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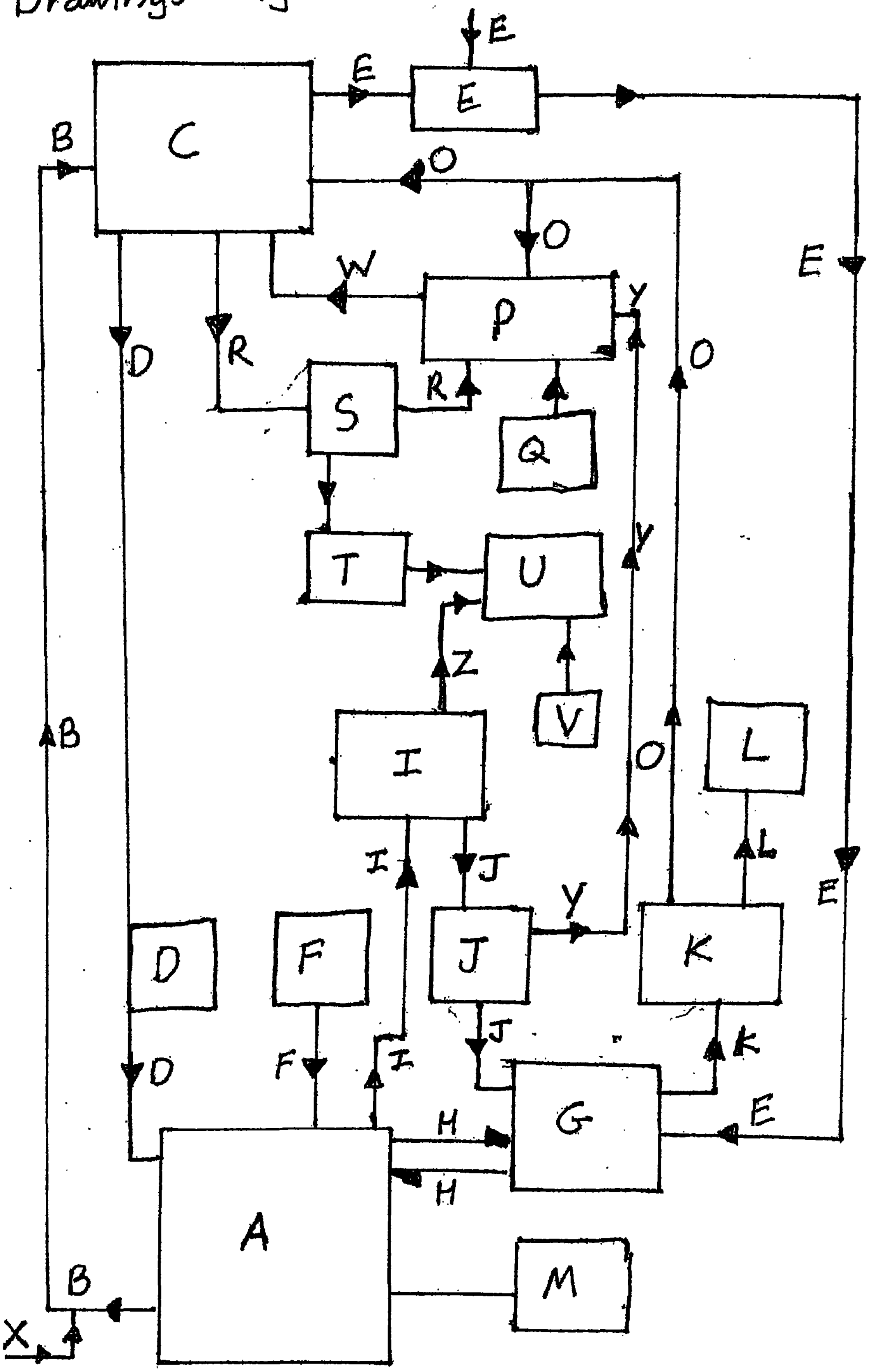
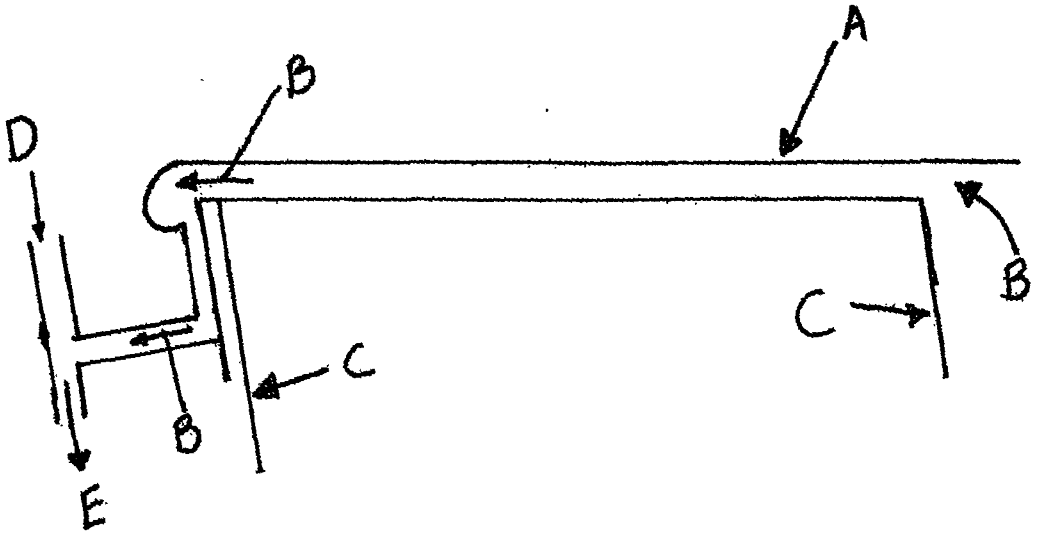
Drawings Figure 1

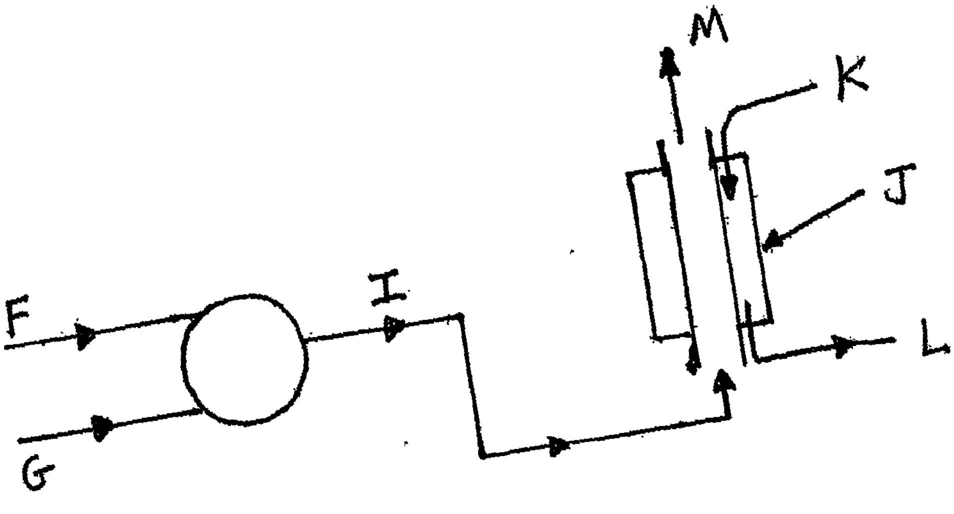


Drawings Figure 2

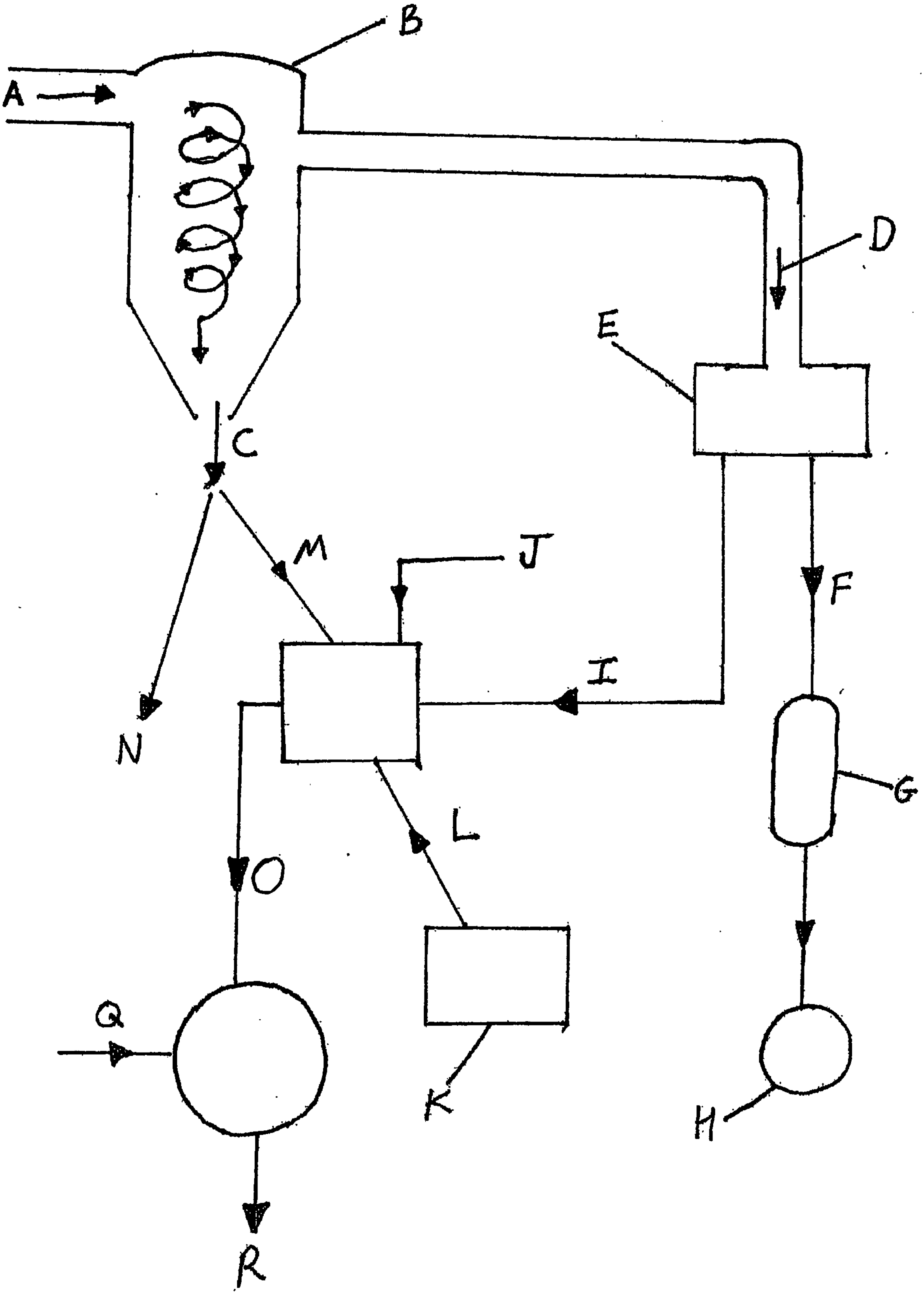
i)



ii)

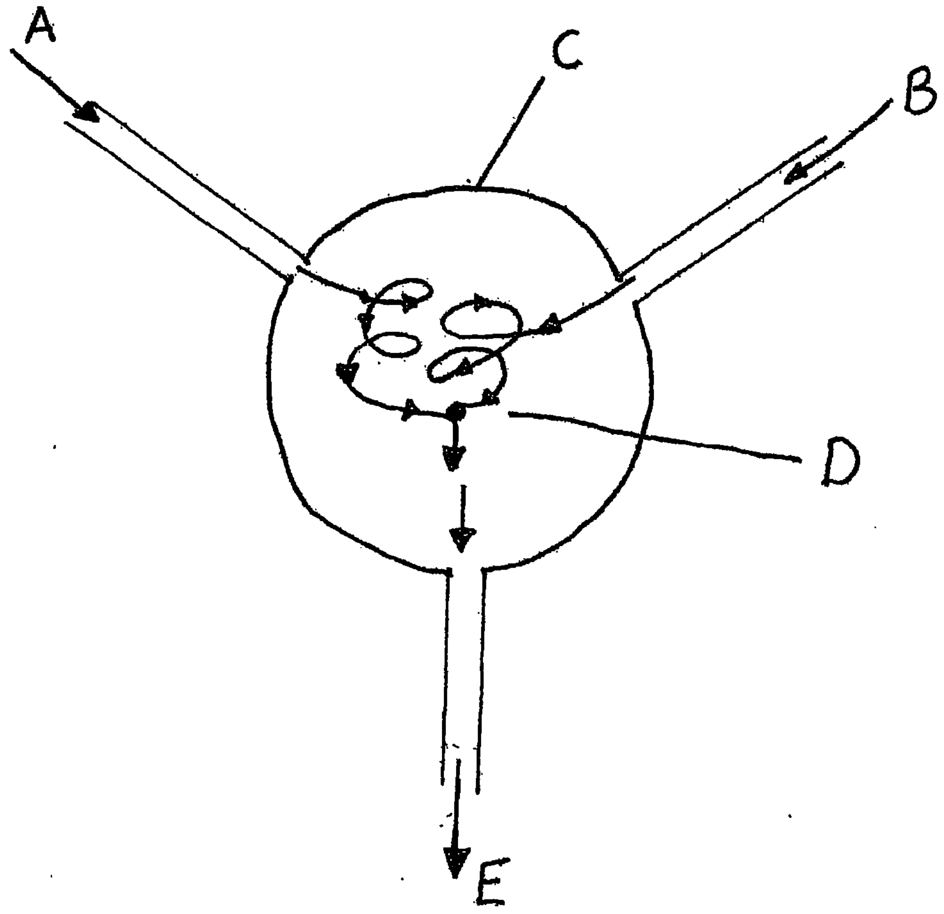


Drawings Figure 3



Drawings Figure 4

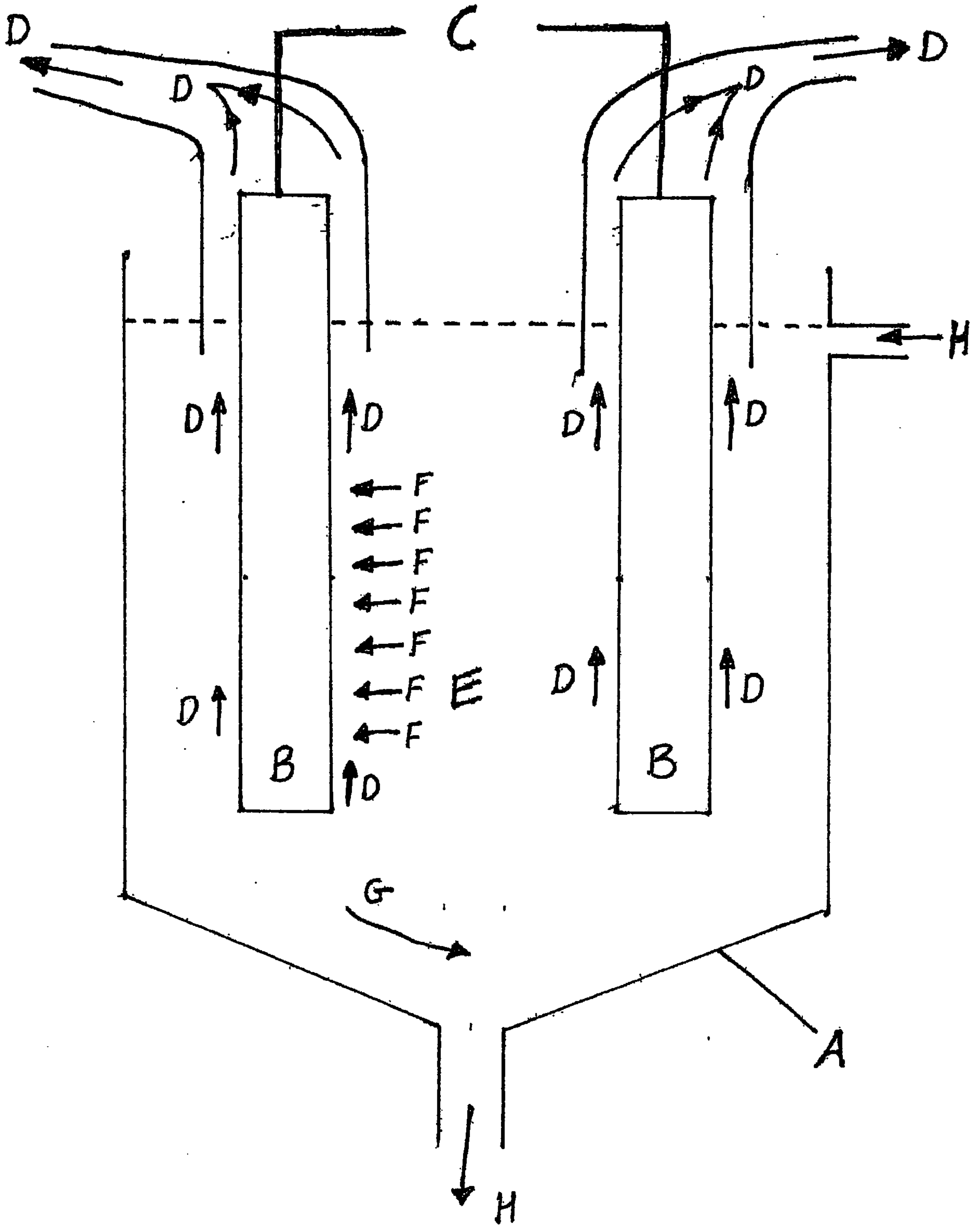
i)



ii)

$$CO_2 + 4H_2 \longrightarrow CH_4 + 2H_2O$$

Drawings Figure 5



Title: A system design of an efficient power generation plant

Introduction and brief description:

Power stations that generate electricity use fuels that are burnt or use nuclear fission reactions to raise steam to power turbines that then power generators which supply the electricity distribution networks and electricity user. They can however be inefficient in terms of energy used to make electricity in ways such as inefficient burning, heat energy conservation, end by products and electricity losses through distribution distance from end user. In the case of nuclear end products are radioactive and of long toxic duration. End products for fossil fuel and biomass are Carbon Dioxide and other pollution gases as well as ash/char. This system design invention of a new type of power station expresses a number of efficient processes and can convert Carbon Dioxide into useful by products such as $CaSO_4$ (Calcium Sulphate) a form of cement from $CaCO_3$ (Calcium Carbonate) or CH_4 (Methane) a gas that can be stored or burnt. These plants are designed to burn fossil fuels and biomass in ratios as yet undefined, but emits low or zero Carbon dioxide as this is used to make end products. These plants use an exterior renewable energy source such as solar, although wind and hydro power could be used, to power a water electrolysis bank that generates the gases Oxygen (O_2) and Hydrogen (H_2) from the disassociation of H_2O (water).The Oxygen is then used to increase combustion efficiency and the Hydrogen is used to react with CO_2 (Carbon dioxide) at a high temperature and pressure, in what is known as the Sabatier reaction to make CH_4 (Methane). No water cooling towers, a common feature of fuel burning plants would be required as this power generation plant would recover heat to re-use and in using the Sabatier process to make Methane and also make water (H_2O) to help with water use on site .

Introduction to Drawings:

Drawings Figure 1: A schematic drawing showing the flows of electricity and gases and end by product choices within the power station components.

Key

A=Power station building containing furnace/burners/boiler, turbine/engine and electrical generators and possibly other components in schematic diagram.

B=Electricity generated from solar cell on roof of building A or from Solar array supplemented or replaced from flow X.

C=Water electrolysis bank containing a group of electrolysis cells that when energised by passing a controlled electrical current between two electrodes immersed in water (H_2O) or water with a salt solution known as an electrolyte ,in this case a solution containing $CaCO_3$and in operation can produce Oxygen and Hydrogen gases from the dissociation of the water molecule. Also creating solid/small particles of solid Calcium Carbonate removed from specified electrodes via a method not shown in application or drawings to flow in route R.

D=Oxygen (O_2) gas, Oxygen store from water electrolysis to feed furnace/burners to increase combustion efficiency

E=Hydrogen (H_2) gas, Hydrogen store from water electrolysis or from an external source to feed item G which is Sabatier gas reaction chamber

F=Fuel (biomass/fossil fuel) and air blown into the furnace /burner/boiler in item A and recovered heat from parts of item K and solar cell roof and possible other items in the process

G=Gas reaction chamber in which Hydrogen and Carbon dioxide from route/item J are mixed together at controlled temperatures and pressures and inputs to facilitate the Sabatier reaction, heat being provided from flow H which is steam from the boilers although heat could be from another source.

H=Controlled steam raised from combustion of fuel in furnace/burners/boiler and returned back to steam circuit, after heating Sabatier reaction chamber.

Drawings continued
Figure 1 key continued

I=Combustion products Char/ash and gases in flue, post combustion in furnace/burner/boiler and separation of ash/char (which can be collected separately as they are) and non-Carbon dioxide gases to process via route Z and Carbon Dioxide gas via route/item J.

J=Carbon dioxide gas and store being sent to item G to mix with Hydrogen at controlled temperatures and pressures and inputs.

K=outputs from item G consisting of reaction products of Methane (CH_4) and Water (H_2O) which are cooled and separated into route/item L Methane and Methane store, and exit to gas grid, and output route O for water which is sent to the water electrolysis bank C and Electrolyte processing in item P.

L=Methane route and store/exit to gas grid/user/end user.

M=Electricity to grid/user/end user produced by main generators, driven by steam turbines.

O=Water from gas reaction products separator K. To supply water for hydrolysis in water electrolysis bank item A and also to provide water for making and re constituting the electrolyte used. Treated external source of water could be used additionally (not shown in drawing figure 1)

P=Electrolyte making and circulation item for electrolysis cells made (in this case) by adding Calcium Oxide from Q in a controlled and measured way to water which then has Carbon Dioxide has been bubbled through it, to make an aqueous salt electrolyte of Calcium Carbonate ($CaCO_3$), which is the used as electrolyte in the water electrolysis cells via route W

Q=Calcium Oxide supply to add to water in a controlled and measured way in item P prior to Carbon Dioxide being bubbled through, to make a solution of Calcium Carbonate

R=Returning electrolyte containing spent electrolyte and small particles of solid Calcium Carbonate from specified electrodes in the water electrolysis bank of electrolysis cells.

Figure 1 key continued(Drawings continued l)

S=Separator to remove solid Calcium Carbonate ($CaCO3$) from electrolyte route/circulation flow R , Flow R then returning to item P to remake electrolyte as outlined in P.

T=Calcium Carbonate (which can be processed to user/end user as it is) held stored or sent to item U to process as slurry

U=Slurry tank fed with Calcium Carbonate from item T and flue combustion products from route Z ,through which Sulphur Dioxide ($SO2$) can be bubbled to create Calcium Sulphate ($CaSO4$) which can then be sent to user/end user

V=Sulphur Dioxide supply

W=fresh electrolyte or returning remade electrolyte

X=Electricity to power water electrolysis bank from a source other than the solar cell roof/array and could be a renewable

Z=Flue gases and combustion products other than Carbon dioxide gas separated out in item I and processed in item U.

Drawings Figure 2: A drawing showing heat recovery from items to feed back into the furnace or burners.

Key for I: Cross section through main building, housing boiler and generation components.

A=solar roof/array generating electricity and heat

B=air intake air flow cooling back of solar panels

C=building structure

D=fuel feed

E=Fuel feed and heated air (recovered from flow B and flow L of drawings 2 II) feeding into furnace/burner/boiler.

Key for II: Sabatier gas inputs and reaction device, showing schematic cooling of Sabatier reaction flows and heat recovery to section E of drawings figure 2 I.

F=Carbon Dioxide gas from store

G=Hydrogen gas from store

H=Sabatier process mixing chamber at controlled temperatures and pressures

I=Sabatier gas reaction products of Methane and water

J=Air cooled water column through which reaction products pass/bubbled

K=Air cooling inlet

L=Air cooling outlet to go to E in section I drawings figure 2

M=Methane out flow, to store, processing, grid, end user.

Drawings Figure 3:A drawing showing combustion flue products and processing :

Key

A=Combustion products and flue gases

B=Cyclonic separator (or filters) to remove solid ash/char

C=Ash/Char particles

D=Flow of gases of combustion

E=Carbon Dioxide membrane separator (or other device of CO2 separation)

F=High purity CO2

G=CO2 Store

H=Feed to Sabatier gas reaction device/chamber

I=combustion gases other than CO2 bubbled through/absorbed in CaCO3 slurry

J=Slurry mixing tank

K=Water electrolysis bank (also making O2 and H2 gases not shown)

L=Calcium Carbonate from water electrolysis salt deposition on electrode when cell is energised.

M=Ash/char pulverised and added to slurry mix (option and/or to N).

N=Ash/char to processing for agricultural use (option and or to M)

O=Slurry of Calcium Carbonate and ash /char non CO2 combustion/flue gases

P=Reactor tank through which controlled input of Sulphur Dioxide gas is bubbled through the CaCO3 slurry to create CaSO4 in slurry.

Q=Sulphur dioxide gas

R=Slurry of Calcium Sulphate CaSO4 to be further processed.

Drawings Figure 4:A drawing showing the conditions of gas mixing in the Sabatier reaction to make Methane and water. (

Key for I

A=Pre heated Carbon Dioxide gas to specified temperatures and pressures

B=Pre heated Hydrogen gas to specified temperatures and pressures

C=vessel reaction chamber heated by steam or other means to specified temperatures and designed to pressure containment required.

D=gas mixing

E=Outflow of reaction products Methane and water to go onto to be cooled and separated, heat to be recovered or energy further used.

Key for II

Sabatier reaction chemical formulae, reaction conditions suggest 300-400oC and 50 PSI/344kpa pressure, but these could vary.

Drawings Figure 5:A drawing showing Calcium Carbonate deposition on an electrode in the electrolysis cell when energised , and gas collection from each electrode .

Key

A=Electrolysis cell tank to contain electrolyte (material to be non-electrical conducting)

B=Electrodes suggested material copper

C=Electrical supply from solar roof/array or other source possible renewable

D=Gases ascending up the vertical sides of the electrodes to be collected and stored.

E=Electrolyte consisting of Calcium Carbonate in solution (but could be water without a salt)

F=When energised Calcium carbonate will be deposited on one electrode surface (if using a salt in electrolyte)

G=If a device can remove the deposited Calcium Carbonate from the electrode (not shown) into small particles that sink to the drain at bottom of tank to be removed.

H= Liquid electrolyte and solid Calcium Carbonate particles go to separate Calcium Carbonate out from electrolyte to then go to slurry process. Electrolyte to be reconstituted/re made by adding a measured/ controlled amount of Calcium Oxide to create Calcium Carbonate in solution.

I=Re made/reconstituted Electrolyte re introduced at a fixed level in the electrolysis tank by using balance tanks in circulatory system.

Description:

It is doubtful that any large fuel burning power generation plant would be located underground so it is assumed that large power generation plants would be above ground and therefore housed in a building to keep them from the weather. If they are housed above ground the roof can provide a platform for solar cell fitting and the surrounding land for additional solar array if required. If solar is not the chosen renewable to power the water electrolysis banks to disassociate water to Hydrogen and Oxygen then the electrical feed to the electrolysis bank would not come from the building , as shown in the drawings figure 1. The amount of electrical energy supplied to the water electrolysis cells has to be controlled, so that each cell can be fed with electricity up to its electrical design specification, therefore the number and specification of the water electrolysis cells is related to the electricity supplied to them from the renewable source.

The furnace or burners that heat the water to raise steam or other thermal material such as a gas in a physically separated jacket that receives the conducted heat from the furnace or flue, and be of material specified temperature and pressure requirements such as steel ,and should also be of a design as to provide re heating sections in line with large steam turbines being of two or more stages .Actual heat output requirements of the furnace/burners should be specified to the amount and specifications of the steam temperature and pressures required in both powering the turbine that rotates the generator and in what is required to heat the gas reactor for the Sabatier reaction to take place .Water is fed into the boiler via pipe and heated with biomass or fossil fuel burning to the specified temperatures required ,this could be a first stage ,the spent steam returning to be reheated to power a second stage , the spent steam from the second stage being re heated in the boiler to provide steam for a third stage, spent steam from the third stage then requiring to be heated to provide the heat to heat the gas reactor device that facilitates the Sabatier reaction that requires Carbon Dioxide and Hydrogen gases (kept in storage vessels or tanks) to be mixed at temperatures of 300oC to 450oC and pressures of around 50 pounds per square inch to make Methane (these temperature and pressure parameters may be varied as required to gain reaction efficiency or energy efficiency).

If the furnaces/burners use fuel of a small to medium pellet or particle size, or a gas this can be fed in with the air , as a blown mixture .This would allow systems of heat recovery to transfer heat into the incoming feed air , providing some thermal efficiency improvement and improving fuel usage compared to systems without heat recovery. The main sources of heat recovery are from the solar roof and array where the solar cells generate heat and run more efficiently if cooled by something like air , and the recovery of heat from the output of the gas reaction device where the Sabatier reaction is carried out which could transfer its heat to air , that could then feed to the fuel/air supply, combined these two heat recovery sources could act to improve thermal efficiency and reduce fuel used by inputting the waste heat back into the furnace. In large heat system it would take a little time due to some aspects being heated in consequential series, for the full heat recovery efficiency to appear in the system, however it should be more heat/fuel efficient than any system that does not use heat recovery. Oxygen from the water electrolysis bank can be stored in vessels or tanks and the fed by pipes into the furnace/burners with the blown in air/fuel or via a separate pipe introduced into the furnace /burners so as to distribute the oxygen evenly in the dynamics of the furnace/burners of the boiler. The Oxygen would not only increase complete combustion and create more heat and higher temperature but allow the use of lower grade fuel if required such as paper or straw biomass making some previous lower grade biomass more useful. The electricity generated from the steam turbines and generators would then exit the power station to the end use/user. The by-products of combustion ash/char/flue gases should then be processed to firstly remove the ash/char by cyclonic separation or other means and then to separate out the Carbon Dioxide gas to go to store as a gas, this should be of high purity quality and gas membrane technology or other means should achieve this, heat recovery could be used at this separation stage of the flue gases but is not shown in the drawings. The remaining flue gas products can be sent via pipe to the Calcium Carbonate ($CaCO_3$) processing section, the Calcium Carbonate being in slurry, enabling the residue flue gases to be bubbled through the slurry as gas within controlled temperature requirements where with addition of Sulphur Dioxide gas (SO_2) before introduction to the slurry, they will react to make Calcium Sulphate from the Calcium Carbonate. If the flue gases are not to be used in Calcium Carbonate processing to Calcium Sulphate then these would have to go via chimney or exhaust to atmosphere or other process. Calcium Carbonate produced in the electrolysis bank ,or Calcium Sulphate produced can then be sent to use/user (shown in drawings) for further processing and packing, or could be done on site (not shown in drawings)

The separated/filtered Carbon Dioxide in store can then be used to supply the gas reaction device in which the Sabatier reaction would take place given as the following Chemical equation $CO2+4H2$------$CH4+2H20$. Separate feeds of Carbon Dioxide and Hydrogen are pre heated in controlled temperatures gases are mixed in controlled ratios ,and will need to be at 300oC to 450oC and around 50 pounds per square inch pressure (these parameters may vary according to gain reaction efficiency and energy efficiency requirements) .The heating for the temperatures required could be supplied by energy from a steam heating stage of the fuel burning boilers (as shown in the drawings) returning to the boiler input as spent steam to be re-introduced and help with thermal efficiency in raising steam and fuel used to raise steam, or the Sabatier reaction heat could come from another source such as electrical heating from a renewable source (not shown in drawings).

The outflow from the gas reaction device should contain a high amount of reacted product methane (CH4) as well as a small amount of unreacted Carbon Dioxide or Hydrogen, and should go on the process to extract and purify the Methane (CH4) and if required (as shown in drawings) heat recovery, the methane (CH4) can then either go to store or be treated to specification of introduction to the Natural gas grid supply to end use/user. The other by product of the Sabatier reaction is water (H2O) which will be in large quantities in large gas through put reactions which will also be heated and have to be removed from the main methane gas. Methane is insoluble in water so most systems of water removal would be through a water column enabling some heat recovery (in the drawings suggested as to be conducted through a vessel wall into circulating air) this air which then feeds to air/fuel feed to input recovered heat back into the furnace/burner/combustion chamber of the main fuel burning boiler. The water made when cooled into liquid in the column, could be sent via pipe to provide a further heating use such as a horticulture greenhouse or provide heat for a drying process or reaction (not shown in drawings) or be sent via pipe to the water electrolysis bank, to be electrolysed as hot/warm water (H2O) which will aid the electrolysis process by the water having some additional energy than water at lower temperatures extracted from bore hole or river source.

The electrolysis bank would be specified according to the electrical supply feeding it .The electrical supply to each individual electrolysis cell would be controlled and specified in electrical quality in terms of alternating or direct current, the voltage expected to be around 1.23-1.5 volts but could be more or less dependent upon electrolysis cell performance, the cycles per second or Hertz and an amperage maximum capacity for each electrolysis cell as specified on the size of cell and electrodes used.

Although any conducting material could be used as electrodes it envisaged copper would be suitable due to its conductance. Pure water does not electrolyse as readily as water with a dissolved salt, some salts being more suitable than others, for other reasons .In order to make CaCO3 (Calcium Carbonate) prior to the water entering the electrolysis cell ,the water would have to be treated with CaO (calcium oxide) to a controlled /measured saturation ,Carbon Dioxide (CO2) would then be bubbled through this solution ,in a measured/controlled way ,the CO2 reacting with CaO to produce Calcium Carbonate in solution (CaCO3 aqueous). Once the desired level of CaCO3 in solution is achieved the water and CaCO3 solution can be introduced into the electrolysis cell as electrolyte .When the cell containing two electrodes ,is energised a current is passed between the electrodes using the CaCO3in solution to improve electron transfer. At one electrode Hydrogen (H2) gas will be produced which will rise up around the electrode and be collected as an ascending gas, at the other electrode Oxygen (O2) will be produced as an ascending gas and collected. However the CaCO3 in solution will precipitate out on one of the electrodes and will build up, requiring some form of device that can remove it from the electrode in dynamic operation, to maintain electrode and electrolysis cell performance .This precipitated or solid Calcium Carbonate should then fall as small particles to the bottom of the electrolysis cell/tank where circulating electrolyte (introduced at the top of the cell electrolyte level) is removed ,to extract the Calcium Carbonate solid, and then sending the electrolyte to be re-constituted, re- made with CaO (Calcium oxide)in a mixing tank/vessel in a controlled /measured way to create CaCO3 in solution and fed back via pipe as electrolyte into the electrolysis cell.

The wet CaCO3 solid should form slurry and held in tank/vessel and be of a controlled viscosity/constituency, Sulphur Dioxide (SO2) gas, if not available in the final flue gas residues, can be made by burning sulphur in air/oxygen ,Sulphur Dioxide gas from a store when passed through the CaCO3 slurry in a controlled and measured way will react to form CaSO4 (Calcium Sulphate) which is also a basic form of cement used in buildings construction, this can be sent onto further processing such as drying and packing (not shown in the drawings) or whatever further processing is required. The char/ash can be further processed into building material or agricultural use as require

Possible modifications and variations:

1) The heating for the gas reactor device could be provided from a renewable source in electric heating or geo thermal or by using a direct heat such as Methane being burnt, rather than the steam from the main boiler.

2) The electricity to supply the electrolysis bank could come from a source other than solar roof and array, such as renewable wind or hydro power or geo thermal or even from the main electricity generators (or inward supply from the grid).

3) The electrolysis bank runs more efficient if a salt in solution is used, however The water electrolysis bank could be run without a salt in the electrolyte of the water electrolysis cells or from any variant of electrolysis including a form of electrolysis using a solid replacement electrolyte that uses and intrinsic semi-conductor material or N&P materials as used in a diode.

4) Methane and/or Calcium Sulphate can be made depending upon what is required ,so the power generation plants will need specifying before building as to what end products other than electricity is required.

5)In the design shown a solar roof/array is shown as providing power to electrolyse water in the electrolysis bank ,this will create a certain quantity of Oxygen (O2) and Hydrogen (H2) gases dependent upon the sunlight available ,which have to be stored. This could mean that when the supply of Hydrogen gas runs out, the Sabatier gas reaction can no longer be supplied and would be shut down .An external supply of Hydrogen may be needed if the Sabatier reaction is to be done in night time working of the main boilers which make the Carbon Dioxide from combustion of fuel. Also the supply of oxygen may run out decreasing the heat output from the main furnace/burners, where it is used to increase combustion efficiency.

6) By using Oxygen to increase combustion efficiency lower grade fuels may be used in the furnace/burners of the boiler.

7) If using solar cells on the main roof of the building or in an array, a way of cooling via air can be used to make the solar cells run more efficiently as well as provided heated air for the fuel feed supply. Also heat recovery from other

suitable parts of the power generation plant can supply the fuel feed air for the air fuel in feed system ,which will help to reduce fuel use by putting lost heat back into the main boilers/furnace/burners.

8) That the power stations can be built to specified outputs of electricity and by products such as Methane or Calcium Carbonate as required, or fuel usage.

9) If using the Sabatier gas reaction to make Methane this will provide water for the water electrolysis bank, if not using the Sabatier gas reaction additional water will have to be used from bore hole or river.

10) A drum or rotating electrolysis electrode could gather the Calcium Carbonate better and continuously (not shown in Drawings).

11) The water electrolysis banks and Sabatier gas reaction and chamber could be added to current fossil fuel burning power stations, as with a solar roof or solar array to give similar functionality to this design, it may be less efficient though through lack of efficient component outlay and not being able to use fully the heat recovery systems of this plant.

Claims

1. A power station for combusting or burning fossil fuel and / or biomass comprising:

a boiler which uses heat from said combusting or burning of fossil fuel and/or biomass to make steam;

one or a plurality of power turbines, which are powered by said steam made by said boiler;

a plurality of electricity generators powered by said power turbines, said plurality of generators operable to make electricity to supply to a distribution grid and /or an end user; and

an electrolysis tank containing an electrolyte comprising calcium carbonate in solution;

wherein oxygen produced by said electrolysis tank is used in said combustion of fossil fuel and/ or biomass.

2. The power station as claimed in claim 1, further comprising:

a solar array;

a Sabatier gas reactor;

wherein heat from said solar array and heat from the Sabatier gas reactor are introduced back into the boiler in a fuel-air feed; and

the energy of the combustion products in a combustion flue are transferred to heat and re-heat sections of a water circulation circuit of the steam generation in order to improve thermal efficiency and fuel efficiency.

3. The power station as claimed in any one of the preceding claims, wherein said electrolysis tank comprises:

a tank;

a said calcium carbonate solution;

wherein

said tank contains two spatially separated electrodes suspended in the one tank containing the electrolyte, so as to produce oxygen at one electrode and hydrogen at the other electrode; and

said oxygen and said hydrogen are collected separately as vertically ascending gases close to each separate electrode, when energised by passing a controlled electric current between the two electrodes.

4. The power station as claimed in claim 2, wherein said Sabatier gas reactor comprises a gas mixing reaction chamber; and wherein

said Sabatier gas reactor produces methane and water as reaction products by mixing carbon dioxide and hydrogen at controlled temperatures and pressures in a gas mixing reaction.

5. The power station as claimed in any one of the preceding claims, in which:

sulphur dioxide (SO_2) gas is passed through a slurry of calcium carbonate ($CaCO_2$) resulting from an electrolysis process, so as to result in production of calcium sulphate ($Ca SO_4$).

6. The power station as claimed in claim 3 as appendant to claim 2, wherein said hydrogen produced in said electrolysis tank is used in said Sabatier gas reactor.

7. A process of power generation comprising:

combusting or burning fossil fuel and / or biomass;

using heat from said combusting or burning of fossil fuel and/or biomass to make steam;

powering one or a plurality of power turbines using said steam;

powering a plurality of electricity generators by said one or plurality of power turbines to make electricity;

supplying said electricity to a distribution grid and /or to an end user; and to

an electrolysis tank containing an electrolyte comprising calcium carbonate in solution

wherein oxygen produced by said electrolysis tank is used in said combustion of fossil fuel and/ or biomass.

8. The process as claimed in claim 7, further comprising:

generating electricity from a solar array; and

generating heat from a Sabatier gas reactor;

wherein said electricity generated from the solar array and said heat generated from the Sabatier gas reactor are introduced back into said combustion in a fuel-air feed; and

the energy of the combustion products in a combustion flue are transferred to heat and re-heat sections of a water circulation circuit of a steam generator

9. The process as claimed in claim 8, wherein

said Sabatier gas reactor produces methane and water as reaction products by mixing carbon dioxide and hydrogen at controlled temperatures and pressures in a gas mixing reaction.

10. The process as claimed in any one of claims 7 to 9, wherein

said calcium carbonate solution is made from adding calcium oxide to water and passing and/or bubbling carbon dioxide through said water; and

oxygen and hydrogen are produced by electrolysis; and

collecting said oxygen and said hydrogen separately as vertically ascending gases each close to a separate electrode, when energised by passing a controlled electric current between the two electrodes.

11. The process as claimed in any one of claims 10 to 13, in which:

sulphur dioxide (SO_2) gas is passed through a slurry of calcium carbonate ($CaCO_2$) resulting from an electrolysis process, so as to result in production of calcium sulphate ($Ca SO_4$).

12. The process as claimed in any one of claims 10 to 14, which by using the carbon dioxide resulting from said combustion of fossil fuel and/or biomass, little or no carbon dioxide pollution is emitted into the atmosphere from said combustion.

13. The process as claimed in any one of the claims 10 to 15, which is capable of operating in a continuous manner other than for planned servicing/maintenance.

14. The process as claimed in any one of claims 10 to 16, which provides relatively low emissions if sufficient hydrogen is supplied for the Sabatier reaction to mix with the carbon dioxide produced in said combustion.

15. The process as claimed in claim 13 as appendant to claim 12, wherein said hydrogen produced in said electrolysis tank is used in said Sabatier gas reactor.