On a New Type of Expansion Apparatus

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All the reactions which are catalysed involve the movement of a hydrogen atom, and the breaking of a bond (although the decomposition of dimethyl ether, which can be formulated in this way, is not catalysed). In general the energy of activation of the catalysed reaction is very much lower than that of the uncatalysed reaction, and this energy, instead of being distributed through the whole molecule, appears to be placed in a part of the molecule where it can be efficiently used in breaking the bond. The existence of a dipole moment in or near the bond broken suggests that the selective energy transfers are favoured by polarization and attraction of the iodine molecule. Actual weakening of the bond and loosening of the hydrogen atom in the presence of the iodine must, however, be assumed also to play a part.

On a New Type of Expansion Apparatus.

By C. T. R. Wilson, F.R.S.

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The cloud-chambers hitherto used for the photography of tracks have all, so far as I am aware (with the exception of the Shimizu apparatus), been essentially of the same type. A definite volume change has been produced by the rapid motion of a piston or plunger (forming the "floor" of the chamber) which has been suddenly brought to rest by striking against a base plate. While the volume thereafter remains constant the pressure increases as the temperature within the chamber rises.

Whether a water, oil, or rubber "seal" is used to prevent leakage past the piston, rather exact workmanship is required in the construction of the apparatus; and the original form with the water-seal can hardly be used except with the axis vertical and with the plunger forming the bottom of the chamber.

In the apparatus now to be described the expansion is made by suddenly reducing the pressure from one definite value to another; the pressure thereafter remains constant while the gas expands as a result of the rising temperature.

The usual method of making the expansion by the sudden displacement of one end of a shallow cylinder avoids the stirring up of the air at the moment

of expansion. This form of the apparatus lends itself also to the maintenance of an approximately uniform electric field within the chamber.

In the new type of apparatus these advantages are retained by giving the cloud chamber a fixed " floor " of wire gauze through which a portion of the air escapes at the moment of expansion. The mechanism for allowing the pressure fall is attached to a second chamber separated from the cloud-chamber by this gauze partition. Any turbulent motion is prevented from reaching the cloud-chamber proper by the wire gauze partition, which also forms a convenient electrode for maintaining the necessary electric field. The necessary fall of pressure is effected by suddenly opening communication between the second chamber and the atmosphere or a large vessel at the desired final pressure.

If it is desired always to use the same gas in successive expansions, this gas is kept separate from the atmospheric air by a sheet of thin elastic membrane across the second chamber.

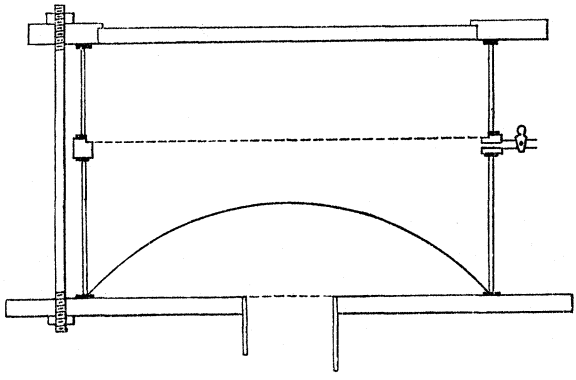

FIG. 1.

For the purpose of testing the working of this type of cloud-chamber the apparatus shown in fig. 1 was designed. It was constructed in the workshop of the Cavendish Laboratory by Mr. P. C. Ho. It is shown as used for working with a final pressure equal to that of the atmosphere. The cloud-chamber is about 16 centimetres in diameter.

Two glass cylinders, separated by a brass ring, to the top of which is soldered the wire gauze partition, are bolted together between the roof (a brass ring with a glass disc cemented into it) and the brass base plate. The base-plate has a central aperture to which is connected the mechanism for making sudden communication with the atmosphere. Rubber rings are inserted between the

glass cylinders and the brass plates or rings to make an air-tight seal. The wire gauze partition is of copper wire about 0·2 mm. in diameter, spaced 1 mm. apart. A piece of similar gauze was inserted over the mouth of the aperture in the base-plate with the object of damping the oscillations of the air column.

A sheet of thin balloon rubber is inserted below the lower glass cylinder; it is shown in the position it occupies when the air is in its compressed condition before an expansion.

The central brass ring which carries the gauze partition is insulated by the glass rings, so that the potential difference required for the removal of ions may be maintained between it and the rest of the apparatus.

The central ring is bored below the level of the gauze to receive two side-tubes, provided with stopcocks, for admitting gas and for connecting to a gauge for the measurement of the initial pressure.

The initial pressure is adjusted to the value required to give the desired expansion by pumping air into the space below the rubber sheet, while the communication with the atmosphere or low pressure chamber through the wide exhaust tube is closed.

The sudden expansion is effected by suddenly opening this communication by the same kind of mechanism as is used in the ordinary type of expansion apparatus.

After some preliminary tests made by Mr. Ho in the Cavendish Laboratory, the apparatus was further tested by Mr. Ho and Dr. E. C. Halliday at the Solar Physics Observatory by taking a number of track photographs. Arrangements for illumination and for timing the operations were in readiness for use with my old expansion apparatus, which was being applied by Dr. Halliday in an attempt to detect penetrating radiation from thunderclouds. The new experimental apparatus could easily be substituted for the old, and a number of photographs of tracks due to electrons ejected by X-rays and to α- and β-rays were obtained.

These photographs do not appear to be inferior to those obtained with the old apparatus. Further tests are being made on such points as the extent to which the expansion is oscillatory, and the best amount of damping to be introduced into the exhaust tube. But even without further improvements on the form described above, which is that of the original design planned to test the possibilities of the method, the apparatus is suitable for giving good track photographs.

The apparatus is extremely simple to construct, and admits of much greater

variations in shape or size than the older form, and it may be placed in any position.

It should be noticed that the thin rubber sheet is not really an essential part of the apparatus. If it is omitted, fresh dust-free air or gas has to be admitted after each expansion to replace that which has escaped. This may be a convenient method in certain circumstances, as for example, in experiments at low pressures.

One might ask whether there is any advantage, apart from practical convenience, in making the expansion consist in a definite volume change followed by an increase in pressure as the temperature rises, or in a definite pressure change followed by an increase in volume. So far as there is any difference, the advantage would seem, for certain purposes, to lie with the second method. For here the rise of temperature in one part of the cloud-chamber, due to heat conduction from the walls or condensation to form cloud, does not, as in the first method, cause simultaneous compression and consequent rise of temperature in the rest of the chamber; after an expansion a longer interval of time may therefore be available in which the super-saturation necessary for the production of sharp tracks persists.

It may finally be pointed out that the apparatus which has been described may be converted into one of the definite volume-change type with exceedingly light moving part by inserting the thin rubber sheet above instead of below the lower glass cylinder (*i.e.*, immediately below the wire gauze) and placing below it a perforated platform against which it is tightly pressed by a large excess pressure at the completion of the expansion; the rubber sheet, the initial position of which is varied according to the expansion required, takes the place of the moving plunger or piston of the older type of apparatus.

Summary.

A new type of expansion apparatus is described which is more easily constructed than the usual form, and is less restricted as to the size and shape and position of the cloud-chamber.