Table 1

Steam introduced in 1 m.^{3} air	Liquid condensed as cloud in 1 m.^{3} air (calc.)	Activity in condensate (counts per min.)	Activity on filter paper (counts per min.)	Efficiency with respect to filter paper
500 gm.	11 gm.	27·8 ± 1·7	0 ± 0·3	1·0
500 gm.	11 gm.	15·8 ± 1·3	0·5 ± 0·2	0·97
350 gm.	9 gm.	13·8 ± 1·4	0·9 ± 0·2	0·94
180 gm.	8 gm.	11·0 ± 0·7	0·7 ± 0·2	0·94
100 gm.	6 gm.	10·4 ± 0·8	3·9 ± 0·4	0·73
100 gm.	6 gm.	8·0 ± 0·6	2·9 ± 0·3	0·73

Room temperature ~35° C.
Amount of air used in each experiment ~5 m.^{3}

The still smaller aerosols are also efficiently removed since they get attached quickly to cloud droplets through Brownian motion. However, it may be desirable to cause condensation directly on the smallest aerosol by expanding the saturated air adiabatically. This is being done at present. It is clear that these condensation processes can be used to remove radioactivity from large quantities of air with a high degree of efficiency.

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Plasma Heating by Current-Saturation

SEVERAL attempts have been made (for example in *Zeta*[1], *Sceptre*[2], *Perhapstron*[3], etc.) to produce high-temperature plasma in a toroidal discharge by means of large induced currents. These experiments have shown that Joule-heating of the plasma by the induced electron current is inefficient. Increasing this current alone does not seem to be sufficient to produce the required high-temperature plasma for controlled fusion. On the other hand, it is observed in toroidal discharges that acceleration of ions takes place, as indicated by the anisotropy of neutron distribution[4] and by the Doppler shift of spectral lines[5]. Ion acceleration is possible[5] when ion-electron collision cross-section becomes small, a condition which sets in when the electrons begin to 'run away'.

Early estimates for the 'run away' condition[6] did not take into account the possibility of processes[7] that create this condition. Recent estimates[8] of the rate of production of 'run away' electrons show that large current densities due to 'run away' electrons can be built up within a fraction of a millisecond after the initiation of the discharge. (It may be pointed out that in the light of these experimental results and theoretical possibilities, it does not seem justified to use the usual arguments[9] to show that 'run away' cannot take place in these discharges. These arguments, which are applicable only to conservative systems[10], do not represent conditions in these discharges). Thus suitable conditions are created for acceleration of ions which produce neutrons in a deuterium discharge. These neutrons have been called 'false' or 'wrong' neutrons. Nevertheless, a high-temperature plasma which is in thermodynamic equilibrium may not be achieved in these discharges where the energy density of the applied electromagnetic field is even comparable with that of the plasma.

It is suggested here that the process which produces 'run away' ions may be exploited to increase the energy density of the plasma even though such a plasma is not in thermodynamic equilibrium. If one tries to increase the number of 'run away' ions by increasing the duration of the discharge or the magnitude of the applied field, the corresponding total current, which is mainly the electron current, becomes very large, with accompanying losses in the primary circuit and the magnetic cores. These losses could be reduced if the electron current could somehow be limited.

In a transformer when the primary current, say, increases, the secondary current also increases. In ordinary practice, there is a large number of electrons in the secondary conductor and the comparatively small velocity of the electrons, as determined by their mobility, is sufficient to satisfy the demand for current in the secondary. But, a secondary can be visualized, as in a toroidal discharge, where the number of available electrons is comparatively small. An increased demand in the secondary current can be satisfied only by the increase in velocity of the electrons. Now, if the current in the primary is continuously increased, the secondary current density, nev tends to an upper limit nec, where n is the number of electrons per cm.^{3}, e is the electronic charge and v is the velocity of the electrons, which tends to the velocity of light, c. Under this condition, the electron-ion collision cross-section[11], which is proportional to e^2/mv^2, rapidly decreases and the electron current tends to become decoupled from the ions, leaving the ions comparatively free to be accelerated. A situation can then be realized, if sufficient time is allowed, when, say, about half the ions 'run-away' and become accelerated to energies of several thousand electron volts and produce nuclear reactions with the slowly moving ions. Such an assembly of ions is somewhat equivalent to a one-dimensional gas at a very high temperature. It may not be possible to achieve this condition in the present machines. For example, in *Zeta*, with about 6×10^{16} electrons per cm. length of discharge, the saturation electron current would be about 3×10^8 amp., which is about a thousand times the actual current.

It should be emphasized that in this scheme the highly pinched relativistic electron beam[12] suggested for high-energy accelerators is not essential.

Calculations on some of the problems, such as the time for current saturation and ion acceleration, the requirements of the magnetic and electric fields, and the nuclear reaction-rate will be published elsewhere.

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