arranged for observing or photographing any desired operations.

Reference has already been made to articles describing the construction of the air turbine. Some dimensions used in a typical apparatus include: diameter of wire, 0.5 mm; stator of 8 holes made with a No. 60 drill; 3 cm steel turbine with 30 flutings; 9 cm duralumin rotor weighing 450 grams and shaped as shown in the drawing; brass vacuum chamber $5\frac{1}{2}$ inches in diameter, $4\frac{3}{4}$ inches in height and wall thickness of $\frac{1}{4}$ inch.

The rotational speed is limited only by the strength of materials. The rotor just described exploded when the speed reached a little above 2,200 revolutions per second. At this speed approximately 12 cubic feet of air per minute (as measured at atmospheric pressure, room temperature) were being supplied to the turbine at a pressure of 70 lbs./in.^2 The maximum centrifugal force was approximately 900,000 times gravity. The linear speed at the periphery was over 2,000 feet per second, or nearly twice the velocity of sound in air. The kinetic energy of rotation was approximately 3.7×10^{11} ergs, which corresponds to about 8,800 calories.

The method described offers numerous advantages and opportunities for research. The apparatus is simple and inexpensive to build and to operate. Where compressed air is not available, it should be well adapted for operation with other gases or perhaps steam, since the main rotor and the driving mechanism can be easily thermally isolated and controlled. Also slower types of motors could be substituted for driving the rotor if necessary. The flexibility of the wire makes possible an extremely smooth and even rotary motion not usually obtainable otherwise. This, coupled with the fact that the rotation takes place in vacuo, makes the apparatus highly suitable for the centrifuging of solutions and suspensions, especially where the particles separate so slowly that convection currents in the liquid are apt to give trouble. The poor results of many high-speed centrifuge experiments can often be traced to very slight temperature gradients within the rotor which have been introduced through friction or some other external source. The new arrangement allows a considerable increase in both the capacity and the speed of an air-driven centrifuge.

In view of the foregoing facts, we believe the apparatus affords not only a most efficient centrifuge, but a means of investigating many different phenomena.

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A NEW METHOD OF DIFFERENTIATION OF AMYLASES AND STARCHES

In a communication in Science for October 5, 1934, p. 317, Grace E. Pickford and Frances Dorris have described a micro method for the detection of proteases and amylases. In this connection, it may be of interest to point out that the same method has been developed by the present writer for characterization of different amylases occurring in plant and animal, and that the results of the investigation have already been published in the *Journal of the Indian Institute of Science.*[1]

This method has been extended for the differentiation of various starches. In the course of an investigation on the hydrolysis of different starches by amylases, it was found that the color reactions produced with iodine by the different starches in the course of hydrolysis differ markedly with the kind of starch and also with the concentration of iodine used. These differences in colors obtained with iodine are made use of in the present method. Agar plates impregnated with starch were prepared by mixing equal parts of hot solutions of agar and starch, so that the total concentrations were 1 and 0.2 per cent., respectively, the resultant mixture being spread on a petri-dish and allowed to set. A drop of the amylase solution was then added to the agar plate and allowed to diffuse at the laboratory temperature for about 24 hours. At the end of the period, the starch agar plate was stained with dilute iodine solution (N/100) and the colored zones obtained were observed. The color zones produced differ with different starches and also with the type of amylase used.

In Table I the color zones obtained by different

TABLE I

Starch	Color zones	
	Taka-diastase	Salivary amylase
Potato	Light-green zone surrounded by a violet ring	Colorless zone
Sweet potato	“ “ “	“ “
Rice	Blue zone surrounded by a violet ring	Narrower blue zone
Maize	Central violet zone with a bluish violet zone surrounded by a violet ring	Violet zone
Wheat	“ “ “ “ “	“ “

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[1] K. Venkata Giri, *Jour. Indian Inst. Sci.*, 17A: 127, 1934.

starches by using taka-diastase and salivary amylase have been described.

The amylases used in the present investigation were taka-diastase, 0.5 per cent. (Parke, Davis and Company) and salivary amylase (human saliva centrifuged and diluted 10 times).

From the data given in Table I, which is only a rough indication of the color zones obtained with several starches, it can be seen that tuber starches can be easily differentiated from those of cereals, as the latter give deeper and more differently colored zones than those of tubers. Amongst cereal starches wheat and maize give violet-colored zones. Thus the method affords an easy way of identifying the common starches adulterated in foodstuffs, particularly when the starch is cooked and its structure destroyed, in which case there is no method available in literature for its identification. With the help of a colored chart prepared by the analyst for a number of starches it is possible to identify the individual varieties, whether cooked or otherwise, in which latter case the method is a good supplement to the conventional microscopic method.

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SPECIAL ARTICLES

THE SIGNIFICANCE OF THE PERSISTENCE OF THE CRYSTALLINE STATE ABOVE THE MELTING POINT[1]

THE purpose of this paper is to show that the application of Boltzman's law allows the original objectives of van der Waals to be more effectively pursued. Additional gains in our understanding of liquids are also made thereby. The process of vaporization may be readily visualized on the basis of kinetic theory and by this means Trouton's rule is readily derived. This holds approximately for liquids except those boiling at very low temperatures. One is accustomed to regard the process of fusion as one formally similar to evaporation, each representing a kinetic exchange process across an interface at which an amount of energy is given up by or imparted to molecules crossing the interface. One might expect, therefore, that a Trouton's rule might govern the melting point. For ''monatomic'' substances, there is a rough approximation to this, but it is not even approximately true for more complex substances. The explanation of these facts must be that in the process of fusion, molecules do not pass over into a state which remains unchanged with increase in temperature until the boiling point is reached, but that the process of fusion represents but a partial breakdown of the crystalline structure. The failure of the van der Waals equation arose from the application of the misconception that molecular forces are of long range, instead of very short-range forces as we now know them to be. De Bye and Keesom, by applying the idea of short-range forces and the well-established Boltzman equation, obtained the expression

$$\overline{U}\rho = \frac{N_A^2}{V}\int \varepsilon(r)e - \frac{\varepsilon(r)}{kT}\ dV$$

for the average energy added to the internal energy of a gas containing N_A molecules in volume V, ε(r) being the potential energy of two molecules at distance r apart. k is the Boltzman constant. (See Herzfeld's chapter on imperfect gases and the liquid state in Taylor's ''Treatise on Physical Chemistry,'' 2nd edition. van Nostrand Company, 1931.) This equation reduces to that of van der Waals at high temperatures. It is equivalent to the precise equation of state of Onnes. This treatment accounts for deviations from the perfect gas law, not through long-range forces, but through the formation of clusters of molecules. In 1923 C. V. Raman (*Nature,* pp. 428, 532, 1923) utilized a similar idea to account for the viscosities and the temperature coefficient of the viscosities of liquids,

$$\eta_{liq.} = \eta_{vap.}e^{\frac{F}{RT}}$$

where $\eta_{liq.}$ is the viscosity coefficient of the liquid, $\eta_{vap.}$ is that of the vapor and F is the heat of fusion. The perfection of the fit of this equation is very striking for most liquids of not too great complexity. However, the supposition that the energy term F is to be identified with the heat of fusion for all substances is not borne out, and from the foregoing discussion of the process of fusion, this is not surprising and does not condemn the more fundamental elements of Raman's theory. Furthermore, η should be the viscosity of the ideal liquid rather than of the vapor. A large amount of evidence has been accumulating from other quarters to support Raman's concept of the nature of a liquid, which may be consolidated with the present uniform view of the organization of matter. This evidence was reviewed in the 1933 discussion of the Faraday Society on ''Liquid Crystals and Anisotropic Melts.'' There should be mentioned: (a) The x-ray investigations of G. W. Stewart, which led him to believe that ordinary liquids consist chiefly of orderly arranged aggregates of molecules but also in part of molecules having a much more random distribution. (b) The work of Ornstein and his collaborators, who arrived at a similar view of the structure of liquids through investigations of dielectric losses, measurements of dielectric constants in magnetic fields and x-ray investigations of liquids in electric and magnetic fields. (c) And that of Bernal and Fowler (*Jour. Chem. Physics,* I, 515, 1933) on the nature of water. Diffusion coefficients and viscosity coefficients of liquids are related to each other in a reciprocal fashion in accordance with the Einstein-

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[1] Read before the National Academy of Sciences, Cleveland, November, 1934.