may, 1964

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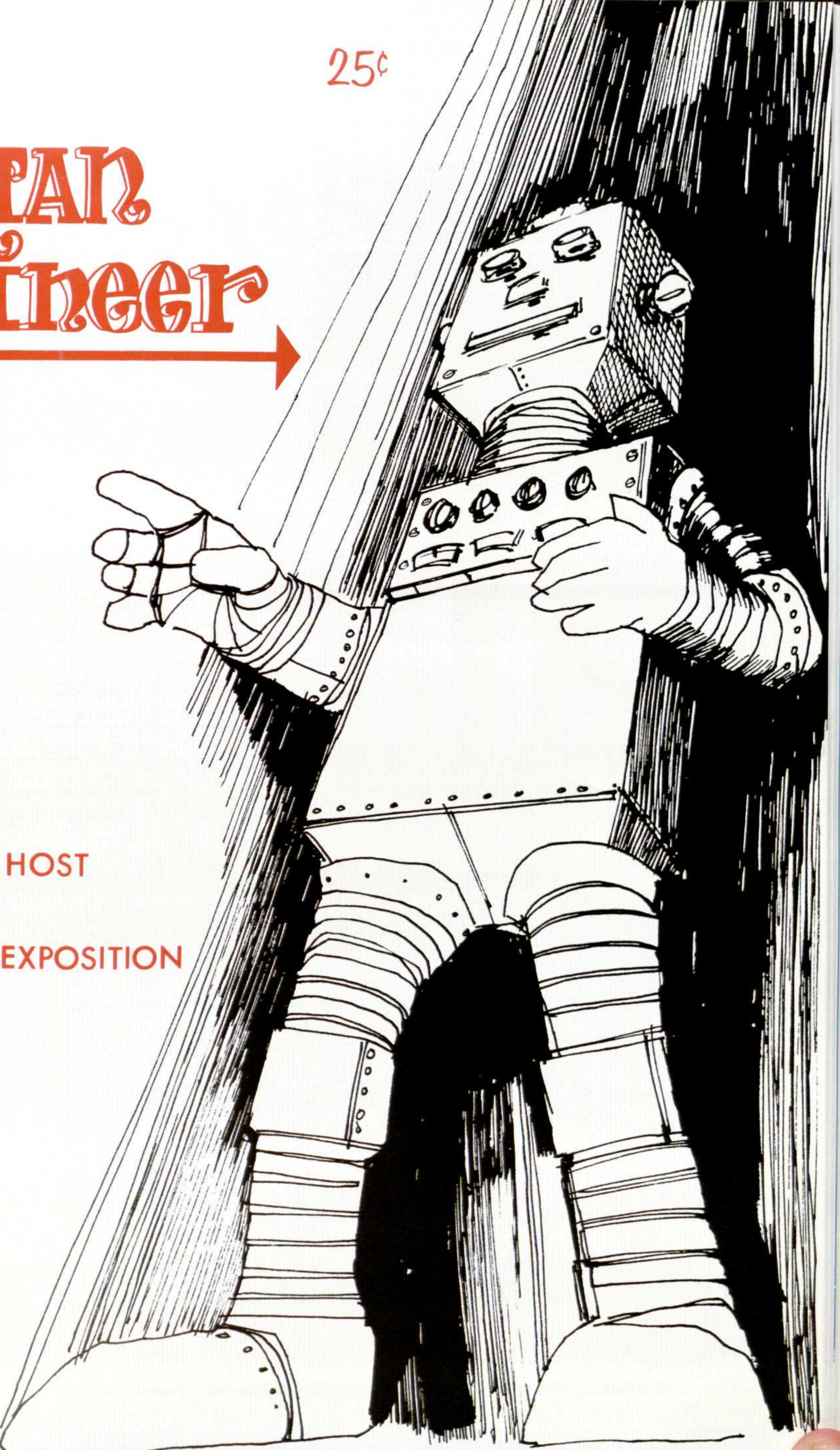
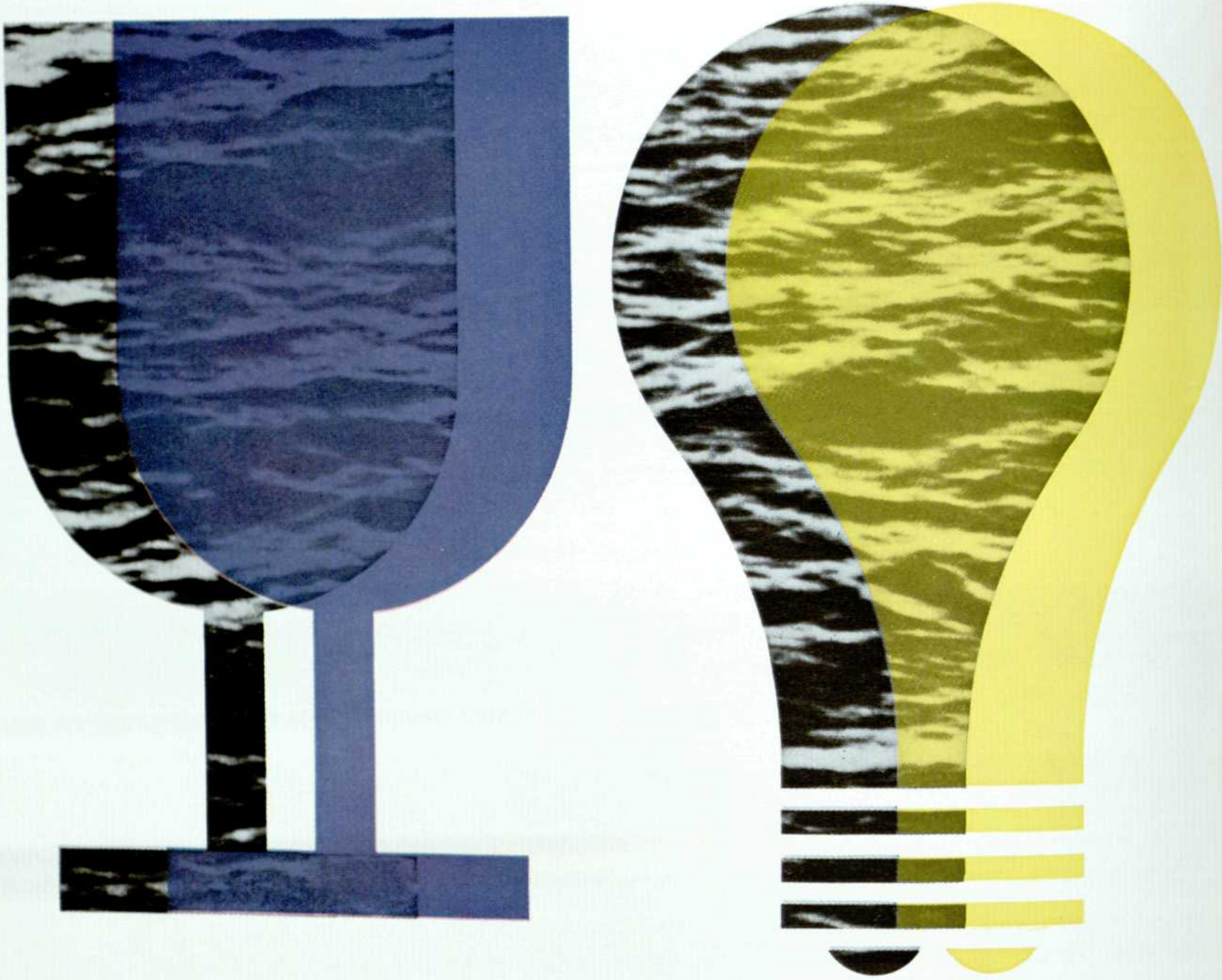
SPARTAN Engineer



SIDNEY, YOUR HOST
FOR THE 1964
ENGINEERING EXPOSITION



Spartan Engineer

Volume 17 No. 4 May, 1964

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The Cover, by Phil Frank, is of Sidney, the robot, host for the 1964 Engineering Exposition.

FEATURES

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Member, Engineering College Magazine Associated
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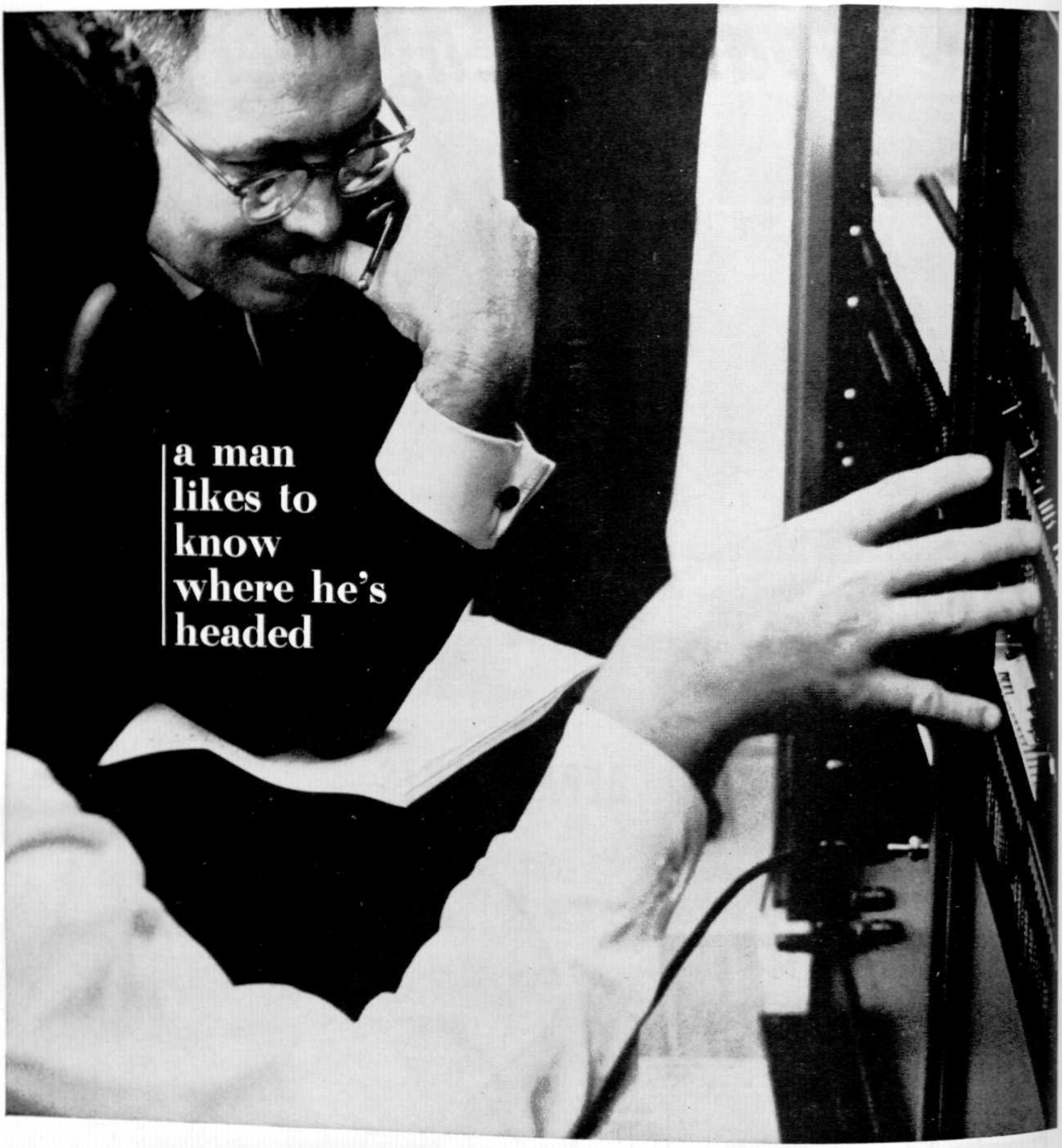
Publisher's Rep.: Littell-Murray-Barnhill, Inc.
369 Lexington Ave., New York 17, N. Y.
737 N. Michigan Ave., Chicago, Ill.

Published four times yearly by the students of the COLLEGE OF ENGINEERING, MICHIGAN STATE UNIVERSITY, East Lansing, Michigan. The office is on the first floor of the Engineering Bldg., Phone 355-3520. Second class postage paid in E. Lansing, Michigan, under act of March 3, 1879.

Subscription rate by mail $1.00 per year. Single copies 25 cents.



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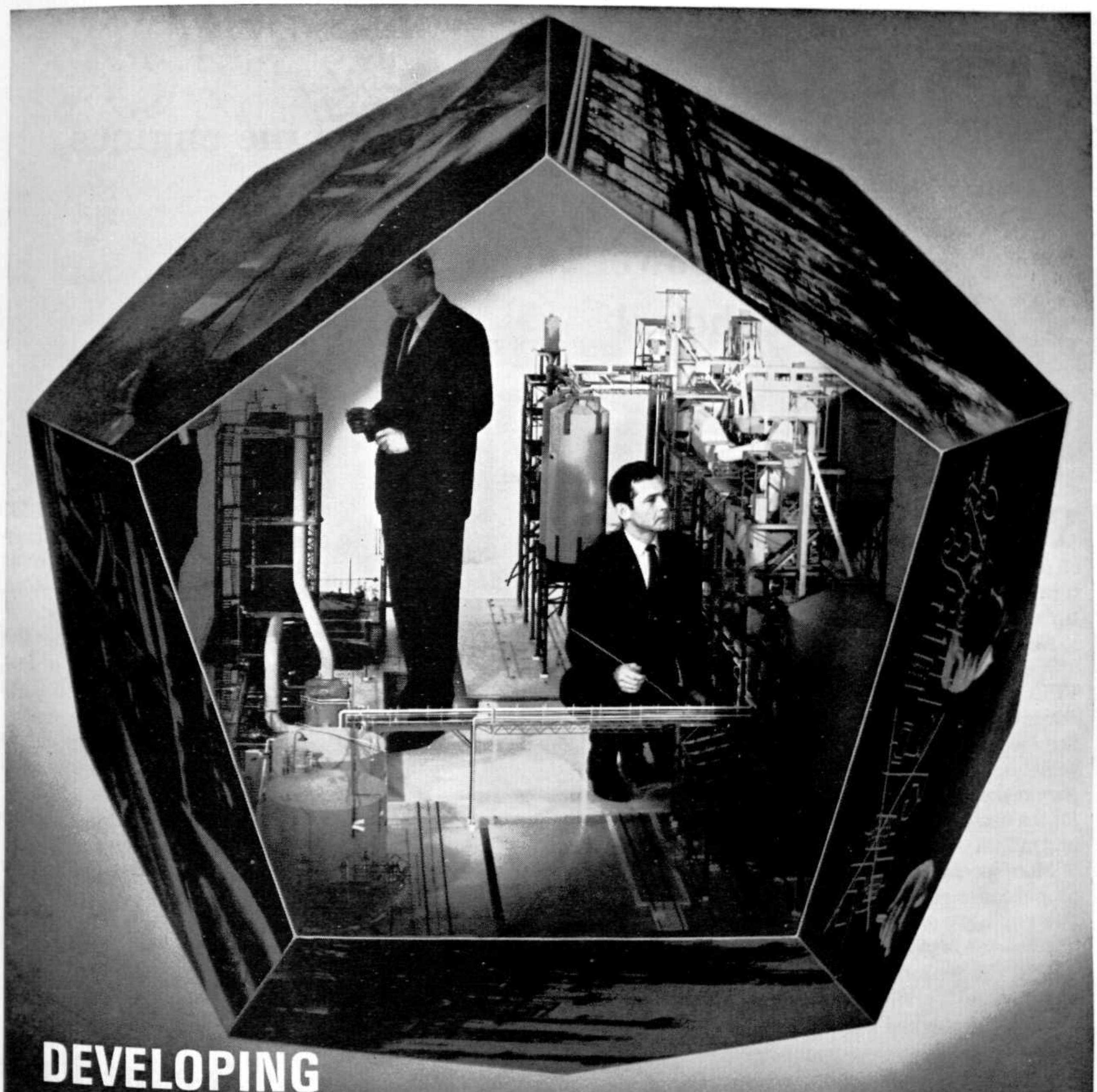

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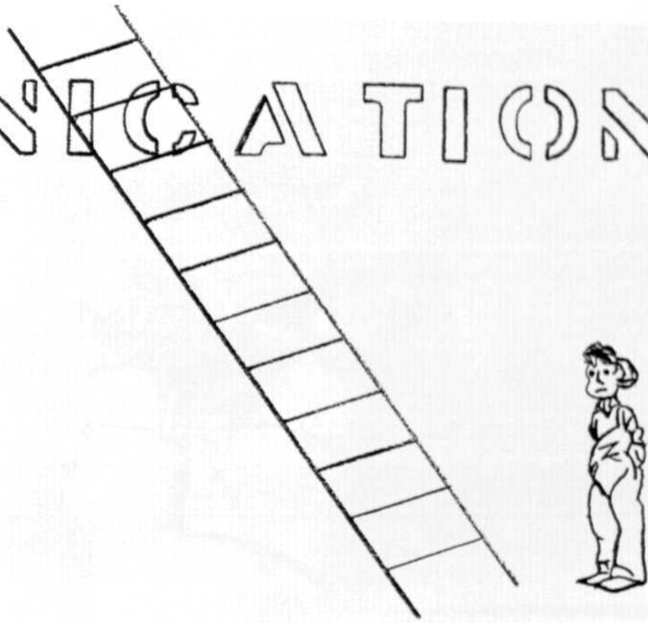
COMMUNICATION



This year's Engineering Exposition is here. It is too late to enter any more exhibits. A toast! "To those who had the intestinal fortitude to take a whack at communications."

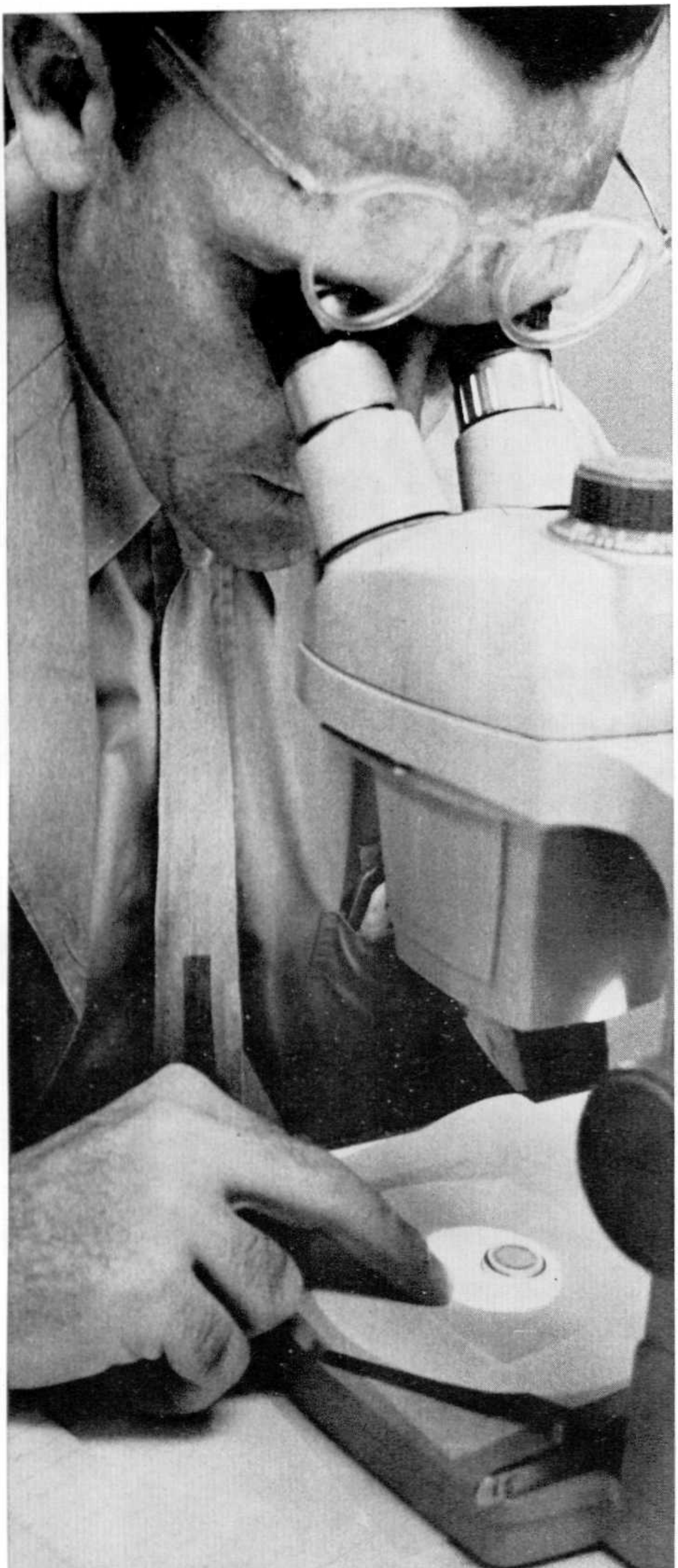
This brick wall, laid across the success path of every engineer, is one of the toughest to surmount. Few engineers have the time or ability to delve into the art of explanation and communications. All of them need this knowledge.

Oh, what a glorious day when the liberal arts major, who can't even repair a radio, will understand the theories of quantum mechanics. That day is here. Wandering through the Exposition, one sees many such theories and ideas put into layman terms and depicted by visual aids. All these people have worked long and hard to find the best method to speak their thoughts and communicate their knowledge.

Raise your glasses high then, and let us pay merry, boisterous tribute to the conquerers----the 1964 Engineering Exposition exhibitors.

Very silently now, shall we pray together that there be more next year.

John B. Locke, Editor



Delco Means Opportunity to George Fitzgibbon

■ George Fitzgibbon is a Senior Experimental Chemist at Delco Radio. He's pictured here examining silicon rectifier sub-assemblies for microscopic solder voids during the development stage.

George received his BS in Chemistry from the University of Illinois prior to joining Delco Radio. As he puts it, "I found, at Delco, an opportunity to take part in a rapidly expanding silicon device development program. The work has proved to be challenging, and the people and facilities seem to stimulate your best efforts."

The young graduate engineer at Delco will also find opportunity—and encouragement—to continue work on additional college credits. Since our inception, we've always encouraged our engineers and scientists "to continue to learn and grow." Our Tuition Refund Program makes it possible for an eligible employee to be reimbursed for tuition costs of spare time courses studied at the university or college level. Both Purdue and Indiana Universities offer educational programs in Kokomo, and Purdue maintains an in-plant graduate training program for Delco employees.

Like George Fitzgibbon, you too may find challenging and stimulating opportunities at Delco Radio, in such areas as silicon and germanium device development, ferrites, solid state diffusion, creative packaging of semiconductor products, development of laboratory equipment, reliability techniques, and applications and manufacturing engineering.

If your training and interests lie in any of these areas, why not explore the possibilities of joining this outstanding Delco—GM team in forging the future of electronics? Watch for Delco interview dates on your campus, or write to Mr. C. D. Longshore, Dept. 135A, Delco Radio Division, General Motors Corporation, Kokomo, Indiana.

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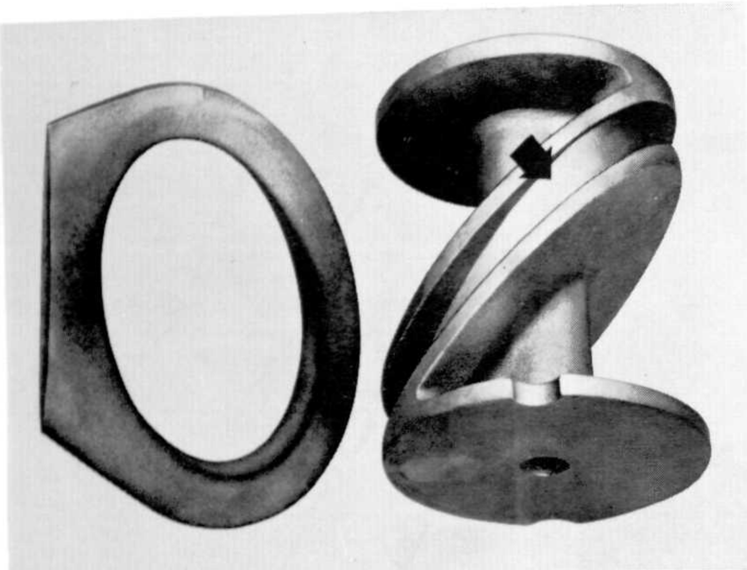
YESTERDAY'S FICTION / TODAY'S FACT

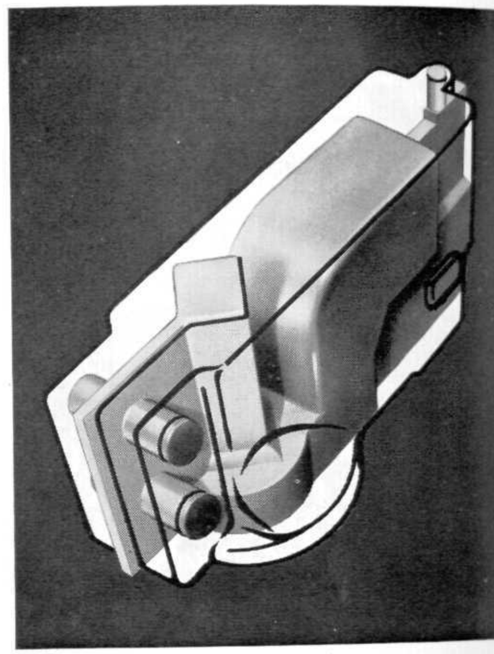
With that slogan we introduce to you the MSU Engineering Exposition for 1964. Engineers were responsible for changing yesterday's dreams into machines or systems which work and think for us today. While Leonardo da Vinci predicted the airplane, Jules Verne proposed a submarine, and Dick Tracy popularized the wrist radio, these were all made workable and useful by engineers who were tired of riding a horse, rowing a boat, or getting busy signals on the dormitory telephone. These were dissatisfied engineers, and all good engineers are dissatisfied. They saw that yesterday's best was not very good, they knew there must be a better way, and they improved on nature for man's benefit.

May I invite you to our Engineering Exposition, where you, too, can learn how to become dissatisfied, how to be unhappy with today's best (even that new Monza) -- and how we make many fine students dissatisfied, thereby turning them into some of the world's best engineers!

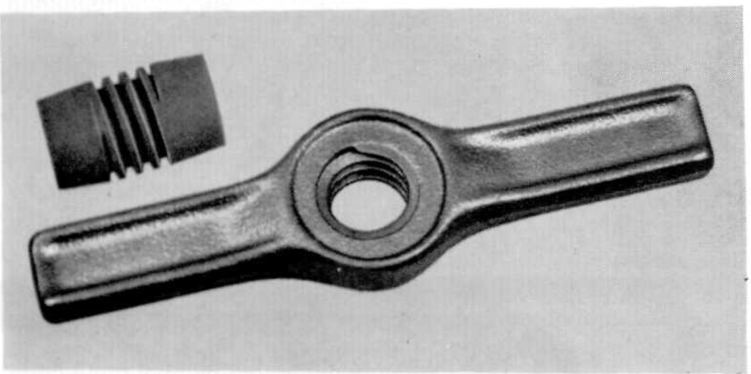
J. D. Ryder, Dean



The groove on this Malleable iron cam for a packaging machine requires a fine finish. A shell core used on the outside of the part produces such a smooth, accurate surface that no machining is required.



The machining once required to produce this lever bracket included broaching the square hole, milling the slot, drilling and reaming the two large bolt holes, and drilling the small hole. All machining has been eliminated through the use of a single shell core.



Shell coring produces such exact detail that the acme thread on this Malleable iron trench brace wing nut is used without any machining. Previously produced with a standard oil sand core, it required reaming and tapping.

Solve Design Problems, Reduce Machining with Shell Cored Malleable Castings

Shell cores are most often used to create interior surfaces but, in addition, they can be utilized at other locations in a green sand casting to impart smoothness, provide closer tolerances, reduce machining, and solve a variety of design problems.

Shell cores create surface finishes of 50 to 250 microinch rms. Thus, excellent detail can be obtained in Malleable castings for gear teeth, holes, dove-tails, mating surfaces and threads with this modern casting technique.

The internal air passages and chambers in the pneumatic wrench handle, shown at right, are excellent examples of the amazingly complex details which can be created accurately and economically in Malleable castings with shell coring. They are produced—completely finished except for tapping—in the basic casting.

The advantages obtainable from shell coring in selected applications, combined with Malleable's high strength, ductility, easy machinability and reliable uniformity, make Malleable castings an outstanding choice for high-quality, low-cost parts.

Send for your free copy of this 16-page "Malleable Engineering Data File." You will find it is an excellent reference piece.

Precise dove-tails, intricate air channels and other interior details of this impact wrench handle are produced in the Malleable casting by the three shell cores shown. A variety of machining operations is eliminated by this relatively low-cost technique.

For further information on Malleable castings, call on any company that displays this symbol—

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USAF F-105, unleashing air-to-ground rockets at simulated enemy target.

DEVELOPMENT OF MANAGEMENT IS OUR MOST IMPORTANT FUNCTION

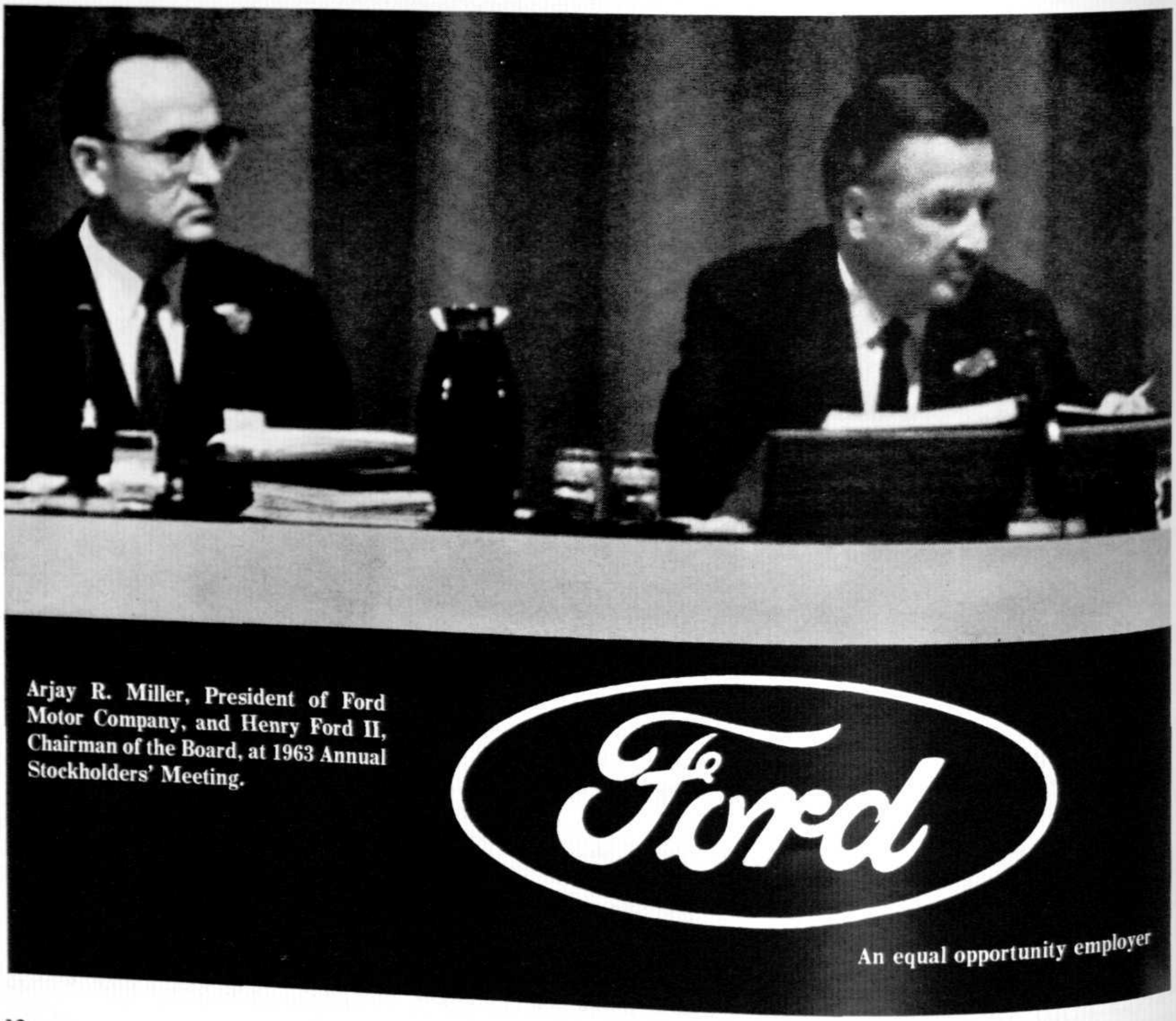
At the 1963 stockholders' meeting, Arjay R. Miller, President of Ford Motor Company, emphasized the Company's far-sighted recruitment program and its accent on developing management talent:

"Obviously, our long-run future will be determined by the development of our management. Here, every one of us—at all levels of supervision—recognizes this as his most important function. Since 1946, the Company has recruited widely varied talent—talent that can be blended to give us the required combination of tight administration and creative scope.

"Under a carefully conceived management development program, we try to recruit the best personnel available, both in training and experience. Once we get them, we have a program for giving them varied opportunities and increasing responsibility. This program is in force in all parts of the Company—in manufacturing, finance, styling, engineering and marketing.

"The program is paying off. We have developed a real depth of management talent in the Company, and we are dedicated to seeing it continued and reinforced. Because of this, I feel not only very fortunate in being associated with this management group, but also very confident of its long-run success. We know our goals and how to achieve them."

Ford
MOTOR COMPANY
The American Road, Dearborn, Michigan



Arjay R. Miller, President of Ford Motor Company, and Henry Ford II, Chairman of the Board, at 1963 Annual Stockholders' Meeting.

Background on the Engineering Exposition

By RUSS PERKINS

So you're interested in engineering? You wonder what a transistor is or what engineering students learn at MSU. You want to see some of the latest developments from industry. If so, the 1964 Engineering Exposition is the place to be.

The Exposition is the enterprise of the Engineering Council, the coordinating body for the vaious engineering student organizations at MSU. It is presented as a service to the students and public and as a learning opportunity for both.

The principal feature of the Exposition is the student exhibits. This presents a great challenge of communication to the student. How does he explain the operation of a feedback system to his younger brother, parents, or the professor of Anthropology?

The individual's contest is based more on theoretical knowledge than on the practical aspect of the project. The individual entries will be judged on a point system of 0-20 points for originality, 0-40 points for theoretical content, 0-30 points for workmanship, and 0-10 points for the general impression.

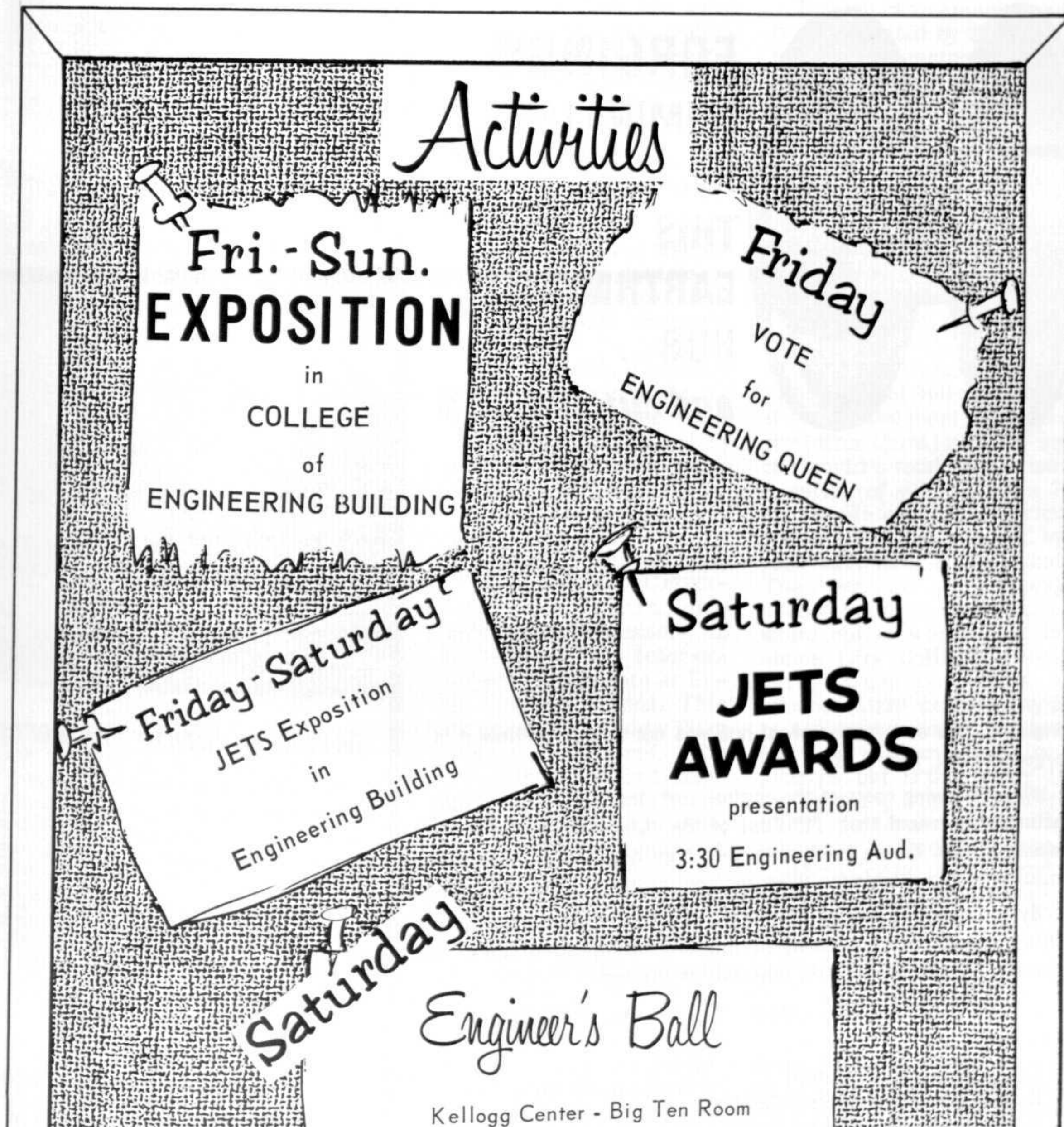
There is also a group or organization contest open to the engineering departments, societies, and others. These exhibits are judged primarily on practicality. Originality on the group receives 0-1- points; theoretical content 0-30, workmanship 0-40, and general impression 0-20 points.

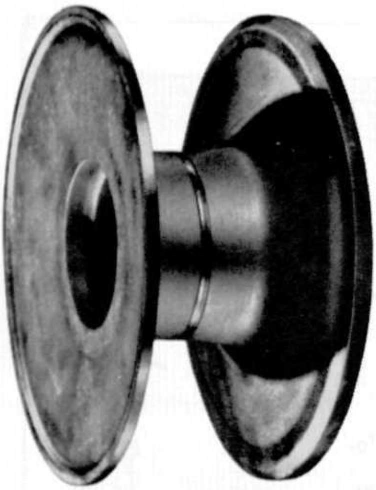
Traditionally, there is rivalry among the engineering departments for the Dean's Trophy which is given to that department having the best overall display. Departmental displays, group of organizational displays, and the individual student exhibits are eligible for this prize. Also judged on the point scale, 0-30 points are given for the overall effect, 0-30 for applicability to its department's interest, 0-20 for quality represenative of individual displays, and 0-20 points for quality representative of group organization displays.

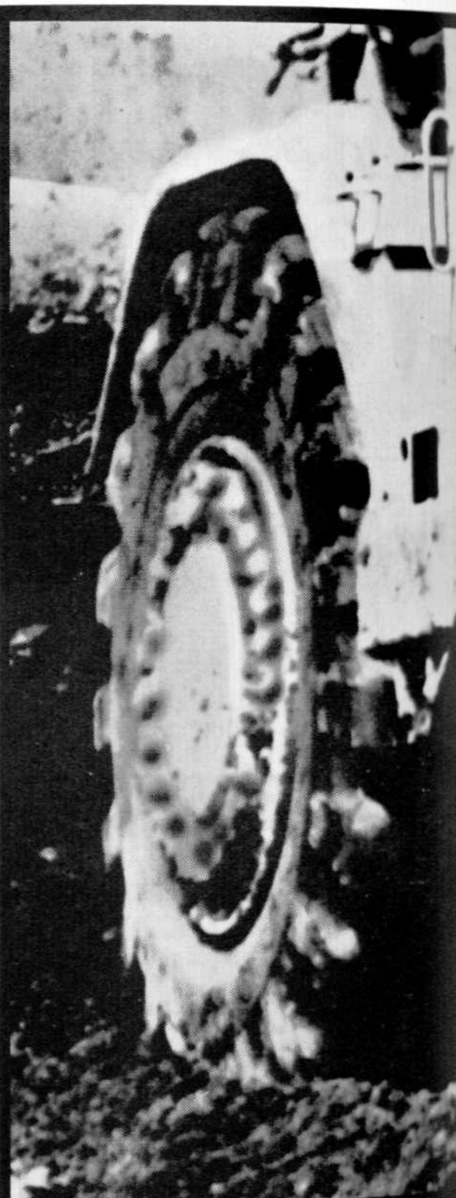
Industrial exhibits are sponsored by each of the engineering departments to exemplify the work being done in industry in their respective branches of engineering. This year, the National Aeronautics and Space Agency, Chrysler Corporation, Douglas Aircraft Company, Consumers Power Company, Ford Motor Company, and the Argonne National Laboratories are present.

Exposition Weekend

May 15-17







MSU At Poona, India

By IAN O. EBERT
Associate Professor of E.E.

One would hardly expect to find Michigan State University staff members working one-hundred miles southeast of Bombay, India but this is the location of one of our far-flung international activities. Since 1961 five engineering professors have represented Michigan State as advisors and teachers at Engineering College, Poona.

Poona, with a half-million population has had an illustrious history as a center for the fearsome Marathas who once controlled much of India. Poona was also the scene of the final defeat of the Marathas at the hands of the British in 1817. Because of its 2000 foot altitude and the protection of the Western Ghats (the range of mountains along India's coast) its climate is much more pleasant than that of Bombay. The British capitalized on this superior climate by establishing here the monsoon residence of the Governor of Bombay, a large army cantonment, and an excellent track for horse racing. These have been continued since independence in 1947. Good transportation has encouraged rapid industrialization in the last decade. Branches of industries based in the United States, Germany, Italy, Holland, Sweden, Japan, and other countries give Poona a cosmopolitan atmosphere.

College of Engineering, Poona is located on the northwest side of the city at the confluence of the Mula and Mutha rivers and straddles the highway to Bombay. Founded in 1854, just one year earlier than Michigan State University, it is one of the oldest engineering colleges in India. Over the years it has graduated many who later became outstanding engineers so its reputation for excellence is well established. Departments of Civil, Electrical, Mechanical, Electrical Communications, and Metallurgical Engineering now grant undergraduate and graduate degrees. An enrollment of 1300 (which includes only the final three years of a five year undergraduate program) compares favorably with that at Michigan State's engineering college.

Technical education is one of the most important problems of a developing nation. Recognizing this, the Government of India encouraged Engineering College, Poona and other progressive institutions to utilize assistance and advice available from nations more technically advanced. Such help is now being given India by Great Britain, West Germany, the Soviet Union, and the United States. The United States effort is being administered by the Agency for International Development through contracts with several of America's outstanding Universities.

In 1961 Michigan State University accepted a contract to provide engineering professors to serve as advisors and teachers for selected departments at Engineering College, Poona. This project is being directed by Dean J. D. Ryder through Prof. John U. Jeffries, campus coordinator for International Programs in engineering. Initially a lone professor, Loren B. Almy, was sent to Civil Engineering. The group now consists of Maurice S. Gjesdahl, Mechanical; Melvin A. Thomas, Electrical; Ian O. Ebert, Electrical Communications; and David O. Van Strien, Civil. Professor Almy has since completed his assignment and has returned to the United States. Activities of this group range from consulting with government officials on broad goals for technical education to advising an individual student on a research project or on his plans for overseas graduate study. The greatest portion of the time has been used in developing modern courses and laboratories and in working with the administration and faculty to effect desirable changes.

The job of an American advisor is complicated by the differences in the engineering needs and in the educational system of India compared to those of the United States. This means that he should not advocate changing the Indian college to fit the image of a similar United States institution unless the changes clearly fit the needs of India. Some aspects of the problem are discussed in the following paragraphs.

India has an area of 1.2 million square miles, one-third the area of the United States, and a population of 460 million making it the second most populous country (after China) with one-seventh the world's total population. It is a nation of villages with 70% of the people engaged in agriculture and more goods carried by bullock cart than by truck and rail. The average annual wage is around sixty dollars. Even among white collar workers an income above fifty dolllars a month is rare. Common labor earns around thirty cents a day for up to ten hours work! Food, clothing, and shelter are quite inexpensive but little money is left for anything else. Manufactured items, particularly those having imported components, are very costly, In spite of this, producers of automobiles, appliances, etc. cannot meet the demand. (For example, the waiting period for a motor scooter is over four years even though it costs twice as much as in the United States!)

The inability of industry to meet the demand can utlimately be traced to the shortage of foreign exchange. Restrictions on the importation of foreign goods increases the demand for indigenous products but the beginning, low-production factories are unable to meet the demand. These industries are unable to expand enough to quickly meet the demand because such expansion almost always requires machines and materials from abroad! In this protected market the emphasis is more on quantity production than on quality. Engineering designs are supplied by parent companies abroad and almost no changes are made from year to year. Engineers thus do little reserach and design but are hired primarily for supervisory and production work. Except for Agricultural, Architectural, Civil, and Railway engineers there is a deficiency of engineering jobs. Eventually, increasing product competition at home and the desire to sell in foreign markets will force manufacturers to do more engineering. The educational program for engineers must allow for this as well as for present requirements. For many years though the emphasis must be on more mundane things than guided missiles or rockets to the moon!

Indian education, which is patterned on the British system, differs in many respects from ours. Prior to college the student spends eleven years in primary and secondary schools. Five more years must be spent by the engineering student to get his B. E. degree. Advanced degrees require two more years for a Masters and a further two or three years for a Ph.D.

In comparing the primary and secondary schools to American grade and high schools several things are apparent:

1. There is more emphasis on languages. This is because India is a land of many languages. Each student going on to higher education must know three languages: His local language which is generally used in lower schools; Hindi which is the national language; and English which is essential for science and is generally the medium of instruction in colleges and universities.
2. Mathematics and science material is introduced earlier, more time is devoted to it, and subjects advance faster.
3. More emphasis is placed upon memorization and the ability to reproduce lecture material - - less on experimentation and reasoning.
4. Discipline, respect for the teacher, and seriousness of attitude are greater. Part of this seriousness stems from the high regard for a college degree and the practice of assigning the limited number of college "seats" strictly on the basis of secondary school "marks".

The first two years of the five year university degree program are often taken at an institution other than that for the final three years. Students accepted by Engineering College, Poona must have had top marks in the two year interscience program concentrating on humanities, science, and mathematics. In the final three years the student spends many more hours per week in class than do our students. Almost all the subjects taken are related to his specialty - - no humanities or liberal arts type courses are offered these years.

If one were to make some comparative observations at the college level the following would generally be noted:

1. Indian college buildings are more austere and less well lighted than ours. Classrooms and laboratories are not so well equipped.
2. Emphasis is still on memorization at this level. There is little class participation by the student and almost no homework problems.
3. Class attendance and discipline is often poor.
4. There are no periodic examinations or quizzes. An end-of-year examination administered by examiners selected from outside the institution determines the grade for the entire year.

Present Michigan State University advisory group at Engineering College, Poona. L to R: Maurice Gjesdahl; Mr. Chari, project secretary; David Van Strien; Ian Ebert; Melvin Thomas.

Main Hall of Engineering College, Poona viewed from the Poona-Bombay highway.

Some feel that poor discipline is largely caused by this "external" examination. Since the instructor has no control over the course grade, he may not be taken too seriously. This is especially true if he deviates from material listed in the syllabus and known to be on previous years examinations! When examination time approaches, students stop coming to classes so they can spend their entire time cramming with the help of purchased copies of previous years examinations and often are coached by a paid tutoring service!

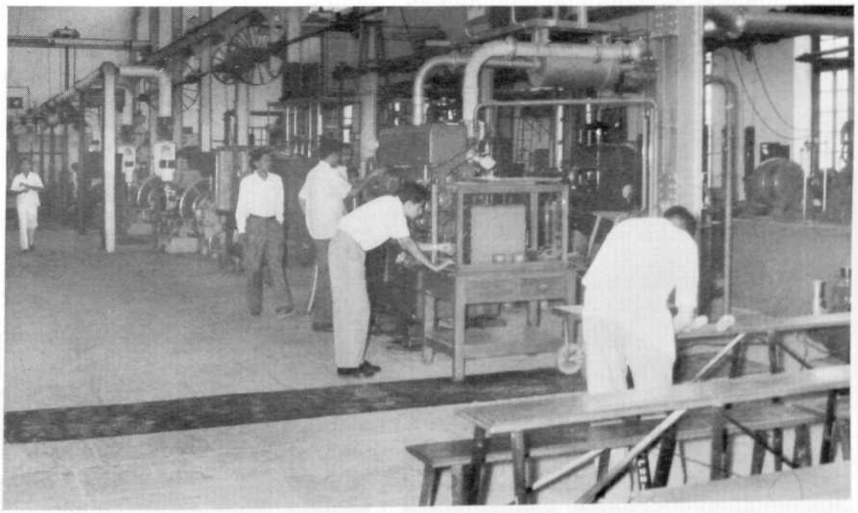
Indian universities have no big spectator sports program such as our football and basketball. Instead there is lively participation in cricket, rowing, badminton, tennis, and other outdoor sports. Every student at Engineering College, Poona is a member of the boat club. The rowing team is nationally known. Table tennis, carroms, bridge, and chess are indoor games that attract great interest and generate many trophys. The average student is in better physical trim than his American counterpart probably because bicycles are the chief mode of transportation. No students and almost no staff have automobiles.

In the foregoing, more emphasis has been placed on differences than on the predominant similarities. The Indian student is just as aware of the challenges of the modern world, just as dedicated to freedom and his country, and just as anxious to make his contribution to mankind. If anything, these feelings are stronger because the evidences of need surround him more oppressively and only recently has his country become free.

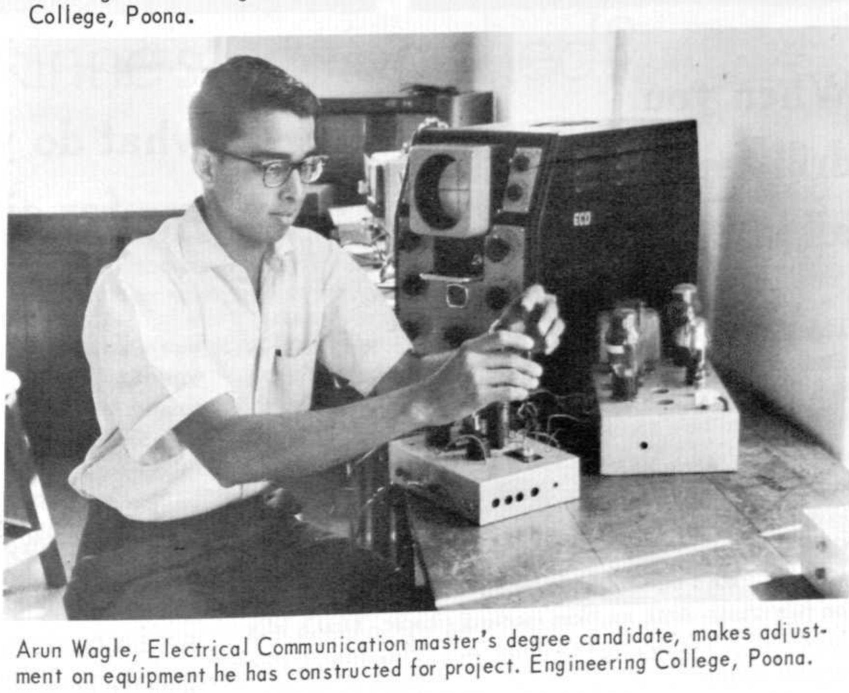
The members of the Michigan State University advisory group have been impressed by the ability and dedication of the Indian officials, administrators, and faculty we have met. With such leadership current problems will be overcome and India need have no fear for the future.

Friendliness toward America and Americans is clearly seen everywhere. Further exchanges of students, faculty, administrators, and government officials at all levels will help erase remaining misconceptions and help our two great countries work together for a better world.

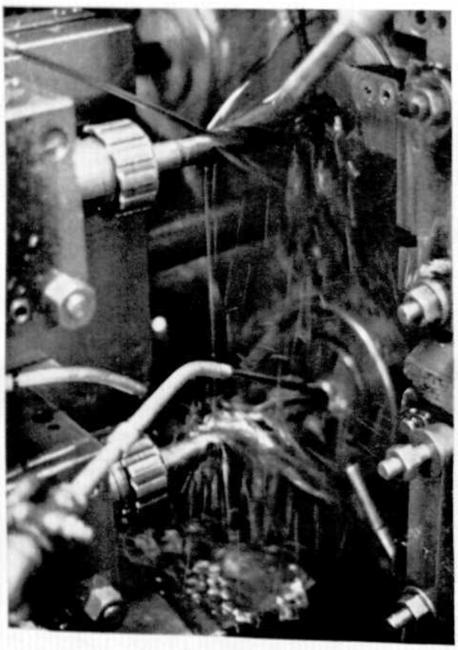
Motor-generator laboratory in Electrical Engineering Department, Engineering College, Poona.



Running a Diesel engine test in Mechanical Engineering laboratory, Engineering College, Poona.



Arun Wagle, Electrical Communication master's degree candidate, makes adjustment on equipment he has constructed for project. Engineering College, Poona.



Bob Turley, on right, American Oil Company Sales Engineer discusses cutting oil problem with Walter Binkley of Schwinn Bicycle Company.

When you drill·tap·form·mill·shape all in 22 seconds...

what do you use for oil?

That's the kind of problem a sales engineer here at American Oil comes up against. It actually happened to Bob Turley when the Schwinn Bicycle Company asked him what oil he'd recommend for this complicated metal cutting problem. He had the answer—one of our special cutting oils—he solved the problem, and made the sale.

Bob's a graduate of Purdue—and the American Oil Company Sales Engineering School. He knows machines and oils. He's our "outside" man with the inside track on lubricants. And, he likes meeting people. That's why he's a sales engineer, combining two fields into a successful career.

Bob's a mechanical engineer. Yet, he might have been working for us if he were a metallurgist, chemist, mathematician or physicist. Petroleum takes on a multitude of uses and requires people of every skill. For information regarding a career in sales engineering or other fields, write to C. L. Wells, Room 1036, American Oil Company, 910 S. Michigan Avenue, Chicago, Ill. ZIP Code 60680

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A JETS Exhibit

Belleville High School JETS Report on Making Liquid Air

The Junior Engineering Technical Society of Belleville High School explored the field of Cryogenics by designing, building and operating a liquid air cryostat. By undertaking this project, we hoped to further our understanding in the practical application of cryogenics. This task began in February 1963 and after much research and experimentation successful results were obtained on March 28, 1964.

MATERIALS AND METHODS

The liquid air cryostat is based on the theory that when air expands it cools. To obtain liquid air, low temperature and high pressure are needed. In the first attempt, the apparatus was designed and contructed as in figure 1. A compressor, which pumps 5.5 cubic feet of air at 1000 psi was donated to our organization by the R. B. Richardson Company. This compressor, made by Ingersoll-Rand, operates on 220 volts, three-phase current. The air, compressed to 1000 psi, was fed into a coil, 120 feet long located in a deep freeze full of ice water (figure pa). The purpose of this was to cool the compressed air from '50° C to 0° C. From here the air was put into a heat exchange, the necleus of the cryostat. This consisted of 3/8 inch OD high pressure copper tubing threaded through 1 1/4 inch OD copper tubing. These coils were incased in 3 inches of zonalite insulation inside of a 4 x 8 x 1 foot plywood box. This enabled air which had been cooled by previous cycles to recirculate over the incoming air (figure 1b). Finally, the cool compressed air was expanded by a steel Joule-Thompson valve, allowing the air to enter the expansion (figure 1c). The expansion chamber consisted of 6 3-foot square metal sheets welded together. This was insulated by 6 inches of styrofoam and incased in a plywood box. A draining valve was welded in the bottom of the expansion chamber allowing any liquid air to drain off. The Joule-Thompson valve previously mentioned was located inside the expansion unit. The cool air which did not liquify in the expansion unit was sent back to the compressor in hope that this would cool down the compressor. This machine, as explained above, ran for 12 hours before shut down was necessary.

After much experimentation with the above method, we realized that modifications were necessary. The results of these modifications can be readily seen in the displayed cryostat (figure 2). The principle ideas behind the modifications were to decrease the surface area and to proportion the size to the output of the compressor.

Using the same compressor we again compressed the air to 1000 psi and fed it into a pre-cooling unit. This was a new introduction into our system. It consisted of 120 feet of coils 3/8 inch OD high pressure copper tubing inside of a 30-gallon oil drum to direct the air from the fan onto the coils. From here the compressed air was then put into the deep freeze and run through another 120 feet of coils. Coming out of the deep freeze the compressed air was at 0° C which was much lower than in our previous arrangement. To deal with impurities, mainly water, which would solidify in our pipes, a desiccant chamber (figure 2a) was made. This consisted of a large steel cylinder 18 inches long and 4 inches in diameter. The walls of the chamber were 1/4 inch to insure safety at 1000 psi. To seal the cylinder 1/8 inch thick plates were inserted in the ends and welded. The chamber was first tested at 2000 psi before being installed in our system. It would filter out any water vapor in the lines by one of two methods. The first method is based on centrifugal force as the air at 1000 psi enters the side of the chamber near the bottom and is forced to take a sharp turn through the chamber, thus forcing any droplets of water to fall to the bottom. The upper half of the chamber, which is filled with silica gol, is separated from the first by a fine screen. By passing air through these fine granules, any water which was not eliminated by the first stage of the desiccant chamber would be absorbed by the silican gel. Also, any oil or carbon deposits would be stopped from further travel through the system. These tiny granules cannot be used for more than 15 hours effectively. They must be baked to restore their absorbing properties.

The compressed air, being cooled to 0° C and free of any impurities, such as water and oil, was ready to be sent through the heat exchange. Through insulated tubing (fiber glass wool) the compressed air entered a newly designed heat exchange (figure 2b). Still based on the theory previously discussed (figure 1b), the new heat exchange was made more compact. This was accomplished by running the threaded tubing (now only 3/4 inch OD tubing) in a parallel sequence instead of a coil, thus cutting down the volume of the heat exchange to one-third of its original size. By doing this, we were able to reduce heat transfer between the heat exchange and the air. Finally, the compressed air (1000 psi) at an ultra-cold temperature (-155° C) reached the Joule-Thompson valve (needle valve) and was allowed to expand into a new expansion chamber. (figure 2c). Our previous expansion unit was a three foot cube, but more calculations and discussion on the matter proved this to be quite wrong. Thus, we introduced into our system a smaller expansion chamber. This new chamber was a segment of copper tubing 3 1/2 inches in diamter and 12 inches in length. It is sealed at both ends with copper caps brazed to the tubing. A baffle plate was also installed in this compact chamber to direct the expanding air to the bottom of the chamber instead of allowing it to rush out the escape valve. There was no need for high pressure tubing to be installed here, as the 1000 psi would diminish to a mere 40 psi once inside the expansion chamber. It was suggested that a safety valve be installed in the expansion chamber to keep the pressure from building up and going over 60 psi. This was done, along with the installation of a pressure gauge, both coming off of the expansion chamber. It should be noted here that they are located in one oblong plywood box, thus reducing the transfer of heat from the air into the box. The entire box was insulated with a rockwool and styrofoam to a thickness of 4 inches on all sides. Finally, a small needle valve located on the outside of the plywood box allows the liquid air to flow.

To see if our system was functioning according to theory, that is, whether it was at the correct temperature and pressure, pressure gauges and thermocouples were introduced in the system. A pressure gauge graduated to 1500 psi was installed immediately after the pre-cooling unit as well as one graduated to 100 psi on the expansion chamber. Thermocouples, of the copper-

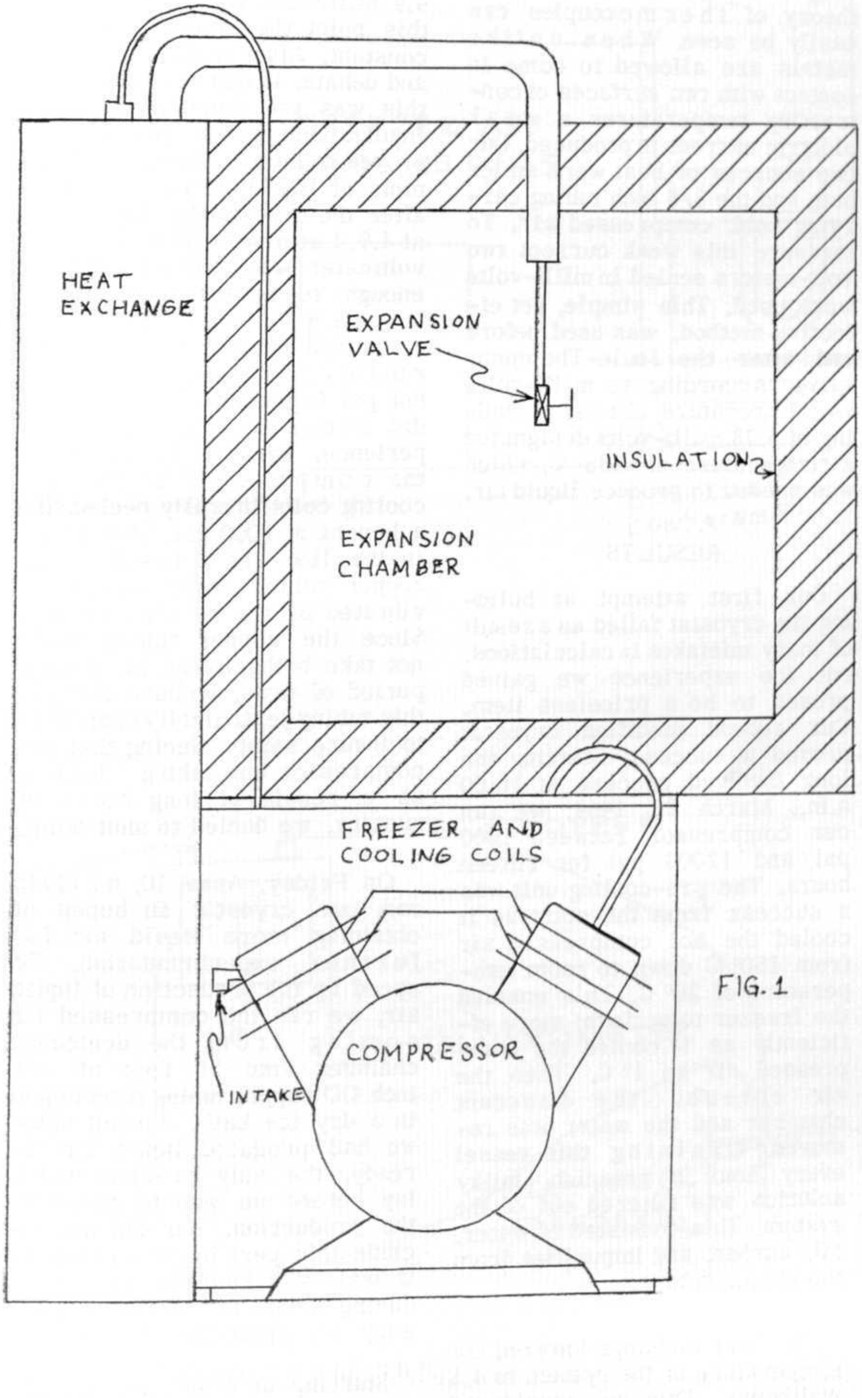


FIG. 1

constantan type, were another new idea in our modified system. Conventional thermometers could not be used at these cold temperatures.

By using the schematic diagram (figure 3), the basic theory of thermocouples can easily be seen. When unlike metals are allowed to come in contact with two surfaces of contrasting temperatures a weak electric current is produced. Our two sources of heat were an ice bath and the 3/8 inch tubing carrying cold, compressed air. To measure this weak current two volt-meters scaled in milli-volts were used. This simple, yet effective method, was used before and after the Joule-Thompson valve. According to milli-volts vs. temperature charts, a reading of 5.28 milli-volts designated a temperature of -183° C, which was needed to produce liquid air.

RESULTS

Our first attempt at building the cryostat failed as a result of many mistakes in calculations, but the experience we gained proved to be a priceless item. Our second modified cryostat proved a success. Starting the long involved process at 10:00 a.m., March 26, 1964, we ran our compressor between 1000 psi and 12000 psi for fifteen hours. The pre-cooling unit was a success from the start as it cooled the hot compressed air from 150° C down to room temperature of 20° C. This enabled the freezer to perform more efficiently as it cooled the compressed air to 1° C. Then the air entered the desccant chamber and the water was removed. Draining this vessel every hour a greenish, milky solution was filtered out of the system. This consisted of water, oil, carbon, and impurities from the copper tubing.

The heat exchange lowered the temperature of the system to 4.8 millivolts. This we considered a major achievement as our new heat exchange proved its efficiency. No leaks were found in the system, thus assuring us better things in the future runnings. We felt that by running it the first day we had cooled the insulation. The next day, March 27, work began at 8:00 a.m. The system, showing no signs of fatigue, operated 16 1/2 hours without stopping. All valves and pipes were wrapped in fiberglass insulation to prevent gains in heat into the system. Starting at 0 millivolts (0° C) the system decreased in temperature until 4.9 millivolts were reached. At this point the system remained constant. After much calculation and debate, it was concluded that this was the reading at which liquification took place. This proved to be the answer as 1 1/2 pints of liquid air were obtained after the cryostat for four hours at 4.9. Later we realized that our voltmeter was not sensitive enough to read the millivolts.

The following Monday we again ran the cryostat. Although we did not get liquid air this time, we did encounter a unique experience. The pipe leading from the compressor to the precooling coils literally peeled like a banana at 1000 psi. This break in the line was a result of the copper tubing being heated and vibrated by the compressor. Since the copper tubing could not take both abuses for a long, period of time, we have changed this tubing periodically since then to insure safety. Seeing that our compressor was taking a beating as a result of long hours of running, we decied to shut down.

On Friday, April 10, we again ran our cryostat in hopes of obtaining more liquid air for further experimentation. To speed up the production of liquid air, we ran the compressed air coming from the desiccant chamber into 50 feet of 3/8 inch OD copper tubing submerged in a dry ice bath. We felt since we had produced liquid air already, the only problem which lay before us was to speed up the production. We did not include this part in our system as it was only installed as a time saving device and was not necessary in producing liquid air.

Starting at 6:00 p.m., Friday night, our problems seemed to come as fast we could solve them. First, carbon deposits developed in the lines all the way to the freezer. This was caused by oil coming from the compressor. After blowing out these lines and cleaning them with methylene chloride, we again started the system running only to encounter more difficulties. This time the ice deposits we had feared might develop in the 120 feet of tubing in the freezer became a reality. By wrapping the tubing in hot cloths we were able to warm the tubing and blow out the ice. Finally at 2:30 a.m. we were able to start up the cryostat. With the help of the dry ice bath we obtained 1 1/2 pints of liquid air in about 9 hours.

Many experiments were made to determine the characteristics and uses of liquid air. In all six experiments were tried when this report was written. We will continue to do experimentation as long as time permits.

In the first experiment, a rubber eraser was supended in the liquid air for approximately 30 seconds and then shattered with the rap of a hammer. Other articles such as carrots and cork were shattered in the same manner giving us our first idea as to how cold this liquid really was.

Next came a balloon experiment. This consisted of placing liquid air in a pyrex test tube and sealing it with a balloon. Thus, after 2 minutes the balloon had inflated to its capacity. To determine how much this liquid air expanded a controlled expansion experiment was made. This was done by letting the expanding liquid air bubble up into a 1000 ml flask filled with water and turned upside down in a pan of water until all of the water in flask had been forced out by the incoming air/ 3 ml of liquid air in a test tube expanded producing 2350 ml of air. Thus liquid air and air volumes were in the ratio of over 1:750 respectively.

To see how good a fuel liquid air makes (oxidizing agent), we put 10 ml of liquid air in a pyrex test tube and connected the test tube to the stem of a lit smoking pipe by means of rubber tubing. As the liquid air boiled off it went to the pipe producing a four foot flame originating from the pot of the pipe.

Another experiment which we tried was a mercury hammer. This consisted of dipping a stick into a dish of mercury. After pouring liquid air over the mercury, the mercury became a solid with the stick submerged in it.

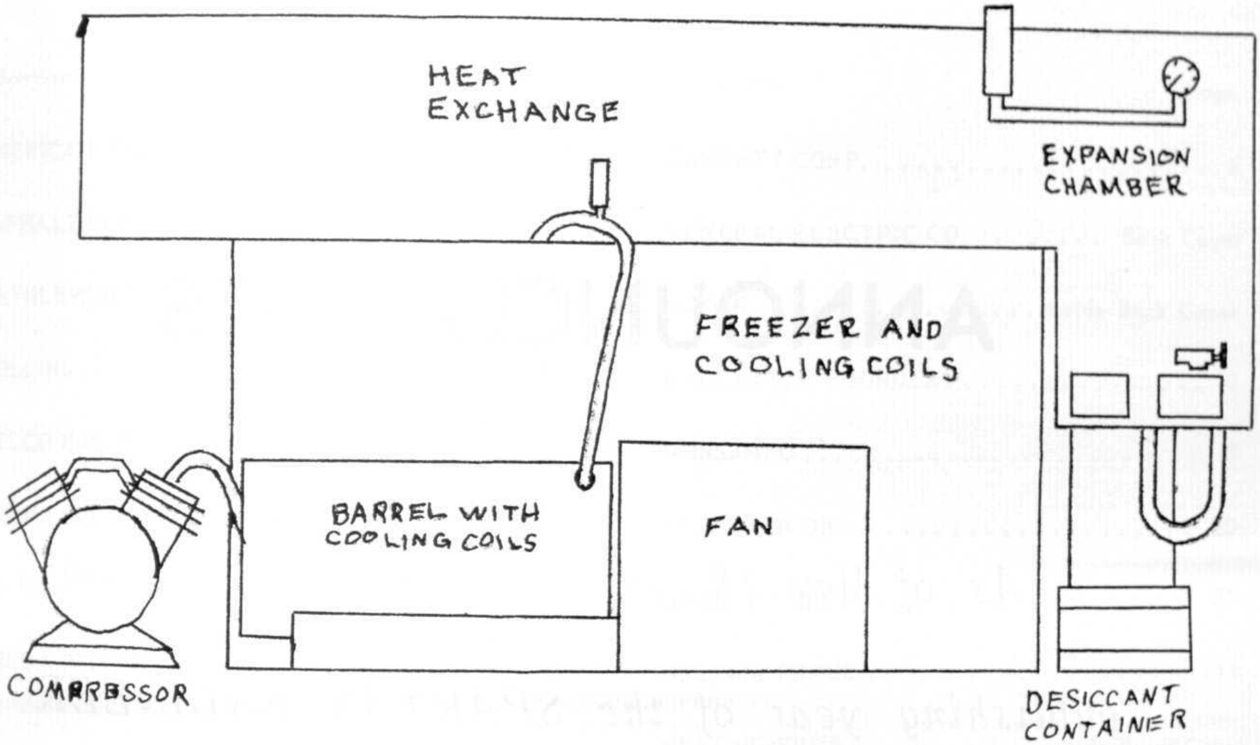
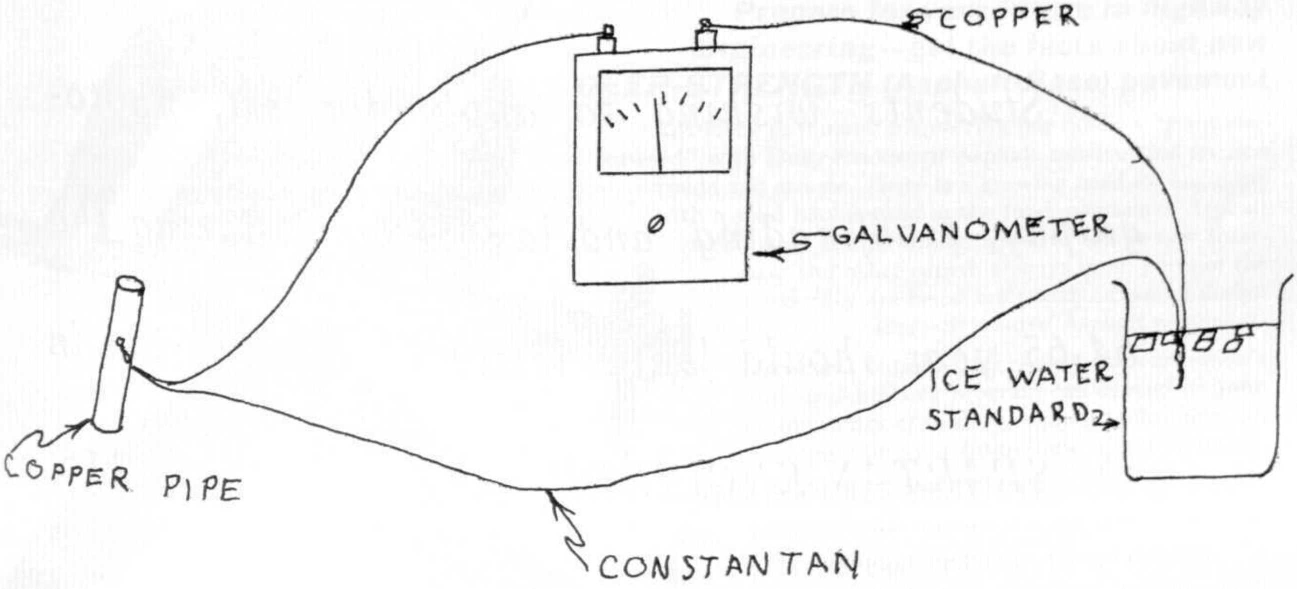


FIG. 2



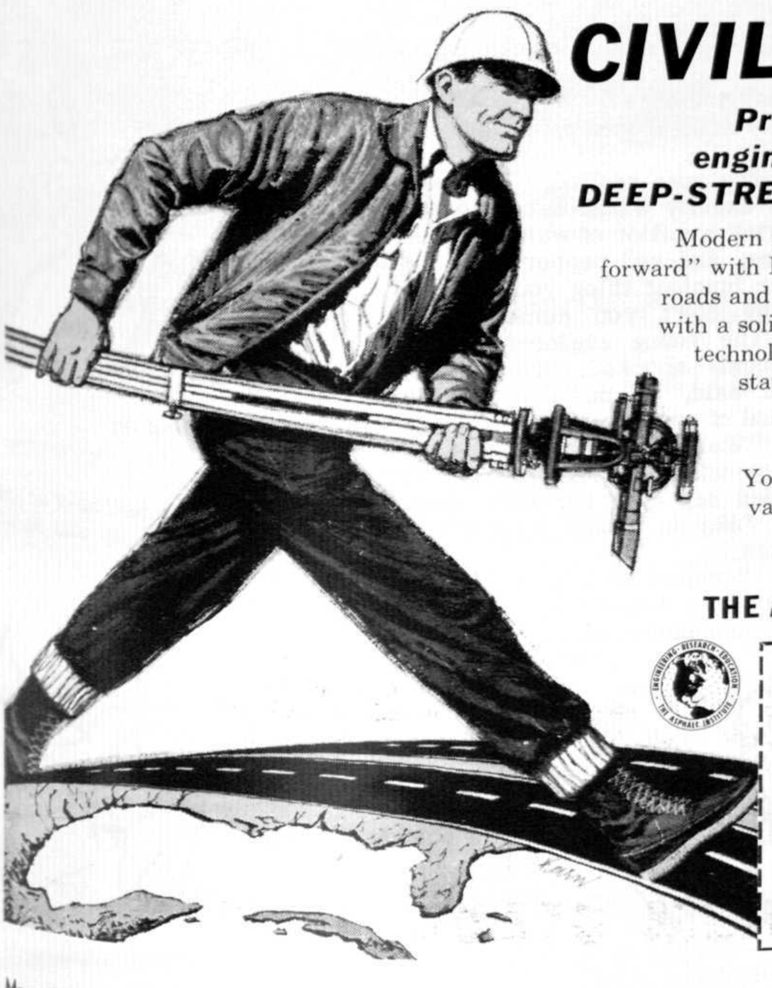
THERMOCOUPLE FIG. 3

ANNOUNCEMENTS

As of May 18, subscriptions for the 64-65 publishing year of the SPARTAN ENGINEER may be obtained at 144 or 116 Engineering Bldg. Rate: $1.00.

Students wishing to apply for art, photography, proofreading, and layout work during the 64-65 year should leave letter of application in the SPARTAN ENGINEER mailbox in Room 116

THE ADVERTISER'S INDEX



Laffs*

Opera is where a man is stabbed in the back and instead of bleeding to death, he sings.

A woman went to a doctor to complain about her husbands delusions.

"It's terrible," she complained. "All the time he thinks he is a refrigerator."

"Well," consoled the medical man, that isn't too bad. Quite a harmless delusion, I'd say."

"The delusion I don't mind, doctor. But when he sleeps with his mouth open, the little light keeps me awake."

Father: "When Abe Lincoln was your age, he was making his own living."

Son: "Yes, and when he was your age, he was President."

The farmer was "assisting" at the birth of his latest child-- he was holding the lamp. When the doctor delivered three fine babies, the farmer suddenly left the room.

"Come back with the lamp!" yelled the doctor.

"Nope," was the reply. "Ain't comin' back Doc! It's the light that's attractin' them."

A young engineer got a job in a remote mining camp. On his first day off, he approached his boss and asked: "Say, boss, what do you do around here for amusement?"

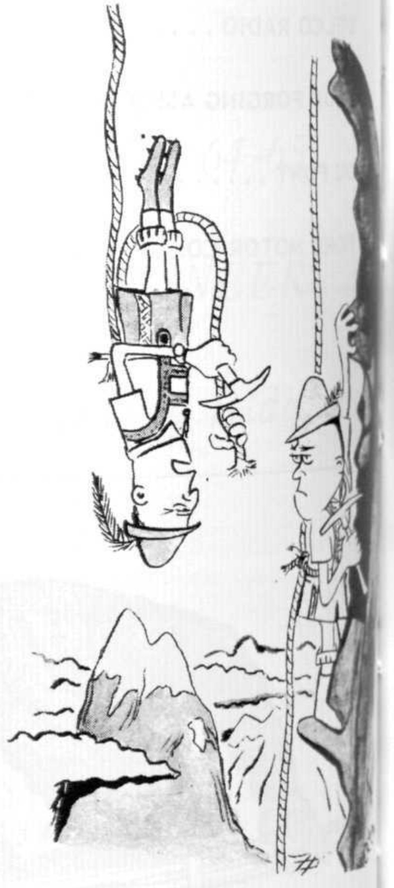
The boss replied, "Well all of us usually watch Sam, the cook, drink a gallon of whiskey, gasoline, and red pepper juice. It's the funniest thing you ever saw. Why don't you come along?"

The young engineer was obviously shocked. "No thanks," he said, "I don't go for that kind of amusement."

"Well," answered the boss, "I sure wish you'd come. We really need six men for this thing."

"Why is that?" asked the new man.

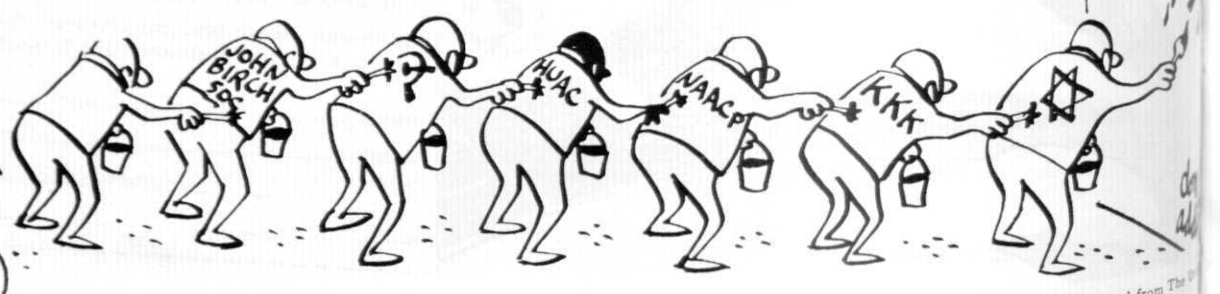
"Some of the boys have to hold Sam. He doesn't go for that kind of amusement either."



"Hold on . . ."

San Jose State L...

On the tombstone of an aethe... "All dressed up and no place ... go."



Swiped from The U...

Advancement in a Big Company: How it Works

An Interview with General Electric's C. K. Rieger, Vice President and Group Executive, Electric Utility Group

C. K. Rieger

■ Charles K. Rieger joined General Electric's Technical Marketing Program after earning a BSEE at the University of Missouri in 1936. Following sales engineering assignments in motor, defense and home laundry operations, he became manager of the Heating Device and Fan Division in 1947. Other Consumer-industry management positions followed. In 1953 he was elected a vice president, one of the youngest men ever named a Company officer. Mr. Rieger became Vice President, Marketing Services in 1959 and was appointed to his present position in 1961. He is responsible for all the operations of some six divisions composed of 23 product operations oriented primarily toward the Electric Utility market.

Q. How can I be sure of getting the recognition I feel I'm capable of earning in a big company like G.E.?

A. We learned long ago we couldn't afford to let capable people get lost. That was one of the reasons why G.E. was decentralized into more than a hundred autonomous operating departments. These operations develop, engineer, manufacture and market products much as if they were independent companies. Since each department is responsible for its own success, each man's share of authority and responsibility is pinpointed. Believe me, outstanding performance is recognized, and rewarded.

Q. Can you tell me what the "promotional ladder" is at General Electric?

A. We regard each man individually. Whether you join us on a training program or are placed in a specific position opening, you'll first have to prove your ability to handle a job. Once you've done that, you'll be given more responsibility, more difficult projects—work that's important to the success of your organization and your personal development. Your ability will create a "promotional ladder" of your own.

Q. Will my development be confined to whatever department I start in?

A. Not at all! Here's where "big company" scope works to broaden your career outlook. Industry, and General Electric particularly, is constantly changing—adapting to market the fruits of research, reorganizing to maintain proper alignment with our customers, creating new operations to handle large projects. All this represents opportunity beyond the limits of any single department.

Q. Yes, but just how often do these opportunities arise?

A. To give you some idea, 25 percent of G-E's gross sales last year came from products that were unknown only five or ten years ago. These new products range from electric tooth brushes and silicone rubber compounds to atomic reactors and interplanetary space probes. This changing Company needs men with ambition and energy and talent who aren't afraid of a big job—who welcome the challenge of helping to start new businesses like these. Demonstrate your ability—whether to handle complex technical problems or to manage people, and you won't have long to wait for opportunities to fit your needs.

Q. How does General Electric help me prepare myself for advancement opportunity?

A. Programs in Engineering, Manufacturing or Technical Marketing give you valuable on-the-job training. We have Company-conducted courses to improve your professional ability no matter where you begin. Under Tuition Refund or Advanced Degree Programs you can continue your formal education. Throughout your career with General Electric you'll receive frequent appraisals to help your self-development. Your advancement will be largely up to you.

FOR MORE INFORMATION on careers for engineers and scientists at General Electric, write Personalized Career Planning, General Electric, Section 699-11, Schenectady, N. Y. 12305

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