

of heat and the more the production of sonorous vibrations, for a greater number of air atoms will collide with warmed surfaces in a given time. That this assumption is justified is proved by the fact that this absorption of radiant energy renders the particles of dissociated nitrite of amyl and other vapours visible as well as warm, and therefore they can assume dimensions that are comparable with the particles of smoke.

II. "On the Limit of the Liquid State." By J. B. HANNAY, F.R.S.E. Communicated by Professor G. G. STOKES, Sec. R.S. Received February 22, 1881.

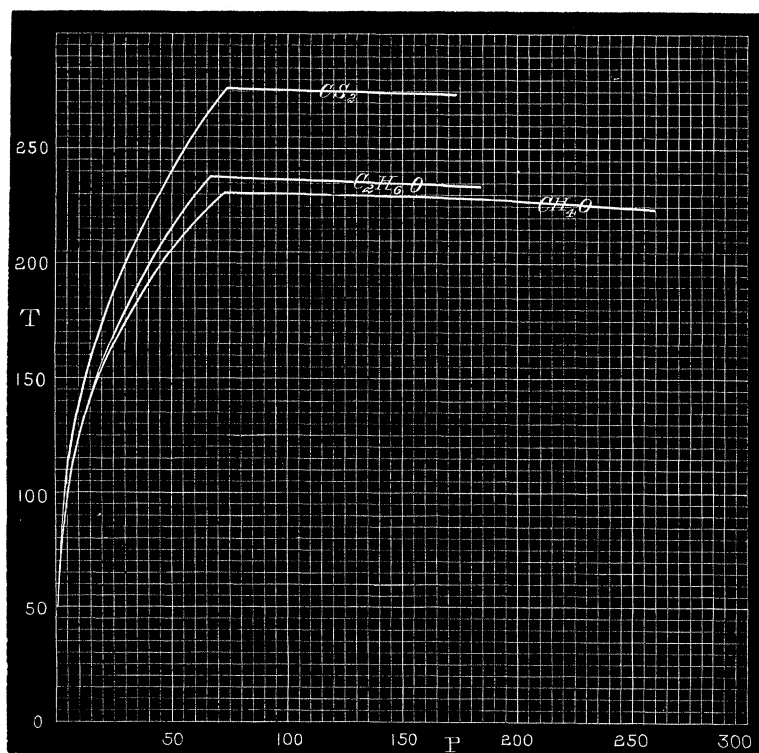
(Abstract.)

In this paper the author gives an extended account of the work undertaken to determine whether the liquid state extends above the critical temperature, or whether it is bounded by an isothermal line passing through the critical point, as had been indicated in a former paper. A large apparatus was constructed, with several improvements before described, details of construction being given in the full paper. It was found that manometers with small bores gave higher readings than those with larger internal diameter, so the manometers used were of the largest size compatible with the strength required to resist the pressure. The thermometers were carefully prepared by heating and cooling, and compared with the standard at Kew. All the usual precautions were taken to obtain accurate numbers. The critical temperature and pressure of the liquids were first determined accurately, and then a quantity of a gas insoluble in the liquid was compressed over the liquid, and the critical temperature again determined under increased pressure. When the densities of the two bodies, *e.g.*, alcohol and hydrogen, are far apart from each other, the gas shows no effect in lowering the critical temperature, as is the case with carbon dioxide and air, whose densities approach much nearer, but simply acts as a spring against which the upper surface of the alcohol bears, thus having a surface free for observation at pressures far above that of the vapour of the liquid. When the liquid passes the critical temperature at any pressure the meniscus is lost, and the fluid freely diffuses into the superincumbent gas, but this does not occur at temperatures below the critical, except where very high pressure has made the gas appreciably soluble in the liquid. Thus the curve of vapour tension, that is, the curve representing the temperatures at which a given pressure will produce liquefaction suddenly becomes isothermal at the critical point, and passes along the co-ordinate denoting the critical temperature.

As surface tension is the only property by which the liquid state

can be known, the capillary height of the liquid at various temperatures was next determined. The capillary height becomes zero at the critical temperature, and this is the case whether the pressure is the critical pressure or a higher one. Curves indicating the loss of capillarity with rise of temperature are given, and the observations repeated at higher pressures, the pressures being obtained by compressing hydrogen over the liquid. The surface tension is lowered a little by the action of the compressed hydrogen, but the change of

FIG. 1.

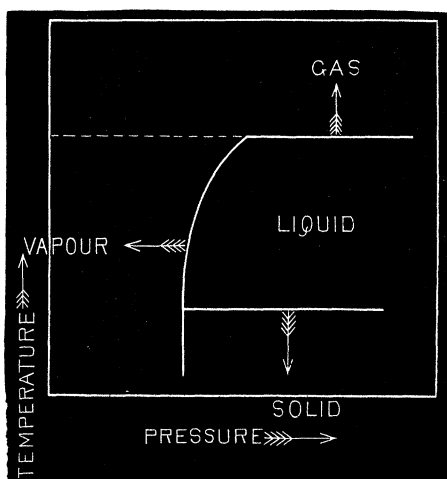


capillarity follows that of the liquid alone very closely, and the capillarity sinks to zero a few degrees below the critical temperature. Nitrogen may be substituted for hydrogen with the same results, and various other liquids being used—carbon bisulphide, carbon tetrachloride, and methyl alcohol. Curves are given, showing their behaviour under high pressures, as in the case of alcohol. In no case could any of the properties of the liquid state be found to exist above the critical temperature. The paper concludes: "Three

curves have been drawn to show the slight depression of the critical temperature with increase of pressure, and these lines have been continued down the curve of vapour pressure to show the break at the critical point." This will be clearly seen in the annexed fig. 1.

The consideration of these results yields a novel mode of looking at the states of matter which I have shown at fig. 2. From this, it appears we might classify matter under four states: First, the gaseous, which exists from the highest temperatures down to an isothermal passing through the critical point, and depending entirely upon temperature or molecular velocity. Second, the vaporous, bounded upon the upper side by the gaseous state, and on the lower by absolute zero, and depending entirely upon the length of the mean free path, because shortening of the mean free path alters the state. Third, the liquid state, bounded upon the upper side by the gaseous, and on the lower by the solid or absolute zero. Fourth, the solid state.

FIG. 2.



The gaseous state is the only one which is not affected by pressure alone, or in which the molecular velocity is so high that the collisions cause a rebound of sufficient energy to prevent grouping at any pressure. Another distinction between the gaseous and vaporous states is, that the former is capable of acting as a solvent of solids, while the latter has not that power.

The two conclusions arrived at are:—

“1st. The liquid state has a limit which is an isothermal passing through the critical point.

“2nd. The vaporous state can be clearly defined as a distinct state of matter.”

FIG. 1.

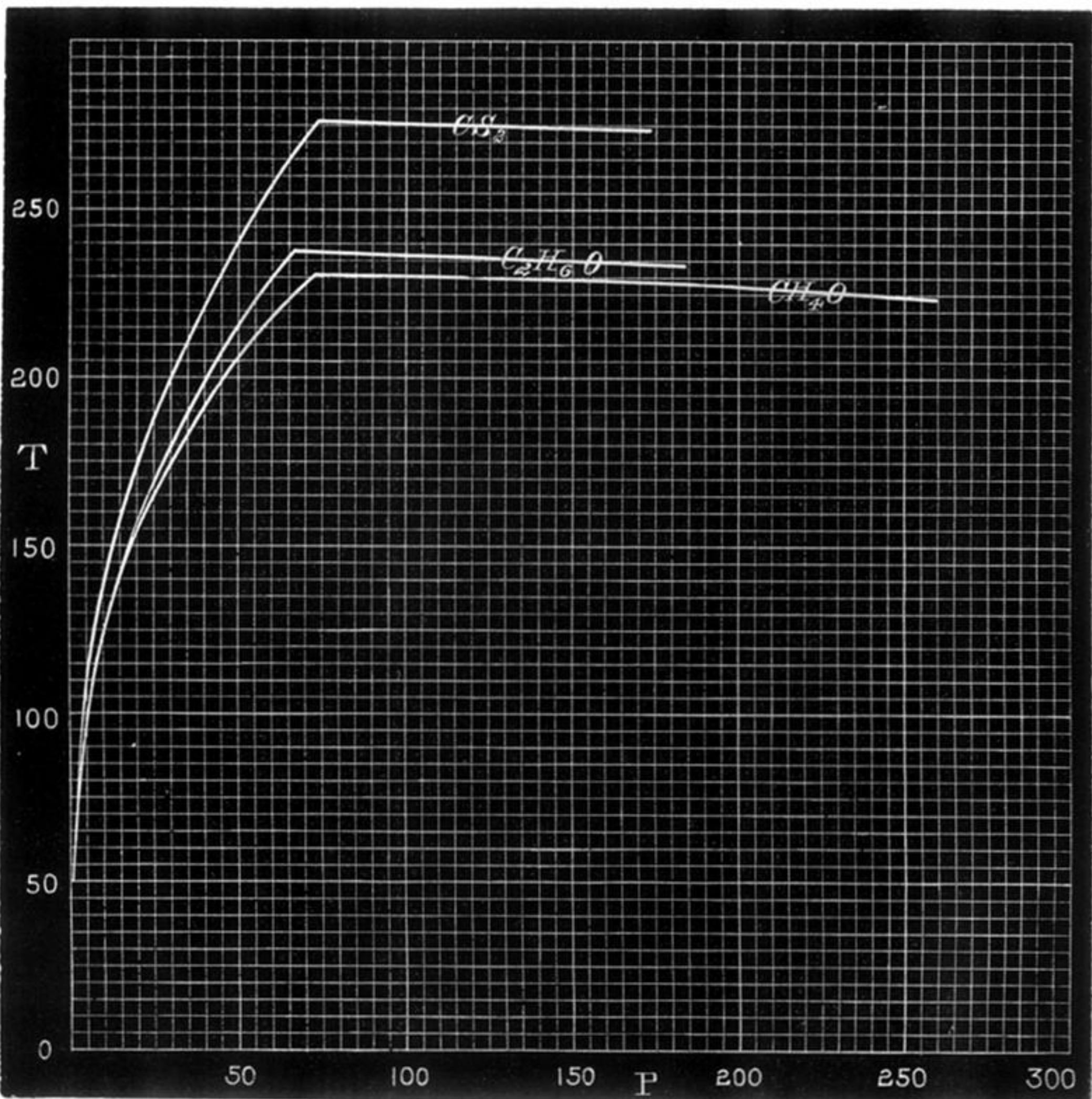


FIG. 2.

