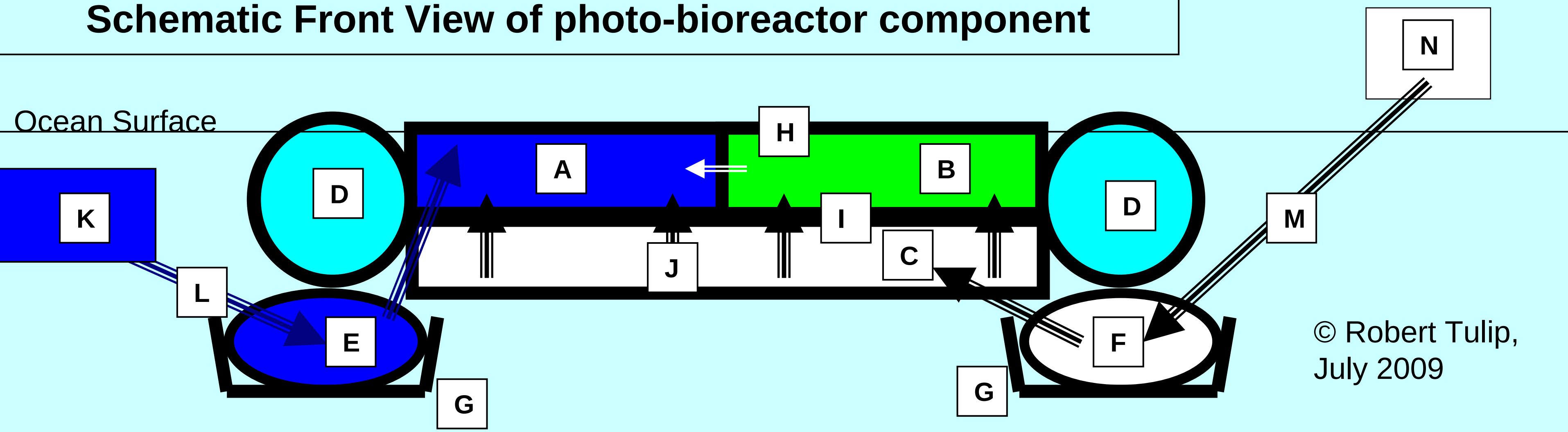
Ocean-based Algae Production System
Schematic Front View of photo-bioreactor component

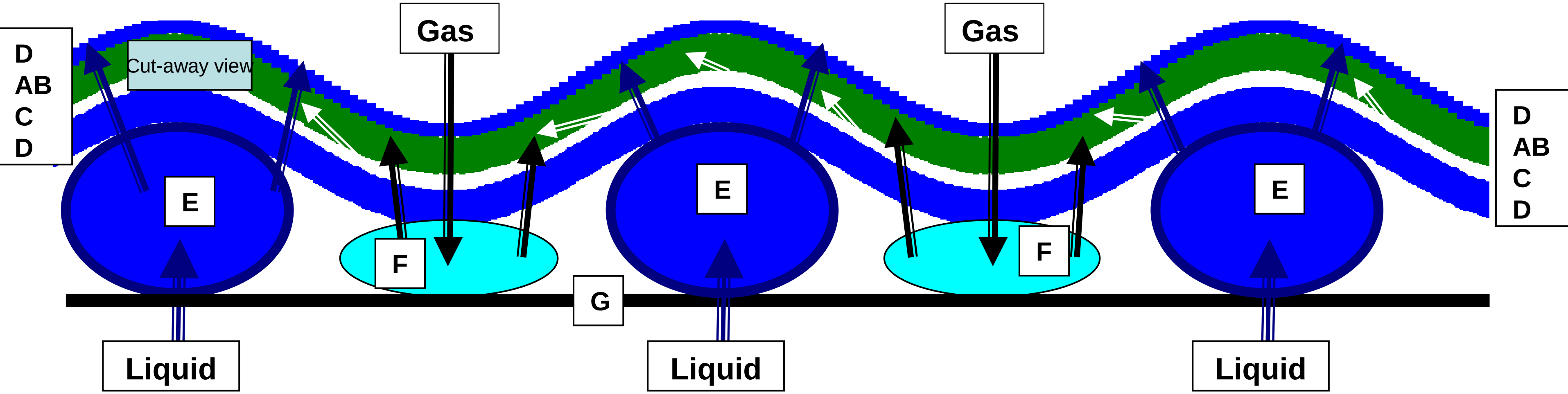
Drawing A



1. The Algae Production System is a photo-bioreactor floating in the ocean, made primarily of polymer fabrics and enclosed contents.
2. Algae production chamber shown at A and B is a continuous chamber floating at ocean surface. (A) indicates points of addition of inputs and (B) indicates output point for algated content.
3. Lower chamber (C) contains gas (eg air or CO2) which passes through one way valves (four vertical arrows (J) through polymer layer (I) into algae chamber A and B.
4. Polymer bag (D) contains fresh water, surrounding algae production chamber A-B, and connected to submarine bags E and F as shown at separate schematic drawing of top view.
5. Liquid source (K) and gas source (N) are pumped through inlet pipes (L) and (M) into submarine pumping chambers (E) and (F).
6. Rise and fall of bag D with wave causes chambers E and F to expand and contract, pumping liquid from bag E into chamber A and gas from bag F into chamber C.
7. Rigid base container G extends beneath and connects all bags E and F, such that wave energy transmitted from bag D expands and compresses bags E and F to provide pumping pressure rather than causing bags E and F to rise and fall with the swell or expand and shrink horizontally.
8. Barrier I between chambers C and A-B is reflective and insulated to maximise retention of sunlight and heat entering through transparent polymer layer (H) into upper chamber E and F.
9. Volume of gas in chamber C can be increased or decreased to regulate depth of entire system. When chamber C is full the system will float high, and when empty it will sink lower.

Ocean-based Algae Production System: Schematic Side View of photo-bioreactor component

Drawing B

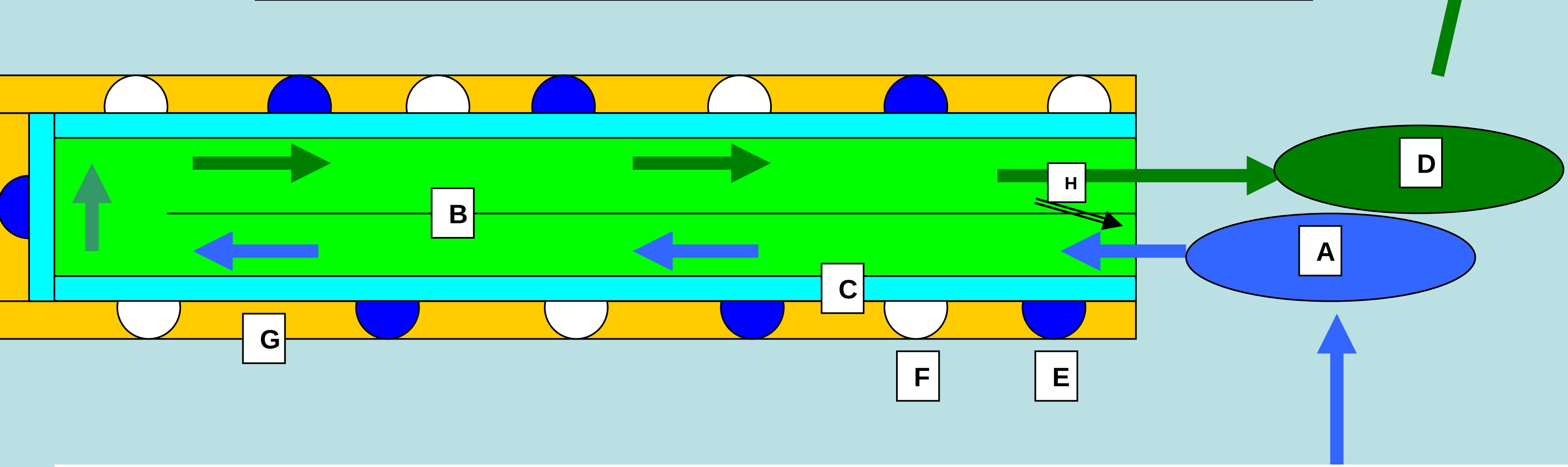


1. Partial side view of system for algae production at sea, combining nutrient-rich deep sea water (E) with air (F) at the ocean surface between polymer sheets (ABC).
2. Tubes full of fresh water (D) at either side of the sheet provide buoyancy, control and pumping energy.
3. Wave-powered pump bags (E/F) are located beneath the lateral waterbags (D) for constant intake of nutrient rich water and air and/or system propulsion, with inlet valve open on rising swell and outlet valve open on falling swell.
4. Air layer (C) beneath algae layer (AB) is used for aeration and for depth regulation, enabling entire system to submerge in rough weather.
5. Valves (shown by arrows) from air layer C to algae production layer (AB) enable aeration of algae.
6. Bags E and F are connected to rigid submarine board (G) which causes bag E/F to expand on rising swell and to contract on falling swell.

Drawing C

Ocean-based Algae Production System

Schematic Top View of photo-bioreactor component



A: Polymer bag containing CO_2, fresh water or ocean water with high nutrient level

B: Continuous flow algae photo-bioreactor chamber with arrows showing direction of liquid flow

C: Polymer bag containing fresh water for buoyancy, pumping and stability

D: Polymer bag containing algated water output from chamber (B)

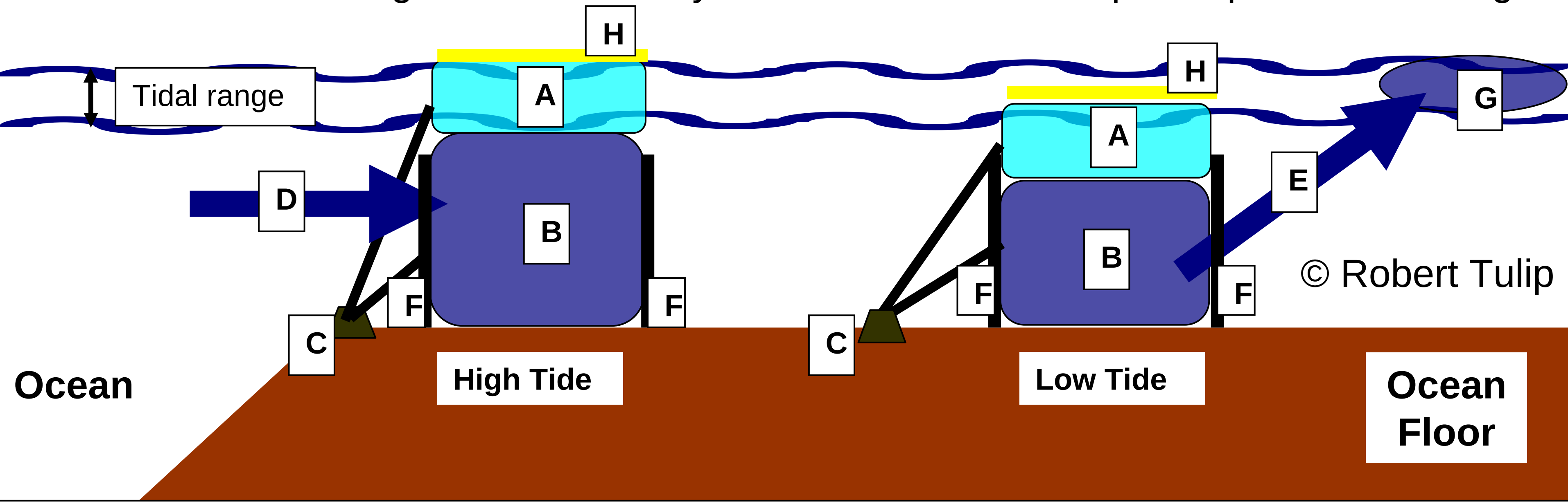
E: Submarine chamber pumping water from source (A) into chamber (B). (Note, chamber E can be replaced by a tidal pump as described in separate drawing).

F: Submarine chamber pumping air or CO_2 into chamber below chamber B as shown at side and front views

G: Rigid submarine platform at base of chambers E and F providing pumping resistance.

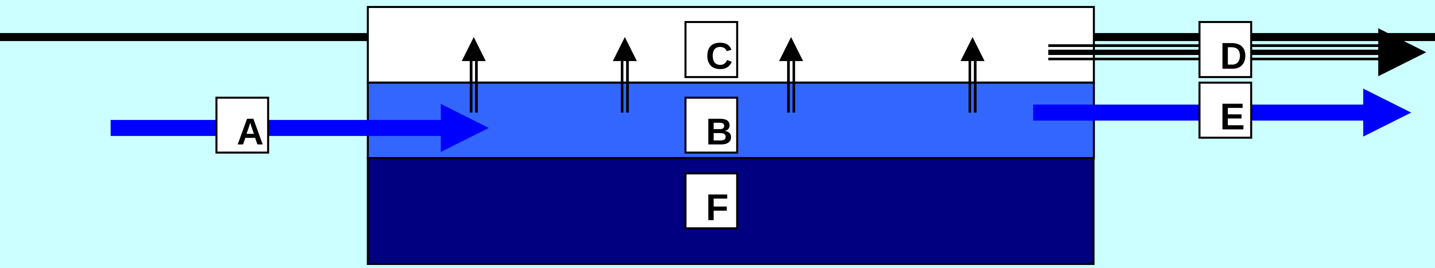
H: Return pipe transferring algated water to mix with nutrient-rich water from bag (A).

Ocean-based Algae Production System: Tidal Water Pump Component Drawing D



1. The tidal water pump is a pumping system made of two connected upper and lower fabric bags containing liquid and tethered in position on the ocean floor or flat platform.
2. Upper fabric bag (A) contains constant volume of liquid floating at constant depth from ocean surface, for example fresh water sitting at ocean surface or brackish water at constant ocean depth eg 180 metres.
3. Lower fabric bag (B) is a pumping inlet-outlet chamber.
4. A mooring point (C) on the ocean floor tethers the pumping system in place.
5. During rising tide, bag A rises with the tide, causing liquid to enter bag B through inlet valve from pipe D.
6. During falling tide, upper bag A falls with the tide, placing weight and pressure on lower bag B and causing liquid to leave lower bag B through outlet valve into pipe E.
7. Bag B is enclosed by and connected to barrier (F) to prevent horizontal expansion or contraction of bag B and enable pressure from bag A to transmit pumping energy via bag B to pipes D and E.
8. The inlet and outlet pipes D and E connect to fresh water dam, deep ocean water, waterbag, algae bioreactor or other liquid source or destination.
9. Floating polymer bag (G) can mix output with CO2 or air to enable flotation for towing to algae bioreactor.
10. Triple layer polymer sheet (H) over surface of bag (A) at ocean surface separates input salt water into fresh water and brine (separate drawing attached).

Ocean-based Algae Production System: : Desalting Component



1. A polymer fabric apparatus floating on the ocean surface, designed to remove salt from ocean water using solar energy.

2. Ocean water is pumped through inlet pipe A into polymer chamber B. Heat from the sun causes evaporation into chamber C, with resulting fresh water collected in outlet pipe D. Brine residue from Chamber B returns to the ocean through outlet pipe E.

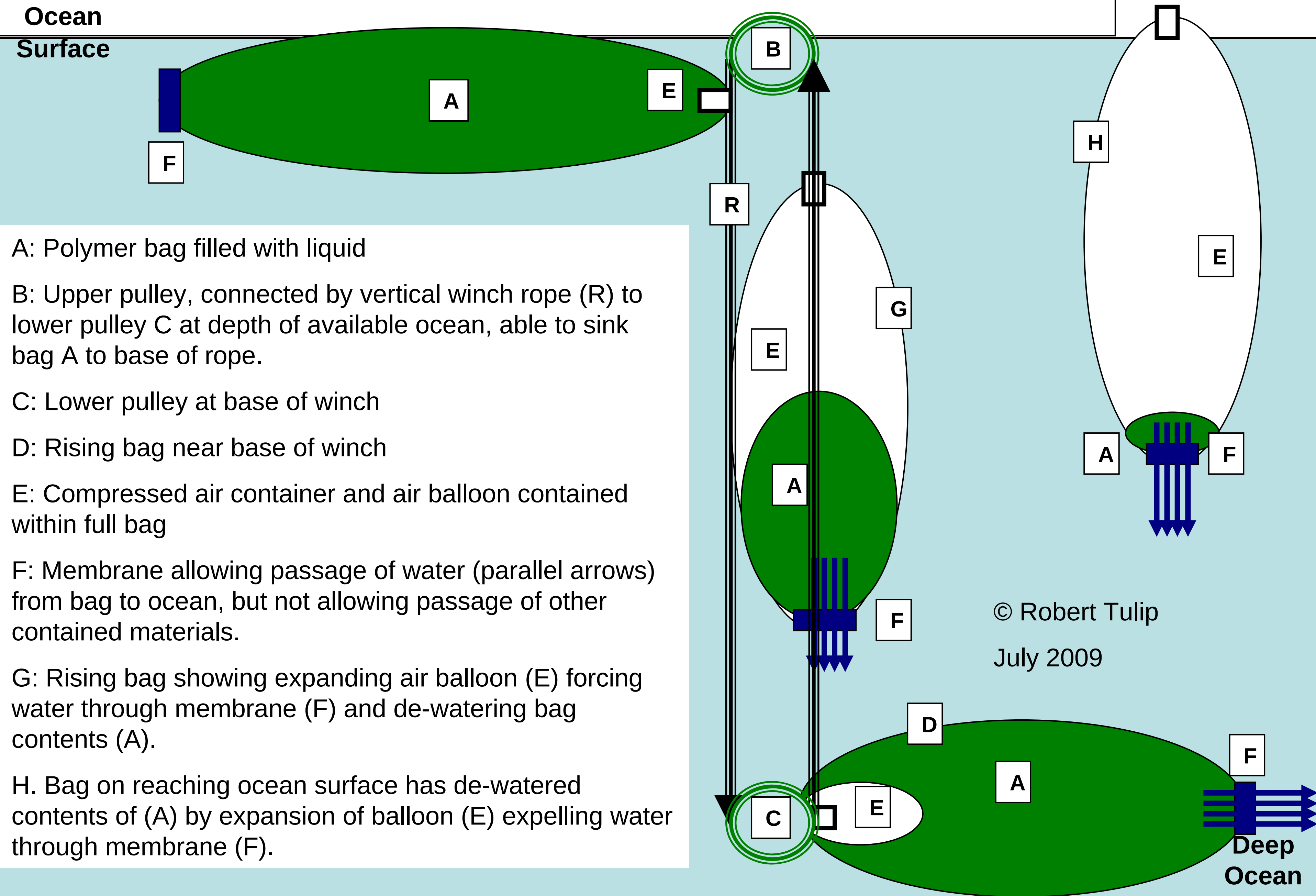
3. Chamber F, below Chamber B, is filled with fresh water such that chamber B floats on the ocean surface.

4. The polymer barrier between Chambers B and F is reflective and insulated to maximise retention of solar heat in Chamber B.

5. The polymer barrier between Chambers B and C is transparent, and contains valves (shown by arrows) or other mechanism to allow evaporation from Chamber B to rise into Chamber C

Ocean-based Algae Production System: Schematic Diagram of Liquid Concentration Apparatus

Drawing F



A: Polymer bag filled with liquid

B: Upper pulley, connected by vertical winch rope (R) to lower pulley C at depth of available ocean, able to sink bag A to base of rope.

C: Lower pulley at base of winch

D: Rising bag near base of winch

E: Compressed air container and air balloon contained within full bag

F: Membrane allowing passage of water (parallel arrows) from bag to ocean, but not allowing passage of other contained materials.

G: Rising bag showing expanding air balloon (E) forcing water through membrane (F) and de-watering bag contents (A).

H. Bag on reaching ocean surface has de-watered contents of (A) by expansion of balloon (E) expelling water through membrane (F).

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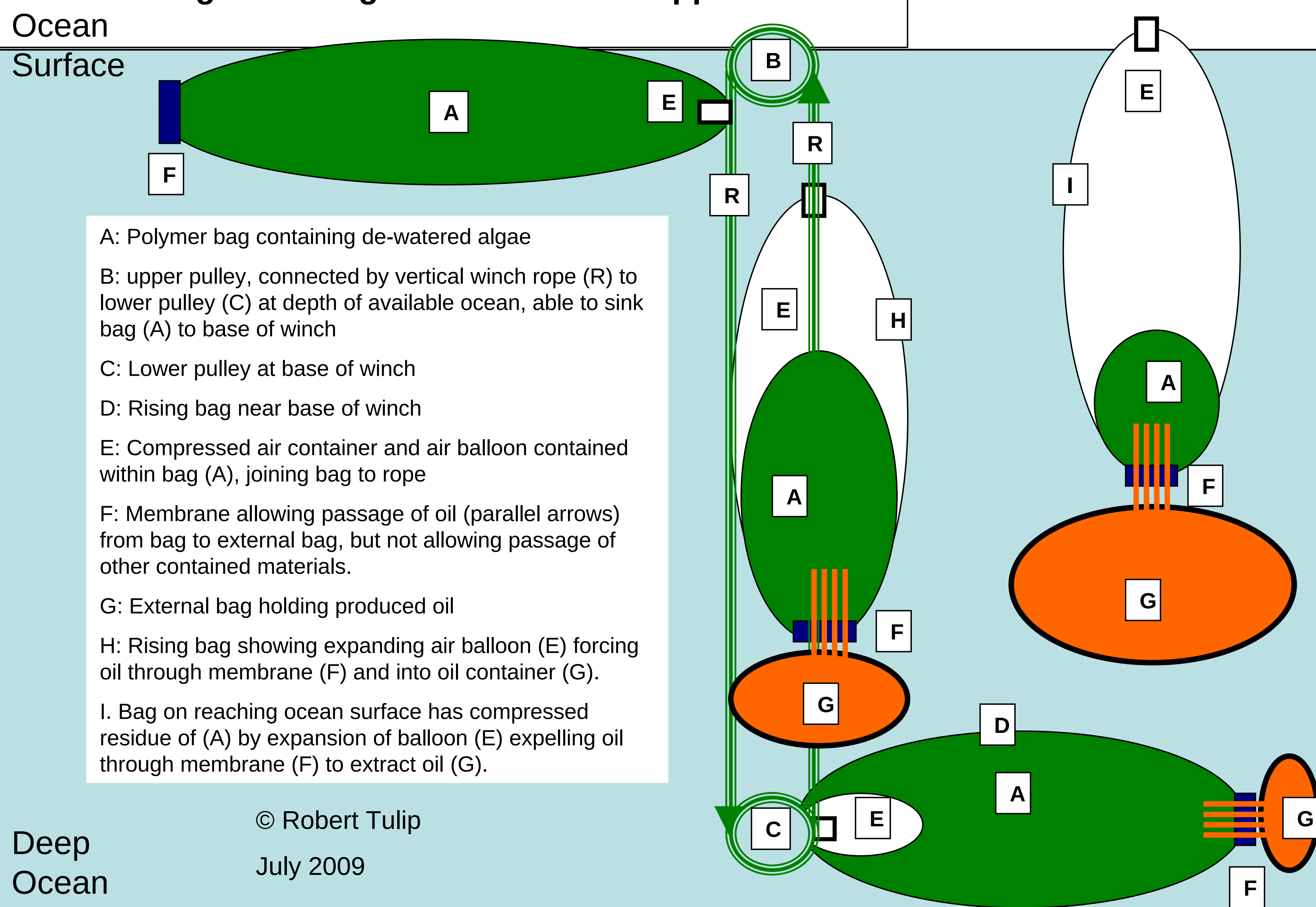
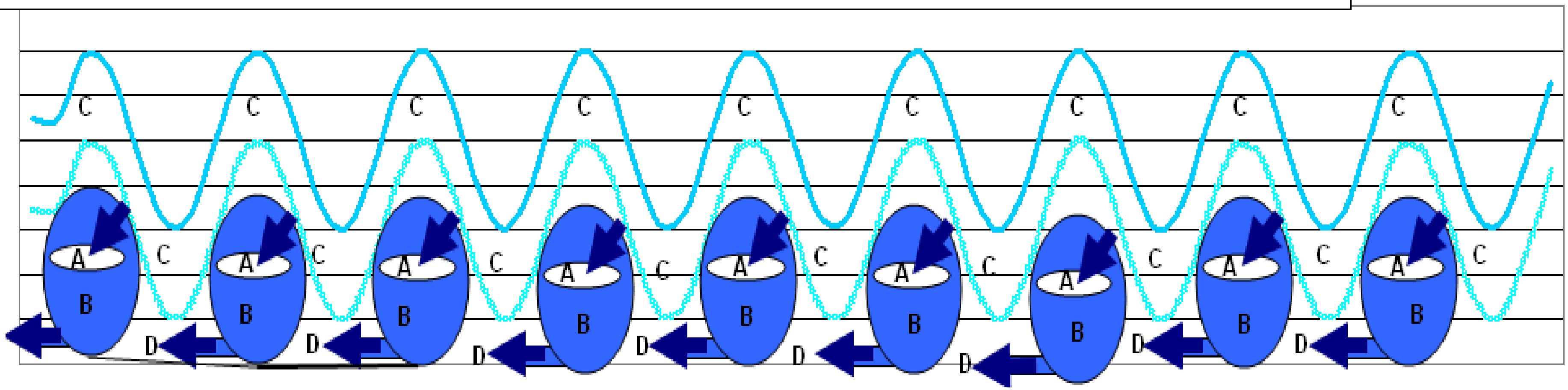
Ocean-based Algae Production System: Schematic Diagram of Algae Oil Extraction Apparatus

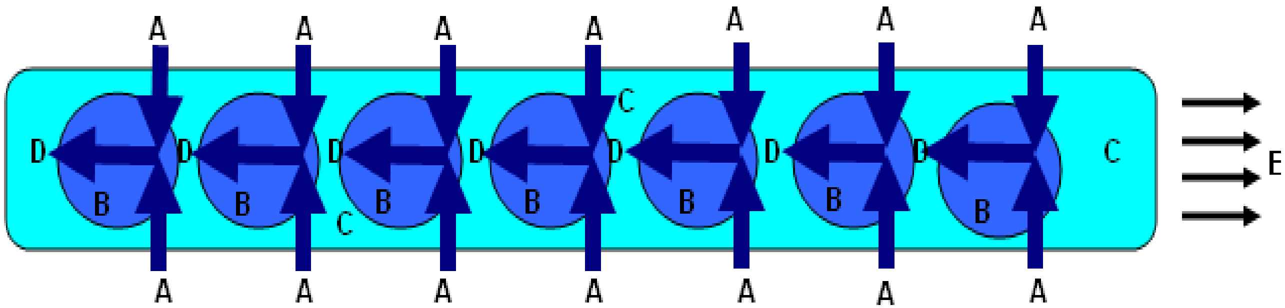
Drawing G



Ocean-based Algae Production System: Schematic Diagram of Component for using wave energy for pumping and propulsion

Drawing H





A method to convert ocean wave energy into propulsive power for large waterbags.

Ocean water (A) enters propulsion bags (B) underneath the waterbag train (C) and is expelled through jet outlet (D). The propulsion bag inlets are simple fabric valves which allow water to enter but not to exit, while the outlet has a similar valve preventing water entry. As the waterbag rises to the peak of the swell, the propulsion bag fills with ocean water. As the waterbag falls to the trough of the swell, ocean water is forced out of the propulsion bag through a jet outlet pointed to the rear of the waterbag, causing the train to move forward (E).