the secret of such magic mirrors, then accidentally made, and how he had demonstrated their manufacture as a possibility. In honor of this discovery the university annual published by the students of Ohio University was called *Makio,* which, I am told, is Japanese for magic mirror.

JOHN KAISER

MARIETTA, OHIO

SCIENTIFIC APPARATUS AND LABORATORY METHODS

HIGH ROTATIONAL SPEEDS IN VACUO

THE need for some simple, inexpensive method of producing high rotational speeds in vacuo has frequently been felt in many fields of experimental science. The air-driven ultracentrifuge has been adapted to supply such a demand. A brief description of its basic features may prove of value.

The rotating member consists of three main parts: (1) a small, conical, air-driven, air-supported turbine;[1] (2) a much larger and heavier rotor of any desired shape, which spins in the vacuum chamber; (3) a steel piano wire extending vertically downward along the axis of rotation from the vertex of the turbine above the vacuum chamber to the larger rotor which it supports and drives. A cross-sectional view of the rotating member, the turbine stator and the cylindrically shaped vacuum chamber is given in Fig. 1. The wire enters the chamber through a special type of brass gland with two holes that leave very slight clearances. Viscous oil slowly forced by a gravity feed into these clearances both lubricates the gland and serves to make it vacuum tight. This lubrication and the small diameter of the wire reduce friction losses to a negligible amount.

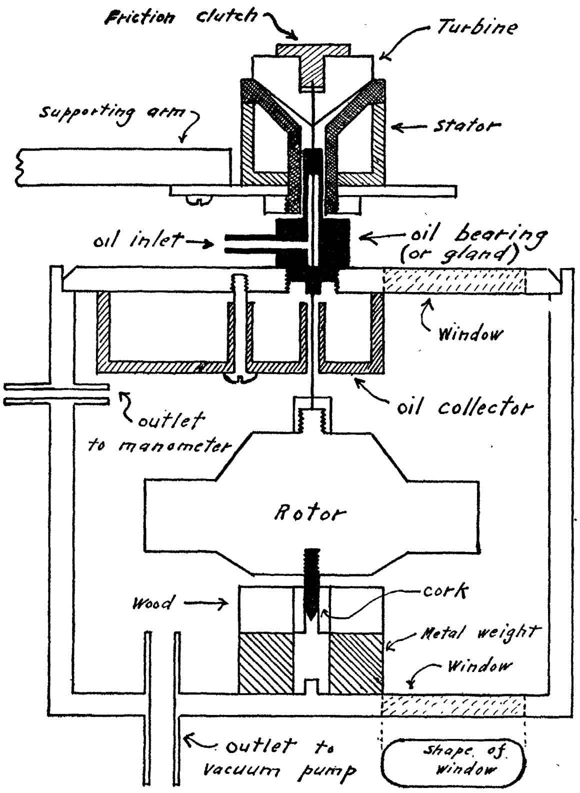

FIG. 1.

To prevent sudden accelerations or decelerations from excessively twisting the wire, it is not fastened to the turbine proper, but passes through a small hole along its axis and is clamped to a friction clutch. The stator is supported by three arms made of light, stiff strips of channel brass, each flexibly mounted and about 6 inches in length. They are provided with ample adjustment for centering, raising or lowering the stator. Fastened to the top, inside the vacuum chamber, is a circular, cup-like container to collect any oil leaking from the gland. A very small disk (not shown in the drawing) attached to the wire just below the gland will throw this oil into the collector and prevent its reaching and clouding any windows in the apparatus. Below the rotor is a circular block composed of metal, wood and cork and arranged as shown in the figure. The rotor is supplied with a steel tip fitting loosely enough into the cork for friction to be negligible. The block is free to move about on the floor of the chamber within a limited range so that it will automatically settle into the correct position when the rotor is spinning. It is heavy enough, however, to prevent undesired precessions from being set up by the rotor.

The rotor becomes vibrationless soon after the turbine is started and the air pressure has been raised sufficiently to support it. It might be noted that great precision in machining and balancing the rotor is not essential, as was well attested by the smoothness with which a 3-inch steel rotor spun after having a $\frac{1}{4}$-inch hole drilled near the periphery. An air turbine weighing less than 50 grams will rotate an 800 gram rotor at a speed just slightly less than that of the turbine alone. The unguided sections of the wire are not long enough to permit objectionable standing waves being set up. The vacuum obtainable is apparently limited only by the slight vapor pressure of the oil. Oil consumption in the gland amounts to less than 1 cc per hour. In stopping the rotor, wear on the turbine and stator can be minimized by lowering the stator and allowing the rotor to drag on the wooden block below it. Windows are conveniently

[1] See Beams, Weed and Pickels, SCIENCE, 78: 338, 1933; *Journal of Chemical Physics,* 2: 143, 1934.

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.

E. G. PICKELS
J. W. BEAMS

ROUSS PHYSICAL LABORATORY
UNIVERSITY OF VIRGINIA

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	" " " " "	" "

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