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INDUSTRIAL SCIENCE LOOKS AHEAD[1]

By DAVID SARNOFF

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INDUSTRIAL science at war is shaping a new world. While the battlelines of the United Nations encircle the Fortress Europe and the pincers of Victory tighten on the enemy in the Pacific, civilization advances ever closer to the post-war horizon. With Victory will come the day when the scientific instruments and processes of war will turn abruptly to peace. Machines and tools, as well as industrial and economic thinking, will be converted quickly from the demands of war to the needs of peace. Industry will be called upon to relieve the strains of war with utmost speed by ministering anew to human welfare, health and comfort. Already post-war planners are at work in many fields of industrial endeavor.

But it is not new for American industry to be surveying and planning for the future. That process is always at work here, whether the world is at peace or at war. Only by advanced thinking, research, engineering and continual pioneering, can industrial science put new ideas into action. By doing this, industry serves its workers and the people, and thereby wins the right to survive.

We have but to consider some of the outstanding wartime developments of industrial science to realize their widespread applications in all fields; from automobiles to giant turbines and diesel engines, from cameras to facsimile and television. Endlessly, these advances extend into every realm of our daily lives. Among the promises of better living we are told of new plastics, light metals, synthetic textiles, high-octane gasoline, artificial rubber, luminescent lighting, air-conditioning, dehydration of foodstuffs and many other innovations. We even hear of glass flatirons and plastic lenses. We are promised revolutionary changes in homes, aircraft, communications, ships, railroads, automobiles, highways, clothing and foods. In myriad ways the wartime inventions in electricity,

[1] Address before the Lancaster Branch of the American Association for the Advancement of Science, delivered at Franklin and Marshall College on November 11, 1943.

resolution of structural detail by the electron beam the thickness must be only one one-hundredth as great, or about 0.1 micron. Such a section thickness would lead from gross tissue and cell structure into the realm of cellular elements. Unless such a thin section is produced, the electron beam furnishes us only with silhouette images. Those images may be large and striking but are of limited value.

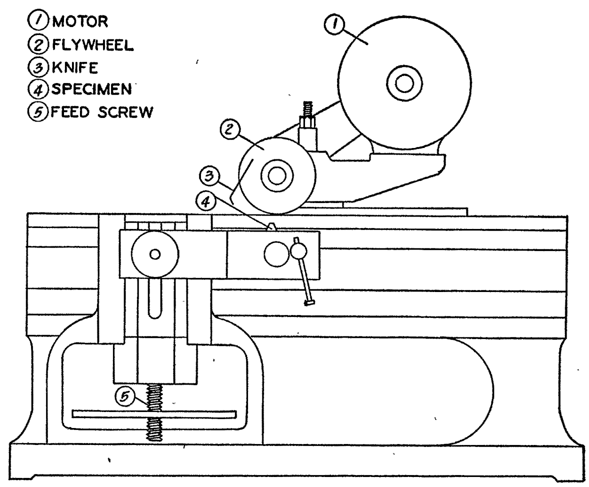
It has been obvious since the invention of the electron microscope that new methods of histological and cytological techniques must be discovered. With the finest of modern microtomes, it is possible to procure sections of biological material of approximately one micron in thickness. Such sections are produced only with great difficulty, and are ten times too thick to be used in electron microscopy. Some success has attended the production of thinner sections by the so-called wedge technique. The difficulties and irregularities accompanying this technique have been almost insurmountable.

To overcome these difficulties and in order to produce uniformly thin sections suitable for electron microscopy, a new feeding arrangement and rotary knife has been developed. In this new microtome the specimen is constantly moved toward a rotary "Cyclone" knife revolving at 10,000 r.p.m., or faster, the edge describing a circumference of eight inches. At 12,500 r.p.m., the blade is traveling 100,000 inches per minute which is about 1,000 times as fast as ordinary microtome movement. The advantage of this speed is apparent when the inertia of the specimen is considered, since at high speeds, strain distribution is localized at the knife edge. Limited stress distribution at high speed more readily overcomes the shearing force of the material and, in effect, a thinner stress plane exists ahead of the knife edge. We may liken the effect here to that of a rifle bullet striking a plane of glass. Only a small hole is produced; the whole glass plane will not be broken. For a given force and work expended on the specimen block, its consequent deformations are minimized by the short period of knife contact. The contact period is of the order of only 0.0001 second.

In sectioning, the properties of the tissue or other material must be considered; plastic flow, hardness, coefficient of thermal expansion, etc. With high-speed cutting plastic flow does not occur. The thermal expansion effect when sections are made with this high-speed knife is negligible. In view of this, material may be sectioned *in toto* without embedding, or sectioned in softer media, or frozen to lesser degrees than in ordinary techniques.

The 0.1 micron sections cut with the high-speed knife fly out at a tangent and are dispersed in the air. They may be collected on collodion films or other films mounted on the usual electron microscope screens held near the knife.

The accompanying drawing and description will show something of the general nature of this instrument. Arrangement has been made to feed the specimen up to the knife by means of a micrometer feeding



"CYCLONE KNIFE" MICROTOME

FIG. 1. The motor (1) as shown in the figure is a high speed, 10,000 R.P.M., 1/14 horse power motor. A flywheel (2) of Duraluminum, $\frac{1}{2}'' \times 2''$, supported by a $\frac{1}{4}''$ shaft rotating on preloaded ball bearings and pulley-driven to revolve at 12,500 R.P.M. The edge of the knife (3) which is bent to decrease the cutting angle describes a circumference of 8 inches. A feed screw (5) has 50 threads per inch. When turned by the feed wheel at approximately 2.5 R.P.M., 0.1 micron sections may be cut from specimen (4).

mechanism. The knife is revolved by means of a motor which may be slid along the top of a sliding microtome block.

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BOOKS RECEIVED

CREIGHTON, H. JERMAIN. *Principles and Applications of Electrochemistry.* Illustrated. Pp. ix + 477. John Wiley and Sons. $5.00.

DANIEL, GLYN E. *The Three Ages. An Essay on Archaeological Method.* Pp. 59. Cambridge University Press and Macmillan.

GRAY, GEORGE W. *Science at War.* Pp. xi + 296. Harper and Brothers. $3.00.

JAMIESON, GEORGE S. *Vegetable Fats and Oils.* Pp. 508. Reinhold Publishing Corporation. $6.75.

JACOBS, DONALD H. *Fundamentals of Optical Engineering.* Pp. 487. McGraw-Hill Book Company. $5.00.

OLSEN, ALLEN L. and JOHN W. GREENE. *Laboratory Manual of Explosive Chemistry.* Illustrated. Pp. vi + 106. John Wiley and Sons. $1.75.

PITLUGA, GEORGE E. *Science Excursions into the Community.* Illustrated. Pp. viii + 154. Bureau of Publications, Teachers College, Columbia University. $1.75.

THAT'S what most research workers are trying to find out —what factors underlie the "better" characteristics. For example, what happens when carbon is added to rubber? Why do different kinds of the same substance—carbon black, for instance—react differently when added to the same rubber mixture? If the answers to these questions were more exactly understood, it might be possible to develop still better rubber. The RCA Electron Microscope—with its enormous resolving and magnifying powers—is a logical approach to the study of these problems.

Why do sulfa drugs work? What do they do to germs? Why? What does this suggest? The RCA Electron Microscope offers fascinating possibilities to bacteriologists.

Why does one pigment have greater "hiding power" than another pigment apparently similar? Why are elastomers elastic? What is the secret of the strength of certain fibers? What more can we learn from crystalline structures? Why does chromium make "stainless steel" rust-proof? How do detergents—"wetting" agents—work?

Science knows part of the answers. But much remains to be learned. The RCA Electron Microscope is an ideal tool for such researches. This amazing instrument, by using electrons instead of light for illumination, has 50 to 100 times better resolving power than that of microscopes dependent upon light. This means that with the RCA Electron Microscope the research worker can see particles and details 50 to 100 times smaller (permitting useful magnifications of 100,000 diameters and more), since the high voltage electrons employed have a wavelength that is more than 50,000 times shorter than that of visible light.

Write for data and literature about this remarkable instrument, installed in important scientific and industrial laboratories, and serving the armed forces. Address inquiries to RCA Victor Division, RADIO CORPORATION OF AMERICA, Camden, New Jersey.

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