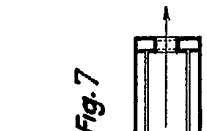
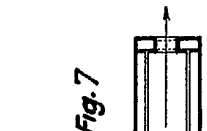
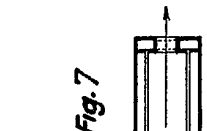
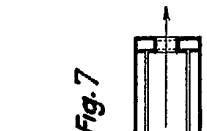
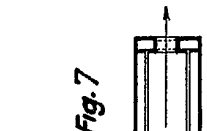
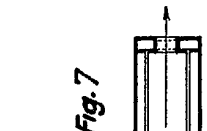
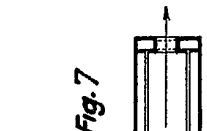
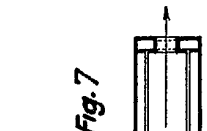
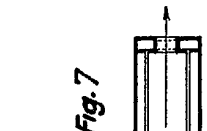
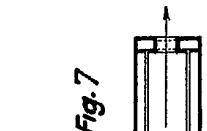
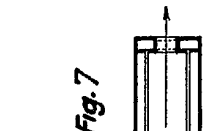
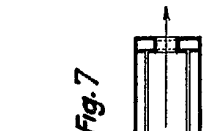
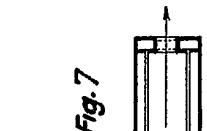
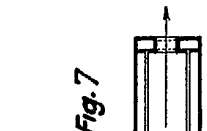
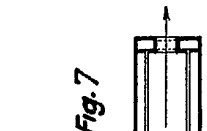
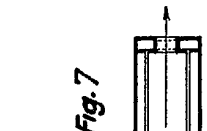
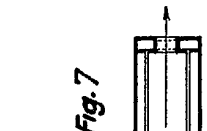
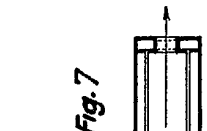
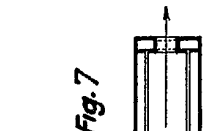
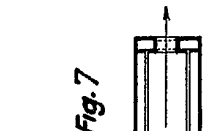
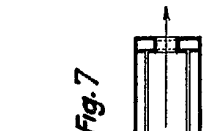
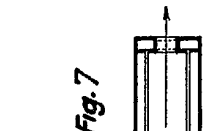
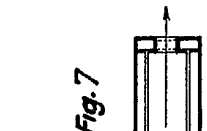
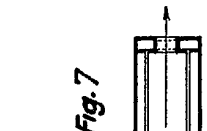
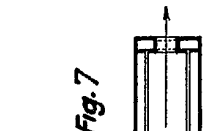
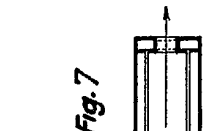
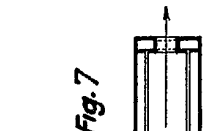
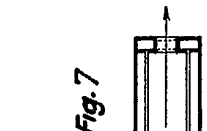
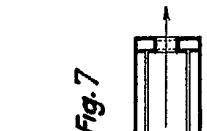
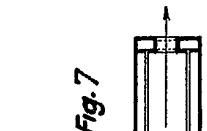
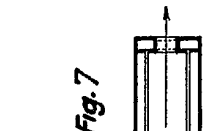
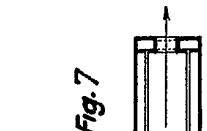
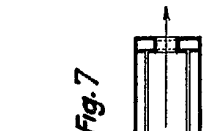
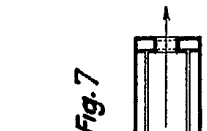
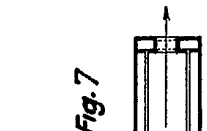
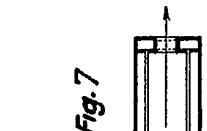
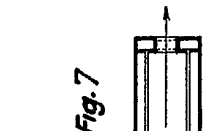
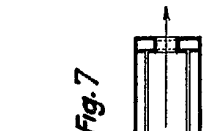
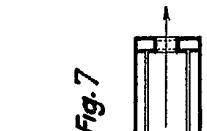
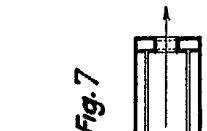
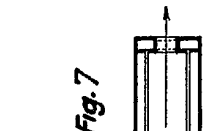
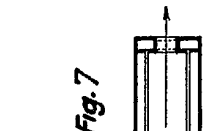
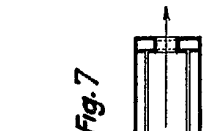
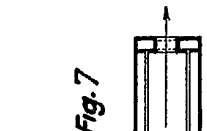
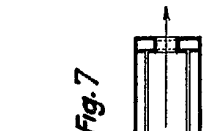
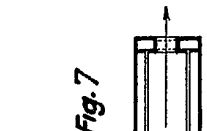
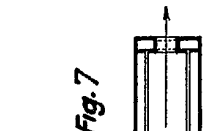
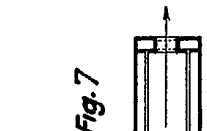
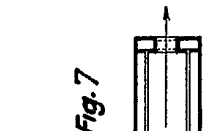
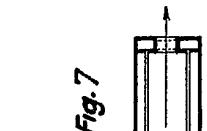
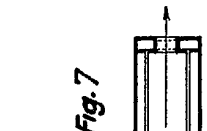
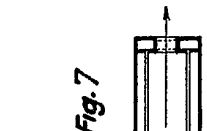
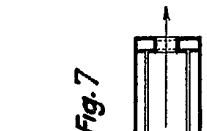
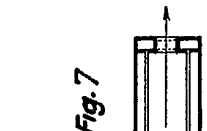
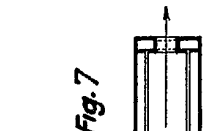
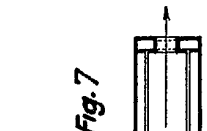
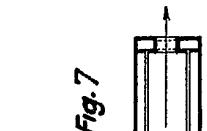
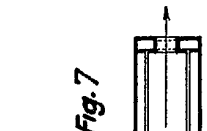
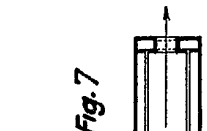
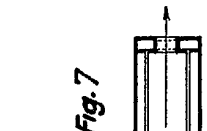
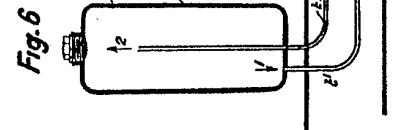
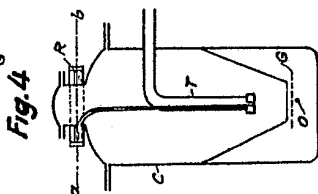
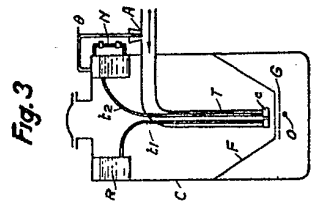
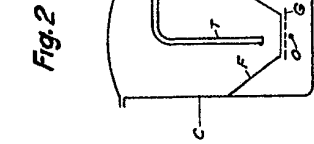
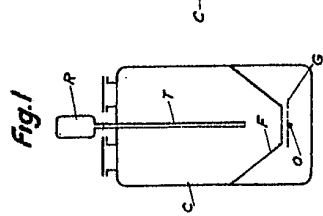


Fig. 13







2<sup>nd</sup> Edition

[This Drawing is a reproduction of the Original on a reduced scale.]

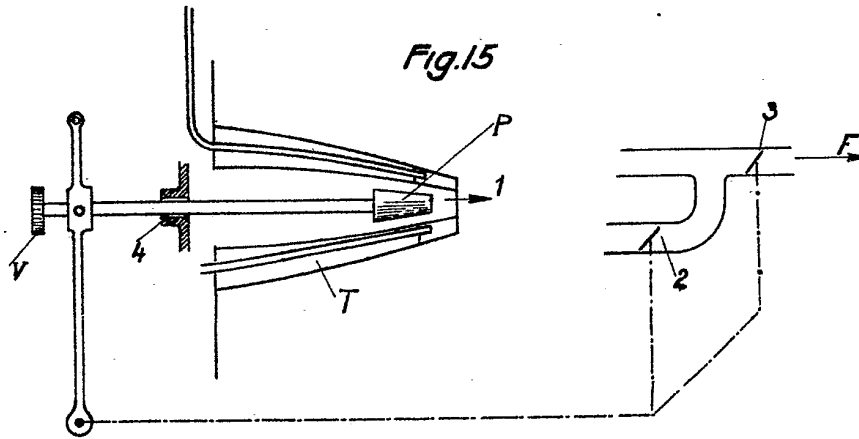


Fig. 16

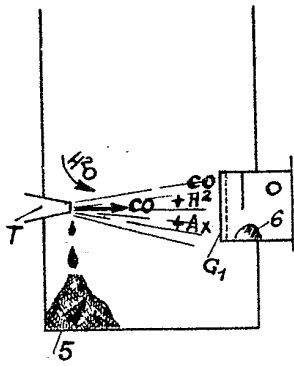


Fig. 17

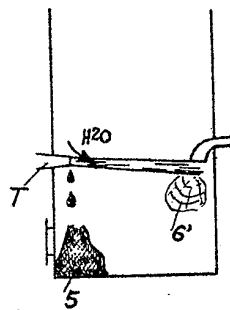


Fig. 20

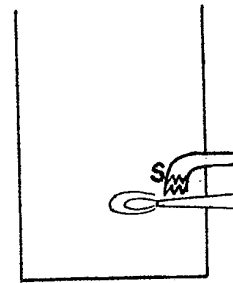


Fig. 18

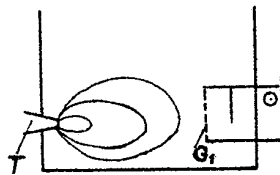


Fig. 19

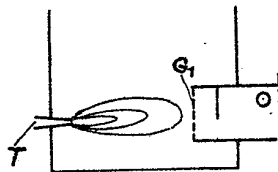


Fig. 21

