Winter 3-1951

Volume 62 - Issue 6 - March, 1951

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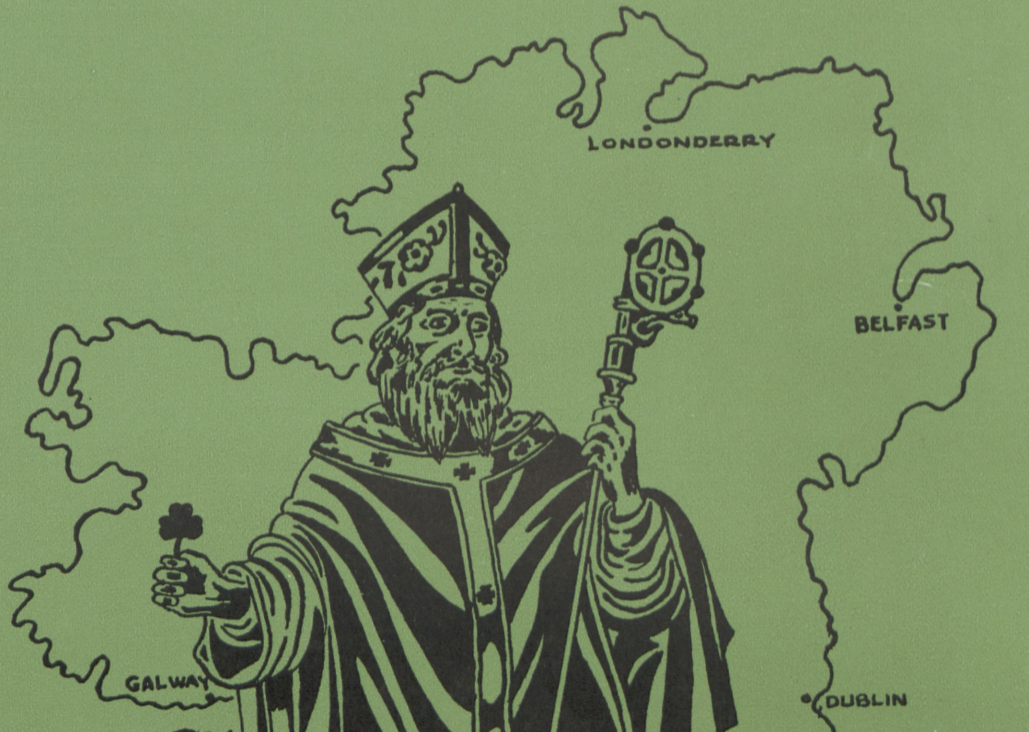
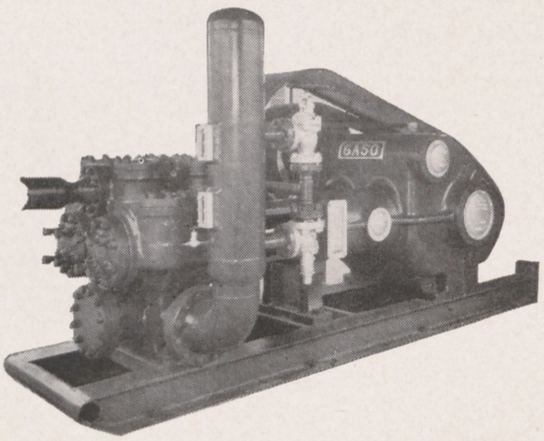
Rose-Hulman Institute of Technology

Rose Technic



Another page for **YOUR BEARING NOTEBOOK**



How to keep a pump in its prime

Piston power pumps, used to pump oil through long pipelines, often have to operate 24 hours a day. To prevent breakdowns and minimize maintenance under this tough service, designers mount pump crankshafts on Timken® tapered roller bearings. Timken bearings take the heavy radial, thrust and combination loads. They prevent wear, insure trouble-free operation.

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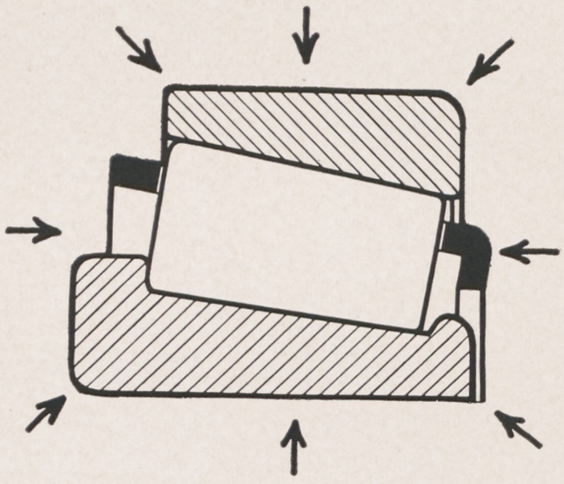
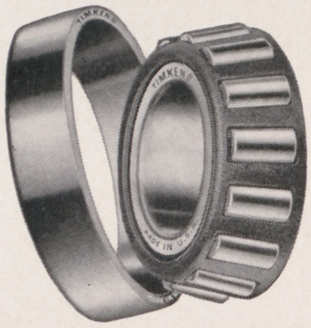
Due to their tapered design and line contact between rollers and races, Timken bearings carry the heaviest loads from any direction. They keep the crankshaft in proper alignment so that gears mesh more smoothly—last longer. And they eliminate crankshaft wear.





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Rose Technic

VOLUME LXII, NO. 6 MARCH, 1951

In This Issue

Cover

St. Patrick standing on the old sod, by Richard B. Deane.

Frontispiece

An ethylene fractionating tower at Du Pont's Sabine River Works in Texas. Courtesy of E.I. DU PONT DE NEMOURS & COMPANY, INC.

PHOTO CREDITS. Page 10: RADIO CORPORATION OF AMERICA.

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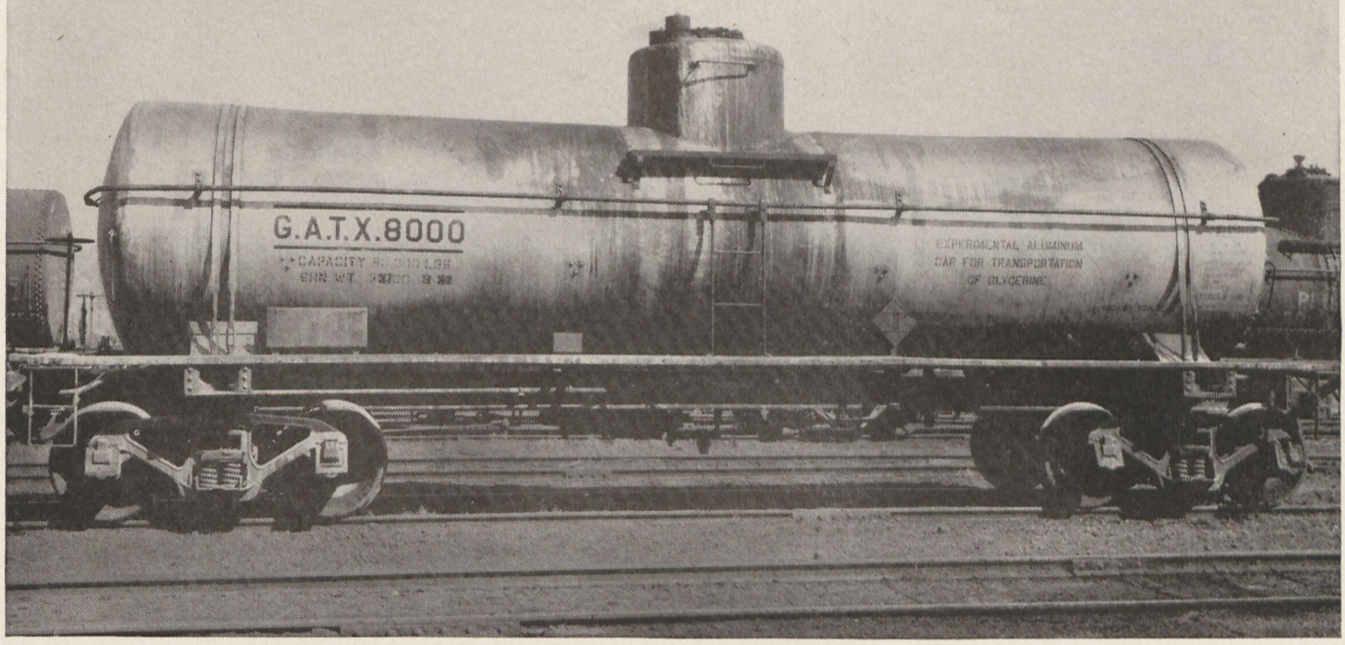
THEY MADE HISTORY!

This car, and the men who designed it



Back in 1928 Alcoa engineers pointed out the advantages that aluminum would bring to railroad tank cars carrying hard to hold chemicals; easily contaminated foods. So Alcoa designed and undertook to pay for the first aluminum tank car. The car builder and a shipper became interested. On completion of the car, the builder assumed the cost and leased it to the shipper for regular service.

Interest in aluminum tank cars increased. Impact recorders and strain gauges gave the designers new data. The aluminum production men rolled the heaviest plate; made the largest rivets produced up to that time. The second car was made from 8 instead of 16 plates. Joining time cut in half!

Today three plates, plus heads, joined by newly developed welding methods make an aluminum tank car. And 1,300 of them, including the first one ever made, are in service. Another instance where Alcoa engineering and co-operation have brought the advantages of aluminum to a new application. Throughout the Alcoa organization, in research, production and sales, similar pioneering jobs are in progress now and others are waiting for the men with the imagineering ability to tackle them.

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ROSE POLYTECHNIC INSTITUTE

Terre Haute, Indiana

"Gladly wolde he lerne, and gladly teche"

—Chaucer, "Canterbury Tales"

THESE "students" are Standard Oil lubrication specialists, skilled and experienced in the use of modern lubricants. They are representative of the groups who come year after year from throughout our territory to keep up to date so that they can do a better job of serving our customers.

Their "instructor" might be a Standard Oil research man, well qualified to demonstrate the advantages of the latest product improvements from our laboratories and pilot plants. Or he might be a Standard Oil mechanical engineer, or a chemical engineer, or from any one of many technical departments.

This scene is typical of the two-way flow of information that goes on constantly throughout Standard Oil and its subsidiary companies. From our technically trained men, Standard Oil men in the field learn the practical applications of scientific improvements. From the field men, our scientists receive a wealth of specific performance reports and suggestions that make their work more productive and more useful.

The free interchange of ideas is part of the favorable intellectual climate in which Standard Oil technical men work. Such a system provides real benefits for Standard Oil and its customers. But perhaps most important of all, it is a system that profoundly stimulates and satisfies the scientists who participate in it.

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STANDARD

Highest piece of equipment at Sabine is this ethylene fractionating tower.

The Legend of the Shamrock

Long ago, when Ireland was the land of the Druids, there was a great bishop, Patrick by name, who came to teach the word of God throughout the country. This saint, for he was indeed a saint, was well-loved everywhere he went. One day, however, a group of his followers came to him and admitted that it was difficult for them to believe in the doctrine of the Holy Trinity. Saint Patrick reflected a moment and then, stooping down, he plucked a leaf from the shamrock and held it before them, bidding them to behold. the living example of the "three-in-one." The simple beauty of this explanation convinced these skeptics and from that day the shamrock has been revered throughout Ireland.

On March 17, where true Sons of Erin gather, the shamrock is proudly worn as a symbol of the faith that is ..... IRELAND.

R. B. Deane.

Vector Analysis

By Alvin B. Thomas, jr., ch.e.

Why should an article discussing vector analysis — a branch of pure mathematics — appear in an engineering magazine? This question may have arisen in many minds, along with an obvious answer — vector analysis must have something to do with engineering; but a complete justification for this article goes deeper than that.

Engineers, being immediately concerned with the economical and practical uses of matter and energy, tend, perhaps, to forget that the wealth of products and services they as engineers have developed have arisen mainly from the theory of pure physics. This physical theory has its backbone, mathematics — of which vector analysis is no small part. Aside from recognizing algebra, trigonometry, and differential and integral calculus as tools for calculating needed quantities in the solution of a specific engineering problem, many of us fail to appreciate plays in producing the theoretical the all-important role mathematics "raw material" of engineering. By presenting a short history of vector analysis and describing the applicability of vector analysis to physics, it is hoped that an appreciation of the importance of higher mathematics in research and everyday engineering as well will be furthered.

Josia Gibbs

Early History

Vector analysis, which mathematically treats quantities having direction as well as magnitude, had its origin in the attempts of John Wallis (1616-1703) and Caspar Wessel (1745-1818) to construct a geometric representation of (a+bi). By designating a real axis and an imaginary axis perpendicular to one another as the co-ordinate system such complex numbers could be graphically represented. Conversely a+bi was an algebraic way of expressing a vector quantity existing in two dimensions.

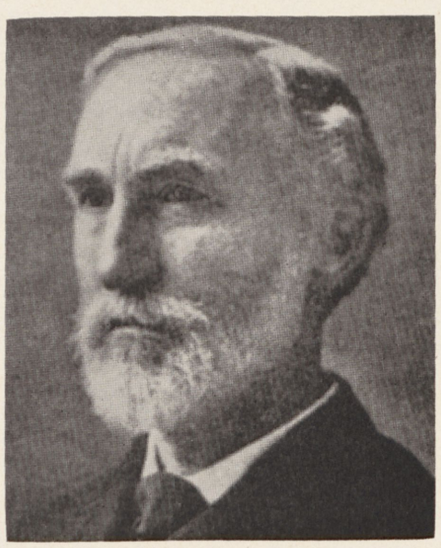
In 1843, Sir William Rowan Hamilton (1805-1865), Irish mathematician par excellence, announced his invention of Quaternions. The subject of Quaternions was a type of multiple algebra in which the commutative law was not followed (that is, ab was not equal to ba). An algebra of vectors in three dimensions was contained in Quaternions, but the vector was subordinated to the more general mathematical entity, the quaternion. Hamilton devoted the rest of his life to the development of Quaternions with the hope that they would prove to be the most useful mathematics since the differential and integral calculus.

In 1866 Hamilton's "Elements of Quaternions" were published. The "Elements" contained hundreds of quaternionic applications to physics and geometry. Convinced that Quaternions were the master key to geometry, mechanics, and mathematical physics, Peter Guthrie Tait, (1831-1901) competent Scotch mathematician and physicist, joined the Quaternionic cause and religiously devoted himself to the subject. Despite the demonstrated utility of Quaternions in physics, theorists other than Hamilton and Tait did not make use of them to any significant extent.

Oliver Heaviside, British electrical engineer, mathematician, and physicist, who wrote a three volume "Electromagnetic Theory", and invented the highly useful Operational Calculus, summed up the faults of Quaternions in the preface of his "Electrical Papers" in 1892:

> "The notorious difficulty of understanding and working Quaternions will always be a bar to their serious practical use by any but mathematical experts; the numerous letter prefixes of the Quaternionic system contribute greatly to the difficulty of reading Quaternionic investigations.
>
> "Again, in most physical mathematics, the Quaternion does not even present itself for consideration, or at any rate may be readily dispensed with.
>
> "The Quaternionic system, by its very nature, cannot be harmonized with Cartesian mathematics as it obviously should be." [Much previous math-

Lord Kelvin



ematics used the familiar Cartesian co-ordinate system exclusively.]

As a final condemnation, Heaviside said, "That Quaternionic experts may do valuable work is undoubted, but how can the bulk of mathematicians possibly understand it?"

Thus Hamilton and Tait died champions of a lost cause with such men as Lord Kelvin, James Clerk Maxwell, and Heaviside rejecting their mathematical "Ultimate" Quaternions.

Interjection

The *Ausdehnungslehre* of Hermann Grassmann, German scholar and mathematician, appeared in 1844, the year following Hamilton's announcement of Quaternions. Grassmann's work, dealing in part with the extension of algebra to n dimensions, set forth certain vector principles free of quaternionic implications, but the *Ausdehnungslehre* was neglected for decades because it was too far ahead of its time and because it was smothered with philosophical abstractions and peculiar teminology. Had, however, Grassmann's work been studied in the middle Nineteenth Century, vector analysis might have evolved sooner than it did, possibly through the efforts of James Clerk Maxwell who used certain vector ideas derived from quaternions.

The theory of matrices used in the Quantum Theory and the Tensor Calculus, which made possible the General Theory of Relativity of Albert Einstein, were implied by Grassmann's *Ausdehnungslehre,* but these mathematical concepts had to wait until the Twentieth Century for development.

True Beginnings

Although Quaternions failed, they pointed the way to a mathematical system that physicists wanted. Hamilton had developed, in Quaternions, a self-consistent algebra which was non-commutative; this "broke the ice", so to speak, for later non-commutative algebras such as vector algebra. If the vector part of the quaternion was divorced from the quaternion itself an extremely useful vector mathematics could be built up. This new vector analysis could be designed so that it would harmonize with Cartesian mathematics.

Heaviside and particularly the American chemist and mathematical physicist, Josiah Willard Gibbs, independently developed, in the 1880's, a vector algebra and analysis using certain tenets from both Hamilton's and Grassmann's works. At last the mathematics needed was invented, which as Heaviside said, "could be used, comparatively speaking, by the multitude."

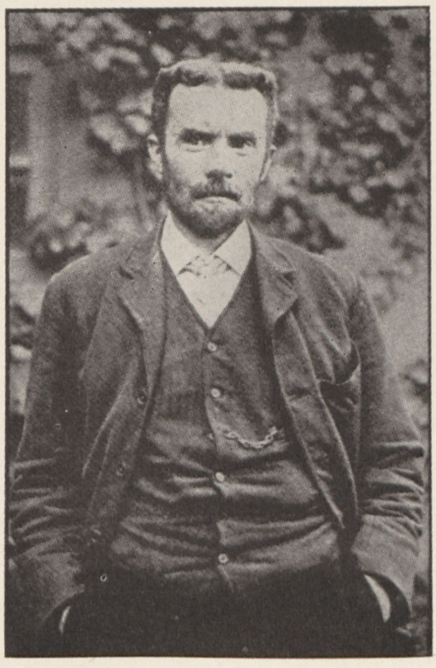
The vector analytical notation of Gibbs eventually displaced that of Heaviside and a multitude of European substitiutes for Quaternions, despite the fact that Peter Guthrie Tait had refered to Gibbs' notation as "a sort of Hermaphroditic Monster, compounded of the notations of Hamilton and Grassmann."

Important Characteristics

Vector analysis provides a natural means of expressing three dimensional problems of physics and engineering because it is concise and free from mathematical detail.

The naturalness of vector analysis arises from its most important property: a dual nature. Vector analysis can either be free of co-ordinate systems entirely, or it can be connected with a co-ordinate system, whichever is desired.

Oliver Heaviside



We are all familiar with the x, y, and z, axes of analytic geometry and calculus upon which most elementary equations are based. These Cartesian axes are usually fixed in space or fixed in the physical body under consideration and any equations developed refer to the particular set of axes chosen. This is an unnatural situation. How can the laws of physical reality be dependent on the reference axes chosen; that is, how can the truth vary with the language used to express it?

An electric field, velocity field, or a field of force exists and exhibits certain properties and relationships with other physical phenomena whether or not a certain set of axes has been laid out.

The theorems and generalizations of vector analysis are easier to arrive at and to comprehend because they are not bogged down in lengthy and artificial symbolisms resulting from a co-ordinate system. These theorems must of course be referred to a co-ordinate system when actual computation is to be done because the various points in a (*specific*) vector or scalar field can only be identified by means of co-ordinates.

Another advantage of the dual nature of vector analysis is that theorems that were deduced in Cartesian form before the invention of vector analysis can be put into the simpler, co-ordinate-free vector notation and manipulated easily thereafter.

A restatement of the duality of vector analysis follows: without the use of the of co-ordinates, general theorems can be derived by vector analysis with facility, but for numerical problems and certain other instances the co-ordinate-free form of an equation can be transformed in to the co-ordinate system desired and the calculations made.

Applications of Vector Analysis

This section of the article must, of necessity, be highly general, since a detailed outline of the applications

Concluded on page 16

Research and Development

By Fritz Wheeler, soph., e.e., Jack Vrydagh, soph., m.e., and John Rinker, soph., ch.e.

Color Measurement

A simple new instrument, which for the first time enables quick and accurate measurement of color from a direct light source, has been developed by RCA.

Called a tristimulus photometer," the new instrument uses only five electron tubes and is no larger than a shoe-box. It simultaneously determines the relative strength of the three basic color components in a light source under study and gives an instantaneous reading. Previous methods of color specification require roughly one-half hour of measurement with a spectrometer followed by several hours of computation.

Through the spectrophotometric method gives a higher degree of accuracy, the tristimulus photometer can give values of the three color components sufficienly precise for every-day engineering work and can readily distinguish between two different color samples which are close enough together in value so they would appear identical to the eye.

The instrument was designed specifically to provide a laboratory and studio check on the faithfulness of color reproduction in color television. However, since it can determine the values of a reflected light source as well as a direct one, the device may also have valuable application in the textile, paint and other industries where color matching is critical. A direct-reading electronic instrument has been designed by the National Bureau of Standards, which can define the components of reflected light, but cannot handle a direct source such as that of a television screen.

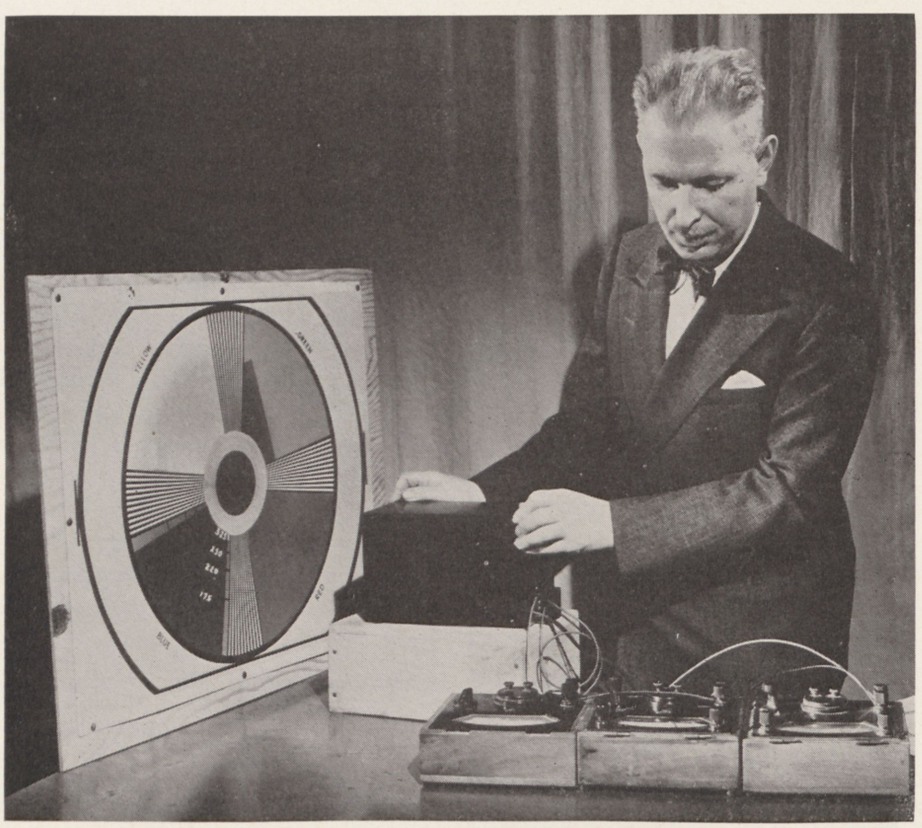
The new instrument consists essentially of an "eye' and a "brain." The "eye" is made up of a lens which focuses the light under study onto a mirror assembly designed to slit the beam into three parts of equal intensity. The three beams then pass through three filters, each sensitive to a range of wavelengths corresponding to the basic color components.

The "brain" of the instrument starts with three photocells, one for each filter. The photocells convert the light energy to electrical energy which passes through circuits, each of a different design, to compensate for the mathematical dissimilarities between the three color components. Finally, a corrected value for each component is read on microammeters.

The readings are in terms of the three theoretical basic components, as definned by the International Commission of Illumination, by which any color in nature can be described in standard terms. The filters select the closest real approximations to the theoretical primaries, which are referred to in colorimetry as X, Y and Z. Then the electronic circuits mathematically "shape" the actual values, transforming them to the theoretical of I. C. I. color specifications.

The theoretical color values have no counterparts in the realm of actual colors. The use of the theoretical primaries is necessary in colorimetry to do away with the use of negative quantities of light in the mathematics of color definition. However, by employment of the theoretical primaries, a practical system of color measurement is attained.

Tristimulus Photometer



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Campus Survey

By James Myers, jr. e.e., Duane Pyle, jr. c.e.
Carl Bals, jr., ch.e., and Allen Forsaith, jr. m.e.

St. Patrick, The Engineer

The time has again arrived, and passed if the Technic came out on time, when all prospective young engineers lay down their slide rules and steam tables to pay their respects to dear old St. Patrick. The festivities at Rose, sponsored by Blue Key, consisted of an afternoon's athletic activities featuring the Freshmen and Sophomores, followed by the traditional St. Pat's Day Dance held in the Rose Blue Room to the music of Buddy Beck and his Orchestra.

Why all the fuss over St. Pat? Ask almost anyone and they'll tell you that St. Patrick is the patron saint of engineers because he performed the greatest engineering feat of all time when he drove the snakes out of Ireland. Sure, anyone will tell you that except a History of Ireland or the Encyclopedia Britannica. One book on Irish history, obtained at the Emily Fairbanks Library of Terre Haute, stated that in 1831 a Mr. James Cleland turned six snakes loose in the vicinity of St. Pat's burial place. Four of these snakes were later killed; the other two were unaccounted for. Obviously these two were of the same sex for it is an established fact that there are no snakes in Ireland today.

In the absence of factual proof of St. Pat's engineering ability, we have gathered a few bits of information, certified as being historically true, the proper interpretation of which will not only prove that Pat was an engineer, but will also prove that he met the requirements for an instructor in engineering, as follows:

While baptizing an Irish Chieftain, St. Patrick, a bit wearied by the ceremony, leaned heavily on his crozier. A crozier is the staff or rod of a bishop, abbot or abbess, resembling a shepherd's crook and borne as a symbol of the pastoral office. The end of the rod was resting on the chief's big toe, unknown to St. Pat. The rod was pointed on the end. The Irish Chieftain thought that this bit of physical torture was all part of the ceremony and didn't utter a sound until the ceremony was over even though he was bleeding profusely. Even today the Irish call the place Struthfluil, meaning stream of blood. Thus ends illustrative example.

St. Pat must have been an engineer because he was carrying and holding a rod. St. Pat met the requirements for an engineering instructor; he jabbed a fellow with a pointed rod and the poor guy had to suffer quietly because he thought it was all a part of the program.

Upon further consideration, the story about the snakes sounds more convincing than the rod story. In either case, comes St. Patrick's Day we get out of school a half day. Who cares why?

In A Blaze of Glory

The Fighting Engineers closed with a rush to win the last five games of the season. The string started with the defeat of Blackburn College by a 66 to 51 score and ended with the massacre of Earlham by a 71 to 60 margin. In between, the Carrmen conquered McKendree 69-65, Principia 65-52, and Huntington 71-63.

The combination that put Rose back on the victory trail consisted of Don James at center, Warren Allen and Harry Badger in the forward slots, and Leo Little and Harry Zorman at the guard positions.

Warren Allen, captain of the team, was high point man for the ball club and a consistent scorer throughout the season. He finished with a 19.7 point average, the fourth highest in the state.

Concluded on page 22

'50-'51 Hardwood Squad

Alumni News

By Chris Sharpenberg, jr. m.e.

'90 Otto G. Hess Passed away October 15, 1950.

'98 John M. Lansden, Jr., E. E. died October 30, 1950, in New York City after a long illness. He was born July 8, 1877, in Cairo, Illinois. After graduating from Rose, he followed his profession as both an electrical and mechanical engineer. He worked in Detroit, where he associated with the pioneers of the automobile industry. At one time he was an executive in the General Motors Corporation.

Mr. Lansden organized the Lansden Electric Company which manufactured electric automobiles, utilizing for the first time the Edison storage battery. While operating this company, he became a close friend and associate of Thomas A. Edison.

Later he organized a truck manufacturing company, and in recent years he was engaged in research work in connection with suspension and spring systems of trucks and automobiles.

Mr. Lansden is survived by two sisters, Mrs. Robert P. Bates of Chicago and Miss Emma L. Lansden of Cairo, Illinois.

'11 Joseph N. Stephenson, Ch. E., has recently compiled and edited the first of a series of four volumes of a technical nature, published by McGraw-Hill Book Company.

This volume, (Preparation and Treatment of Wood Pulp), describes pulpwood, its preparation, treatment, and testing. It was written by a number of authors under the direction of the Joint Textbook Committee representing the Pulp and Paper Industry of Canada and the U. S. Mr. Stephenson, editor-in-chief of the Pulp and Paper Magazine of Canada, was responsible for assembling the material for the text.

'34 Gene A. Zwerner, E. E., formerly district sales engineer for the Link Belt Company at Detroit has been transferred to Johannesburg, Union of South Africa, as sales manager for the South Africa branch of Link Belt.

'35 Robert B. Asbury, M. E., is now a Lt. Colonel in the Air Force. He is charge with direction of operations and training at the Portland Air Base, Portland, Oregon.

'35 Merrit Myers, Ch. E., formerly production manager of the American Stove Company's St. Louis domestic range factory, has been named to the newly created post of director of production planning. In this new position, Mr. Myers will be charged with the responsibility of planning overall company production and relating it to factory capacities. He will act as coordinator between the American Stove Company's four plants and their individual production managers. This is expected to improve service for the sales and parts departments.

After graduating from Rose, Mr. Myers was employed by the Cities Service Oil Company, East Chicago, Indiana, for eight years. He joined the American Stove Company in 1943 as plant engineer of the Harvey, Illinois, division. He was placed in charge of the division's industrial engineering, production, and material control functions in 1944, and this was expanded eventually to include accounting, budgets, IBM and payroll functions. In 1949 he was transferred to St. Louis to fill the post of production manager.

'35 Bernard P. Melton, C. E., passed away February 21, 1951 at his home in Indianapolis. Born in Terre Haute, Mr. Melton moved to Indianapolis upon graduating from Rose. He was active in the First United Brethren Church, Centre Masonic Lodge, Scottish Rite, and the Indiana Society of Professional Engineers.

Since 1940 Mr. Melton had been assistant chief engineer for the Ayrshire Collieries Corporation. Previous to this, he was employed by the Indiana State Highway Department.

Surviving Mr. Melton are Mrs. Garnet L. Melton, two daughters, and his mother, Mrs. Byron F. Patterson of Greenfield.

'37 John E. Sonnefield, M. E., has been named Works Master Mechanic for the Aluminum Company of America. He has had the difficult task of assuming his new post before being fully relieved of his former duties as Plant Engineer in N-Plant.

A native of Terre Haute, Mr. Sonnefield joined Alcoa in Cleveland as a Works Engineer draftsman in 1940; but he was called into the Army Engineers, the following year as a second lieutenant. He returned to the Cleveland Works in October, 1945 with the rank of Lt. Colonel, a Purple Heart, eight battle stars, and the Legion of Merit Award for constructing a bridge under enemy fire at Vire, France.

Mr. Sonnefield is married and has two children—a girl eight and a boy four. They have recently moved into a new home at 14431 Cleminshaw Road.

'37 Thomas N. Wells, E. E., is now a Lt. Colonel in the Air Force and is stationed in Dayton, Ohio.

'38 Ora E. Myers, E. E., is a graduate student of physics at the University of Colorado. He has received his M. S. from there and is

Continued on page 23

"Mr. Bell, I heard every word you said — distinctly!"

75 YEARS OF TELEPHONE SERVICE

On the evening of March 10, 1876, on the top floor of a boarding house in Boston, the telephone carried its first intelligible sentence.

It seemed like a miracle to our grandparents and great-grandparents. Yet today, the telephone is a part of our everyday living. And that is the real miracle — the fact that the telephone has come to mean so much to so many people in so many ways.

The telephone is an indispensable tool of business and government — today's tremendous job of production and defense could not be carried on without it. It serves in minor emergencies and great ones. It helps maintain family and community ties. And it keeps right on growing and improving.

Never in the history of the telephone has it been so valuable to so many people as right now.

BELL TELEPHONE SYSTEM

Fraternity Notes

Alpha Tau Omega

Gamma Gamma chapter was happy to welcome the following freshmen as new pledges: Louis Sasso, Frank Rendaci, Leo Webb, Rex Hauser, Jim Matthews, Bob Miller, Don McCune, and Gary Stoker. At formal initiation ceremonies held at the chapter house Chuck Rinker, Don Latham, and Gary Moore were made active members following their twelve-week pledgeship.

On Friday, March 2, Johnny W. Vann, worthy grand chief of Alpha Tau Omega fraternity, was the honor guest at an informal reception held at 63 Gilbert. Those attending included A.T.O. actives, pledges, and alumni; faculty members; and Dr. Wilkinson.

The following day A.T.O.'s from Indiana, Purdue, DePauw, Northwestern, Monmouth, Illinois, and Rose met at the Claypool Hotel in Indianapolis for the annual "State Day" conclave. The highlight of the affair was the banquet, at which Johnny Vann was the principal speaker, followed by a singing competition, and an informal dance in the hotel's Riley Room.

Two house parties, planned by "The Bushman," rounded out the social calendar for the month. One was held on March 10, and the other following the St. Pat's Day Dance on the 17th.

Theta Xi

Kappa completed a very sucessful rush week by pledging its quota of thirteen men namely Joe Buecher, Joe Verdeyen, Dave Cotton, Bob Steinhauser, Harry Zorman, James Schwartz, John Sawyers, Darrell Tague, Bob Rader, Joe Turpen, Gene Sovereign, Bob Kawano, and Erwin Ulbrich. The rush program included such outstanding entertainers as "The Outhouse Eight Minus Thirteen," George "Is dis de Flamingo" Wence, "Peanut" Hailstone, and "Brittle" Grinsdale. After the pledge ceremony the fellows were treated to a show, dinner, and stag party.

Congratulations go to Jim Moulten who recently pinned Miss Helen Tindall of Terre Haute.

A softball tourney is being held at Rose in the very near future with TX chapters from Indiana University and Purdue participating. Kappa's basketball team won its eighth game of the season, 42-40 from the pledges, but the pledges came back in a second game to win 30-28. Where's de frigging paddles?

An open house was held after the recent Military Ball and a stag party and a pledge dance are scheduled for March.

Lambda Chi Alpha

Theta Kappa welcomed pledges Abe Samuels, Andy Mudron, Norman Sparks, Bob Barton, Jack Farrel, "Blackie" Freely, Bill Foreman, "Skip" Zopf, Roy England, George Runyon, Jim Long, Howard Clark, Ronald Smith, George Ross, and Ken LeForge into the chapter with a party and ceremony Wednesday night, February 21, 1951.

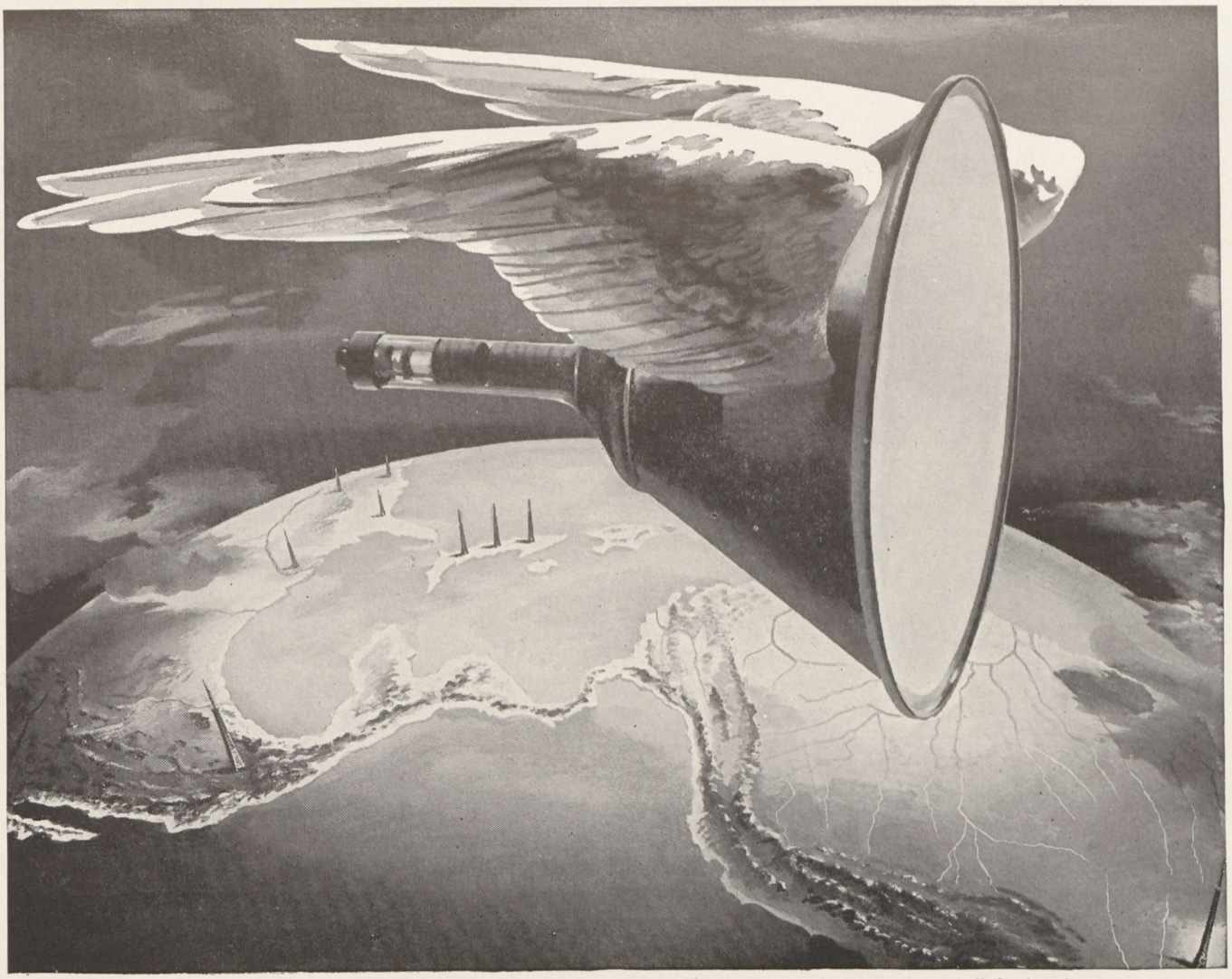
After the final basketball game, the chapter house was opened to the actives, pledges, and guests. The rugs were rolled back in the living room for dancing. Toward the end of the evening, the group gathered around the piano, and many old favorites were sung. Refreshments were served.

The list of Lambda Chi's wearing the ball and chain was increased by one when Al Stiles presented his pin to Miss Betty Gilson of Indiana State Teachers College. The members of the chapter are very pleased with the pinning, since they can smoke cigars again for a while.

Sigma Nu

Bringing to a close their period of pledgeship to Sigma Nu, Bill O'Brien, Bob Dedert, Neal Gochenour, Maurice Mardis, and Sam Wooley were formally initiated as members of the fraternity on Sunday, February 11, following the traditional "Fun Week" fracas.

Following a hectic but fruiful rush week, Sigma Nu welcomed the following rushees as pledges on Monday, February 26: Don Fyfe,of Muncie, Indiana; Vernon Bertram, of Indianapolis; Rex Leonard, of Winchester, Indiana; Glenn Matteson of Washington, D. C.; Owen Meharg, of Chicago; Dick Green, of Indianapolis; and John Voelker, of Terre Haute. The new pledges were entertained at a semi-formal dance in the Rose auditorium, where Jimmy Holler and his orchestra maintained a smooth rhythm, and afterward at a house party for those who were still kicking.



Five new RCA-equipped stations in Mexico, Brazil, and Cuba, add television to the forces which make Good Neighbors of all the Americas.

Now television goes "Good Neighbor"

As little as 10 short years ago, television—to the average man on the street—seemed far away. Today, television is in 10,500,000 homes.

Newest demonstration of TV's growth is its leap to Latin America. 3 RCA-equipped stations are now in Cuba, 1 in Mexico, another in Brazil—and more are planned. They are contributing to television progress by following a single telecasting standard. They also use developments from RCA Laboratories: the image orthicon television camera, electron tubes, monitoring equipment, and antennas.

And as our neighbors to the south watch television at home, they see another development of RCA research—the kinescope. The face of this tube is the "screen" in all-electronic home TV receivers . . . on which one sees sharp, clear pictures in motion.

* * *

See the latest wonders of radio, television, and electronics at RCA Exhibition Hall, 36 West 49th St., N. Y. Admission is free. Radio Corporation of America, RCA Building, Radio City, New York 20, New York.

Continue your education with pay—at RCA

Graduate Electrical Engineers: RCA Victor—one of the world's foremost manufacturers of radio and electronic products—offers you opportunity to gain valuable, well-rounded training and experience at a good salary with opportunities for advancement. Here are only five of the many projects which offer unusual promise:

- Development and design of radio receivers (including broadcast, short wave and FM circuits, television, and phonograph combinations).
- Advanced development and design of AM and FM broadcast transmitters, R-F induction heating, mobile communications equipment, relay systems.
- Design of component parts such as coils, loudspeakers, capacitors.
- Development and design of new recording and producing methods.
- Design of receiving, power, cathode ray, gas and photo tubes.

Write today to National Recruiting Division, RCA Victor, Camden, New Jersey.

Also many opportunities for Mechanical and Chemical Engineers and Physicists.

RADIO CORPORATION of AMERICA

World Leader in Radio—First in Television

VECTOR ANALYSIS

Concluded From Page 9

of vector analysis would require an extensive knowledge of physics to convey any meaning.

Not only have new laws been evolved using vector analysis as the mathematical framework, but innumerable older laws and theorems have been transcribed into vector notation and henceforth handled with conciseness and facility.

Subjects such as mechanics, hydrodynamics, aerodynamics, and elasticity have benefited greatly in their theoretical development through the use of vector analysis. But the most striking utility of vector analysis is found in the field of electricity and magnetism. Nearly the entire theory of static and dynamic electricity is handled today by vector analysis.

Heaviside and Lorentz were the first to adopt vector equations exclusively and treat them by purely vectorial methods. Maxwell introduced fundamental vector ideas into the theory of electromagnetic fields, but he did not make use of vector analysis, since it had not yet been developed. He had to rely on the lengthy Cartesian methods, but today his work is nearly always expressed in vector notation.

To see for himself how widespread and diversified the countless specific applications of vector analysis are, the reader has only to glance through modern books on mathematical physics, electricity, and related subjects; such books are, for example, L. Page's *Introduction to Theoretical Physics,* L. M. Milne-Thomson's *Theoretical Hydrodynamics,* and R. W. Smythe's *Static and Dynamic Electricity.* (Vector notation is easily recognized by the bold-faced type it uses).

We may indeed expect the accelerating application of vector analysis to physical studies to yield even more "raw material" for engineering in the future. It is a mathematical system still fresh enough to yield many new results if someone will but apply it.

Build Confidence ON BROAD EXPERIENCE

by ARCH COOPER
Manager, Empire Region
ALLIS-CHALMERS MANUFACTURING COMPANY
(*Graduate Training Course—1909*)

YOU NEED the confidence that comes from wide experience, whether you intend to be a salesman, designer, researcher, or production man. Confidence based on knowledge is one of the greatest assets an engineer can have. Here is what I mean.

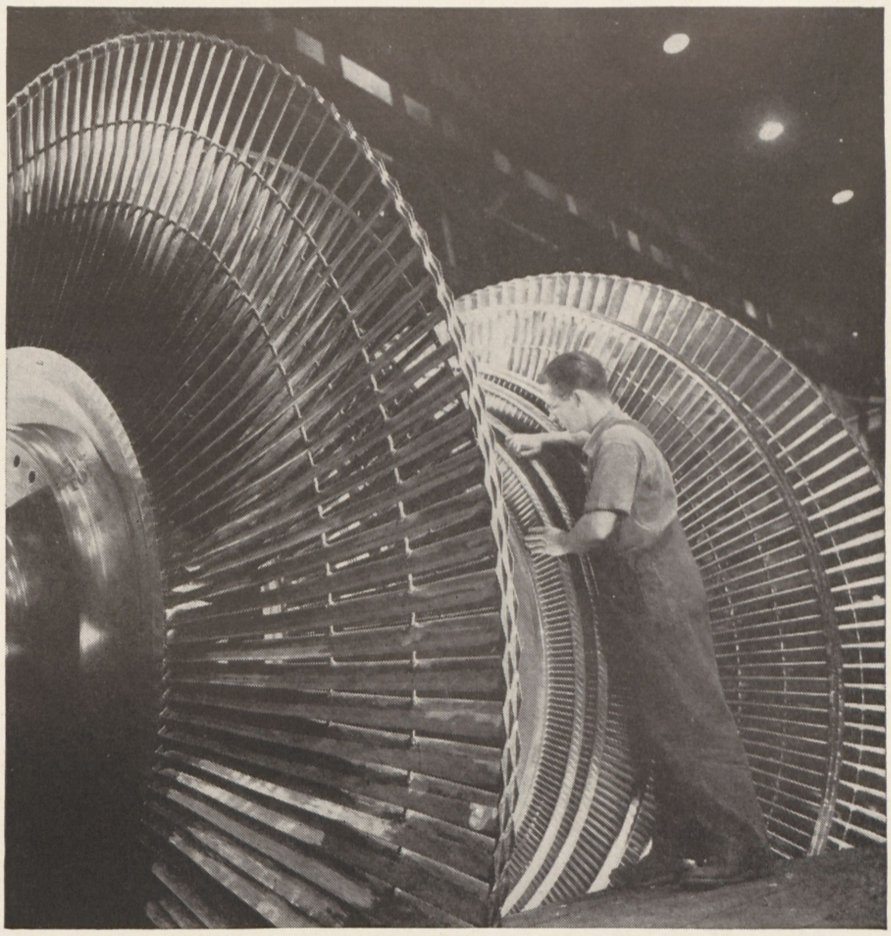
ARCH COOPER

You may visit a mine with the idea of talking about crushing equipment, but find that their engineers have an electrical problem. Or you may visit a utility to talk about electrical equipment and find that they're all excited about a pump break-down.

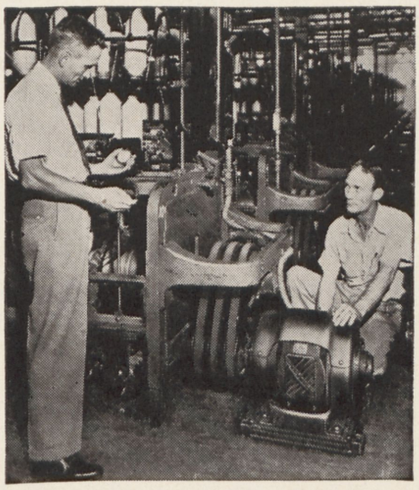
Offer All-Around Help

Can you help them? Or are you just another peddler who is taking their time when they have problems on their minds. In my work I call on electric utilities, cement plants, machinery builders, textile mills, paper mills, shoe factories and many other types of plants. In each of them, I try to help the engineers and mechanics I call on.

It's a good credo for salesmen, but it takes broad experience to carry it out. It's the kind of experience you must deliberately set about acquiring as early as possible. I had heard of Allis-Chalmers equipment, seen A-C's giant Corliss engines in Australia's biggest power plant and decided to study design at Allis-Chalmers. It looked like the best place in the world to get a broad engineering background.



High temperatures and speeds raise tough design and production problems on giant steam turbine spindles like these.



Textile mills are getting adjustable speed at lower cost by using new automatic Vari-Pitch sheaves on spinning frames as shown.

I joined the Allis-Chalmers Graduate Training Course after graduation from Sydney Technical College in 1908 . . . worked on steam turbines, wound coils of all types, performed tests for the electrical department. After that there were field trips to erect electrical equipment. It was soon apparent that I wasn't a designer at heart, and my sales career started.

Broad Opportunity

Forty-one years later, Allis-Chalmers still offers the same opportunity for broad experience. A-C still builds equipment for electric power, mining and ore reduction, cement making, public works, pulp and wood processing, and flour milling.

And the Allis-Chalmers Graduate Training Course is still flexible. Students help plan their own courses. They can switch to design, manufacturing, research, application, sales, or advertising—divide their time between shops and offices—and can earn advanced degrees in engineering at the same time.

Men at Allis-Chalmers get a close-up of the basic industries. No matter what path they take in the industrial world, experience gained with this broad organization lays a foundation for the confidence that comes with all-around knowledge.

ALLIS-CHALMERS

Allis-Chalmers Manufacturing Company, Milwaukee 1, Wisconsin

RESEARCH AND DEVELOPMENT

Continued From Page 10

New Inspection Technique

Tiny crystals, which pass off torrents of electrons when excited with rays, promise to make possible for the first time the high-speed inspection of thousands of products, ranging from canned baby food to blasting fuses, according to scientists of the General Electric X-Ray Corporation.

The crystals, which are 1,000 times more sensitive than the photo-electric cells used in "electric eye" applications, also can be used to improve the performance of X-ray apparatus used to detect and treat disease.

Capable of increasing a million times the energy they receive from X-rays, the crystals perform work that hitherto required a much more complex system of vacuum tubes and amplifiers. Also, only low-power X-rays are required.

Canned or packaged products or any one of a wide variety of possible items are carried by conveyor between the crystals and an X-ray machine, which is producing a low-power beam of X-rays.

The items being inspected absorb some of the X-rays, the exact amount depending upon the characteristics of the item.

An inadequately-filled can of baby food, for example, would absorb a quantity different from that absorbed by a satisfactorily filled can.

The rest of the X-rays strike the crystals, causing them to give off electrons. When the crystals are hit by X-rays passed by an unsatisfactory item, they generate sufficient electrons to actuate relay devices which call attention to the defective item.

The relay devices can operate a meter or chart graph upon which certain fluctuations would indicate an unsatisfactory item. Or they can cause a light to flash or paint to be dabbed on a faulty part. Or they can actually stop an entire production line until the faulty product or process is eliminated.

Because of the high sensitivity of the crystals, X-rays necessary to actuate them are far below the intensity and quantity at which the item or the user of the item would be affected in any way.

A new inspection technique employing the crystals promises to perform at unprecedented speeds, inspecting as many as 600 units per minute in the case of canned foods and liquids, it was said.

Operating as a sort of industrial "slave eye", the crystals may solve such inspection problems as controlling and checking the product level in containers; detecting voids, cracks, and variations in material thickness in a wide variety of homogeneous materials; checking for absence, misplacement, or misalignment of inserts and other internal parts and even eventually spotting foreign particles in certain foods, metals and other products.

Laboratory models of the crystal detection equipment have inspected rubber heels, gaged the product level in baby food, soup, beer, and other canned and packaged products, and checked for voids in powder trains used in blasting fuse.

One special application of the crystals that offers particularly great promise is the rigid control of the output of X-ray tubes, regardless of variations in current. This promises to improve the performance of medical X-ray apparatus.

The crystal detection equipment, does not in general use a large "spray" of X-rays, as do conventional X-ray machines or fluoroscopes, but rather narrow pencil-like beams. In some installations, this may mean that the radiation hazard will be greatly reduced, and the cost of constructing special concrete or lead partitioning would be either reduced or eliminated entirely.

Radio Controlled Life Boat

The Air Force's big A-3 lifeboat dropped by parachute in air-sea rescue operations will soon boast radio

Concluded on page 20

☆ In 15 years of aviation pioneering a remarkable series of "Firsts" have been credited to Bell Aircraft Corporation. Bell engineers—with imagination and initiative—have been *writing* the aviation books. Every "First" has bulwarked Bell's position as a leader in the industry.

FIRST twin-engine escort fighter, multi-place, and mounting a 37 mm cannon in flexible gun turrets (Airacuda).

FIRST American fighter designed around its armament, firing cannon thru propellor hub, with tricycle landing gear (Airacobra).

FIRST commercial helicopter, with automatic stabilizing control.

FIRST supersonic airplane (X-1).

FIRST in many defense projects now restricted.

OTHER FIRSTS: Bell's pioneering spirit also developed—

FIRST satisfactory .50 caliber machine gun shock dampener which became standard for both Army and Navy.

FIRST modern all-wood military fighter (XF-77).

FIRST jet-propelled fighter in the U. S. (Airacomet).

FIRST commercial helicopter with 200 hp. engine and skid landing gear.

In the column at the right of this page we have listed many of the positions now available to qualified engineers, physicists, and applied mathematicians. Whether your interest lies with guided missiles, helicopters or supersonic aircraft, it is time to seriously consider YOUR future. Bell Aircraft's accomplishments in research, development and design provide the opportunity for permanent employment in all of our long-range programs.

We believe in the future of the aviation industry. Do you believe in YOUR future? Where will you be in your chosen career 10, 15, 20 years from now? Inquire NOW to find out how your abilities and training may mean a full and satisfying life for you with the leader in aircraft engineering. Salary, insurance and retirement benefits are most liberal. Secure application from your college placement office or write: Manager, ENGINEERING PERSONNEL.

BELL *Aircraft* CORPORATION
P. O. BOX 1, BUFFALO 5, NEW YORK

CAREER OPPORTUNITIES

Check Yourself:

- ☐ Electrical Designer
- ☐ Thermodynamicist
- ☐ Aerodynamicist
- ☐ Electronics Engineer
- ☐ Servomechanisms Engineer
- ☐ Electro-mechanical Engineer
- ☐ Telemetering Engineer
- ☐ Structural Analysis Engineer
- ☐ Instrumentation Engineer
- ☐ Rocket Motor Development Engineer
- ☐ Structural Designer
- ☐ Rocket Motor Test Engineer
- ☐ Missile Coordinator
- ☐ Flight Test Engineer
- ☐ Transmission Design Engineer
- ☐ Project Engineer
- ☐ Microwave Engineer
- ☐ Flutter Engineer
- ☐ Static Test Engineer
- ☐ Vibrations Engineer
- ☐ Weight Control Engineer
- ☐ Specifications Engineer
- ☐ Radar Engineer
- ☐ Structures Research Engineer
- ☐ Communications Engineer
- ☐ Dynamics Engineer
- ☐ Ultra-high Frequency Engineer
- ☐ Missile Test Engineer
- ☐ Electrical Systems Engineer
- ☐ Mechanical Systems Engineer

Concluded From Page 18

control that will bring it up to survivors, allow them to board and then set the boat on course.

It's all done by an operator in the plane which dropped the boat. By simply maneuvering a stick on a small control box he can take over when the A-3 hits the water and keep control until survivors are on their way to safety.

The A-3 itself is of all-metal construction, measures 30 feet long and is designed to carry 15 men. It is powered by a four cylinder water-cooled engine, housed in a water tight compartment. Carried "bombed up" under the SB-29 (research and rescue version of the B-29 bomber), the A-3 is dropped to survivors by a massive 100-foot parachute.

When the boat hits the water, the chute is jettisoned by an explosive charge. A sea anchor goes out with the chute and holds the boat in position.

After the chute is jettisoned, the operator in the carrier plane takes over on a five frequency transmitter which is matched up by a five frequency receiver in the boat. He sends his first signal from the control box. This, in order, releases the stabilizing fins which hold the boat steady in descent, frees the rudder board, opens the engine's air vents and cranks the motor intermittently. When the motor catches and is running at a fast idle, the sea anchor is released.

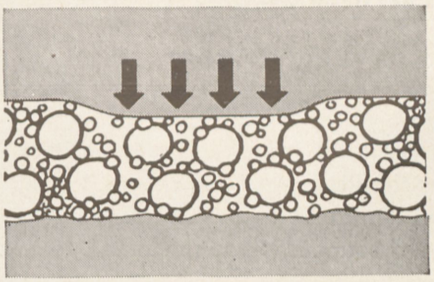
At the operator's next signal, the engine speeds up, the reduction gear goes into forward, and the boat moves ahead. The operator can control its direction right and left and a flux-gate gyro compass connected to the servo electric system on the boat will keep it on whatever course he sets.

The operator stops the boat when it comes to the survivors' raft and idles the motor while they board. The boat is equipped with a "walkie talkie" radio set for communication between the rescued men and the operator in the plane, who will then set the A-3 on its course. The gyro compass will keep it on that course with only slight variations that can be checked by a magnetic compass and corrected.

The boat itself is equipped with duplicate controls and a manual over-ride which would enable the survivors to break off the radio control at any time.

The A-3 is equipped with rations, survival equipment and gasoline enough to cruise 800 miles. If the distance is longer than that the boat can be resupplied from the air, since its pre-set course will be known.

THE DU PONT DIGEST



Cross-section *of wax film shows how pressure of foot pushes the hard "Ludox" particles into the wax, causing a snubbing action.*

With silica, water and imagination Du Pont scientists have found

How to Tame Slippery Floors

Teen-agers in high schools used to have great, if hazardous, fun running and sliding on newly waxed corridor floors. Of late many of them haven't been able to do that. For numerous schools, as well as office buildings and institutions, are now using waxes that have been made skid-resistant.

The product that is taming slippery floors is "Ludox" colloidal silica —adapted by Du Pont chemists to floor wax through cooperative research with the wax industry.

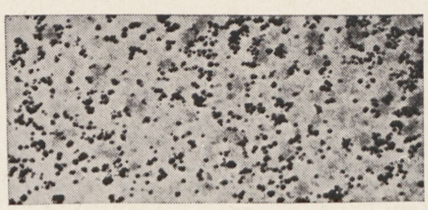
If you mix plain sand with floor wax, you'll have an anti-slip surface, but it would be unsightly and thoroughly impractical. With "Ludox," you are using a water suspension of invisible colloidal silica particles less than a millionth of an inch in diameter.

Du Pont "Ludox" *makes floor waxes harder as well as safer. Other wax qualities—gloss, freeze- and water-resistance, leveling—are unaffected. It is now used by many manufacturers.*

A problem child

'Ludox" was quite a problem child to scientists who developed it. For instance, research men had to know how silica would act in the presence of floor wax. So they turned to the electron microscope and learned that the little silica spheres attach themselves firmly to the surfaces of wax spheres five times their size.

But it was also necessary to find out how "Ludox" affects a waxy film after it is laid down on a floor. While a polished waxed floor looks smooth enough, it is actually a series of hills and valleys and these irregularities have an important bearing on the behavior of a surface.



"Ludox" particles (*dark, in this electron photomicrograph*) *surround the larger wax particles throughout depth of film.* Magnified 25,000 x.

Working with a waxed surface presented difficulties. The electron microscope functions only if electron beams can pass through the membrane upon which the specimen is placed. And electrons can't "see through" a floor!

Study in duplication

Often, problems like this have been solved by preparing a thin replica or copy of the surface for examination in its stead. However, the conventional method for making a replica—the one frequently used in studying metals—requires solvents. These would dissolve and ruin a wax surface.

So it became necessary for the chemists and electron microscopists to develop an entirely new way to make a replica of a surface. This they did, as part of a research program that lasted several years.

With it some remarkable pictures were made. They showed that many "Ludox" particles stay at the surface of a wax film, even though they are denser than wax. As you walk on a floor, your shoe presses the tiny silica particles down into the wax spheres that make up the film. This sets up a snubbing action which keeps you from slipping.

Much more could be told about Du Pont research on colloidal silica. For example, chemical and mechanical engineers had to develop manufacturing equipment, including a specially designed ion exchange column. Organic and physical chemists used research findings to formulate better waxes, as well as silica-containing adhesives and anti-slip treatments for rayon fabrics. Like practically all Du Pont achievements, "Ludox" is the result of close, continuous teamwork of men and women trained in many fields of science.

DID YOU KNOW . . .

it costs more than $10,000 on the average to provide the tools, machines, factory space and working capital for an American worker. Du Pont's average operating investment per employee is $17,800.

Concluded From Page 11

Operating from the pivot position was the Engineers' ace rebound man, Don James. Don provided the height and rebounding that made the team click.

Harry Badger improved with every game. His deadly shooting was one of the major assets of the club.

The guard positions were well filled by Harry Zorman and Leo Little. Both men are fine shots and expert ball handlers. Their ball hawking did much to break up the opponents offensive and set up our own.

Ralph Bennett alternated with Don James at center, while Marvin Stohler, Phil Gardner, and Vernon Bertram proved to be first class reserves for the guards. Roy England, George Ross, and Ken Brinson filled the roster for the 1950-51 edition of the Fighting Engineers.

This year's team turned in the best record of any Rose team during the last 10 years. A lion's share of the credit goes to Coach Jim Carr who kept the team going through the dismal seasons of the past few years and co-ordinated this year's outfit into the smooth pointmaking machine that it was.

Track 1951

Leading the cinder stompers around the oval this spring are co-captains "Bones" Bohrman and "Rapid Robert" Failing. Hot on their trail are the three returning lettermen, Ralph Schmidt, Gene Hailstone, and Harry Badger.

One senior, Gordon Fowler; three juniors; Mac Fehsenfeld, Jim Moulton, and Morris Griffiths; and two sophomores, Jim Mook and Harry Harris complete the squad of upperclassmen.

The prospects for the season look brighter with each freshman that turns out for the manly sport. About twenty greencaps are currently working out in the fieldhouse under the guiding hand of Coach Phil Brown in anticipation of the first meet with Indiana Central on March 15.

Chicago Tribune Award

At the weekly drill period on Monday, February 26, Lt. Colonel Howard F. Brook presented Donald W. Fyfe and John L. Coddington with the Chicago Tribune Awards. These awards, a gold and a silver medal, are annually given to the two cadets who have excelled in competitive drill.

March 10, Don and John will be entertained in Chicago by the Tribune with a dinner, a radio show, and an opportunity to see the stage production "Student Prince."

Library

Among the more recent acquisitions in the library is *The Engineering Index,* which the librarians wish to call most emphatically to your attention. The library had not received any volumes of *The Index* since 1927; the new volume is for 1949. This is an exceedingly expensive service and that is one of the reasons why we would like to see great use made of it, that we may feel justified in adding it to our research materials.

The Index can be an extremely useful research tool. Technical publications reviewed in the *Index* include those of engineering, scientific, and technical societies, engineering and industrial periodicals, and publications of government bureaus, engineering experiment stations, universities and other research organizations. Articles published in these periodicals which deal with the art and science of engineering as their basis are those which are included in *The Index.* These are briefly abstracted.

now working for his doctor's degree.

'38 John F. Weinbrecht, M. E., is an Army Captain assigned to the Philadelphia Quartermaster depot as the assistant post engineer.

'41 William M. Males, E. E., is now a Lt. Colonel in the Army, stationed at Fort Leonard Wood in Missouri.

'42 Jack K. Kennedy, M. E., is in Terre Haute as the division engineer for the Girdor Corporation working at the Wabash Ordinance Plant.

'42 John H. VanderVeer, M. E., has been transferred to Seattle, Washington, as a district representative for Sperry Gyroscope Company.

Feb. '43 George D. Blakey, M.E., is now assistant manager of field training for Sperry Gyroscope Company at Great Neck, Long Island, New York.

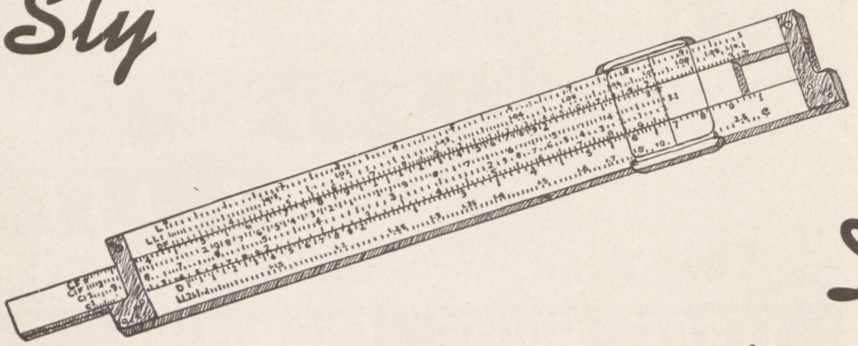
Feb. '43 Gerald H. Fagg, E. S., is in Cincinnati, Ohio, as chief engineer for the Cintronic Corporation.

Feb. '43 Charles T. Thomas, M. E., is a first lieutenant in the Air Force.

Oct. '43 Vinton B. Haas, E. E., is an assistant professor of electrical engineering at the University of Connecticut, Storrs, Connecticut.

July '44 Charles R. Fox, E. C., is a Lieutenant, J. G., in the Navy aboard the USS LSM(R) 525.

Sly Droolings



By Richard Myhre, soph., m.e.
and Bud Welling, soph., ch.e.

Pre-Med Student: "You girls wouldn't care to go with us, would you?"

Arts Student: "Would you girls care to go with us?"

Engineer: "Where do we go, you lucky girls?"

* * * * *

Freshman: "What is the difference between a sewing machine and girl running for a trolly?"

Senior: "A sewing machine has only one bobbin."

* * * * *

Hubby: "If there are any more additions to this family I'll shoot myself!"

Wife: "Wait, dear; don't shoot an innocent man."

* * * * *

I love my little sweater girl,
She snuggles when we waltz,
And any day I hope to learn
If she is true or false.

* * * * *

Imagine the newspaper boy's embarrassment when he opened the wrong door in the depot waiting room and yelled: "Extra paper."

* * * * *

At the race course an excited lady felt something slipping and asked for a safety pin. Just then someone yelled, "They're off!" and the lady fainted.

* * * * *

A drunk in the Empire State Building stepped into an elevator shaft and dropped thirty stories to the basement. When he landed, he shook his fist and remarked, "I shaid up, not down!"

* * * * *

Dean: "Know you? Why I knew you when your mother was kicked out of college."

* * * * *

1951 Fashion note: The return of the bustle may become a stern reality.

* * * * *

"Waiter," said a testy patron. "I must say I don't like all the flies in this dining room."

"Tell me which ones you don't like," said the conciliatory waiter, "and I'll chase them out for you."

* * * * *

The designer bent across his board,
Wonderful things in his head were stored:
How can I make this tough to machine?
If this part here were only straight,
I'm sure the thing would work first rate.
But 'twould be easy to turn and bore,
It would never make a machinist sore.
I'll put in a right angle there,
Now he'll surely pull his hair.
Now I'll put the holes that hold the cap
Way down here where they're hard to tap.
This piece will work, I'll bet a buck,
But it can't be held in a jig or chuck.
It can't be drilled and it can't be ground,
In fact, the design is exceedingly sound.
He looked again and cried "at last!"
"Success is mine! It can't even be cast!"

A soldier wrote: "Dear Pop: I can't tell you where I am but I have just shot a polar bear." Sometime later another letter came. "Dear Pop: I can't tell you where I am but I have been dancing with a hula-hula girl." Again the old man got a letter. "Dear Pop: I can't tell you where I am but the doctor says I should have danced with the polar bear and shot the hula-hula girl."

* * * * *

Sign in Real estate office: Get lots while you are young.

* * * * *

Over-heard at a sorority meeting: "I'm getting married."

"How careless of you."

* * * * *

WANT AD: For trade — One study lamp for a bed. Am transferring from ROSE to STATE.

* * * * *

When Jane returned from a ride, her mother noticed that one of her shoes was muddy.

"Why is just your right shoe muddy and not your left?" she asked.

"I changed my mind," she answered simply.

* * * * *

Alice: "What's your father's occupation, Bill?"

Bill: "My father's a cop; but I'm no flop."

Alice: "My father's a baker; but I'm no Quaker."

Fred: "Huh, my father's a chauffeur, but I'm no loafer."

Helen: "Er—ah, my father's a surgeon."

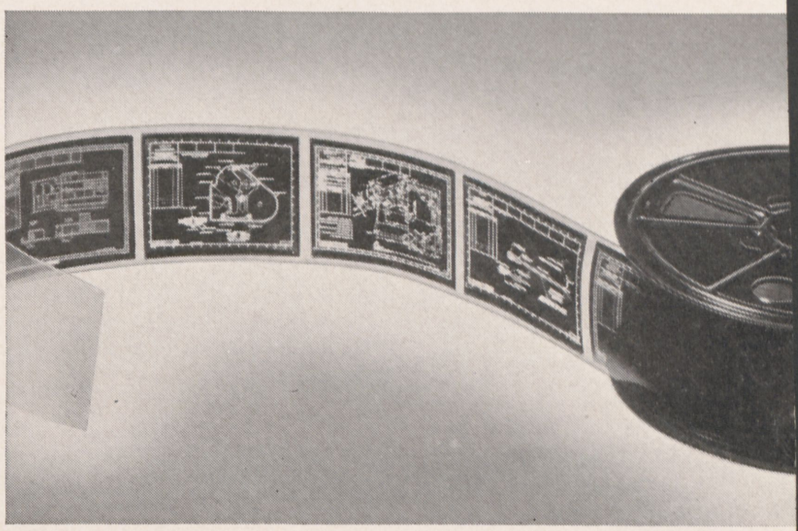
Extreme accuracy makes photography a matchless engineering tool

DRAWINGS ARE COPIED FAITHFULLY. Photocopying reproduces engineering drawings, data, specifications, with high speed, utmost accuracy and in any quantity. Bright copies can be made from dimmed material. Originals are saved from wear and tear.

Accuracy is but one of the unusual abilities of photography which are important in engineering and other professions and businesses alike. Through its speed it can provide movies that slow down action which would be far too fast for eyes to follow. Through radiography it checks castings, welds, and assemblies without destroying the part.

And so it goes all through the profession. You find photography saving time, improving products and procedures, simplifying processes.

Eastman Kodak Company, Rochester 4, N. Y.



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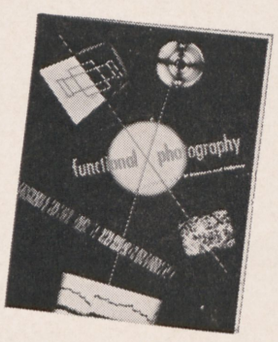
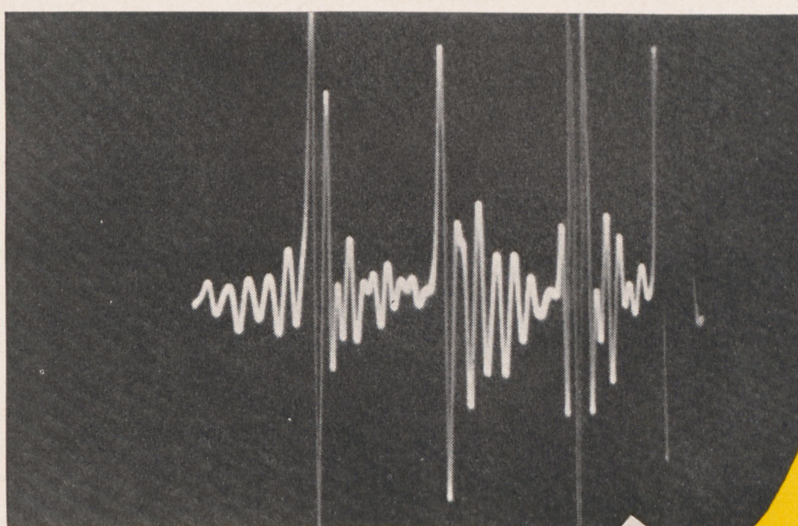


It tells how photography is used to:
Speed production · Cut engineering time
Assure quality maintenance · Train more workers faster · Bring new horizons to research



INSTRUMENT READINGS RECORDED. Fleeting traces of the galvanometer mirror or cathode-tube beam can be recorded for study and analysis. Movement too fast for the eye is caught accurately by photography.

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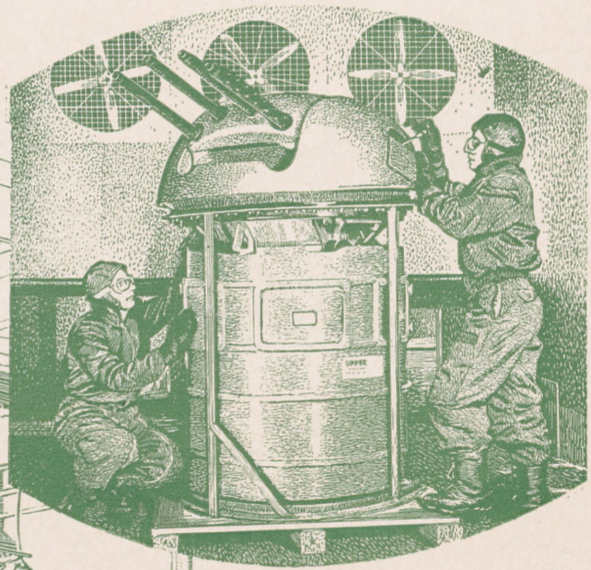
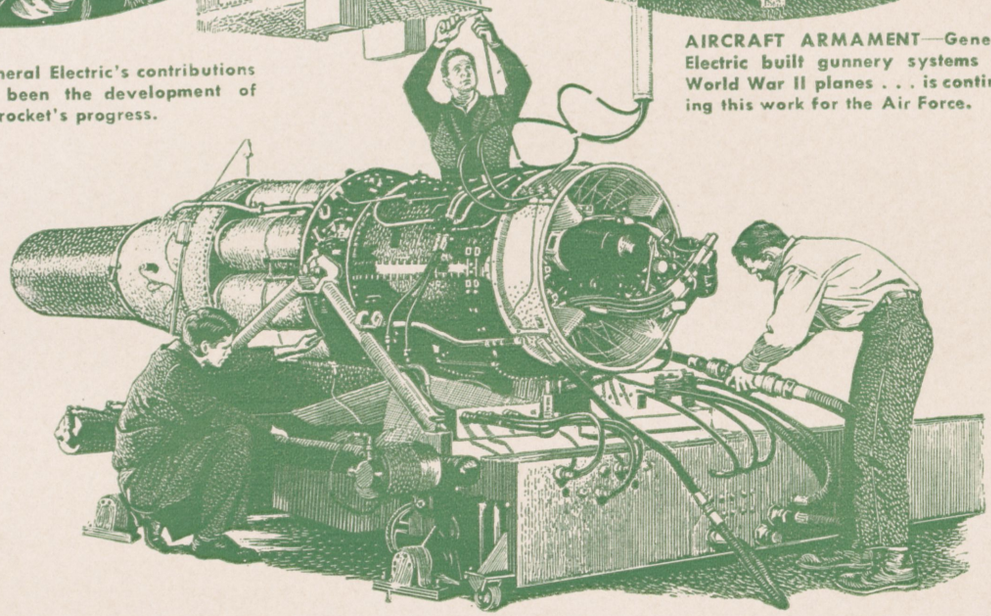
GUIDED MISSILES—Among General Electric's contributions to this military project have been the development of compact transmitters to report rocket's progress.



AIRCRAFT ARMAMENT—General Electric built gunnery systems for World War II planes . . . is continuing this work for the Air Force.



JET ENGINES—In 1941, the Air Force asked General Electric to build the first U.S. jet engine. Today, G-E engines power such fast planes as the F-86 Sabre, holder of world's speed record.

College graduates at General Electric are working on some of the nation's most vital projects

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