Rose-Hulman Institute of Technology
Rose-Hulman Scholar

Technic | Student Newspaper

Spring 3-1967

Volume 78 - Issue 5 - March, 1967

Rose Technic Staff
Rose-Hulman Institute of Technology

Follow this and additional works at: https://scholar.rose-hulman.edu/technic

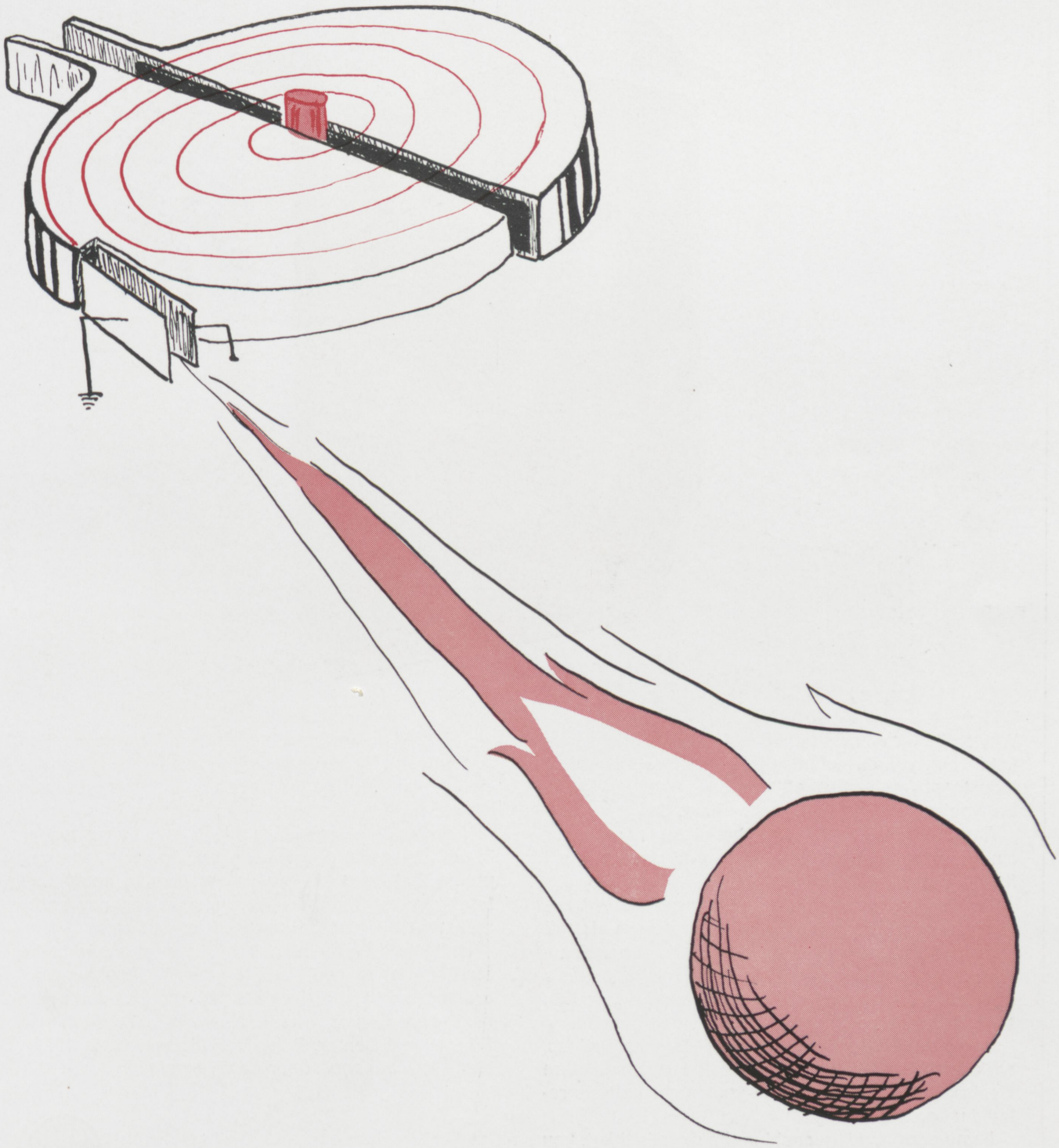
Recommended Citation
Staff, Rose Technic, "Volume 78 - Issue 5 - March, 1967" (1967). *Technic*. 30.
https://scholar.rose-hulman.edu/technic/30

Disclaimer: Archived issues of the Rose-Hulman yearbook, which were compiled by students, may contain stereotyped, insensitive or inappropriate content, such as images, that reflected prejudicial attitudes of their day--attitudes that should not have been acceptable then, and which would be widely condemned by today's standards. Rose-Hulman is presenting the yearbooks as originally published because they are an archival record of a point in time. To remove offensive material now would, in essence, sanitize history by erasing the stereotypes and prejudices from historical record as if they never existed.

This Book is brought to you for free and open access by the Student Newspaper at Rose-Hulman Scholar. It has been accepted for inclusion in Technic by an authorized administrator of Rose-Hulman Scholar. For more information, please contact weir1@rose-hulman.edu.

Rose Technic

March 1967



Particle Accelerators

Engineering Education

Don't be pigeonholed till you've had a chance to fly

Why settle for a limited choice of opportunity in your field when you can choose from the whole world of industry at Westinghouse? No matter what you like to do, you're likely to do it better here.

And if at first you don't find your niche in one of our six operating groups,* there's a good chance you'll find it in another.

Want to be far out? Help us build our NERVA nuclear reactor for space propulsion or design aircraft electrical power systems for tomorrow's super transports. Want to be way in? Help us unlock the ocean's secrets in our *Deepstar 4000* undersea exploration craft. If you're a skin diver, bring your equipment.

Or come help us revolutionize communications, radio and TV with more sophisticated microminiature electronic devices. Or would you rather help us rebuild urban areas?

If you care about quenching the world's thirst, you can help build water desalting plants throughout the world. To date, we have installations for communities and industry from Key West to Kuwait. One of our desalting plants solved the Navy's fresh water problems when Castro cut the water line at Guantanamo.

If you're interested in computers, we're a leader in both their use and application. And not just computers that do a payroll; we're applying computers to steel mills, rapid transit systems, oceanographic research ships and automated warehouses.

Isn't this the wide freedom of choice you want at the start of your career? Talk to your Westinghouse recruiter about it when he visits your campus during the next few weeks or write: L. H. Noggle, Westinghouse Educational Center, Pittsburgh, Pennsylvania 15221.

An equal opportunity employer

You can be sure if it's Westinghouse

***The Westinghouse Operating Groups:** Consumer Products; Industrial; Construction; Electronic Components & Specialty Products; Atomic, Defense & Space; Electric Utility.

In the next few years, Du Pont engineers and scientists will be working on new ideas and products to improve man's diet, housing, clothing and shoes; reduce the toll of viral diseases; make light without heat; enhance X-ray diagnosis; control insect plagues; repair human hearts or kidneys; turn oceans into drinking water...

and anything else that you might think of.

The 165-year history of Du Pont is a history of its people's ideas—ideas evolved, focused, and engineered into new processes, products and plants. The future will be the same. It all depends upon you.

You're an individual from the first day. There is no formal training period. You enter professional work immediately. Your personal development is stimulated by real problems and by opportunities to continue your academic studies under a tuition refund program.

You'll be in a small group, where individual contributions are swiftly recognized and rewarded. We promote from within.

You will do significant work, in an exciting technical environment, with the best men in their fields, and with every necessary facility.

Sign up today for an interview with the Du Pont recruiter. Or mail the coupon for more information about career opportunities. These opportunities lie both in technical fields—Ch.E., M.E., E.E., I.E., Chemistry, Physics and related disciplines—as well as in Business Administration, Accounting and associated functions.

DU PONT
REG. U.S. PAT. OFF.

E. I. du Pont de Nemours & Co. (Inc.)
Nemours Building 2500—1
Wilmington, Delaware 19898

Please send me the Du Pont Magazine along with the other magazines I have checked below.

- ☐ Chemical Engineers at Du Pont
- ☐ Mechanical Engineers at Du Pont
- ☐ Engineers at Du Pont
- ☐ Du Pont and the College Graduate

Name_____

Class_____ Major_____ Degree expected_____

College_____

My address_____

City_____ State_____ Zip Code_____

AMERICA'S OLDEST ENGINEERING COLLEGE MAGAZINE IN CONTINUOUS MONTHLY PUBLICATION — 1891-1967

EDITOR BILL KANE

BUSINESS STAFF
Manager
GARY BRADHAM
DENNY FRITZ

LAYOUT STAFF
Manager
TOM TRUEB
TERRY JOYCE
FRANK NIGH
DON COX
JOHN SHAMBACH
DAN KIRKLAN
ANDY SPENCE
DENNY RANDLE
BOB JOHNSON
MARVIN RAYMOND
BILL McCORD
MIKE WRIGHT
MARTY GOODWINE
SCOTT STEPHEN

COPY STAFF
Manager
DAN MOHR
CARL BAUER
ROY JACOBS
BOB GRAVITT
BILL CURE
DAVE YEAGER
PHIL GERHART
LARRY OLSON

CONTRIBUTING STAFF
Manager
CHUCK RISCH
FRANK NIGH
BOB UHLMANSEIK
WADE SCOTT
DON RILEY
GARY MEEK

ADVERTISING STAFF
Manager
ROBERT BRUNT
JOHN GREVE
BILL ANDERSON
ERNIE DANY
JOHN WARD
TIM SULLIVAN
STEVE RICHS
JOE VUMBACO
TOM WEGMAN
JIM ENGLE

CIRCULATION STAFF
Manager
MARK KELLY
CHUCK RISCH
RON FISHER
NICK VIROSTKO
LOUIS BARDIN
DEAN FEISS
MIKE HOWLETT
ROY KASER
SKIP DOUGLAS

ART STAFF
Manager
TERRY JOYCE
TIM BROWN
DWIGHT KLIPPEL
CHUCK RISCH
PHIL FASSNACHT
PETE DOENGES

PHOTOGRAPHY
CHARLY RUPP

ASSOCIATE EDITOR
JERRY STINEMAN

MANAGING EDITOR
DAVE SLAVKIN

FACULTY ADVISOR
DALE OEXMANN

Member of Engineering College Magazines Associated

IN THIS ISSUE

Just what are the goals of an engineering education? Are they to transform a human into a walking computer or are they to instill a humanized spirit of inquisitiveness about nature within a man.

The fascinating world of physics! Read about the machines that furthered man's insight concerning the nature of matter.

What type of heat measuring instruments are there besides the common theremometer? Read about instruments whose upper parameter of measurements is of such a high degree that the internal components of a rocket in flight can be calibrated with ease.

COVER NOTE

This month's cover is the creation of Dwight Klippel, sophomore E.E. It is a drawing of the essential unit of a paricle accelerator.

Volume LXXVIII, No. 5

March 1967

Rose Technic

5 Goals of Engineering Education ..... John Mercer

8 Particle Accelerators ..... William Dodge

10 High Temperature Measurements

20 R & D: Oceanography

* * * * *

7 Editorial

16 Miss Technic

22 Sports

28 Sly Droolings

Publisher's Representative
LITTELL-MURRAY-BARNHILL, INC.
369 Lexington Avenue,
N. Y. 17, N. Y.
and 737 N. Michigan Avenue,
Chicago 11, Illinois

ECMA Chairman
PROF. J. R. BISSETT
Civil Engineering Department
University of Arkansas
Fayetteville, Arkansas

PRINTED BY MOORE-LANGEN PRINTING AND PUBLISHING CO.
140 North Sixth Street, Terre Haute, Ind.

Published monthly except June, July, August, September and January by the Students of Rose Polytechnic Institute. Subscriptions obtainable by a $3.00 donation to the Student Activities Fund of Rose Polytechnic Institute. Address all communications to the ROSE TECHNIC, Rose Polytechnic Institute, Terre Haute, Indiana.

Entered in the Post-office at Terre Haute as second-class matter, as a monthly during the school year, under the act of March 3, 1879. Acceptance for mailing at special rate of postage provided for in section 1103, Act of October 3, 1917, authorized December 13, 1918. This magazine does not necessarily agree with the opinions expressed by its contributors.

ROSE

ROSE POLYTECHNIC INSTITUTE

TERRE HAUTE, INDIANA

HIGH SCHOOL GRADUATES OF 1967

You are cordially invited to visit Rose Polytechnic Institute where you can earn a degree in:

CHEMICAL ENGINEERING

ELECTRICAL ENGINEERING

MECHANICAL ENGINEERING

CIVIL ENGINEERING

MATHEMATICS

PHYSICS

CHEMISTRY

Office OF ADMISSIONS

ROSE POLYTECHNIC
INSTITUTE
TERRE HAUTE, INDIANA

Goals of Engineering Education

Recommendations

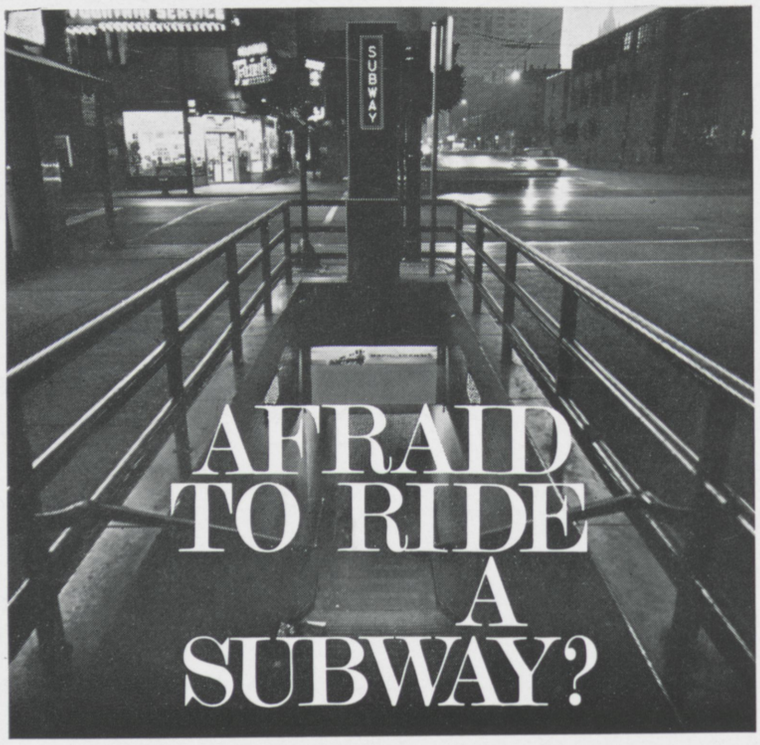
The steadily rising utilization of engineering manpower in the United States and the rising aspirations of individual students for higher levels of education, indicate that a substantial expansion of the national enter prise in engineering education must be planned for the next decade.

Past and present trends justify the prediction that by 1976 the annual rate of graduation will be 75,000 bachelor's degree, 40,000 master's degrees, and 6,000 doctorates. It is likely that as many as 40 institutions not now offering doctorate programs in engineering will be doing so by 1976, and that present programs will have grown steadily. Financial support of research in engineering schools must keep pace with this growth. The U.S. total was $160 million in 1963 and should increase to about $700 million by 1976. New demands on practicing engineers will require increasingly higher levels of professional competence, fuller preparation to accept new and varied responsibilities, and broader acquaintance with the many interrelated facets of modern life. In view of these and other considerations, the Goals Study recommends that:

1. The *first professional degree* in engineering should be the master's degree, awarded upon completion of an integrated program of at least five year's duration. This degree should be uniformly identified as the Master of Engineering degree, without qualifying adjectives or phrases. It is expected that implentation of this recomendation can be accomplished within a period of five to seven years.
2. Four-year bachelor's degree programs leading to an *introductory engineering degree* should continue to be offered.
3. The ASEE, educational institutions, and engineering faculties should immediately exert a positive effort to strengthen and improve the *liberal education* of engineering students to enable them to fully appreciate and discharge their responsibilities to society.
4. Curricula leading to the first professional degree in engineering should continue to be soundly based on *the physical sciences, the engineering sciences, and mathematics* (as recommended in the Grinter Report) and, in appropriate cases, on the life sciences.
5. *Analysis, synthesis, and design* of systems should be given increased emphasis in engineering curricula at all levels.
6. More *diversity and flexibility* should be introduced into engineering programs in order to accommodate the differing aims and talents of individual students. New kinds of learning experience and high-level creative activity are needed at all levels to prepare the student for leadership roles. Even the doctorate should be recognized as broad preparation for many aspects of professional life, and not as preparation for research alone.
7. *The excellence of faculty* is of critical importance in engineering education, and the creation of appropriate policies for faculty recruitment, development, and utilization should be given primary consideration by college administrations.
8. *Cooperation should be promoted* between colleges on the one hand

(*Continued on page* 18)

CONSUMER PRODUCTS ★ COMMUNICATIONS ★ SEMICONDUCTOR PRODUCTS ★ GOVERNMENT ELECTRONICS ★ AUTOMOTIVE PRODUCTS ★ CONTROL SYSTEMS



AFRAID TO RIDE A SUBWAY?

Subways aren't for sleeping. Alertness counts in the underground world of city transit systems. Move quickly, stay awake, and be careful.

A robbery, an accident, a train breakdown can cause panic. Today, with Motorola's 2-way transit radio systems, help is just a button push away.

Subway police can now wear Handie-Talkie portable radios on their Sam Browne belts—speaker on the shoulder strap close to the ear, hands free. Trouble on a train? Word is flashed from Control Center to the nearest patrolman. He's there when the train pulls in.

Problems? In rush hour, some subways run as many as 120, ten-car trains spaced at two-minute intervals. Delay, jam-up, too many sardines trying to get in one car? When the train is equipped with Motorola Transit Dispatcher Radios, the motorman advises the trainmaster. Adjustments are made; other trains notified.

Safety, speed, and security—all part of up-to-date transit system communications and part of Motorola's efforts to help get people where they want to go. Closed circuit TV and radio keep traffic flowing through city tunnels. Motrac 2-way radios route cabs and busses. Special radio systems for railroads get important messages through.

On the go? Comforting, isn't it, when Motorola's along for the ride.

TRUST THIS EMBLEM WHEREVER YOU FIND IT

MOTOROLA

Let The Class Begin

Gentlemen, this is a lecture.

Not a long one but a lecture nevertheless. And a badly needed one. The subject of this lecture is responsibility; the audience is the students of Rose.

The most widely used definition of responsibility is found in Webster's dictionary: the quality of being answerable for one's behavior. That means that we are being held accountable for our own actions. Not by our parents and teachers but by society itself. We're not going to resurrect the old saying that a person is only hurting himself when he fails in his responsibility. That's his business. Frankly, we don't care. But the person who shirks his responsibility is hurting the society he lives in.

We are now referring directly to those who fail in their responsibility to Rose. The men who revile the teacher trying to educate them, the ones who cheat on tests, and those who just don't care; these are the people who are hurting the school and their fellow students.

And we ask: what do I owe to Rose? I paid my five hundred dollars this quarter. Consider for a moment the fact that this five hundred dollars represents only 40% of the cost necessary to educate us. In other words, we're being supported by some very generous benefactors who supply the rest of the money in donations. Doesn't that shake our sense of independence!

The generosity of these people and the efforts of the administration and the faculty demand an equal response from the students! To try hard in our courses; to be fair to the school and each other; to cease grumbling and begin constructive comment: this will keep Rose a fine school!

T. T.

PARTICLE ACCELERATORS

Particle accelerators can be grouped into two general classes; (1) devices in which the charged particle gains all of its energy in falling through a single large potential difference; (2) devices in which the particle is accelerated repeatedly through relatively small potential differences. The second class can be divided again into two subclasses: accelerators in which the particle undergoing acceleration always moves in a straight line; and accelerators in which the particle moves in a spiral or circular path under the influence of a magnetic field. The first subclass includes the various types of linear accelerators (or linic) while the second subclass includes the cyclotron, betatron, and synchrotron.

Particle accelerators are used to accelerate subatomic particles to extremely high energies. These, in turn, are used to study the ordinary atomic nucleus. The particles which are usually accelerated are protons, hydrogen nuclei, deuterons, heavy hydrogen nuclei, alpha particles, and helium nuclei, all of which are positive ions, and electrons, which are negative ions.

CYCLOTRON

The first cyclotron was constructed in the early nineteen thirties and it can be said that the whole field of radioactive tracer technique used in chemical, biological, and medical research received a great boost as a result of the development of the cyclotron. It also made it possible to study the scattering of protons, and neutrons by protons at an energy range otherwise inaccessible.

The cyclotron is composed of two semicircular (D-shaped) hollow electrodes, called dees, between the poles of a magnet and the ion source of the cyclytron is a small metallic chamber into which the particles to be accelerated are placed. These particles, usually hydrogen, deuterium, or helium, are present at a pressure about one hundred times greater than that in the chamber. The ions start near the center and circulate inside the electrodes, crossing the gap between them twice on each revolution.

The ions must be kept from striking the dees during acceleration. This is accomplished by arranging a small radial decrease in the magnetic field, thus giving a slight outward curvature to the magnetic field. It is important that the decrease in energy of the magnetic field from the center toward the outside of the chamber is small. This decrease should be about one per cent. This in turn causes the ion to have a small curvature toward the median plane, which causes it to remain within an inch or two of the magnet poles. The target is placed at the edge of the chamber and in the path of the particle. A deflecting electrode directs the particle toward the target.

There are tens of cyclotrons in use in the world in various types of laboratories today, of which a good part are in the United States. The cyclotron has been most used in the study of the nucleus of the atom. The particles accelerated in the cyclotron have become very important in the study of mesons, particles which are heavier than electrons but lighter than protons. The cyclotron can be used to produce a stream of fast moving neutrons by the nuclear reaction occurring at the target. Another important use is the creation of artificial elements. Until the construction of the atomic reactors the cyclorton was used a great deal to produce radioactive isotopes. To date the cyclotron has proven to be the most dependable machine for accelerating positive ions. This is not to imply that it has always been the most efficient economically.

SYNCHRO-CYCLOTRON OR PHASOTRON

The best way to overcome the energy limitations of the cyclotron is by varying the frequency applied to the dees. This is exactly what is accomplished by the synchro-cyclotron. The chief advantage of this machine is that there is no limit to the number of revolutions the particle may take to obtain the desired energy level. The synchro-cyclotron, however, uses only one dee. Therefore the particle receives only half as much acceleration per revolution as it would in the cyclron, but this gives the machine many mechanical and electrical advantages over the cyclotron.

In the synchro-cyclotron the ions must arrive in the chamber at the proper time or they will not be accelerated. The ion source usually expels ions only during the time of capture by the field. There is also some difficulty in leading the beam of protons out of the chamber, so at the proper moment inhomogenei-

ties of the magnetic field of the synchro-cyclotron are artificially produced. The orbits of the ions are changed and the proton beam comes out of the chamber through a hole in a special magnetic screen.

The synchro-cyclotron has been used for important investigations into the reactions between elementary particles and nuclei. Also the properties and interactions of pi-mesons have been studied in detail by use of the synchro-cyclotron. Of the important discoveries that have been made by use of the synchro-cyclotron, the discovery that nuclear forces are independent of the charge is one of the most important.

By the late nineteen fifties, there were only about sixteen such machines in the world, and only eight of these were capable of producing energies of more than two million electron volts.

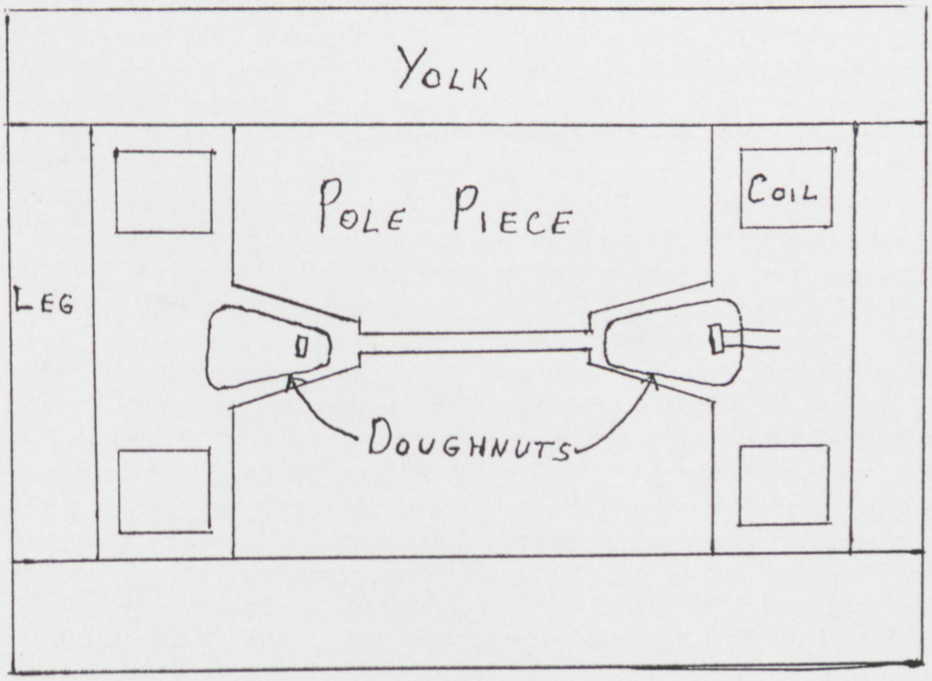
BETATRON

The first betatron was built by Donald W. Kerst at the University of Illinois in 1940. This machine works on the same principle as the ordinary electric generator except it requires an alternate current instead of a direct current magnet like in the cyclotron. The largest machine of this type was constructed at the University of Illinois at the end of World War II. It is capable of accelerating electrons to 350 million electron volts.

It is made only for the accelerating of electrons, and its principle of electromagnetic induction is like that of a transformer. It can produce electrons or X-rays of millions of electron volts of energy without the use of extremely high voltage.

In the betatron the electrons are guided along a circular path within a high vacuum tube called a "doughnut," which is made of glass or porcelain and has the shape of a ring. The most important part in the betatron is the electro-magnet which is a specially shaped guide field, which keeps the electron in a circular orbit or forces it toward one. By traveling around in this high vacuum tube thousands of times, the electron builds up an energy measured in millions of electron volts without causing the insulation problem associated with the actual production of a high potential.

The electrons are introduced by an electron gun, which is placed as far away from the equilibrium orbit as possible, yet close enough for the magnetic field to the proper focusing effect. The electron comes from a hot filament or other thermionic emitter, which is provided with shielding and focusing electrodes so that the electrons are shot toward the hole and emerge in a narrow direct beam. To avoid this gun causing interference with the magnetic field, it is grounded and connected to the conducting coating inside the doughnut. Most of the electrons shot from gun are lost in the doughnut, but the few that remain in the orbit gain energy as long as the field increases. Then when the desired energy is reached, the electrons are caused to strike the target by upsetting the relationship between the guide field and the flux.



Betatrons are used in physics for the study of the fundamental properties of matter and radiation and have also found applications in technology and medicine. They have also been used in the food industry for the sterilization of tinned products. They can also be used to determine defects in great thicknesses of metal and in medicine for the treatment of deep lying growths with less danger of injuring healthy surface tissues.

LINEAR ACCELERATOR

The linear accelerator, or linic, is the most basic type of accelerator. In this machine repeated accelerations through relatively small potential difference is used to achieve high potential energies.

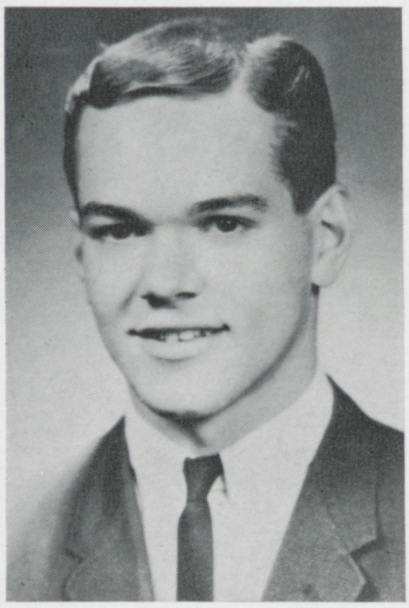
The idea for such a machine originated in the early nineteen thirties, but the first one was not built until 1946. In this machine the particle starts from a source and moves through a series of hollow cylindrical electrodes of increasing length. Every other electrode is connected together and to a source of alternating voltage; therefore the electrodes in between those connected to energy are called "drift tubes," because they allow the particle to drift in them at a constant velocity. In this machine it is possible to obtain beams of particles of very great intensity. This type of machine can be used to accelerate either electrons or protons.

Linear Accelerator for Electrons

The linear accelerator for electrons was developed by applying ideas learned in the radar program of World War II. The machine operates by the use of an electromagnetic, or radar, wave. The electron is injected into the wave as it travels in a cylindrical pipe. This radar wave is used to guide the electron; and

HIGH TEMPERATURE MEASUREMENTS

by Bill Dodge



Bill Dodge is a junior chemical engineer who maintains high grades while being active in many extra-curricular activities. A member of Sigma Nu Fraternity, Bill has been selected to both Blue Key and Tau Beta Pi.

High temperature has been generally defined as the temperature of a system at which its "oxidation states, compounds, and general chemical behavior differ appreciably from those at room temperature." Generally 1000° K may be taken as a lower limit to the high temperature range. Generally, high temperatures are those up to 10,000° K, very high temperatures are those from 10,000° to 50,000° K, and temperatures above 50,000° K are designated as extremely high temperatures.

There are three main types of techniques for measuring temperature. They involve determining the magnitude of changes in the volume, pressure, or electrical resistivity of a substance. For instance, the standard mercury thermometer employs a change-of-volume method for temperature determination. This instrument, however, is only good up to 750°C.

The first man to attempt to exactly estimate high temperatures was Wedgewood in 1782. A century later only qualitative observations existed for temperatures above 500°C. Since then a tremendous amount of work has been done and much progress has been made, but there is still room for more study.

One of the first accurate instruments was developed by Le Chatelier. He tested various metals and found an alloy of platinum and rhodium to be the most satisfactory material. By using a high-resistance galvanometer, he avoided the influence of variations in resistance of the thermocouple when heated.

Some modern methods include a nuclear quadrupole resonance thermometer developed by Benedek and Kushida, a method suggested by Accardo which measures temperatures in the millions of degrees Kelvin range by determining the electron capture decay process of Be^7, and a microwave thermometer developed by Drummond which can measure temperatures from tens of thousands to tens of millions of degrees Kelvin.

There are many instruments developed a century or more ago, which are still being employed for high temperature measurement, especially in industrial applications. These include gas, calorimetric, and radiation pyrometers, resistance thermometers, and thermocouples.

A gas pyrometer measures a change in temperature by the change in pressure of a gas at a constant volume. However, the great volume and fragility of this device make it

(*Continued on page* 12)

We made a raincoat for a bee.

Not just an ordinary raincoat either.

It's a skintight plastic coat so thin you would never know it's there. Yet it covers the bee completely, right down to the individual hairs on the bee's knees. It was done to protect specimens in a natural history museum.

But we didn't spend 12 years on a new plastic just to protect bees. We developed parylene to protect things like bees—fragile, complex things so intricate in shape they are next to impossible to coat.

For instance. Each tiny grain of a highly reactive chemical can be protected to provide stability in the presence of gases or moisture. Tiny electronic capacitors, just one-fifth the size of previous types, can be insulated with a coating as thin as eighty-millionths of an inch.

Union Carbide finished the initial development work on parylene in February 1965. Until then, there was no comparable way to encapsulate delicate objects.

Parylene is one of the latest, most sophisticated new plastics to result from the exploring, researching and discovering that is always going on at Union Carbide. The same scientific inventiveness that has put Union Carbide into a greater variety of plastic products than anyone else. Ever.

That's why we're always looking for talented young people to help us. An equal opportunity employer.

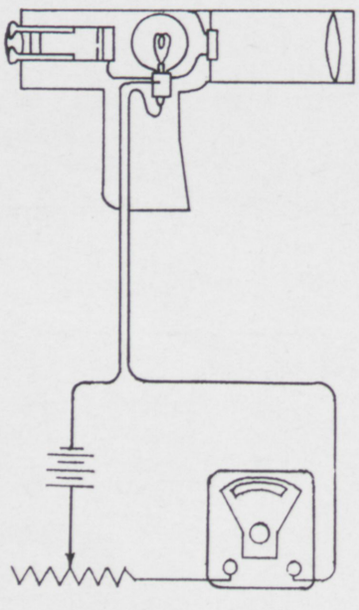
UNION CARBIDE

THE DISCOVERY COMPANY

unsuitable for most applications.

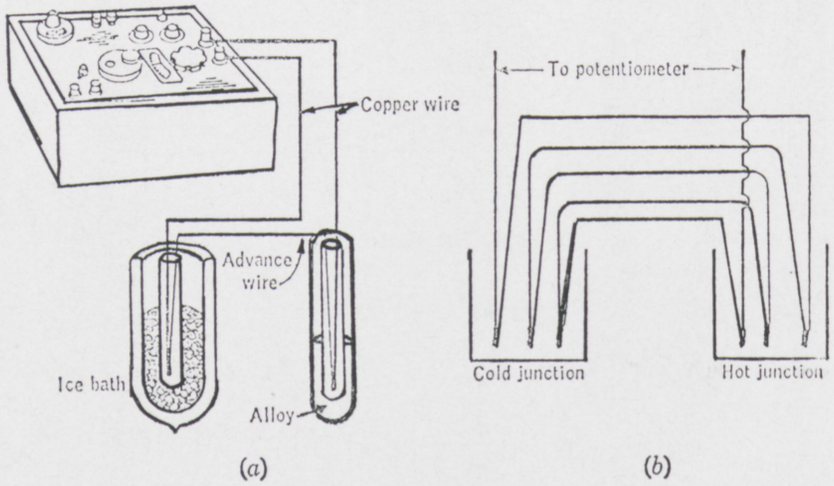
The calorimetric pyrometer is a simple and inexpensive instrument. A known mass of a metal at the temperature to be measured is dropped into a calorimeter. The increase in temperature of the calorimeter system indicates the heat added by the metal. From a curve of temperature vs. heat, the initial temperature of the metal may be determined.

The fact that the radiation from a black body is a function of temperature is the basis for the radiation pyrometer. The amount of radiation is measured to determine the temperature of the emitting body. Four methods are commonly used. In one method, one junctiion of a thermocouple is exposed to the radiation. In another, the change in resistance of a metallic strip is measured. A third method is based on the deflection of vanes in a vacuum, though this is not an accurate method. Optical pyrometers are used in the last method. Temperatures of iron, cobalt, nickel, aluminum oxide, and other refractory compounds, as well as the fireball of an atomic fission explosion have been studied by this method.



Optical Pyrometer.

THE THERMOCUPLE



(*a*) (*b*)

(*a*) Use of the thermocouple in alloy-cooling-curve studies; (*b*) a three-junction thermel.

The optical pyrometric method is used in most high temperature laboratories. This method measures the luminous radiation by photometric determination or by the "disappearance of a bright filament against an incandescent background." This method is good from 800° to 4000°C, especially when access is difficult. Accuracy of this method is hindered by a lack of knowledge of emissivities of different surfaces, difficulty in getting good points of measurement, lack of eye sensitivity, and inconsistency of observers. Errors of one per cent are common.

One of the most precise instruments developed is the resistance thermometer. Its basis is that "the electrical resistance of a wire increases in a regular manner as the temperature rises, and since the resistance of a wire can be measured with great precision, this measurement offers an accurate method for determining temperatures."

Platinum wire 0.008 inches in diameter is used because of its inertness and high resistance. After annealing, it is wound on mica supports in a manner to eliminate strain on the wire from thermal expansion and contraction. The coil is sealed in a tube of quartz or glass. Lag is reduced by enclosing the coil in a flat metal case. With this construction, temperatures up to 1200°C may be measured.

Resistance thermometers called "thermistors" are made of semiconductors in which the resistance decreases sharply as the temperature rises. They are especially useful for measuring small temperature differences.

Perhaps the most widely used instrument for the measurement of high temperatures is the thermocouple. The principle of the thermocouple, discovered in 1821 by Seebeck, states that if two dissimilar metal wires are conected at the ends, a current will flow if the junctions are at different temperatures. The magnitude of this current is proportional to the magnitude of the temperature difference. Galvanometers are used to determine the current.

Usually the hot junction is considered the only source of emf. The cold junction should be kept at a constant temperature. Usually this is done by an ice bath, but other methods are also used.

The temperature-emf relationship is shown by Holman's formula,

$$\text{emf} = mt^n$$

where emf is the electromotive force of the couple for any temperature t when the cold junction is kept at

(*Continued on page* 26)

IS HE YOU?

Wherever a well sucks oil from the earth, you're apt to find our man's ideas.

Timken Company metallurgists have worked with petroleum engineers to develop seamless steel tubing that today's highest well pressures won't pop.

It's used for drill collars, tool joints, lots of other "down hole" applications.

The petroleum industry counts on the uniform quality of Timken® steel tubing. And we count on our engineers to keep it that way.

Could we count on you? Are you interested in meeting industry's demands for finer metals . . . and finer minds?

Then clip the coupon and send today for the free booklet, "Place Your Future on a Sound Foundation." Maybe *you* are our man in offshore drilling?

The Timken Roller Bearing Company, Canton, Ohio.

An Equal Opportunity Employer.

Mail to: Manager of College Relations
The Timken Roller Bearing Company
Canton, Ohio 44706

Rush me a copy of your free booklet,
"Place Your Future on a Sound Foundation."

Name_____

Address_____

School_____

Year_____ Major_____

NEWS for 1966 1967 ENGINEERING GRADUATES

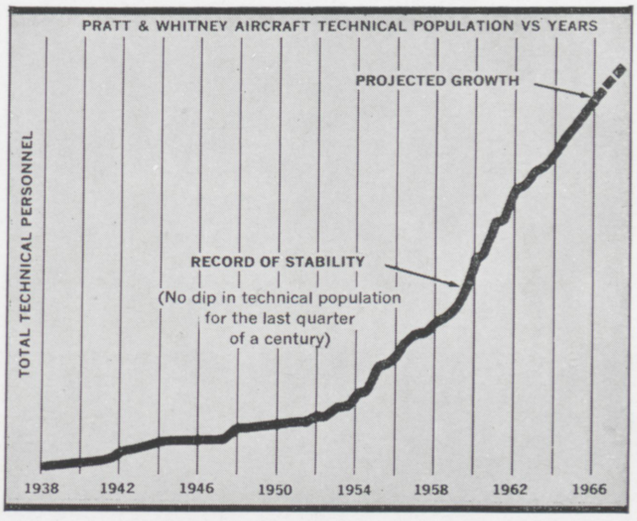
Continued expansion of our military and commercial business provides openings for virtually every technical talent.

As you contemplate one of the most important decisions of your life, we suggest you consider career opportunities at Pratt & Whitney Aircraft. Like most everyone else, we offer all of the usual "fringe" benefits, including our Corporation-financed Graduate Education Program. But, far more important to you and your future, is the wide-open opportunity for professional growth with a company that enjoys an enviable record of stability in the dynamic atmosphere of aerospace technology.

And make no mistake about it . . . you'll get a solid feeling of satisfaction from your contribution to our nation's economic growth and to its national defense as well.

Your degree can be a B.S., M.S. or Ph.D. in: **MECHANICAL, AERONAUTICAL, CHEMICAL, CIVIL (structures oriented), ELECTRICAL, MARINE, and METALLURGICAL ENGINEERING • ENGINEERING MECHANICS, APPLIED MATHEMATICS, CERAMICS, PHYSICS and ENGINEERING PHYSICS.**

For further information concerning a career with Pratt & Whitney Aircraft, consult your college placement officer—or write Mr. William L. Stoner, Engineering Department, Pratt & Whitney Aircraft, East Hartford, Connecticut 06108.



Take a look at the above chart; then a good long look at Pratt & Whitney Aircraft—where technical careers offer exciting growth, continuing challenge, and lasting stability—where engineers and scientists are recognized as the major reason for the Company's continued success.

SPECIALISTS IN POWER . . . POWER FOR PROPULSION—POWER FOR AUXILIARY SYSTEMS. CURRENT UTILIZATIONS INCLUDE MILITARY AND COMMERCIAL AIRCRAFT, MISSILES, SPACE VEHICLES, MARINE AND INDUSTRIAL APPLICATIONS.

Pratt & Whitney Aircraft

CONNECTICUT OPERATIONS EAST HARTFORD, CONNECTICUT

DIVISION OF UNITED AIRCRAFT CORP.

An Equal Opportunity Employer

MISS TECHNIC

Miss Technic for March is Karen McCarty. She is a freshman at Indiana State University and a pledge of Alpha Omicron Pi sorority. Karen is from Evansville, Indiana. While at ISU she plans to direct her studies toward the area of special education.

Karen has an energetic personality and enjoys spending her spare time in outdoor activities. She is a 5′ 5″ brunette with deep brown eyes.

KAREN McCARTY

ENGINEERING EDUCATION

(*Continued from page* 5)

and industry and government on the other, by encouraging practicing engineers to participate directly in academic instruction, and by aranging for teachers to gain practical experience in industry and government on a semester-long basis.

9. Arrangements must be devised to provide adequate *financial support of research* in the years ahead. Federal agencies which have been providing virtually all of this support must face the challenge of increased demand and gain the support of Congress on this urgent national need. New administrative arrangements should be devised to facilitate industry participation, possibly through a nation-wide private foundation patterned after the National Merit Scholarship Foundation, to pool contributions from individual firms and dispense research grants to professors and schools.
10. *Part-time graduate programs* of high quality should be extended to serve practicing engineers. They should be conducted by institutions having full-time programs of high standards. Daytime release for students employed near campuses should be encouraged.
11. *An institution aspiring to a significant role* in graduate engineering education must recognize that it cannot become a "center of excellence" merely by acquiring a special financial grant. But the actual experience of a number of schools mentioned in the Goals Report shows that a school with appropriate plans should be able to make good progress in the next decade.
12. Accreditation by ECPD should be changed from specific curricular accreditation to *accreditation of the over-all engineering unit* (e.g., the engineering college). Such accreditation will then be an assurance that all first professional degrees (Master of Engineering) offered by that unit are judged to be of acceptable professional quality.
13. *Accreditation of graduate curricula beyond the first professional degree* should be postponed until the engineering profession itself is ready to specify a second-level professional degree. (Other professions do not have such degrees, the nearest being certification by the medical specialty boards. These boards do not administer academic degree programs.)
14. *Continuing study* by degree holders at all levels is a recognized need of a learned profession, which appears to be inadequately filled in engineering. It is hoped that specific recommendations will emerge from the ECPD-EJC-ASEE-NSPE Joint Advisory Committee, which is studying the roles of industry, government, academic institutions, and engineering societies in continuing education.

STUDY
ABROAD

"Study year abroad in Sweden, France, or Spain. College prep., junior year abroad and graduate programmes. $1,500 guarantees: round trip flight to Stockholm, Paris or Madrid, dormitories or apartments, two meals daily, tuition payed. Write: SCANSA, 50 Rue Prosper Legoute', Antony - Paris, France".

BEL-AIR BOWL
and
LOUNGE
C-6069

Open Bowling
Monday thru Friday
at
8:30
All Day Saturday and Sunday
Billiard Tables

Twenty-five hundred dollars in cash awards to engineering and metallurgy students.

The Forging Industry Educational and Research Foundation announces a $2,500 award competition for the best paper on the subject "How Mechanical and Physical Properties of Impression Die Forgings Are Best Utilized in Designing Forgings for New Applications." First prize, $1,000, plus eight other awards totaling $1,500.

Competition is open to senior and graduate engineering and metallurgy students. Length of the paper, 3,000 to 3,500 words. Deadline for completed paper: May 10, 1967.

Winner and his faculty advisor will also receive an all-expense-paid trip to White Sulphur Springs, West Virginia, where the award presentation will be made at the 1967 meeting of the Foundation.

For full details fill in and mail the coupon or write:

The President

Forging Industry Educational and Research Foundation

55 Public Square • Cleveland, Ohio 44113

Name _____

Address _____

_____

School _____

_____

Faculty Advisor _____

New hardbound 520-page *FORGING INDUSTRY HANDBOOK*, describing forging design, applications and technology, is available to students at special low price of $2.50. Write, enclosing check or money order, to Forging Industry Association, 55 Public Square, Cleveland, Ohio 44113.

16-millimeter sound and color film, *TO BE FORGED*, describes forging process and design considerations. Length 18 minutes. Sponsored by Forging Industry Association, available on loan free from regional film libraries of Modern Talking Picture Service, Inc., 1212 Avenue of the Americas, New York, N.Y. 10036.

Oceanography

The sea is a mantle that covers 71 percent of the surface of the earth to an average depth of 12,000 feet. If all of the irregularities of the earth's surface were smoothed out, this mantle would cover the complete planet to a depth of 7500 feet. Four-fifths of the animal life on earth, except for insects, live within the sea. On the sea bottom are many forms of animal life, some swimming, some crawling or burrowing, and others, like the coral, stationary. Little is known about the process of birth, life, death, procreation of these organisms, and little is known of the physical environment in which they live—its temperature, salinity, density, sediment, turbidity, currents, oxygen content, light, and many other variables that may be undiscovered and unnamed.

There is abundant wealth within the sea. At a penny a pound, the salt in a cubic mile of seawater is worth 2.3 billion dollars; in this same cubic mile, there is magnesium worth 3 billion dollars, 250 tons of bromine, and 3.8 million tons of potassium sulfate. The sea is of immense economic potential to mankind and immense military significance to America.

Within the last several years there has been a general awakening in the United States to the importance of the sea. The budget for oceanographic research has grown threefold since fiscal 1961, and the U.S. now has a national oceanographic program "to acquire the understanding of the ocean and to translate this understanding into operational concepts and hardware that will enable the United States and its allies to exploit our peculiarly oceanic position militarily, economically, and politically." An Inter-Agency Committee for Oceanography has been formed to coordinate the activity of some eight different government agencies who have an interest in the future of the sea.

To exploit the sea in any manner, the behavior of the sea must first be understood; the natural laws it follows must be known. From these natural laws and observations of covariants, the sea's subsequent behavior should be predictable in much the same way that weather can be forecast. With the sea's behavior accurately predicted, systems of men and equipment can be designed for the sea's exploitation. For example, a ship is a simple man-machine system for transportation over the sea. Its sea-keeping ability is based upon an application of existing knowledge of winds, waves, tides, and surface currents. The first sailors went through painful trial-and-error procedures before learning to forecast the behavior of a given hull form in the sea. Today's modern ocean liner usually weathers the heaviest assault by the elements in the North Atlantic, but a 25-foot cabin cruiser cannot last long under such conditions. This is about the extent of progress in mating man, equipment, and the environment of the sea.

Man's knowledge of the sea is truly minute, perhaps because the sea cannot really be defined generically—its systems are largely unknown.

The modern oceanographic research survey ship makes many calls on a mechanical engineer's skill. The mission may call for the ship to hover over a particular spot on the ocean floor and lower a package of instruments to obtain a profile of oceanographic variables as a function of depth, or perhaps to extract cores from the sea floor. When the ship is under way, it may also tow packages of instrumentation. These may be either deep-running or close to the surface. There is a tempting array of design problems involved in the task of towing a 1000-pound instrument package at five to ten thousand feet below the surface at a speed of five to ten knots. The innteraction of drag with cable profile and strength per unit of cross section presents an interesting combination of variables, and present towing systems are so poor as to make the solution of this one problem an economically fertile field for the developer of something better.

In summary, the outfitting of a seagoing oceanographic survey or research platform presents a challenging opportunity for all branches of the engineering profession to join together in devising the most appropriate and economical system.

We've got the best facilities, the finest benefits, and blah, blah,

blah!

Sure, you've heard it before—probably from so many companies it's lost its meaning for you.

So we'll skip the story about our having the best, or the most, or the finest of anything. Even if we think privately that it's true, it still remains for you to be convinced.

We do have a booklet about our facilities, the work we do, the places where we work, the cities and towns we live in.

And if you've got the maturity to know that a man gets ahead on his own demonstrated ability to handle a job, you're the kind of man Collins would like to talk with.

We suggest you see your college placement officer for details. If he happens to be out of Collins Career books, write to Manager of Professional Employment, Collins Radio Company, in Cedar Rapids, Iowa; Dallas, Texas, or Newport Beach, California.

Then, contact the Collins representative when he visits the campus. You'll get straight talk about careers at Collins.

COMMUNICATION / COMPUTATION / CONTROL

COLLINS

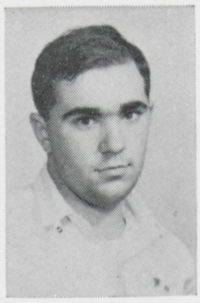
An equal opportunity employer

COLLINS RADIO COMPANY / DALLAS, TEXAS • CEDAR RAPIDS, IOWA • NEWPORT BEACH, CALIFORNIA • TORONTO, ONTARIO

Bangkok • Beirut • Frankfurt • Hong Kong • Kuala Lumpur • Los Angeles • London • Melbourne • Mexico City • New York • Paris • Rome • Washington • Wellington

SPORTS

INTRAMURALS COME OF AGE



The author is Don R. Riley, a junior majoring in electrical engineering from Akron, Ohio. Don is a member of Lambda Chi Alpha fraternity, and is also active in the Glee Club.

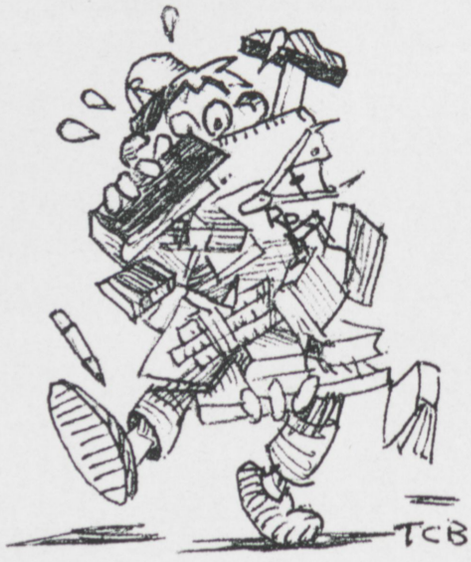
Intramural athletic activity has matured in the past two years at Rose due to a major change in its administration in September, 1965. In retrospect, I would like to review that change in policy.

When I was a freshman, the intramural program was segregated from interfraternity competition. Fraternities would play on Sunday afternoon, while the intramural leagues would meet during the week. Then, due to a lack of facilities caused by the enlargement of the student body, Coach Carr proposed that the fraternities merge with the intramural program. Another factor encouraging this proposal was to draw fraternities and fraternity men closer to the school and the student body. It was felt that the fraternities had isolated themselves from Rose in several respects. When the proposal was presented to the fraternities, it was met with mixed emotions. Some felt that if the proposal was accepted, it would set a precedence for future legislation to be dictated to the fraternities. Others felt that this proposal would strengthen fraternity loyalty to Rose. Still others felt this would be unfair to campus teams because the fraternities would probably dominate the competition. Needless to say, there was still skepticism in the air when the proposal was finally accepted.

It has been two years since the fraternities began competing with campus teams. I feel that all skepticism has vanished. Coach Carr has done a fine job in organizing interfraternity - intramural competition. This fine organization encouraged fraternities to enter more teams. As a result, more men are now able to compete, whereas before, only one fraternity team was established to play. This new program has also tended to bring the student body together. Many friendships are made and many are renewed on the athletic field of competition. Also, fraternity men now have an added opportunity to meet prospective rushees. Freshmen, on the other hand, now have a very important opportunity to judge the fraternities as a whole. The fraternity teams represent as a unit, their respective fraternities. Before this proposal was established, freshmen never really had a chance to see fraternities as a unit, except at the "best foot forward" rush parties.

Lastly, I feel that campus teams are now better organized than before. The reason for this is quite simple. Campus teams have one desire in mind—to beat an experienced fraternity team. This desire paid off for Speed Hall last year for they captured the Intramural All-Sports Trophy. Those who felt that fraternities would dominate, feel that way no more.

Two years ago, this proposal may have seemed unfair to some, but it was a necessary move. Viewing the decision in retrospect, it has been very successful. Rose can be proud of its Intramural Program. Few colleges with no Physical Education programs could successfully challenge Rose intramural teams.



POLYTECHNIC BOOKSHOP

Anton & Grace Hulman
Memorial Union

JOIN THE IDEA CORP.

Right now, hundreds of engineers, chemists, and physicists are exploring their own ideas at NCR. We encourage them because we consider idea-people as the backbone of technological advancement in our field of total business system development.

And it works. Business Management magazine, in its list of "emerging ideas of 1966," credits NCR with two out of seven: pioneering in laser technology for recording data, and development of our new PCMI microfilm storage system.

Whether you're a seasoned pro, or an ambitious self-starter, and whatever your degree, if the excitement and satisfaction of start-to-finish idea development appeal to you, you'll go far with NCR. And so will your ideas.

Here's a good idea to start with: write to T. F. Wade, Executive and Professional Placement, NCR, Dayton, Ohio 45409. An Equal Opportunity Employer.

NCR

THE NATIONAL CASH REGISTER CO. ®

both have the same velocity. The electron's charge affects the radar wave in such a manner as to cause ever-increasing energies.

Of the many uses for this machine, one of the more important is the sterilization of food and drugs, whereas, others of lower power are used as sources of X-rays for the treatment of cancer.

The largest difference between the linear accelerator for electrons and the one for protons is the mass of the particles accelerated by each. As with the accelerator for electrons, the one for protons was developed through material learned by the radar program in World War II. The biggest uses of the linear accelerator for protons are for nuclear research and injectors of protons for circular accelerators.

SYNCHROTRON

The synchrotron was proposed independently, by both V. I. Veksler and E. M. McMillar in 1945 and has proven successful for the acceleration of both electrons and protons.

Synchrotron for Electrons

The synchrotron for electrons was built in 1946 in England. It could accelerate electrons to only eight million electron volts, but it was built only to test the idea of phase stability acceleration. The first high energy synchrotron was built in 1947 at the University of California and could accelerate electrons to 330 million electron volts. Since that time over twenty such machines have been built, half of which are in the United States. There were two machines built in 1957 that have been able to accelerate electrons to twelve hundred million electron volts, the highest energy achieved by any machine.

This machine makes use of phase stability to keep the particles and the applied high-frequency electronic field in synchronism. A magnetic field pulls the particles into a circular orbit, and then the intensity of the field is adjusted to maintain an almost constant radius as the particle gains energy. The magnetic field is used only to attain the circular orbit, not to aid in acceleration. For this reason a much cheaper type magnet may be used, thus giving the synchrotron an economical advantage over the cyclotron or betatron. Electrons have proven to be good particles to accelerate, because they will achieve a velocity almost equal to that of light at a relatively low energy. The acceleration is provided by an electronic field across a gap in a vacuum chamber. The acceleration in the synchrotron is produced by an electric field of high frequency. This electric field is generated by a special device called a "resonator." The acceleration takes place in only one-quarter of the period of the changing magnetic field. To achieve the desired results the electron must be brought up to and maintain a constant velocity. During the first phase of acceleration the chamber must be kept at a very nearly perfect vacuum. When the electron approaches maximum velocity, the electronic field is turned off, allowing the electron to spiral in and strike the target. When this happens, a narrow beam of X-rays is given off.

The synchrotron is used as a source of X-rays for the production of photonuclear reactions and especially the photoproduction of mesons. Those below one hundred million electron volts are more often used in hospitals for the treatment of cancer.

Synchrotron for Protons

The synchrotron for protons is especailly designed for the heavier particles, the protron, the deuteron, and the alpha particle. This constitutes the major difference between the two machines. Another difference is that the velocity of the proton increases as the energy increases. Therefore the orbital frequency increases during acceleration instead of remaining constant as it did in the machine for the elevctrons. The large similarity lies in the fact that here too a cheaper type of magnet can be used. In this machine the particles are preaccelerated and injected into the machine at the proper time for further acceleration. Other than these few differences these two machines, one for electrons and one for protons, are essentially alike in the way that they operate.

The synchrotron is used mainly for the study of nuclear transformations produced under the action of gamma-rays of various energies. Scientists hope to gain much information on the properties of high energy particles by the use of this machine.

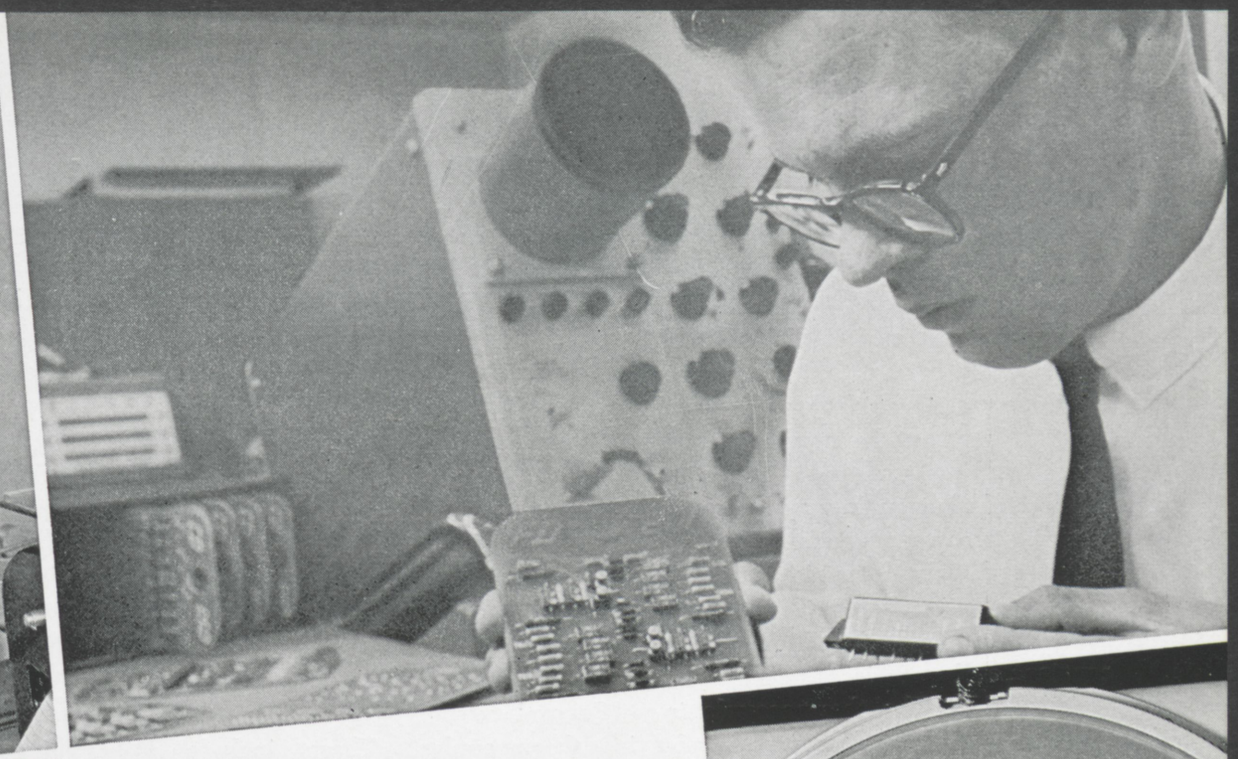
VAN DE GRAAFF ACCELERATOR

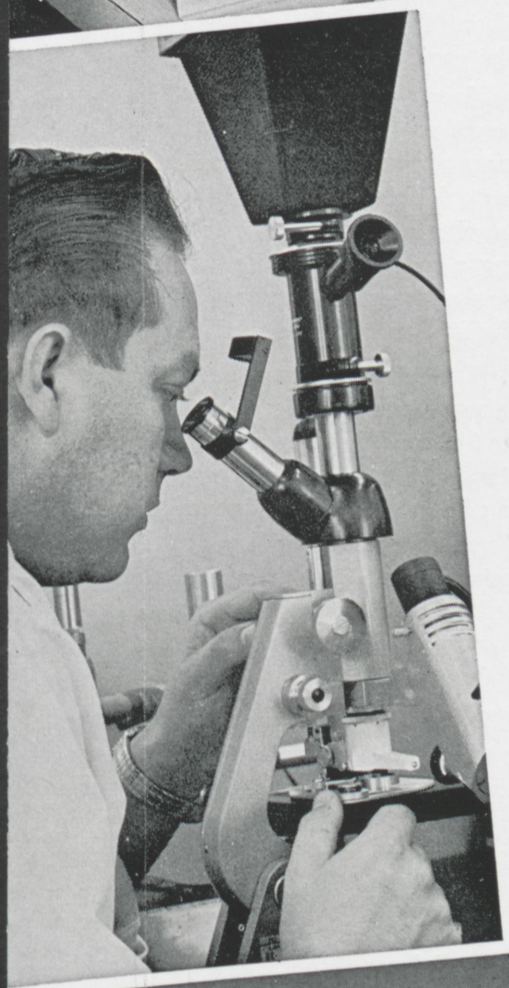
The Van de Graaff accelerator is one of the early types of accelerators and is related to the linear accelerarator. The first successful one was built at Princeton in 1929. Its actual invention, though, is given to Robert J. Van de Graaff at the Massachusetts Institute of Technology in the early nineteen thirty's.

It is composed of a large hollow sphere insulated from the ground. It is charged by a belt in contact with a battery. This belt, which is in continuous movement, is built up to a high potential and is in continuous discharge. The particle is started at the top and is eccelerated as it travels down a tube because of the difference between the very high potential of the sphere and the potential of the ground, which is zero compared to that of the sphere. It operates on the same principle as the electrostatic generator. The battery connections are reversible so that it can run either negatively or positively, depending on the charge carried by the particle being accelerated.

The Van de Graaff accelerators have been widely used in nuclear research and recently have been put to work for preliminary acceleration of ions for some of the newest accelerators.

The author of this article, John Mercer, a Paris, Illinois, native, is a junior here at Rose. With spring on hand, John says his major interest is girls and golf.





Get your career moving

Get together with Delco Radio, the mover in electronics. Make no mistake—the pace is fast and demanding. But our people thrive on it. They're having a ball, pushing the state of the art clear out of sight in microelectronics and silicon devices. New research programs . . . new products . . . new equipment . . . and plenty of new opportunities for new people. Electrical Engineers. Mechanical Engineers. Physicists. Metallurgists. Physical Chemists.

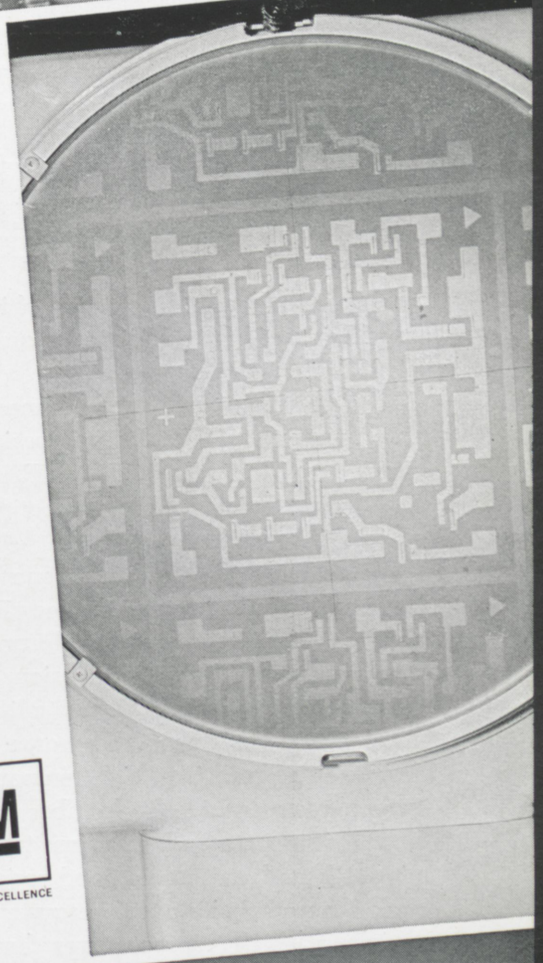
Challenge—benefits—salary—community. You'll find 'em all at Delco. Get your career moving now! Get together with our interviewers when they visit your campus. Better yet, drop a line to C. D. Longshore, Supervisor, Salaried Employment, Delco Radio Division, General Motors, Kokomo, Indiana. An equal opportunity employer.

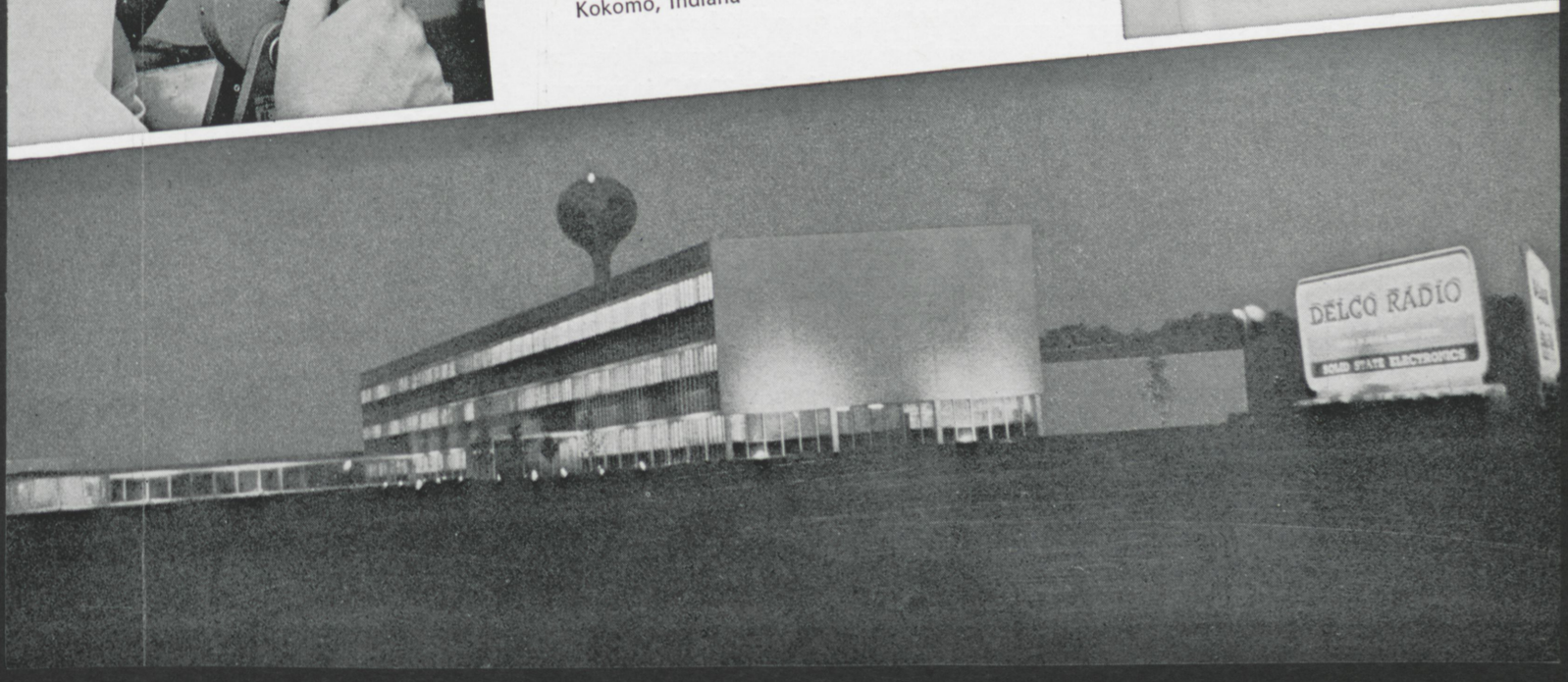
DELCO RADIO

Division of General Motors,
Kokomo, Indiana

GM

MARK OF EXCELLENCE





HIGH TEMPERATURE

(*Continued from page* 12)

O°C. This may also be written

$$\log \text{emf} = n \log t + \log m .$$

If log t vs. log emf is plotted, the slope equals n and the y-intercept equals log m. Once these values are known, they may be used to calculate t from the emf.

The emf of a couple may be measured in two ways — the potentiometer and galvanometric methods. In the potentiometer method, a circuit with a standard cell producing constant emf = E is balanced by a resistance R. The thermocouple is conected and the resistance r is adjusted so that no current flows. Then

$$e = E\ (r/R)$$

where e = emf of the couple. This method may be made as exact as desired. A reference-junction compensator is usually employed to change the reading to that which would occur if the cold junction were at 0°C.

The galvanometric method measures current with a known resistance. By Ohm's Law, E = IR, so that the emf produced is proportional to the current.

Much research has been done in the application of thermocuples. Errors in high temperature thermocouples caused by interdiffusion at the hot junction have been studied. A platinum resistance thermometer for study of transient high temperature phenomena in shock tubes has been constructed. Hot wire techniques have been studied and resistance characteristics of refractory materials at high temperatures have been recorded.

Thermocouples can be made sensitive to 0.00001°C, but errors as great as 20° at 1000°C may result if the temperature distribution along the wires is not controlled. It is possible to increase the sensibility by increasing the emf of the couple. The simplest way to do this is to place two or more couples in series. However, although this increases the emf, it also increases the resistance, and may introduce errors, especially for low-resistance galvanometers.

Thermocouples are widely used, but a material suitable for higher temperature measurements than are attainable with platinum — platinum/rhodium thermocuples has long been desired. Rhenium tungsten alloys and rhodium iridium alloys have been employed. The former have been found suitable to about 3000°C. Tungstenmolybdenum couples can be used above 1250°C. "A variety of new thermocouple materials, including oxides, carbides, and borides, has been suggested for high temperature measurements."

Several advantages are inherent in thermocuples. These include small thermoelectric substance, rapidity of indications, and separability of the measuring device and the reader.

The platinum-platinum + 10% rohdium thermocuple (hereafter called the Pt thermocuple) is found to be best for most measurements when electromotive force, homogeneity, hardness, inertness, and alterability by fire are considered. In application, the Pt thermocouple is often used to determine the temperature of kilns from 600° to 1450° C. When protected by a porcelain tube and an outer fire clay tube, it may be extended as much as six inches into the furnace. The usual depth of immersion is ten times as great as the diameter of the outer tube.

The range of temperatures which can be accurately measured with the Pt thermocouple is from 300° to 1500°C, and "spot" (short duration) readings may be taken as high as 1700°C. Use below 300°C is not accurate since the emf is very low, becoming zero at -100°C.

Calibration is usually carried out with a standard thermocuple, but freezing-point determinations of metals such as cadmium and zinc will be more accurate. The readings for the freezing points of metals are constant and reproducible if the couple is protected from contamination, if it is imersed far enough to prevent heat losses at the junction by conduction along the wire, if the cold junction is kept at a constant temperature, if the metal is pure, and if the metal is kept at a uniform temperature throughout during freezing.

The major problem in retaining accuracy is contamination from the environment, furnace, or refractory materials of insulators and protection tubes. Silicon is the major contaminent from refractory materials. This, combined with grain growth at high temperatures, results in both thermoelectric and mechanical failures. The silicon forms a eutectic with the platinum which melts at about 800°C. This diffuses between the grains and allows fracture.

Keeping the couple in an inert atmosphere, preferably in a vacuum, awary from neutron irradiation, using doublebore insulating tubing, moving as little as possible, and using a mounting to allow for expansion and contraction greatly improve the life and accuracy of the couple.

A Pt couple may be tested for inhomogeneity by keeping both ends at 0°C and heating at various positions along the wire. The emf produced is a measure of inhomogeneity. Another method is by coupling at points along the wire with a standard section of wire and measuring the emf produced when the junction is heated.

Contaminated thermocouples may be restored by dipping in 50% nitric or hydrochloric acid to remove surface contaimnation and annealing to restore homogeneity.

A thermocouple with disposable junctions has been developed by several firms. Use of this couple will eliminate the problem of contamination at a slightly greater cost.

To reduce the high cost of the Pt couple, compensating leads may be used. They are chosen so as to have the same thermoelectric properties as the wires at the junction. Usually a copper wire is attached to the platinum-rohdium leg and a nickel-copper wire is used on the platinum leg.

Welcome to the cold, cruel world.

Of course, if your father's a millionaire, or you're about to marry an heiress, then you have no problems. But, if not, then there's only one sensible thing to do. Come to work at Allison Division of General Motors.

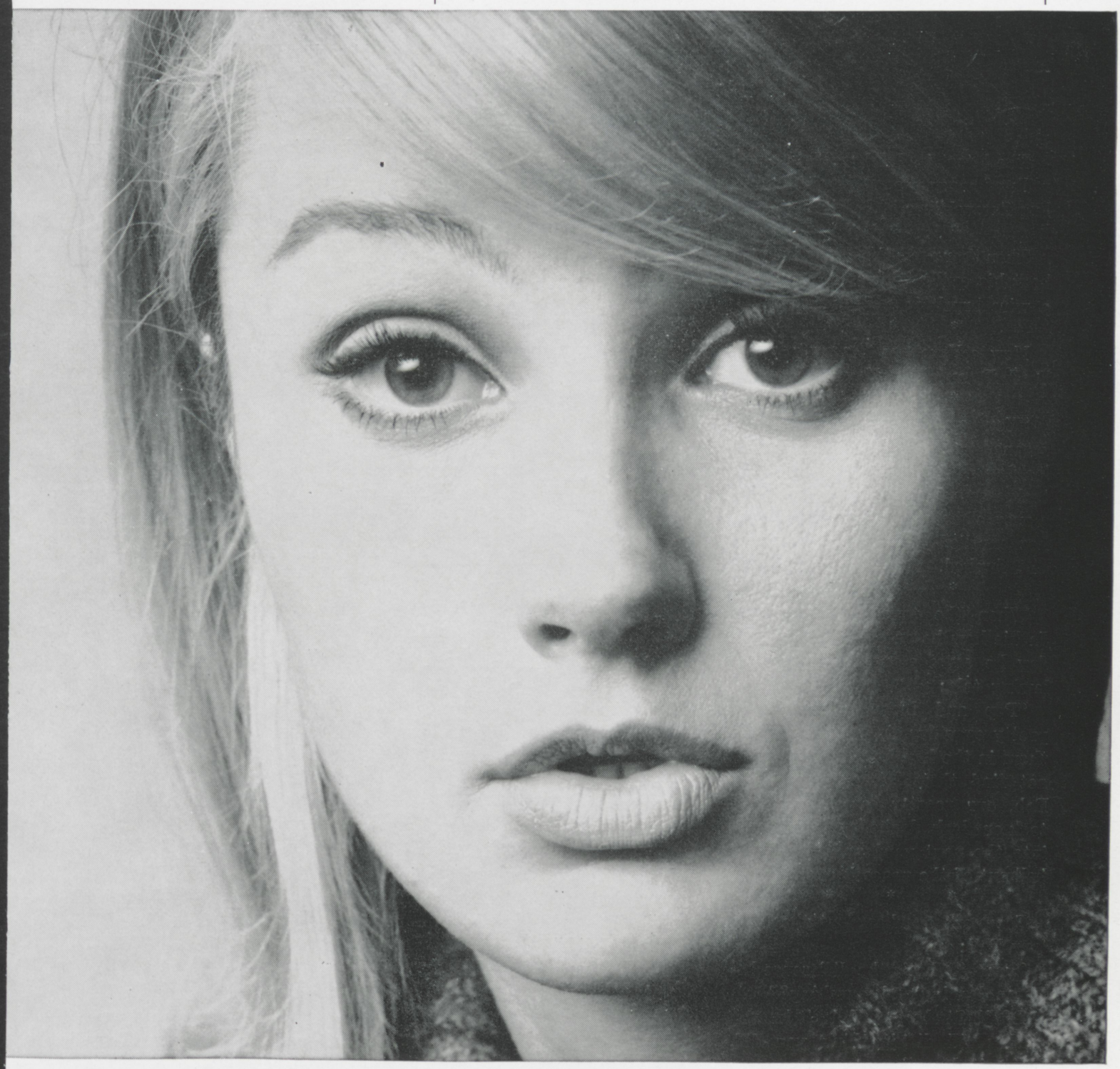
There's nothing cold or cruel here. Just the opposite. Particularly if you're an engineer with big ideas. Aerospace projects? Allison's got them. Turbofan. Turbojet. Turboprop. Turboshaft. Military and commercial applications right across the board.

Maybe you're more down-to-earth. Fine. Some of Allison's advanced motor vehicle projects will be more your cup of tea. Like the new M551 General Sheridan, for instance. The powershift transmission, of course, is our specialty, and even the gun launcher is an Allison brainchild.

There's more. And you can be part of it. Take your time. Check them all. But don't forget Allison. Remember: life can be beautiful . . . even without an heiress.

For the complete story, send for Allison's new brochure: Destination Tomorrow. Write Ken Friedlein, Scientific Placement, Dept. 400, Allison Division of General Motors, Indianapolis, Indiana 46206.

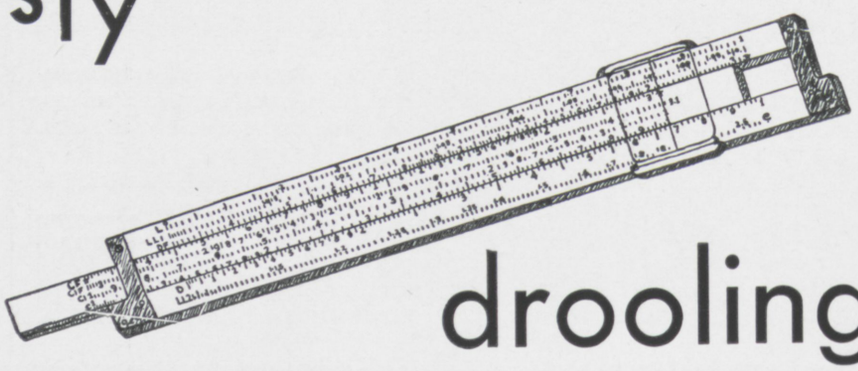
GM
MARK OF EXCELLENCE



Allison

An equal opportunity employer M/F

sly



droolings

Stolen by Tony Tietz, Soph. Chem.

The latest in drinks: Vodka and milk of magnesia. It's called Phillips Screwdriver.

* * *

Then there was the porcupine who bent his quills trying to overpower a wire brush in a dark corner.

* * *

New college grading system: A, B, C, D, and Viet Nam.

* * *

"You can't beat the system," moaned an I. S. U. student after looking at his semester grades. "I took a course in basket weaving for a snap elective, and then two Navahos enrolled and raised the curve, so I flunked.

* * *

When the teacher asked little Jackie how he enjoyed Easter Sunday he came across with the following tale:

"Pop and Mom painted some pretty eggs for sis and me and hid them in the hen house so we would not find them. About that time, Bob, our rooster came along and took one look, dashed over the fence into the next yard and kicked the hell out of the peacock over there."

* * *

Comment overheard at the Military Ball:

She: "What's the difference between dancing and marching?"

ROTC Student: "I don't know."

She: "I didn't think you did. Let's sit down."

An engineer is a person who measures with a micrometer, marks with a piece of chalk, and cuts with a dull ax.

* * *

Typical engineering problem: If it takes 10 hours for a wood pecker with a rubber bill to chop $65 worth of shingles from an oak tree, how long does it take a grasshopper with a wooden leg to kick the juice out of a dill pickle?

* * *

We are engineers,
Tried and true,
We get no dates
Our girls are few;
But we are smart,
You bet your life—
We'll make some dough
And BUY a wife.

* * *

Physics prof: "If in going down this incline, I gain four feet per second, what will be my condition after 25 seconds?"

Smart soph: "You'll be a centipede."

* * *

M.E., "Thought you were going to visit that blonde in her apartment."

C.E.: "I did."

M.E.: "How come you're home so early?"

C.E.: "Well, we sat and chatted a while. Then suddenly she turned out the lights. I can take a hint.

Little Jack Horner
Sat in a corner,
Crib notes under his eye.
He opened his book
And took a quick look,
And now he's Tau Beta Pi.

* * *

Two witches were out fishing. After a short time one said to the other.

"Let's cast a spell."

* * *

Then there was the guy who knew karate so well that he killed himself while saluting.

* * *

The gambler bet his girl five dollars she wouldn't marry him. She called him and raised him five.

* * *

Three polar bears were sitting on an iceberg.

"Now," said the father polar bear, "I've got a tale to tell."

"I, too," said the mother polar bear, "have a tale to tell."

The little polar bear looked up at his parents and said: "My tail's told."

* * *

They tell us that in certain parts of town you can still buy a drink of liquor for a dime—or so a recent autopsy discloses.

* * *

Coed: "Did I ever show you the place where I hurt my hip?"

Date: "No."

Coed: "All right we'll drive by there."

* * *

The haughty senior girl sniffed disdainfully as the tiny freshman cut in:

"And just why did you have to cut in while I was dancing?" she inquired nastily.

The freshman hung his head with shame. "I'm sorry, ma'am," he said, "but I'm working my way through college and your partner was waving a five-dollar bill at me."

* * *

A divinity student named Tweedle
Once wouldn't accept a degree.
It's tough enough being Tweedle,
Without being Tweedle, D.D.

The Air Force doesn't want to waste your college education any more than you do.

Are you afraid of becoming part of the woodwork on a job? Your career stunted by boredom? Few promotions in sight?

You didn't go to college for that.

And it needn't happen, either. Because you can pick the United States Air Force as your employer. Career opportunities are so vast... you'll get a better chance to specialize where you want...in the forefront of modern science and technology.

Suppose, just for example, you wanted to be involved in Electronics. This area alone includes Communications-Electronics, Missile Electronics, Avionics, and others. And these, in turn, involve administrative, research, and other technical aspects.

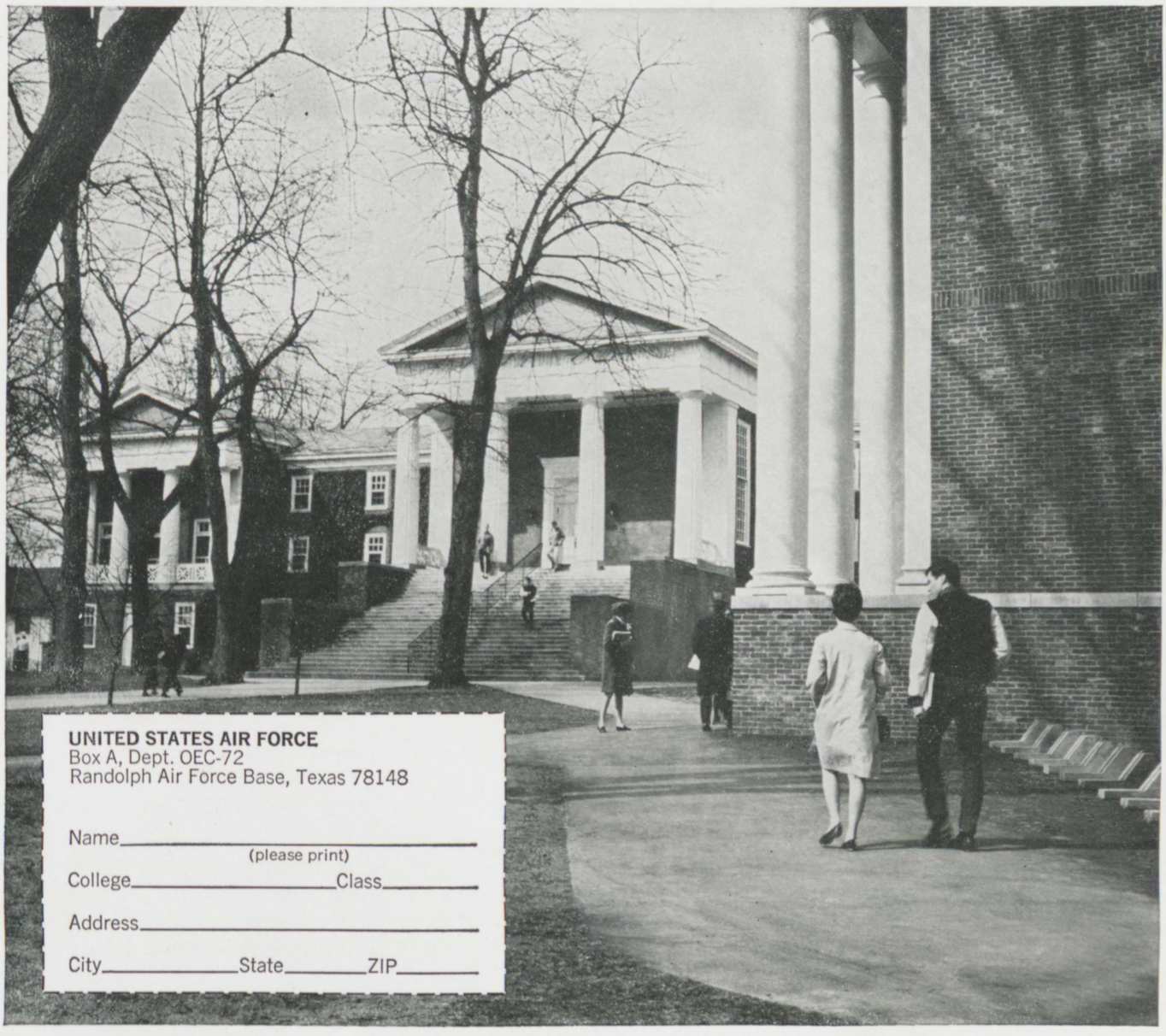
That's just a tiny part of the whole Air Force picture. Just one brilliant opportunity area among many.

You'll enjoy good pay, promotions, chance to travel, active social life, fine retirement benefits. And you'll be serving your country, too.

Or maybe you want to fly? That's great. The Air Force is certainly the place to do it.

As a college graduate you want something extra out of life—to aim at an exciting goal. So send in this coupon.

Make sure you don't get stuck where nothing much is happening.



UNITED STATES AIR FORCE
Box A, Dept. OEC-72
Randolph Air Force Base, Texas 78148

Name_____
(please print)

College_____ Class_____

Address_____

City_____ State_____ ZIP_____

General Electric engineers and scientists are helping to satisfy the needs of society...

like beautiful cities

A technical career at General Electric can put you in the position to help beautify our cities.

Inquisitive minds in research and advance development at G.E. are evolving many concepts to give our cities a clean, all-electric look. Design engineers are translating concepts into components and systems, while manufacturing engineers are developing the methods and machines that bring designs into being as useful products.

Technical marketing specialists are working with electric utilities and city planners to give mushrooming urban landscapes like Phoenix, Atlanta and Chicago, a bright, all-electric face.

Urban living has already begun to change as a result of the contributions made by General Electric engineers and scientists, contributions like air and water purification systems, underground power equipment to preserve nature's beauty, all-electric heating facilities, rapid-transit systems, and a hundred more.

You can help develop new products and concepts, new facilities, processes, and manufacturing systems, or new applications and markets in your technical career with General Electric. For more information write: D. E. Irwin, Section 699-20, Schenectady, New York 12305.

GENERAL ELECTRIC

An Equal Opportunity Employer