

Please note that this is a re-worded extract from the patent and the diagrams have been adapted slightly.

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## **FRACTURE CELL APPARATUS**

### **ABSTRACT**

Fracture cell apparatus including a capacitive fracture cell **20** comprising a container **21** having walls **21a**, and **21b** made of non-electrically conducting material for containing a liquid dielectric **26**, and spaced apart electrodes **22** and **23** positioned outside container **21** with the liquid dielectric **26** between the electrodes, and a mechanism (**8a** and **8b** in **Fig.1** and **Fig.2**) for applying positive and negative voltage pulses to each of the electrodes **22** and **23**. In use, whenever one of a positive voltage pulse and a negative voltage pulse is applied to one of the two electrodes, the other of a positive voltage pulse and a negative voltage pulse is applied to the other of the two electrodes, thereby creating an alternating electric field across the liquid dielectric to cause fracture of the liquid dielectric **26**. The apparatus may be used for generating hydrogen gas.

### **FRACTURE CELL APPARATUS**

This invention relates to a fracture cell apparatus and to a method of generating fuel gas from such fracture cell apparatus. In particular, but not exclusively, the invention relates to an apparatus and method for providing fuel gas from water.

Conventionally, the principal methods of splitting a molecular species into its component atomic constituents have been either purely chemical or purely electrolytic:

Purely chemical reactions always involve "third-party" reagents and do not involve the interaction of (1) an applied external electrical influence, and (2) a simple substance. Conventional electrolysis involves the passage of an electric current through a medium (the electrolyte), such current being the product of ion-transits between the electrodes of the cell. When ions are attracted towards either the cathode or the anode of a conventional electrolytic cell, they either receive or donate electrons on contact with the respective electrode. Such electron exchanges constitute the current during electrolysis. It is not possible to effect conventional electrolysis to any useful degree without the passage of this current; it is a feature of the process.

A number of devices have recently been described which purport to effect "fracture" of, particularly, water by means of resonant electrostatic phenomena. In particular one known device and process for producing oxygen and hydrogen from water is disclosed in US-A-4936961. In this known device a so-called fuel cell water "capacitor" is provided in which two concentrically arranged spaced apart "capacitor" plates are positioned in a container of water, the water contacting, and serving as the dielectric between, the "capacitor" plates. The "capacitor" is in effect a charge-dependent resistor which begins to conduct after a small displacement current begins to flow. The "capacitor" forms part of a resonant charging circuit that includes an inductance in series with the "capacitor". The "capacitor" is subjected to a pulsating, unipolar electric charging voltage which subjects the water molecules within the "capacitor" to a pulsating electric field between the capacitor plates. The "capacitor" remains charged during the application of the pulsating charging voltage causing the covalent electrical bonding of the hydrogen and oxygen atoms within the water molecules to become destabilised, resulting in hydrogen and oxygen atoms being liberated from the molecules as elemental gases.

Such known fracture devices have, hitherto, always featured, as part of their characteristics, the physical contact of a set of electrodes with the water, or other medium to be fractured. The primary method for limiting current flow through the cell is the provision of a high impedance power supply network, and the heavy reliance on the time-domain performance of the ions within the water (or other medium), the applied voltage being effectively "switched off" in each cycle before ion-transit can occur to any significant degree.

In use of such a known system, there is obviously an upper limit to the number of ion-migrations, electron captures, and consequent molecule-to-atom disruptions which can occur during any given momentary application of an external voltage. In order to perform effectively, such devices require sophisticated current-limiting and very precise switching mechanisms.

A common characteristic of all such known fracture devices described above, which causes them to behave as though they were conventional electrolysis cells at some point in time after the application of the external voltage, is that they have electrodes in actual contact with the water or other medium.

The present invention seeks to provide an alternative method of producing fracture of certain simple molecular species, for example water.

According to one aspect of the present invention there is provided a fracture cell apparatus including a capacitive fracture cell comprising a container having walls made of non-electrically conducting material for containing a liquid dielectric, and spaced apart electrodes positioned outside the container with the liquid dielectric between the electrodes, and a mechanism for applying positive and negative voltage pulses to each of the electrodes so that, whenever one of a positive voltage pulse and a negative voltage pulse is applied to one of the two electrodes, the other voltage pulse is applied to the other electrode, thereby creating an alternating electric field across the liquid dielectric to cause fracture of the liquid dielectric.

In the apparatus of this invention, the electrodes do not contact the liquid dielectric which is to be fractured or disrupted. The liquid to be fractured is the simple dielectric of a capacitor. No purely ohmic element of conductance exists within the fracture cell and, in use, no current flows due to an ion-carrier mechanism within the cell. The required fracture or disruption of the liquid dielectric is effected by the applied electric field whilst only a simple displacement current occurs within the cell.

Preferably the liquid dielectric comprises water, e.g. distilled water, tap water or deuterated water.

Conveniently each electrode comprises a bipolar electrode.

The mechanism for alternately applying positive and negative pulses, provides step voltages alternately to the two electrodes with a short period of time during each charge voltage cycle in which no step voltage is applied to either electrode. Typically, step voltages in excess of 15 kV, typically about 25 kV, on either side of a reference potential, e.g. earth, are applied to the electrodes. In effect, trains of pulses having alternating positive and negative values are applied to the electrodes, the pulses applied to the different electrodes being "phase shifted". In the case where each electrode comprises a bipolar electrode, each bipolar electrode comprising first and second electrode "plates" electrically insulated from each other, a train of positive pulses is arranged to be applied to one electrode plate of each bipolar electrode and a train of negative pulses is arranged to be applied to the other electrode plate of each bipolar electrode. One electrode plate of one bipolar electrode forms a first set with one electrode plate of the other bipolar electrode and the other electrode plate of the one bipolar electrode forms a second set with the other electrode plate of the other bipolar electrode. For each set, a positive pulse is applied to one electrode plate and a negative pulse is applied simultaneously to the other electrode plate. By alternately switching the application of positive and negative pulses from one to the other set of electrode plates, an "alternating" electric field is generated across the dielectric material contained in the container. The pulse trains are synchronised so that there is a short time interval between the removal of pulses from one electrode plate set and the application of pulses to the other electrode plate set.

According to another aspect of the present invention, there is provided a method of generating gas comprising, applying positive and negative voltage pulses alternately to the electrodes (positioned either side of, but not in contact with, a liquid dielectric), the voltage pulses being applied so that, whenever one of a positive voltage pulse and a negative voltage pulse is applied to one of the two electrodes, the other of a positive voltage pulse and a negative voltage pulse is applied to the other of the two electrodes, the applied voltage pulses generating an alternating electric field across the liquid dielectric causing fracture of the liquid dielectric into gaseous media. Preferably, voltages of at least 15 kV, e.g. 25 kV, either side of a reference value, e.g. earth, are applied across the liquid dielectric to generate the alternating electric field.

An embodiment of the invention will now be described by way of example only, with particular reference to the accompanying drawings, in which:

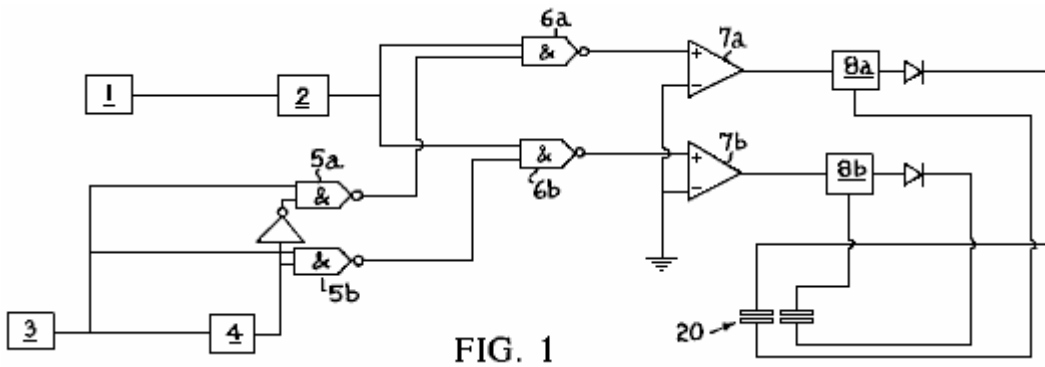


FIG. 1

Fig.1 is a circuit diagram of fracture cell apparatus according to the invention;

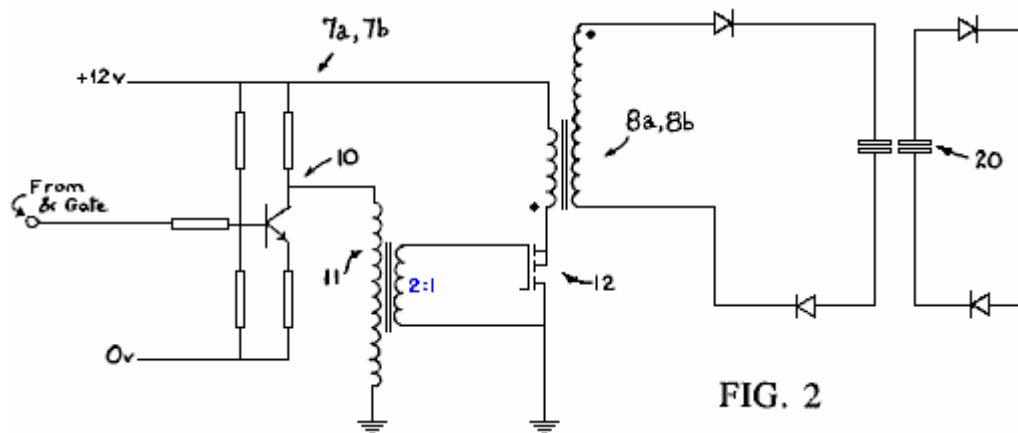


FIG. 2

Fig.2 shows in more detail a part of the circuit diagram of Figure 1;

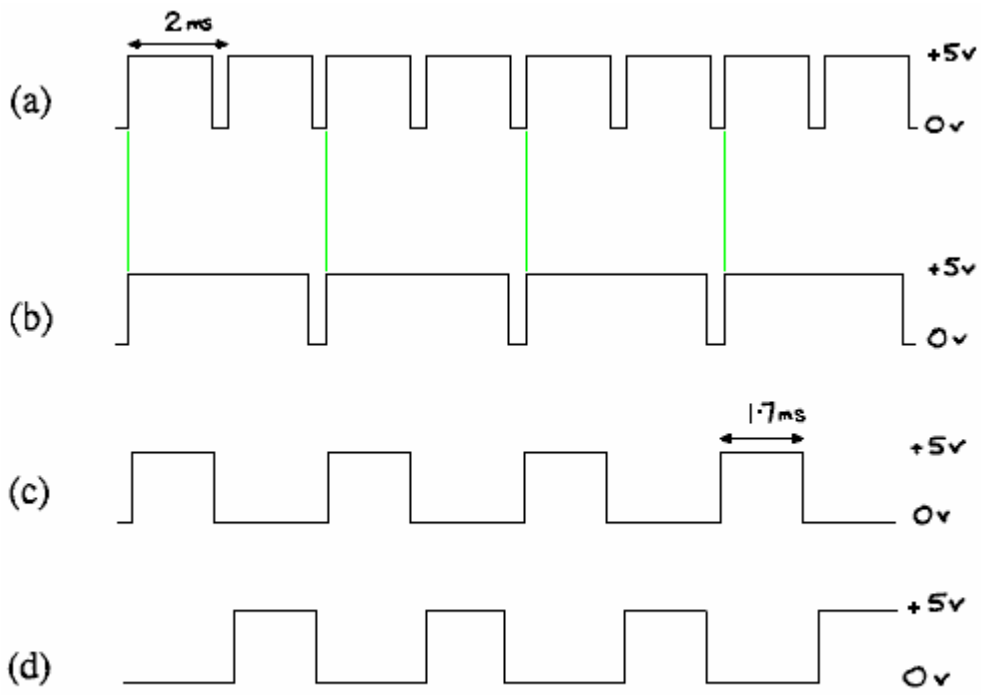


FIG. 3

Fig.3 shows the different waveforms at various parts of the circuit diagram of Fig.1;

FIG. 4

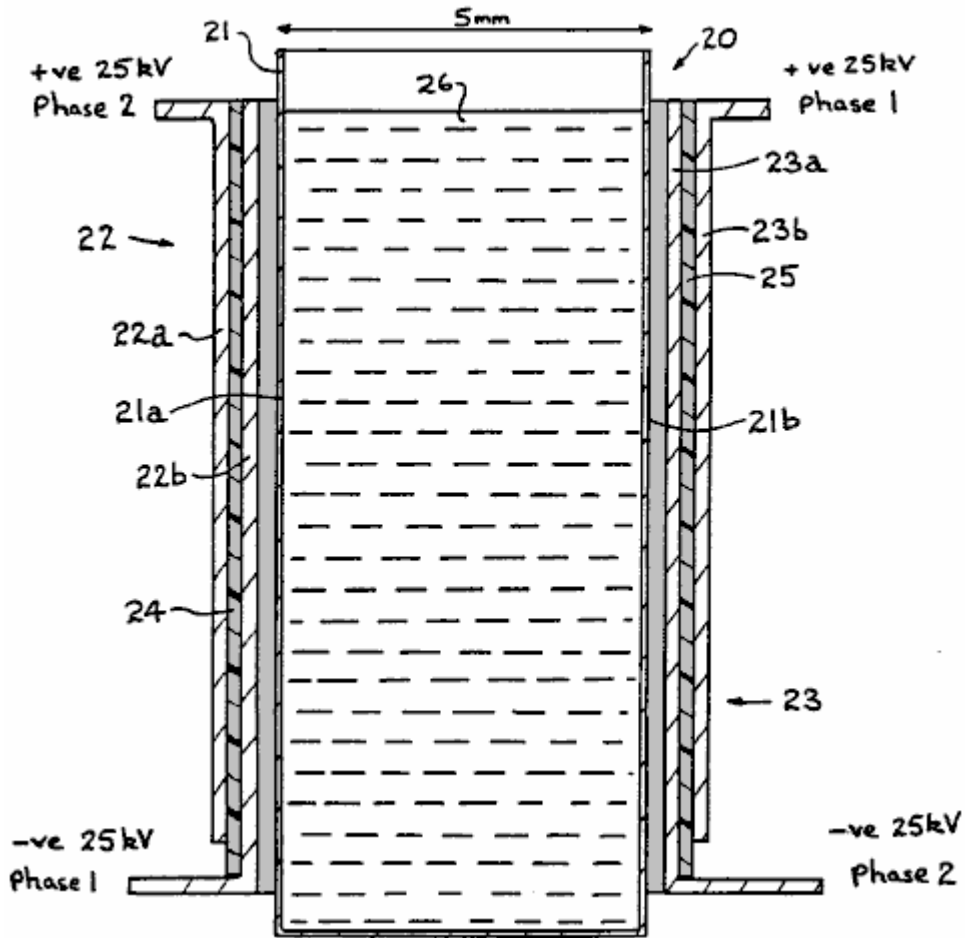


Fig.4 is a schematic diagram of a fracture cell for use in fracture cell apparatus according to the invention,

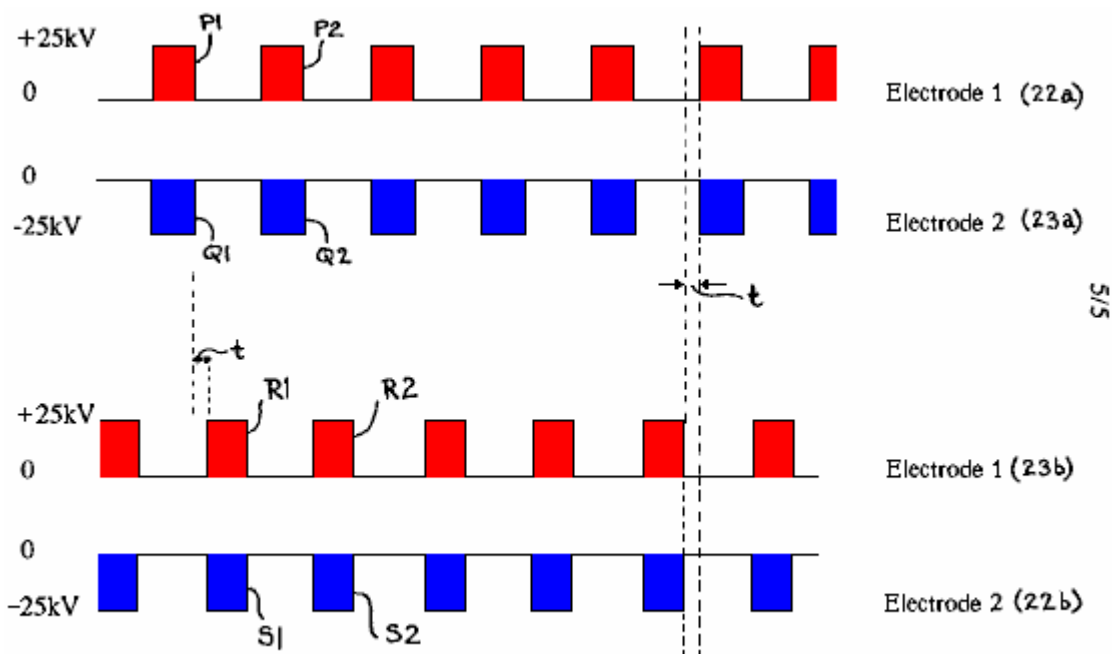


FIG. 5

Fig.5 shows trains of pulses applied to electrodes of the fracture cell apparatus according to the invention.

If a large electric field is applied across a pair of electrode plates positioned either side of a cell containing water, disruption of the water molecules will occur. Such disruption yields hydrogen nuclei and HO<sup>-</sup> ions. Such a molecular disruption is of little interest in terms of obtaining a usable result from the cell. A proton-rich zone exists for as long as the field exists and quickly re-establishes equilibrium ion-product when the field is removed.

One noticeable side-effect, however, is that the hydroxyl ions (which will migrate to the +ve charged plate) are stripped of electrons as they approach the cell boundary. Any negatively-charged ion will exhibit this behaviour in a strong enough potential well, but the OH ions have a strong tendency to such dissociation. This results, momentarily, in a region of negative-charge close to the positive cell boundary. Thus, on opposite sides of the active cell, there are hydrogen nuclei (free proton zone) and displaced electrons (-ve charge zone), both tending to increase in density closer to the charged plates.

If, at this point, the charge is removed from the plates, there is a tendency for the charge-zones to move, albeit very slowly, towards the centre of the active cell. The ion-transit rates of free electrons and of hydrogen nuclei are, however, some two orders of magnitude greater than either H<sup>30+</sup> ions or OH ions.

If the charges are now replaced on the plates, but with opposite polarity, the interesting and potentially useful aspect of the process is revealed. Hydrogen nucleus migration is accelerated in the direction of the new -ve plate and free electron migration takes place towards the new +ve plate. Where there is a sufficient concentration of both species, including the accumulations due to previous polarity changes, monatomic hydrogen is formed with the liberation of some heat energy. Normal molecular association occurs and H<sub>2</sub> gas bubbles off from the cell.

Also existing OH radicals are further stripped of hydrogen nuclei and contribute to the process. Active, nascent O<sup>0-</sup> ions rapidly lose their electronic space charge to the +ve field and monatomic oxygen forms, forming the diatomic molecule and similarly bubbling off from the cell.

Thus, the continuous application of a strong electric field, changing in polarity every cycle, is sufficient to disrupt water into its constituent gaseous elements, utilising a small fraction of the energy required in conventional electrolysis or chemical energetics, and yielding heat energy of the enthalpy of formation of the diatomic bonds in the hydrogen and oxygen.

Apparatus for performing the above process is described below. In particular, electronic circuitry to effect the invention is shown in the simplified block diagram of **Fig.1**. In **Fig.1** a pulse-repetition frequency (PRF) generator **1** comprises an astable multivibrator clock running at a frequency which is preset for any application, but able to be varied across a range of approximately 5-30 kHz. The generator **1** drives, by triggering with the trailing edge of its waveform, a pulse-width (PW) timer **2**.

The output of the timer **2** is a train of regular pulses whose width is determined by the setting of timer **2** and whose repetition frequency is set by the PRF generator **1**.

A gate clock **3** comprises a simple 555-type circuit which produce a waveform (see **Fig.3a**) having a period of 1 to 5 ms, e.g. 2 ms as shown in **Fig.3a**. The duty cycle of this waveform is variable from 50% to around 95%. The waveform is applied to one input of each of a pair of AND gates **5a** and **5b** and also to a binary divide-by-two counter **4**. The output of the counter **4** is shown in **Fig.3b**.

The signal from the divide-by-two counter **4** is applied directly to the AND gate **5b** serving phase-2 driver circuitry **7a** but is inverted before application to the AND gate **5a** serving phase-I driver circuitry **7a**. The output of the AND gate **5a** is therefore ((CLOCK and (NOT (CLOCK)/2)) and the output of the AND gate **5b** is ((CLOCK) and (CLOCK/2)), the waveforms, which are applied to pulse-train gates **6a** and **6b**, being shown in **Fig.3c** and **Fig.3d**.

Trains of 5-30 kHz pulses are applied to drive amplifiers **7a** and **7b** alternately, with a small "off"-period during which no pulses are applied to either amplifier. The duration of each "off" period is dependent upon the original duty cycle of the clock timer **3**. The reason for the small "off" period in the driver waveforms is to prevent local corona arc as the phases change over each cycle.

The drive amplifiers **7a** and **7b** each use a BC182L transistor **10** (see **Fig.2**), small toroidal 2:1 pulse transformer **11** and a BUZ11 power-MOSFET **12** and apply pulse packets across the primary windings of their respective 25 kV line-output transformers **8a** and **8b** to produce an EHT ac voltage of high frequency at their secondary windings. The secondary windings are 'lifted' from system ground and provide, after simple half-wave rectification, the applied field for application to cell **20** (see **Fig.4**).

Cell **20** comprises a container **21** having walls **21a**, **21b** of electrically insulating material, e.g. a thermoplastics material, such as polymethyl methacrylate, typically spaced about 5 mm apart, and bipolar cell electrodes generally designated **22** and **23** and typically constructed from aluminium foil, positioned outside the walls **21a** and **21b**. Each bipolar cell electrode comprises a pair of electrode plates **22a** and **22b** (or **23a** and **23b**) for each side of the cell **20** separated from each other by an electrically insulating layer **24** (or **25**), e.g. of polycarbonate plastics material about 0.3 mm thick.

The electrode plates **22a** and **23a** form one set (set A) of electrode plates positioned on opposite sides of container **21** and the electrode plates **22b** and **23b** form another set of electrode plates positioned on opposite sides of the container **21**. An insulating layer **25**, e.g. of polycarbonate material, similar to the insulating layers **24a** or **24b** may be positioned between each bipolar cell electrode **22** (or **23**) and its adjacent container wall **21a**(or **21b**). A liquid electrolyte, preferably water, is placed in the container **21**.

In use, a train of positive pulses is applied to the electrode plates **22a** and **23b** and a train of negative pulses is applied to the electrode plates **23a** and **22b**. The timing of the pulses is shown schematically in **Fig.5**, which illustrates that, for set A (or for set B), whenever a positive pulse is applied to electrode plate **22a** (or **23b**), a negative pulse is also applied to electrode plate **23a** (or **22b**). However the pulses applied to the electrode plate set A are "out of phase" with the pulses applied to the electrode plate set B. In each train of pulses, the duration of each pulse is less than the gap between successive pulses.

By arranging for the pulses of electrode plate set B to be applied in the periods when no pulses are applied to the electrode plate set A, the situation arises where pairs of pulses are applied successively to the electrode plates of different sets of electrode plates, there being a short interval of time when no pulses are applied between each successive application of pulses to pairs of electrode plates. In other words, looking at **Fig.5**, pulses **P1** and **Q1** are applied at the same time to the electrode plates **22a** and **23a**. The pulses **P1** and **Q1** are of the same pulse length and, at the end of their duration, there is a short time period **t** before pulses **R1** and **S1** are applied to the electrode plates **23b** and **22b**.

The pulses **R1** and **S1** are of the same pulse length as the pulses **P1** and **Q1** and, at the end of their duration, there is a further time **t** before the next pulses **P2** and **Q2** are applied to the electrode plates **22a**

and **23a**. It will be appreciated that whenever a pulse of one sign is applied to one of the electrode plates of a set, a pulse of the opposite sign is applied to the other electrode plate of that set.

Furthermore by switching from one to the other electrode plate set the polarities applied across the container are repeatedly switched resulting in an "alternating" electric field being created across the "liquid dielectric" water in the container.