February 1937

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THE TABULAR VIEW

MAIL RETURNS

HOW many women read The Review; how many are interested in science news and the impact of technology on modern life? We have often wondered and in divers ways sought an answer. Here, unsought, is one woman's answer, fresh from York, Pa.:

To THE EDITOR: Please accept the thanks of an electrical engineer's wife for the not-too-technical articles you publish in The Review. You see, my college training was in classics; consequently, my scientific knowledge is very general, mostly vague. Now that I am surrounded by things scientific, your articles are a great help. If, for example, the conversation goes astronomical, at least I have read about the expedition to Ak Bulak [The Review, November, 1936] and can sit and listen with a slight glimmer of intelligence in my eyes. You know how a woman hates to be completely in the dark . . .

I am so glad that you printed the article, "Technics and the Woman" [The Review, January, 1937]. The author expresses my own feelings, as I never could, and I believe the women of my acquaintance would second those opinions. There is rarely an issue in which there is no article that I can enjoy; The Trend of Affairs and The Institute Gazette I always read. Continue to make The Review interesting to us laywomen and when the subscription fee comes up in the family budget, both budgeteers will assent with loud and hearty ayes.

HELEN MCCAA (MRS. J. R.)

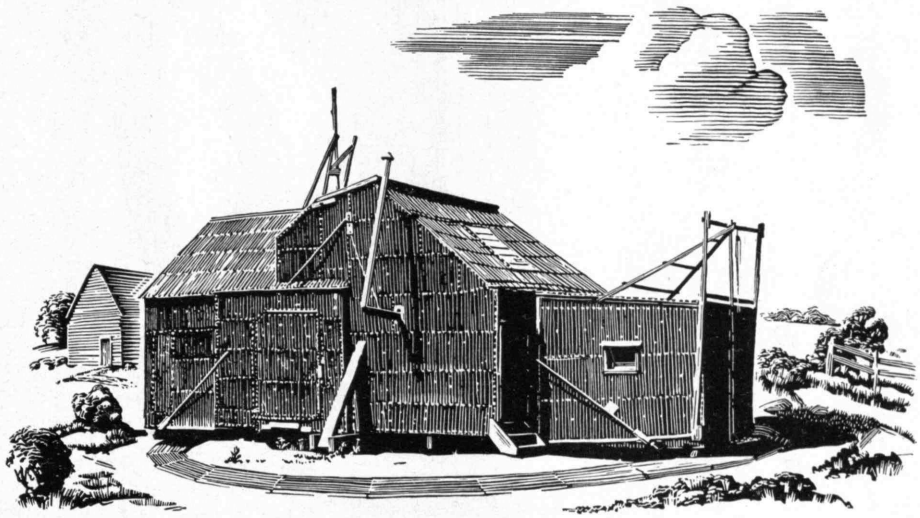
May the ayes have it!

CONTRIBUTORS

IN the great development of America's petroleum industry ROBERT E. WILSON, '16, has played an important part. Trained as a chemical engineer, one-time associate professor of chemical engineering at the Institute, he became, in 1931, director and vice-president in charge of research and development of the Standard Oil Company of Indiana. At the present time he is vice-chairman and director of the Pan American Petroleum and Transport Company and a director of five associated companies. As the author of more than 50 scientific papers and as the holder of many patents on chemical and engineering processes, he is amply qualified to discuss our patent system and the forces that tend to impede or accelerate scientific advances. His article on page 147 was presented originally as an address at the 100th anniversary of the United States Patent Office. ¶ S. PAUL JOHNSTON, '21, is editor of *Aviation*. A recent European trip afforded him many opportunities to observe aeronautical developments abroad and his text and pictures on pages 150 and 151 are the result of this tour. ¶ FREDERICK G. FASSETT, JR., is assistant professor of English at the Institute and a frequent contributor to The Review. His collaborator, PAUL C. EATON, '27, is a colleague of Professor Fassett's in the Department of English. ¶ F. S. LINCOLN, '22, who contributed the cover of this issue of The Review, is recognized as one of America's outstanding architectural photographers. His sunset picture is one of a series of remarkably successful attempts to capture some of the "incredible splendor" of Mont St. Michel.

THOMAS A. EDISON

Creator of Markets



Dubbed by the Edison staff "Black Maria," located in the Edison Laboratory grounds at West Orange, N. J., this unpretentious structure of wood frame, covered with black roofing paper, and set on a pivot so that it could be swung around with the sun, was the first motion picture studio. From this humble birth grew the lavish splendor of the world's most romantic billion-dollar industry!

THE invention of the motion picture camera by Thomas A. Edison made possible the practical adaptation of the flexible tapelike film and laid the foundation for today's glamorous billion-dollar industry. Manufacture of motion picture films now consumes approximately 95% of all silver used in the chemical industry—nearly one-third of all silver produced in the United States.

When Thomas A. Edison opened the first central station for the distribution of electric power, he also laid the foundation for vast world markets for copper, lead, zinc, coal and many other commodities. Today the copper industry looks to the electrical industry for its largest consumer and lead used for cable covering and Storage Batteries now accounts for more than 40% of domestic consumption.

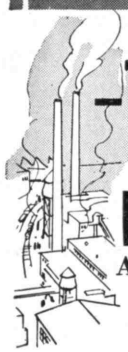
THOMAS A. EDISON, INCORPORATED

West Orange, N. J.

Edison Storage Batteries
Edison Primary Batteries
Edison Dry Cells
Edison Nursery Furniture
Edison (Portland) Cement
Ediphones . . for dictation

Edison Emark Batteries
Edison Electrical Controls
E-K Medical Gas
Edison Ignition Coils
Edison Spark Plugs
Edison Splitdorf Magnetos

-THE FRIEND ALL INDUSTRY WELCOMES



FOR nearly a quarter-century the men who run America's mills and mines and factories have thrown open their doors to the G. T. M.—Goodyear Technical Man. Long ago they discovered that the G. T. M.'s mission was to serve them in their endless fight for greater efficiency and economy. They came to know him as a friend who spoke their language; a practical man who could listen intelligently to their difficulties and understand their specific needs in mechanical rubber goods.

They liked him because he did not pretend to know it all; because he went out into their plants to learn exactly what superintendents, foremen and mechanics wanted in performance; because he carefully analyzed every stress and strain, torque and tension, to determine the construction that would best deliver that performance. And over two decades' experience has proved to them that the G. T. M.'s careful specifications and Goodyear's vast skill in compounding rubber to withstand any operating condition mean great savings—both in longer-wearing mechanical rubber goods and lower operating costs. That is why industry welcomes the G. T. M. as a friend—a friend whom it will pay you to know!

To bring the G. T. M. to your office just send the word to Goodyear, Akron, Ohio, or Los Angeles, California—or the nearest Goodyear Mechanical Rubber Goods Distributor.

THERE'S A GOODYEAR BATTERY NOW!

THE GREATEST NAME IN RUBBER

GOODYEAR

BELTS · MOLDED GOODS · HOSE · PACKING · MADE BY THE MAKERS OF GOODYEAR TIRES

Cable-length view of Columbia Broadcasting System's 625-foot vertical radiator, Wayne, N. J.

THE TECHNOLOGY REVIEW

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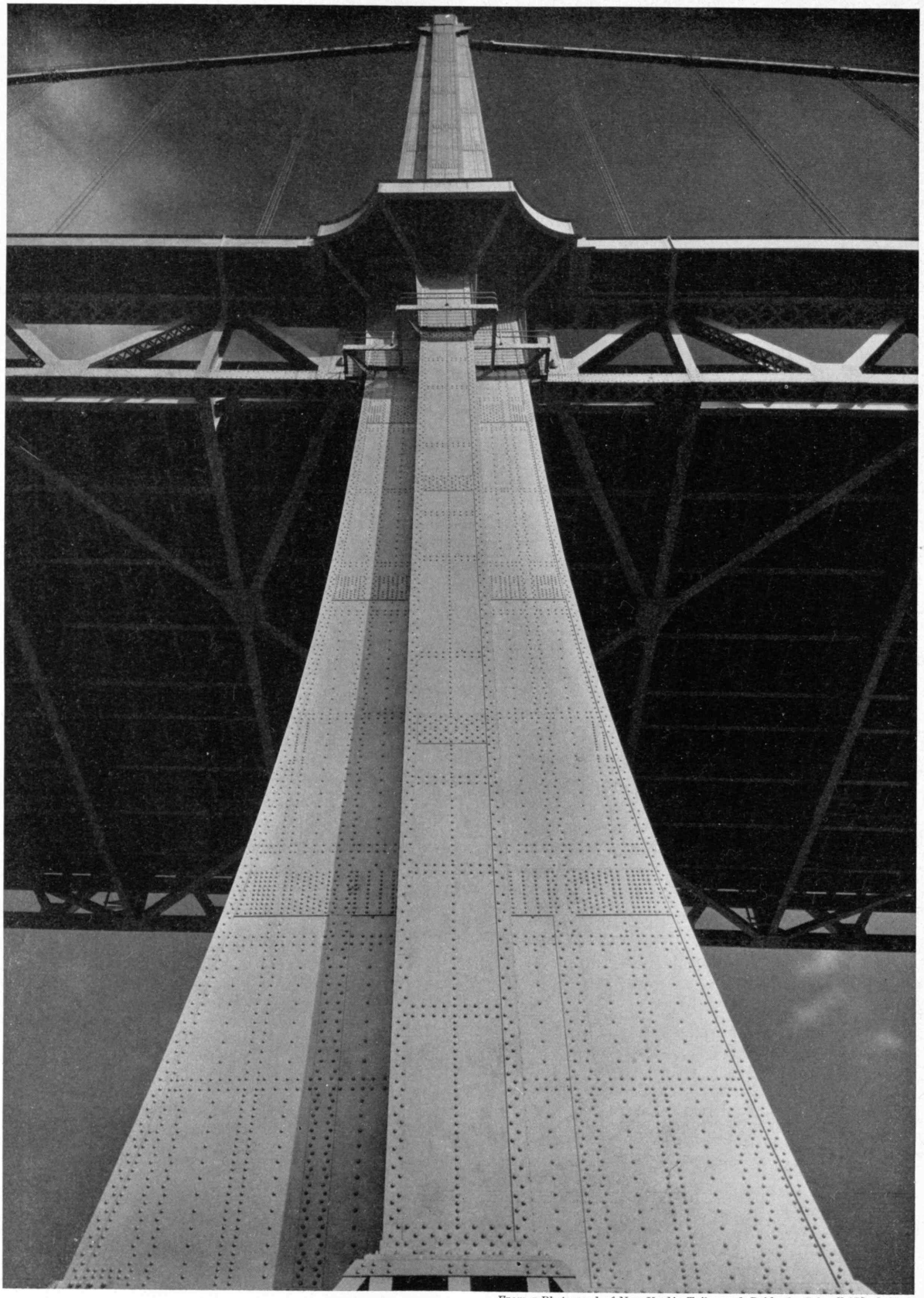
THE COVER

TOUR GABRIEL, MONT ST. MICHEL, FRANCE
SILHOUETTED AGAINST THE SAND AND THE SEA OF THE NORMAN COAST
Copyright by F. S. Lincoln, '22

PUBLISHED MONTHLY FROM NOVEMBER TO JULY INCLUSIVE ON THE TWENTY-SEVENTH OF THE MONTH PRECEDING THE DATE OF ISSUE AT 50 CENTS A COPY. ANNUAL SUBSCRIPTION $3.50; CANADIAN AND FOREIGN SUBSCRIPTION $4.00. PUBLISHED FOR THE ALUMNI ASSOCIATION OF THE M.I.T. DONALD G. ROBBINS, PRESIDENT; C. A. SAWYER, JR., H. B. RICHMOND, VICE-PRESIDENTS; CHARLES E. LOCKE, SECRETARY; J. RHYNE KILLIAN, JR., TREASURER. PUBLISHED AT THE RUMFORD PRESS, 10 FERRY STREET, CONCORD, N. H. EDITORIAL OFFICE, ROOM 11-203, MASSACHUSETTS INSTITUTE OF TECHNOLOGY, CAMBRIDGE A, MASS. ENTERED AS SECOND-CLASS MAIL MATTER AT THE POST OFFICE AT CONCORD, N. H. THREE WEEKS MUST BE ALLOWED TO EFFECT CHANGES OF ADDRESS. BOTH OLD AND NEW ADDRESSES SHOULD BE GIVEN.



From a Photograph of New York's Triborough Bridge by Schnall (Black Star)

SOARING STEEL

THE
TECHNOLOGY
REVIEW

Vol. 39, No. 4

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The Trend of Affairs

No Resistance At All

NOW that physicists have more or less conquered the problem of atomic structure, they have divided their forces and are pushing the further attack in opposing directions. One group is advancing in the direction of still finer detail and is prying open the nucleus to see what makes it work. The other group is proceeding to large-scale phenomena, studying the social behavior of atoms when they are combined to make molecules, or liquids, or solids. Armed with the growing knowledge about the habits of atoms, these investigators are turning back to a study of everyday things — bricks and steel and rubber and oil — a study more searching and much more effective than was possible in the pre-quantum days. Already the results indicate the immense practical value of the research.

At present the study has just begun and only the simplest of atomic communities, the crystals, have been investigated in detail. The crystal, because of its regularity, is in many ways simpler in structure than a single complex molecule or than a liquid. In particular the metal crystal, composed of only one kind of atom, has been studied in some detail. There already exists a fairly voluminous literature on the relation of the structure to the properties and idiosyncrasies of metals: their strength, their specific heats, their optical properties, and so on. Some start has been made toward explaining why the electrons in some metals are foot-loose wanderers and in others are family men, resisting being pressed into service to carry electric current. It is beginning to be clear why so few metals are strongly magnetic. A start has even been made on the alloys.

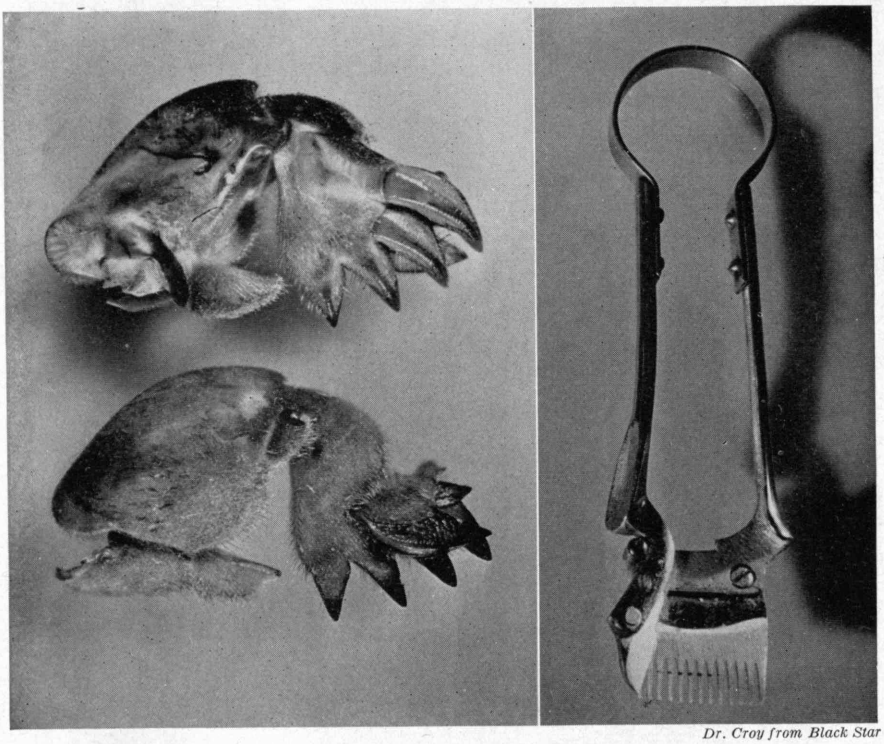
In connection with these studies, a number of predictions have been made as to the behavior of metals at temperatures near the absolute zero, −273.1 degrees C. At these low temperatures the atoms cease their random vibrations and the crystal becomes as nearly perfect as it can be. The specific heat falls to exceedingly low values, less than a thousandth of its value at ordinary temperatures. Since the atomic jostlings are diminished, the wandering electrons are less impeded and the electrical resistance is reduced. Most of these predictions have been verified by the measurements made at very low temperatures during the last few years.

In one important respect, however, the measurements made at low temperatures did not accord with theoretical predictions. It had been predicted that the electrical resistance would diminish smoothly as the temperature decreased, to become zero at absolute zero. The measurements showed another behavior, more interesting and more puzzling: As the temperature was reduced, the resistance fell; first smoothly, as the predictions would have it; then, at some critical temperature, it suddenly vanished completely. This state of no resistance is called the superconducting state. Current, once induced in a loop of superconductive wire, persists indefinitely without any diminishing of intensity. If a magnetic field is produced inside a hollow piece of ordinary metal and the temperature lowered below the transition point, the field inside the superconducting metal is "frozen in"; a change in the field outside hardly affects it.

These bewildering phenomena had not been expected and are not yet fully understood. Recently Professor J. C. Slater, Head of the Physics Department at Technology, has suggested a plausible explanation. Ordinarily the electrons which carry the current are individualists, wandering through the metal and colliding with the metal atoms, but paying little attention to each other. This state of affairs explains the ordinary resistance of metals. Professor Slater has shown that it is possible for the electrons to be in another state, a coöperative

one somewhat analogous to the magnetic state in iron. In this state the electrons help each other along, and thereby may manage to avoid the collisions with metal atoms which cause the resistance. This state is possible only at low temperatures, for it requires the coöperation of all the electrons, and any large temperature motion of the atoms would jostle one or more electrons loose, thereby destroying the coöperation completely. This explanation seems to be the correct one, although its consequences need further investigation before a final decision can be made.

It is research such as this that will demonstrate the value of a thorough knowledge of atomic structure as an aid in unraveling the practical problems of matter in bulk and will ultimately confound the critics of atom splitting. It is evident now that a knowledge of such abstruse things as electron spin and the exclusion principle is necessary for the complete understanding of such practical problems as the ferromagnetism of Heusler's alloys and the toughness of steel.



Dr. Croy from Black Star

Remarkable Alloy

ONE of the most interesting of the new alloys is beryllium-copper, made from one of the oldest metals and one of the newest ones. Beryllium occurs in the mineral beryl, of which mineral emerald and aquamarine are well-known varieties. It is a light metal — density, 1.84 — lighter than aluminum, which has a density of 2.70. It is much harder than aluminum and will, in fact, scratch steel. It needs a high temperature to melt it (1,350 degrees C.), whereas aluminum melts readily at 659 degrees. (Iron melts at 1,533 degrees; gold, at 1,063 degrees.) Commercial beryllium-copper contains 2.0% to 2.25% of beryllium. It is ductile and malleable and can be cold worked or hot worked. After all of the forming operations are completed, articles made from beryllium-copper can be hardened and strengthened by merely heating them for a certain period of time at a comparatively low temperature.

It has been known for many years that copper alloys are hardened by a cold-working process, such as hammering, rolling, drawing, and that such work-hardened alloys can be made soft again by annealing. Beryllium-copper possesses this property; the annealing temperatures which result in softening are limited to a comparatively narrow range in the neighborhood of the melting point. An alloy of 2.15% beryllium, 0.35% nickel, the rest of the metal copper, in the form of a sheet 0.040 inch thick, when softened by annealing at 800 degrees and then quenching in water, had a tensile strength of 60,000 to 80,000 pounds per square inch. The same material, reduced by rolling to half the thickness, had a tensile strength of 118,000 to 130,000 pounds per square inch. Heat treatment alone raised the tensile strength of the soft metal to 170,000 pounds, and cold working and heat treatment together raised it still higher. By suitable methods beryllium-copper articles may be produced which are harder than the hardest bronze. The alloy's resistance to wear is about five times as great as that of the best phosphor bronze and its resistance to fatigue is exceeded only by that of certain of the alloy steels. It may be soldered and welded, and behaves in corrosion tests in about the same way that pure copper does.

Although beryllium-copper is only about four years old, it is finding use in coiled springs, flat springs, diaphragms, switch blades, and so on, where its high resilience and resistance to corrosion and fatigue are desirable; in nonsparking hand tools, hammers, chisels, wrenches, and drift pins, where its hardness and shock resistance are needed; and in bearings, gears, sliding contacts, the handles of surgical instruments, woven wire cloth, and valve parts, where high resistance to wear is advantageous.

Neat

BY tying it down with steel cables, French engineers have strengthened a weakened dam on the Cheurfas River in Algeria. With the dam thus stitched to its steel foundations, the engineers were able to increase the storage level of the reservoir ten feet above its original full height. Cables have been similarly used in basting to its foundation La Jument lighthouse on the West Coast of France.

Other recent engineering activities, neatly handled: ¶ When the Cisco Sports Club, coöperating with the United States Forest Service, set out to stock with