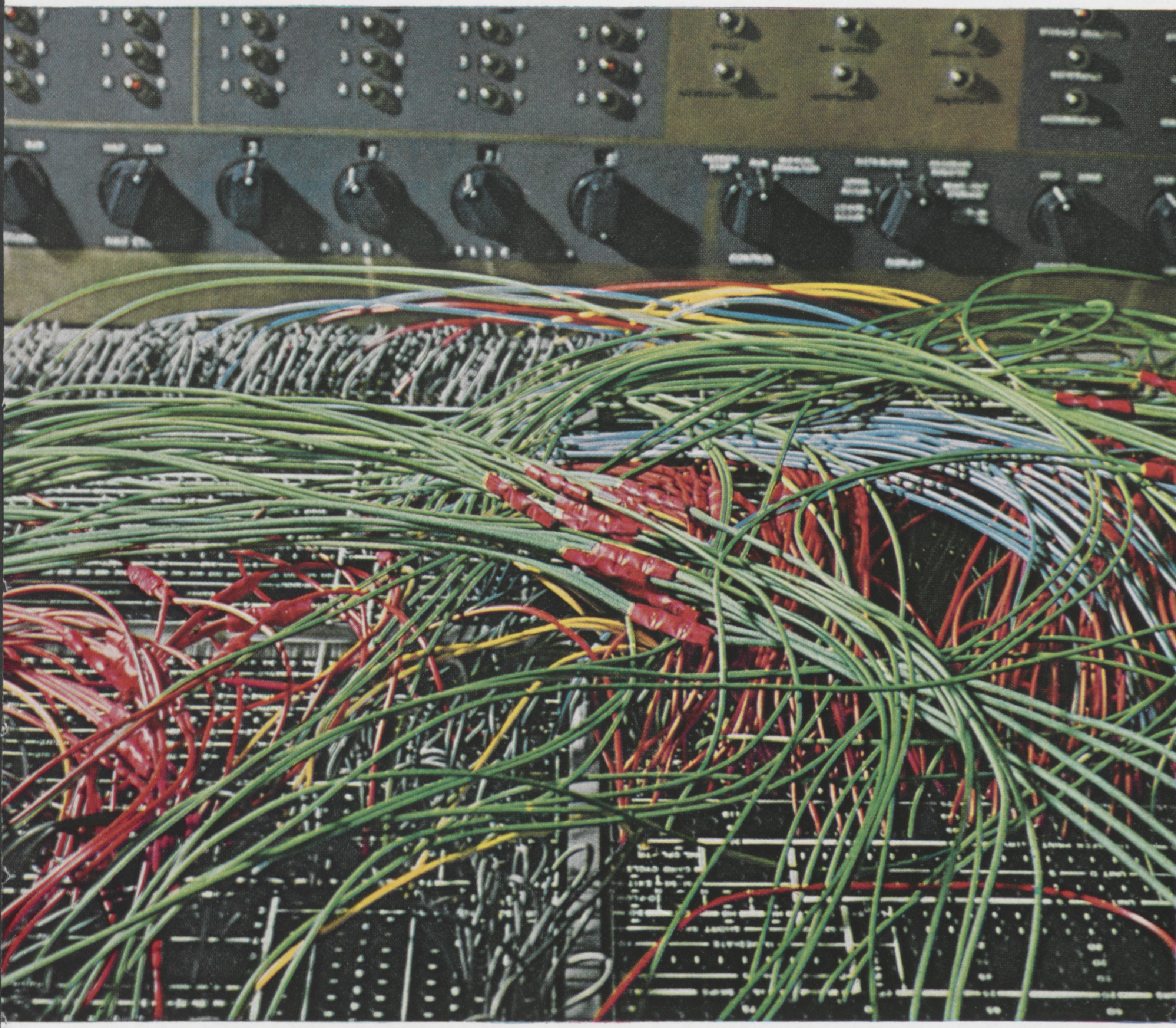
Spring 5-1961

Volume 72 - Issue 8 - May, 1961

Rose Technic Staff
Rose-Hulman Institute of Technology

Rose Technic

May, 1961



In This Issue

FACTS ABOUT

AIR FORCE OFFICER TRAINING

FOR ENGINEERS

Who is eligible?

College graduates, with a degree from an accredited college or university, who are U.S. citizens 20½ to 27½ at time of application. Male applicants may be married or unmarried; female applicants must be single and have no dependents. Applicants must complete written and physical examinations for commissioning.

What kinds of engineers are needed most?

Aeronautical, electrical, mechanical, civil, architectural, industrial. (Also graduates with any degree who majored in nuclear physics, engineering physics or meteorology.)

What is Air Force Officer Training School?

A precommission training course of 3 months' duration at Lackland Air Force Base, Texas. Officer trainees upon graduation receive a commission as second lieutenant. They are then assigned directly to duty or additional training.

Does the Air Force offer career opportunities?

Yes. Technically trained officers have a particularly bright career outlook. They have good opportunities for graduate study.

How can further information be obtained?

Write to OTS Information, Box 7608, Washington 4, D.C., or inquire at any Air Force Recruiting Office, listed in the telephone directory under "U.S. Government—Air Force."

Civilian Career Opportunities

The Air Force also offers challenging jobs for engineers as civilians. Write to Directorate of Civilian Personnel, Hq. Air Force Systems Command, Andrews Air Force Base, Washington 25, D. C., concerning opportunities for individuals with degrees in aeronautical, electrical, electronic, and mechanical engineering. Write to Directorate of Civilian Personnel, Hq. Air Force Logistics Command, Wright-Patterson Air Force Base, Ohio, concerning opportunities for individuals with degrees in industrial engineering.

IMPORTANT DEVELOPMENTS AT JPL...

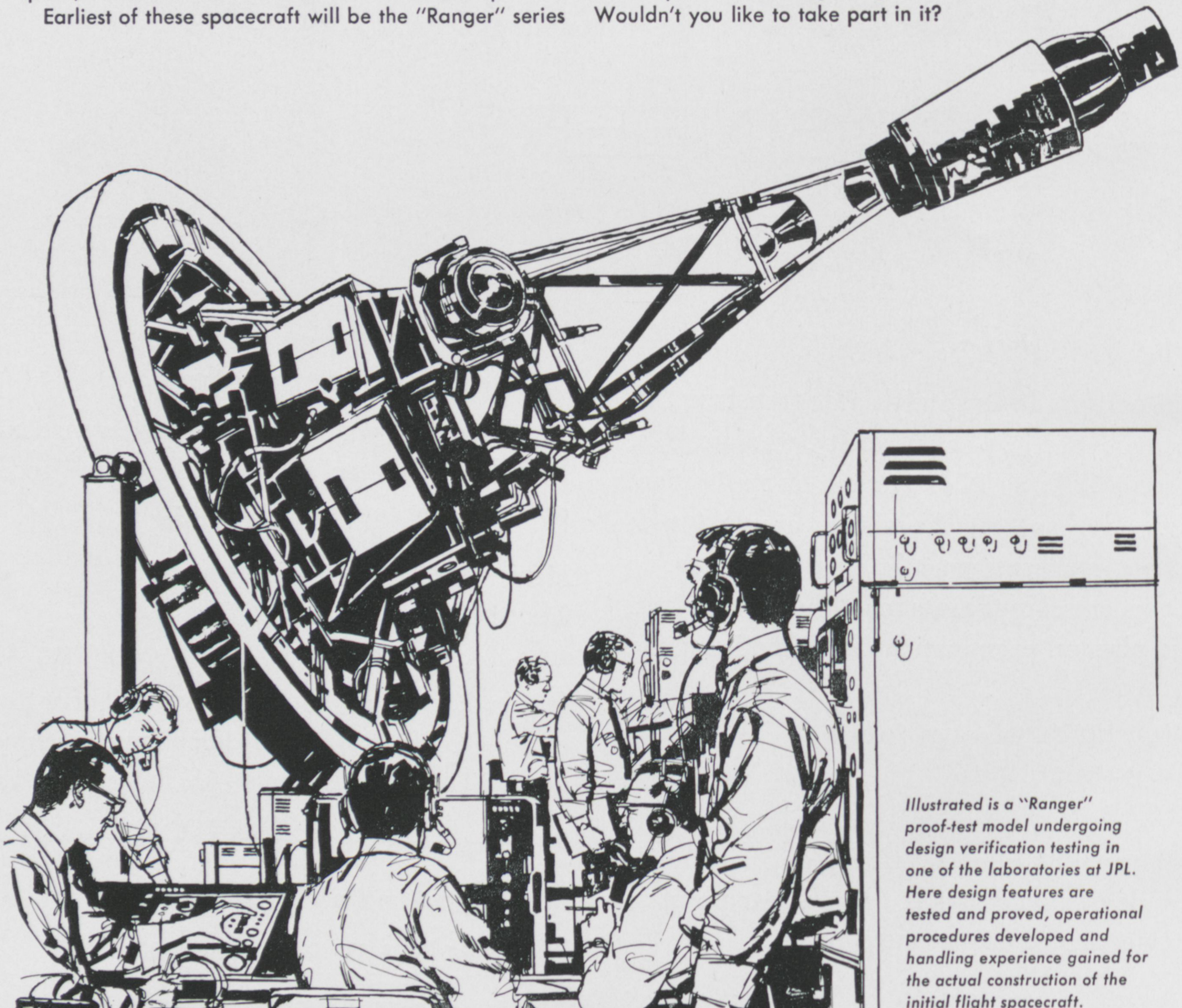
PIONEERING IN SPACE RESEARCH

The Jet Propulsion Laboratory has been assigned responsibility for the Nation's program of unmanned lunar, planetary, and interplanetary exploration. The objectives of this program are to contribute to mankind's fundamental knowledge of space and the space environment and to contribute to the development of the technology of space exploration. For the next ten years, as larger booster vehicles become available, increasingly versatile spacecraft payloads will be developed.

JPL will conduct the missions, utilizing these spacecraft to orbit and land on the moon, to probe interplanetary space, and to orbit and land on the near and far planets.

Earliest of these spacecraft will be the "Ranger" series now being designed, developed and tested at JPL. The mission of this particular series will include first, exploration of the environment and later the landing of instrumented capsules on the moon.

Never before has such a wide vista of opportunity, or a greater incentive been open to men trained in all fields of modern science and engineering. Every day at JPL new problems arise, new theories are advanced, new methods tested, new materials used and new principles discovered. This creates a stimulating work atmosphere for trained individuals and an unlimited field for constructive development of a long-range and rewarding career. Wouldn't you like to take part in it?



Illustrated is a "Ranger" proof-test model undergoing design verification testing in one of the laboratories at JPL. Here design features are tested and proved, operational procedures developed and handling experience gained for the actual construction of the initial flight spacecraft.

These spacecraft will be among the earliest pioneers in the development of space science.

JET PROPULSION LABORATORY

Operated by the California Institute of Technology under contract with the National Aeronautics and Space Administration

PASADENA, CALIFORNIA

Employment opportunities for Graduate Students in these fields

INFRA-RED • OPTICS • MICROWAVE • SERVOMECHANISMS • COMPUTERS • LIQUID AND SOLID PROPULSION • STRUCTURES • CHEMISTRY
INSTRUMENTATION • MATHEMATICS • ENGINEERING MECHANICS • TRANSISTOR CIRCUITRY AND SOLID STATE PHYSICS

Send professional resumé for our immediate consideration. Interviews may be arranged on Campus or at the Laboratory.

Rose Technic

VOLUME LXXII, NO. 8

MAY, 1961

Member of
Engineering College Magazines
Associated

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

Contents

Cover Note

"The secret ingredient in this computer's spaghetti is petrochemicals." Courtesy of the Petrochemicals Department, Gulf Oil Corporation, Pittsburgh, Pennsylvania.

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

Published monthly except June, July, August, and September by the Students of Rose Polytechnic Institute. Subscription $2.00 per year. 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.

Letter To The Editor

Dear Editor:

This publication recently published the opinion of some people who feel that the standards of Rose Polytechnic are being sacrificed in lieu of a reputation of strict academic requirements. It was further expressed that this sacrifice is most evident in the freshman class due to the very low number of people who failed to meet minimum scholastic requirements for the first semester. We realize that there is a definite cause-effect possibility presented there; however we can also see a possible "post hoc ergo propter hoc" fallacy in that type of logic.

We feel there is another approach to this controversial discussion, possibly no more accurate, but certainly, in our opinion, much more reasonable. There are three main reasons for the apparently exceptional showing of the freshman class. According to Dr. Morgen, this freshman class entered Rose having scored an average of fifty points higher on the College Entrance Examination Board tests than the previous year. Also, the standing in the high school class was more than four percentile higher than the class which entered in 1959. We also feel that the week-long orientation program did much to prepare students for the transition which had to be made. Of course, this letter and the one to which it refers are both seemingly concerned with the first semester results. In our opinion this validates the use of orientation week as an argument whereas it may not be as applicable to the second semester.

We are proud to be attending an institution that does not use as a criterion of success the number of students it fails. We feel that the number of failing students is a measure of exactly nothing except of the number of people who will not be graduated from Rose. We feel that Rose will continue to adjust its curriculum in order to provide industry with the same engineers of high standing that in the past have represented our institution.

Bob Valle

John Stockton

A candle in a dark room?

Transverse and/or Visible electro-magnetic waves?

A universal constant?

How many wave lengths in a photon?

Is light affected by gravity?

A full appreciation of light and all its phenomena is essential to the successful completion of our energy conversion mission.

We use this knowledge constantly—as, for example, in our recent development of a photo-voltaic conversion system and a mechanical-optical system to convert light energy to electrical energy.

To aid us in our inquiries we call on the talents of General Motors Corporation, its Divisions and other individuals and organizations. By applying this systems engineering concept to new research projects we increase the effectiveness with which we accomplish our mission—exploring the needs of advanced propulsion and weapons systems.

Energy conversion is our business

ALLISON

Division of General Motors, Indianapolis, Indiana

Varsity Athletics

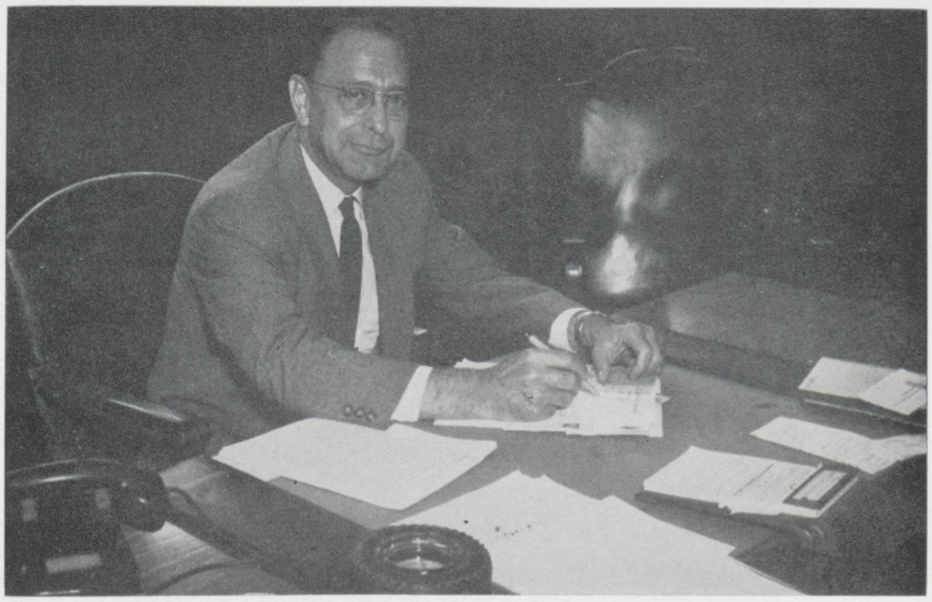
The following quotation is taken from the section on athletics on page 101 of the Student Handbook.

> "Athletics at Rose are carried on as a recreational activity rather than as an all-important program to which all scholastic effort is subordinated. Opportunity for participation in the various sports is provided for those students who desire intercollegiate competition."

Recently there has been some doubt in a few persons minds as to the extent of the "opportunity" stated above. Because of conflicts between scheduled athletic events and tests which involved varsity athletes, it was proposed at a recent faculty meeting that all future intercollegiate athletic competition be limited to Saturday afternoons. In view of the fact that Rose has long been a prominent member of the Prairie College Conference, it seems too much to ask of the other conference members to put such limitations on scheduling. It appears that the athletic department has done an excellent job of scheduling in the past, considering that less than one fourth of the events during the present school year have made it necessary for the participants to miss classes. Very few, if any, other colleges can boast such cooperation between the athletic department and the faculty!

It is well understood by all students and faculty that athletics are deemphasized at Rose and will continue to remain as such. This is also in line with the reasoning that required physical education is unnecessary on the college level of training and can better be replaced with a well-managed military program. However, we are not ready to accept the belief that, just because varsity athletics are not supported to the full extent by students, a varsity athletic program is not an important segment of the extracurricular activities provided at Rose. Instead, it would seem more reasonable and practical to give greater consideration to the athletic department and the schedule it arranges inasmuch as events are usually scheduled a year in advance and posted at the beginning of each semester. In order to promote a better understanding of the athletic program, it is suggested that greater support be given to *all* of the teams by the students and the faculty.

T. C. C.



From the

PRESIDENT'S DESK

By the time this issue of THE TECHNIC is published, the new Lynn T. Reeder Laboratory will be ready to take its place in the educational program at Rose. How important a place and what its contributions will be depend only on the foresight and imagination of the staff and the students to come. As we look back on the past ten years, we try to find out why it was that on October 4, 1957 the Russians put the first satellite into orbit around the Earth. On September 13, 1959 the Russians first hit the Moon. On April 12, 1961 the Russians still held the lead and placed the first man in orbit around the Earth. We know now that the Russians have the capability to send a man to the Moon and probably will do so before we can. At that time, there will, again, be a great hue and cry and questions will be asked "why?".

As the members of the Class of 1961, from Rose, leave the campus to practice engineering, they know the answers to these questions. They know that the Russians are not ahead of us in science. They know that the Russians are not better engineers than we are. They know that the engineers in Russia are not being taught anything which the engineers are not also receiving in their college curricula in this country.

Our lag in the 1940's and 1950's was due to lack of imagination in high posts of administration. We had the scientific knowledge but we did not do the engineering necessary to build large size power plants for space vehicles.

My challenge then, to the Class of 1961, is a great one. You have the background in science, you have the background in the engineering sciences, you know that engineering takes time and planning. Don't be afraid to use this information. More important, use your skills in communication to sell your ideas so that those in high administrative posts will not make, in the 1960's, the unimaginative decisions made in the 1940's and 1950's. With the knowledge we have today, we can go wherever we want ten years from now providing we make the engineering plans now. I hope that it will be a Rose graduate who will use his imagination and make the important decision which will make the United States first in the decade to come.

R. A. Morgan

OBSERVATIONS of SUCCESS

PART VIII: PRODUCTION MANAGEMENT

by Mr. Carl H. Bals
Food Products Process Group Mgr.
Procter and Gamble

This article concludes a series of eight written this year for the TECHNIC by outstanding alumni of Rose describing the nature of their work and the factors which have been important to their success. Demonstrating the wide scope of the engineering field, the series has covered Executive Management, Sales Engineering, Purchasing, Personnel Relations, Research and Development, Design Engineering, and two different views of Production Management, a field of particular interest to most Rose men.

What is Production Management? What does a Production Supervisor do? What knowledge and personality traits are necessary for success in the field of Production? These are questions which many engineering students ask when trying to decide what type of work to enter after graduation. Although it is difficult to answer these questions in one short article, perhaps some understanding of the subject can be gained by first defining the objective of Production Management and then by exploring the role of the production manager in accomplishing this objective.

For certain, a production manager performs different jobs varying with the company and industry with which he is associated; however, the basic objective remains the same, in short: to produce a quality product, at the least cost, for delivery when the customer wants it. As three main ingredients: people, equipment, and raw materials, are normally necessary to accomplish this objective, let us first examine the production manager's responsibilities regarding each of these.

Although it is difficult to say that one of the ingredients, people, equipment or raw materials, is more important than the other, I have found that the handling and direction of people is the most challenging, most time consuming, and the area in which production managers

so often fall short. For the purpose of discussion, the ingredient, "people" should be divided into two areas; operating employees, and other members of management, but both groups are equally important.

An indispensable key to the objective of producing a good quality product, at minimum cost, and at the proper time is a strong, well trained team of responsible operators. First and foremost, the department manager must know his people. This means their backgrounds, their family life, their interests, both at work and outside the plant, their desires, and their gripes. Likewise the operators want to know these same things about their boss. One way is for a new manager to train with each operator in the department and, if possible, actually perform the job of the operator. By so doing, the manager not only learns the details of the departments operation but more important the operator, "Joe," has the feeling that his new boss knows something about his particular job and its problems. With this common ground, the manager learns the things which he needs to know about "Joe." This business of knowing your people, which some text books refer to as good positive relations with the employees, must continue after the manager's training period is over. Now, however, it means getting out of the office and talking with "Joe" on the job about daily events, his family, his interests and his work. To establish a truly good relationship, it means frequent contact, not just once a month or so. And it cannot be done from a desk.

Personal contact, though very time consuming, pays big dividends, for the manager can learn such things as: a certain piece of equipment is starting to act-up, a potential quality problem is starting to rear its ugly head, or that "Joe's" kid is seriously ill and so his mind may not be on his job or his safety. And most important, if a good relationship exists, Joe will tell him if he has a gripe or compaint so that something can be done about it before it becomes a greviance or causes dissension among the entire crew. Likewise, the manager can better convey his ideas on changes, improvements, and problems to his operators.

In addition to simply knowing his employees a production manager has many responsibilities to them. Such things as training, discipline, pay, safety, and working conditions are a daily obligation which must be performed in order for a manager to achieve a well organized, efficient team—a team which can immeasurably help in overcoming production, cost, or quality problems.

The other facet of handling of people concerns other members of management; this includes both line and staff. Again, knowing the people is the starting point, but in this case the department manager's job is to keep upper management informed about events of importance in the department. This, of course, includes production, quality, costs, personnel and so forth. It is accomplished by verbal as well as written communication. Thus in dealing with people, the manager's ability to communicate plays a very important part.

In most organizations staff personnel are available to assist with specialized problems. In working with these people an interest must be shown in their job, in their objectives and in their problems. This does not mean just giving "lip service" but instead being ready and willing to help them. In return the staff people will be willing to help the manager with the result that many of his duties can be delegated. The responsibilities, however, always remain with the production manager.

The second ingredient that is necessary in accomplishing the objective of the production manager is equipment. The manager has the responsibility for its operation and maintenance, but he is not expected to actually operate or repair the equipment. He must, however, have a good technical knowledge as to its function, capabilities, limitations, and method of operation. Some illustrations of the duties a manager performs with respect to equipment include training of a new employee in the proper way to operate a piece of equipment, determination of the changes needed to increase its capacity, or trouble-shooting the cause of equipment breakdown. In this latter case, some would say this is the responsibility of the maintenance foremen, but faster and less costly service will be obtained if the manager has sufficient technical knowledge to precisely describe the symptoms and problem to the maintenance manager or his mechanic. Since the production manager must know when his equipment needs repair or maintenance, an inspection of the equipment is normally included in his daily tour of the department. As a side note, the experienced manager always makes a special effort to see that any equipment problems reported by his operators are corrected as soon as possible. If he fails in this, his operators soon stop mentioning troubles with the thought "If the boss doesn't care about the equipment, why should I? Let it fall apart!" The net result is poor mechanical efficiencies and, in time, very high maintenance costs.

The remaining ingredient is the raw material. With this, the manager must insure that it is received at the proper time and that the required specifications are met. Although this seems straightforward, disastrous results can occur if a rigid plan of inspection and analysis is not adhered to on all incoming material. Normally the off-quality receipt will occur when least expected, and unless the manager frequently audits his methods of inspection, off-quality raw material will slip into his process and contaminate large quantities of product.

Although only people, equipment, and raw materials are required to produce the finished product, the principal job of the production manager is to combine these ingredients together in the proper amount, time, and place. To accomplish this, a

(Continued to page 22)

SOLID and LIQUID FUELS

by Tom Bedwell
Senior M.E.

Over the past two decades, the main work in the field of rocketry and propulsion systems has been done either on the cryogenic, (cold, liquefied gas), or on solid propellants. The cryogenic liquids were the first to be recognized as having high potential in rocket engines for use in space vehicles. Their development was pushed by the major publicity attendant upon the initial success of the German V-2 program during W. W. II. As a result, German developments were incorporated into American progress at the end of the war.

Rockets using cryogenic liquids are characterized by high performance, straightforward techniques of thrust-vector control, and high temperature combustion localized in a small combustion chamber, where it can be handled effectively by regenerative cooling. The use of liquids is attractive because the primary development problems of the system can be concentrated in the rocket-engine chamber. The engine has the advantage of being repeatedly static tested by merely refilling fixed tanks with fuel and oxidizer. The use of liquid propellants also allows on-off operation of the engine.

A major problem in using cryogenic liquids is the need for venting the tanks to permit the propellants to boil off until the instant of firing. Because of this, the motors cannot be stored in the loaded condition, and considerable preparation time is required to load the tanks and top them before launching the rocket or firing the static test. Another drawback of cryogenic propellants is their low density. Also, ignition and stability of combustion is an important consideration as higher enegry fuels are used. In summation, the cryogenic system, after 15 years of development, is a system requiring long preparation time, very extensive ground-support equipment and an engine that looks like a plumbers nightmare because of the vast number of valves, orifices, and pumps designed into the system.

The solid-propellant engines had their beginning during W. W. II as simple, rather small, ordnance units. Initially, because of their success in small weapons, solid propellant engines were thought to be confined to this application alone. However, in recent years, the size and thrust levels have increased so much that they now compete with the cryogenics for use in ballistic missiles. In fact, every major program initiated since 1957 has used at least one solid propellant engine.[1]

Solid propellant rockets are noted for reliability, mechanical simplicity, instant readiness, and lack of need for extensive ground support equipment.

The biggest difficulty inherent in solid propellant rocket engines is the necessity for solving the main problems of the operation of the rocket in the chemistry of the propellant itself. In addition, the entire solid propellant engine is exposed to the high temperatures and pressures of the rocket operation. Consequently, a large mass ratio (large amount of propellant for small amount of structure) has been difficult to achieve. Another drawback of the solid rocket is the relatively poor physical properties of the propellant, which must contain a large amount of oxidizer. Finally, the one shot operation of the solid-propellant engine necessitates the firing of a large number of full-sized engines during the development program.

On the other hand, solid propellants are inherently high in density, and thus become particularly suitable for volume limited applications. However, as the energy level of the propellants becomes greater, the safety of the system leaves something to be desired. Because the oxidizer must be in intimate contact with the fuel, safety in manufacturing and handling is jeopardized by their potential reaction which could possibly amount to an explosion.[2]

Since the beginning of rocket engine development, the liquid propel-

lant types have, to date, received the most extensive study of any type of propellant system used. One reason for this is the fact that, until very recently, only liquid propellants, (which were, until recently, mostly cryogenics) were capable of delivering a high specific impulse. This is a good point to consider because the specific impulse of a rocket engine is an indication of a propulsion unit's propellant economy just as miles-per-gallon is an indication of the gasoline economy of your automobile.[3] In addition to the higher specific impulse, high thrust capabilities and good thrust/weight ratio are among the prime reasons for choosing to develop the liquid propellants. To cite an example; there has been a consolidation of liquid propellant trends during the past few years. One of these trends is toward huge boosters, (sometimes referred to as "trucks"), which make use of kerosene and LOX (liquid oxygen) which can be characterized by the yet undeveloped F-1 booster with a thrust reported to be approximately 1,500,000 lbs.[4] At the same time, development of high energy fuels is being carried on as well as an increased program for the development of storable fuels. In this area, most of the high energy fuels are cryogenics and present some problems when stored for long periods.[5] Some of these problems can be illustrated by considering fluorine which is a high-energy oxidizer. Here, problems of handling, spillage, exhaust products, etc. arise because of the apparent toxicity of the fluorine. Other high energy fuels have similar problems and receive no less consideration. However, because of classification by military and civilian agencies, these problems, for the most part, cannot be discussed.[6]

Reliability, another important feature of rocket engines, must also be a consideration in development programs. Reservations as to the reliability of liquid engines has long been a problem of those charged with the planning of space exploration. It is therefore interesting to examine the record and to evaluate the reliability of liquid engines demonstrated to date. During the past calendar year, the United States has attempted 22 space launchings. Of these, 13 were successful. However, a total of 39 liquid stages were called upon to ignite during these firings. Yet only four times were the liquid rockets responsible for the failure of the mission. Thus the rockets presently in service have demonstrated a reliability of approximately 90%.[7] This approaches the reliability of most of the solid rockets during their early development program.

The simple fact that the fuel is a liquid is an advantage in that it can be stored in a container remote from the engine itself so that it may be gimballed to provide thrust-vector control and guidance. Also, it can be pumped through passageways within the nozzle to points where heat transfer is critical, pick up heat from high-temperature exhaust gasses, and then be fed into the combustion chamber for ignition. This is a regenerative type of process which is an aid in two separate areas. First, by carrying away heat from critical areas, combustion temperatures can be permitted to rise to higher values even with the relatively low melting-point metals used today. Secondly, by absorbing heat, it is possible to add energy to the propellant before it enters the combustion chamber. This will raise the combustion temperature also. However, by controlling the complete process, an optimum condition can be reached whereby the energy added by heat transfer will add to the kinetic energy of the exhaust gasses.[8]

As in all other propulsion systems, there are certain drawbacks in the use of liquid propellants, especially the high energy cryogenics, which make them something less than ideal.

I will renumerate a few, but by no means all, of these in order to show, at least to some extent the development possibility that lies ahead. First of all, the fact that high energy means low stability is important in liquid as well as solid propellant development. Also, the elements which contribute most to high performance limit the physical properties of the corresponding propellant.[9] Another drawback of the liquid propellant system is the fact that the propellant must be pumped into the combustion chamber under pressures which may range as high as 1500 psi. The pumps alone require solving a number of problems such as driving power, lubrication, and erosion at varying altitudes and over large temperature ranges. At the same time, both the fuel and oxidizer, (requiring two pumps in most cases), must be transferred from storage tanks to some central location, metered precisely in the correct proportion, and mixed thoroughly before entering the combustion chamber to be ignited. All of this requires a maze of tubing, valves, and nozzles to perform the operations mentioned; and all of this piping must keep the propellants in a liquid form, calling for temperatures as low as 1° K![10] Even with this requirement alone, one can wonder that any liquid propellant rocket engine has even been developed to the point where it even approaches a reliability of 90%.

A newcomer to the field of large rocketry techniques relative to the liquid rocket engines, the solid rocket engine is proving itself by virtue of recent breakthroughs in propellant development. Even though there is now a large program for developing high-energy storable propellants, the solid propellant engines are becoming firmly entrenched in the ballistics missile field. Let us review some of the reasons why the solid propellants have grown up so quickly.

As you have probably noticed heretofore, propellants contribute in a large measure toward the reliability of a rocket engine.[11] With liquid propellants, precise metering of both fuel and oxidizer are necessary for stable combustion. However, with solid propellants, well controlled mixing techniques are a must for steady burning and constant

(*Continued on page* 24)

MISS TECHNIC OF MAY

That girl who made the Greeks launch a thousand ships had nothing on this month's Miss Technic, Madonna Streaker. Her classic figure of 3.76 slugs is distributed $(4.1015667)^{2.495}$, $(8.306624)^{1.46}$, $4.290840)^{2.43}$. This is enough to make any patient at St. Anthony's Hospital, where Miss Streaker is a Freshman student, feel better. This lass gives much of her time to activities around the hospital. She's a member of the Glee Club, is Freshman representative to the student court, and works on the "Spotlight", the school newspaper.

Brown hair and dark brown eyes finish off the picture in a very pleasing manner as you can see from the photos. I wonder if this combination is a sure cure for spring fever.

She's a girl of action, a fact well supported by the fact that her two favorite sports are horsebackriding and waterskiing.

With someone like this to take care of you, getting sick would be a pleasure rather than a pain; don't you agree?

PLASMA - -

THE FOURTH STATE OF MATTER

by Lindley Ruddick, Freshman

The term "plasma" is credited to Irving Langmuir, the great American chemist. It was generally applied to any gaseous mixture of ions, electrons, and neutral particles that has an overall electrical current and their physical properties.

This term "plasma" as originally defined by Langmuir turns out to be a very general one which covers a wide variety of occurrences and phenomona. Today there is a moderate amount of semantic confusion regarding this definition and therefore the application of plasma. Almost any type of electrical discharge could be called a plasma according to Langmuir's original definition.

The area of plasmas that this article will discuss concerns those that are produced in an applied electric field, such as an arc. An arc generally occurs between two electrodes and is distinguished from other types of electrical discharge by the high temperatures that are produced and the low voltage drop at the negative electrode or cathode. The positive column of such an arc always contains the plasma.

If the electric arc or at least the plasma part of it is confined with a whirling mass of water or inert gas, there is an increase in the density and temperature and the plasma becomes plasmajet. If this plasmajet is then put into a magnetic field, it will be constricted. It is this principle of plasma containment that is used to produce the ultrahigh temperatures found in a plasmajet.

The overall neutrality of a plasma gives it unusual and sometimes abnormal properties. The average kinetic energy of a particle in a plasma may exceed the ionization potential of a monatomic gas molecule. Many people have then compared this average particle energy of a plasma to the heat of fusion of a solid, the heat of vaporization of a liquid, and the heat of dissociation of diatomic molecules. The result of this comparison was an energy scale that indicated plasma was the fourth state of matter. For many years this concept was held in much doubt. However the discovery of more highly energetic states in nuclear physics provided extensions of this energy scale so that plasma is now generally accepted as the fourth state of matter.

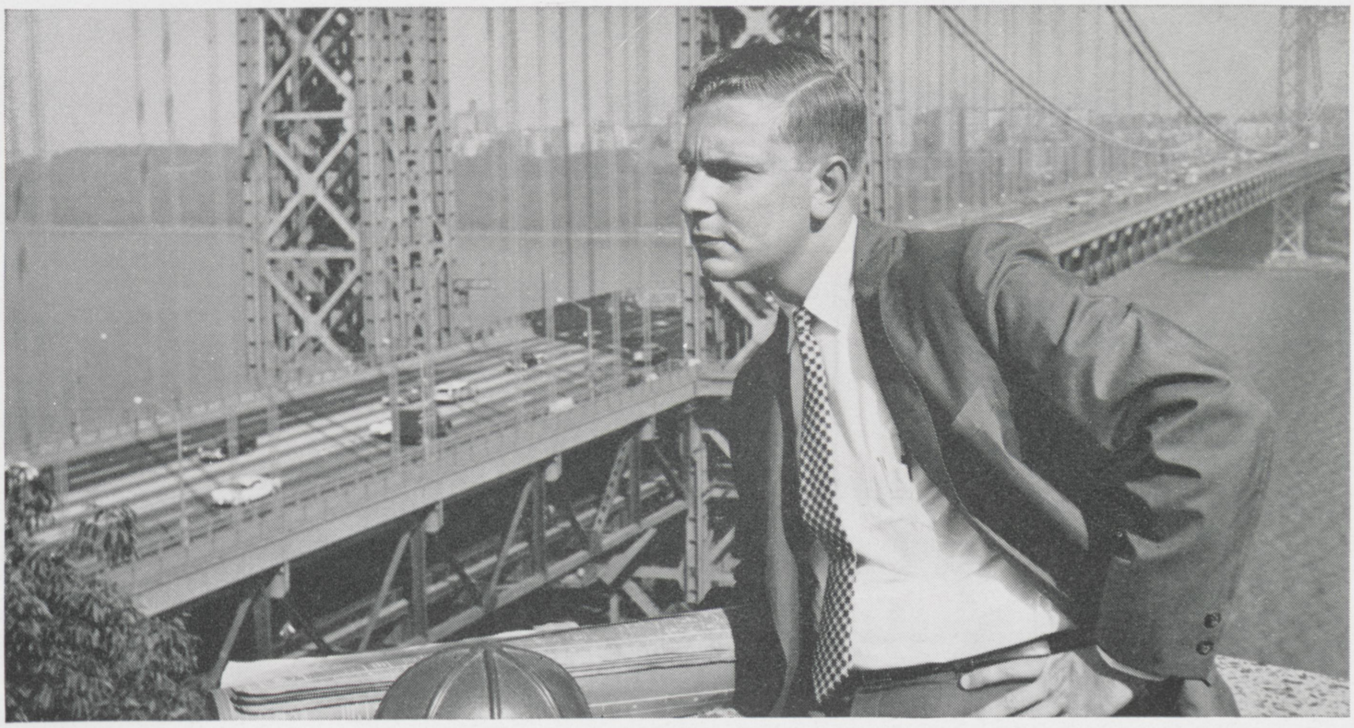
Although well over 99 per cent of our universe may be in the plasma state as evidenced by the atmosphere of the stars and other galactic bodies, we must generate it here on earth by artificial means. In the electric arc method neutral gas molecules are blown through the electron stream of the arc. The gas is then ionized by electron impact and this resultant mixture becomes the plasma. The incessant collisions among these particles and the energy transfer produce an extremely high temperature in the neighborhood of 20,000 to 25,000 degrees F at atmospheric pressure.

There are two main areas for the use of plasmas today. They are (1) turning chemicals into power and (2) producing concentrated streams of high energy particles. The first area is by far the most investigated by both experimentation and theory. The motivation behind this has been the problem of plasma containment, especially when it is produced by a thermonuclear device. The second field has a great potential in that it could constitute a reaction medium that could be used to synthesize compounds that can't be made at ordinarily produced high temperatures. Another possibility is its use to give chemicals reactivity to chemicals that are considered inert.

The outstanding feature of a plasmajet from the chemical viewpoint is the high temperatures that are available. Once the material problem is solved, it is hoped that a temperature of 90,000 degrees F. can be obtained with a constricted plasma. At this ultrahigh temperature the plasma would consist mainly of ionized particles and electrons with an ultrahigh energy content.

A present application of the modest units now in operation is the fusing of refractory materials to base materials. There are at least three units available commercially used for this purpose. Because of the great differences in temperature, the item being sprayed remains relatively cool. Such spraying units are compact, one-man devices with a temperature range of 10,000 to 30,000 degrees F. Materials such as tungsten and tungsten carbide have

(*Continued on page* 25)



THIS YOUNG ENGINEER IS ON THE ROAD TO MANAGEMENT

Dick Cotton knew he wanted to take the engineering route into management long before he joined New Jersey Bell Telephone Company. In fact it was his goal when he was working for his engineering degree at Rutgers.

When he graduated, he had his lines out to eleven other companies. He came to New Jersey Bell because: "I didn't feel I was just a number to these people. There was no doubt in my mind that this job would be the best for the long pull."

His first assignment was a tough one. A complex of major telephone cables lay in the path of the approach to the new traffic level of the George Washington Bridge on the Hudson. Dick's job was to find the most practical and economical way to reroute these cables, and at the same time to provide for future telephone growth in the area around the bridge approach.

Dick ironed that one out and got a crack at another tough job.

Next stop: New Jersey Bell Headquarters Engineering Staff, Special Studies Group. Here Dick was a member of a four-man team whose job was to find ways to eliminate some of the routine work of field engineers to give them "more time to think." Dick also helped plan and control a $100,000,000 annual telephone construction budget.

Presently, Dick is responsible for telephone equipment engineering projects in the Camden, New Jersey, area.

How does Dick look at it? "This is a growing business. I work with this growth every day. And growth means more room at the top. Of course, I don't figure I'll get there overnight—but on my jobs so far I've had a chance to take a good look at how this business is run. And I think the sky's the limit for a man who really wants to work for it."

If you're a guy who can tackle a tough job and deliver the goods—then you're the kind of man who should find out more about the Bell Companies. Visit your Placement Office for literature and additional information.

"Our number one aim is to have in all management jobs the most vital, intelligent, positive and imaginative men we can possibly find."

Frederick R. Kappel, *President*
American Telephone & Telegraph Co.

BELL TELEPHONE COMPANIES

SMOG CONTROL

by Merle Rice
Soph. E.E.

Merle Rice discusses the world-wide problem of air pollution and some of the steps being taken to alleviate the situation . . . .

One of the most popular targets for Hollywood comedians is Los Angeles' smog. While southern Californians wipe their irritated eyes the rest of the nation laughs at their dilemma. But air pollution, or "smog," is not a problem only in Los Angeles, St. Louis, London or Pittsburgh. Terre Haute's chemical plants and coal burning furnaces, Whiting's oil refineries, Gary's steel mills, Fort Wayne's copper mills, Indianapolis' meat packers — each contributes its share to the growing air pollution problem.

In many cases, the primary problem is not one of control. Scientists are not yet sure what they need to devise controls for. The medical profession cannot reach concrete conclusions as to the harmful effects smog has on people. In December, 1952, four thousand people succumbed to smog in London. Other fatalities had been recorded there in 1948, in the Meuse Valley of Belgium in 1930, and Donoia, Pennsylvania in 1948. These cases are concrete proof that smoke and gases of the atmosphere can be harmful. The problem facing today's scientists is the determination of *which* gases are harmful; *how much* of a gas is safe; *where* does the gas (or smoke) come from?

The first of these questions is probably the easiest to answer. It would seem that straightforward laboratory tests could easily determine this data. Yet, Los Angeles County scientists settled on a 1.5 ppm (MAC value) of ozone as dangerous; the Academy of Medicine, Cincinnati, determined 0.1 ppm, as has an industrial research group. Russian hygienists have recommended an unrealistically low 1.7 ppm for carbon monoxide (lower

than even that of rural "clean" air in the United States) as opposed to a Los Angeles 300 ppm value. Similar discrepancies for nitrogen oxides and sulfur dioxide tend to discredit science's efforts in the minds of the public and wreak havoc on the laboratory scene.

The touchiest aspect of the problem is the source of a harmful material. Obnoxious situations such as stockyards, dumps and chimneys billowing black smoke are rather obvious and difficult to conceal. But offensive as they may be, in most cases these are not the real trouble spots.

A prolonged investigation in Los Angeles led to the conclusion that the famous Southern California smog was primarily caused by internal combustion engines—moving about the streets and freeways. An indignant public arose to question this finding. Since the investigations were paid by local industry, the public felt something was being hidden.

This is a rather universal reaction. The press doesn't have personnel qualified to decipher the qualified rambling of the scientists. John Q. Public finds it difficult to believe his car is causing the trouble, rather than the smoky factory down the street. Pressure is therefore often placed on public officials by the noisey misguided public and strange legislation often results. A case in point is Los Angeles' law concerning the olefin content of gasoline. Though olefin was found to be one of the chief problems automobiles cause, it was determined in the same tests that olefin content has no bearing, the gas is a product of the combustion and doesn't just "go through".

Although no industry is anxious to pinpoint itself as a public nuisance, most of the research in the field has been conducted by individual firms and trade groups such as the American Petroleum Institute and American Iron and Steel Institute. Government is entering research more, particularly on a Federal level. Animonity is prevalent between industry and government oftentimes. An early report by Los Angeles County scientists concluded that 60% of hydrocarbons emitted from exhaust evolved during deceleration. Detroit manufacturers undertook a three year program to remedy the problem, only to abandon it when the scientists found 25% to be a more accurate figure. Industry's self imposed regulations, though not meeting popular approval, are usually more practical than legislation evolving from emotional atmospheres.

Three general courses of action present themselves. Each is based upon elimination of the cause.

The most challenging method would be altering the atmospheric conditions which allow smog to accumulate. In normal atmospheres, even in crowded communities, smoke is rapidly dissipated upward because the hot gases are lighter than air. At times, blowing winds also cause horizontal dispersion. A stable atmospheric condition may develop, however, when there is no vertical movement of the air. The atmosphere becomes stagnant and a virtual ailing is effected for waste gases. Fog often accompanies this phenomenon with a resulting smoke-fog mixture—smog. To date, the only atmospheric control methods which have been designed would require such large quantities of power as to make them unfeasible.

Probably the simplest form of industrial control is complete elimination of the source. Los Angeles county forbids burning of fuels with a certain sulfur content currently during the seven month smog season. The petroleum industry is designed for revision to allow these fuels to be used on days when atmospheric conditions can dispurse sulphuric stack gases. It is felt that the County Air pollution Control meteorologists are capable of determining which are going to be "smog days". This method of meteorological control was adopted with promising results by the Consolidated Mining and Smelting Company at Trail, B.C.

Improved refining of fuels, better engineered machinery and substitution of natural gas for coal are other possibilities. The Automobile Manufacturers Association is spending about a million dollars a year in attempts to improve the exhaust features of their products. While this would not be sufficient to run a fifteen minute television show, it is certainly a step in the right direction.

The third and most common approach is arresting the gases before they reach the atmosphere. California law will soon require afterburners on automobile exhausts. City ordinances attempt to cover apartment house incinerators and trash fires, but these domestic controls are difficult to enforce.

Engineers are able to capture many of the troublemakers. Some gases and particles have proved elusive, however, and economical methods are still nonexistant for many others.

Chemical engineers are primarily concerned with effluents (nitrogen oxides and ozone), which are difficult to absorb by contact washings; recovering odorous gases too concentrated for odor cannisters and too dilute for economical recovery; and extension of analytical methods to parts-per-billion range. Aldehyde analysis; removal of sulfuric acid mist and carbon monoxide from the atmosphere; and prevention of nitric oxide and lead resistant oxidation catalysts for exhaust hydrocarbons add to the tasks ahead.

Other engineering problems arising include recovery of hot metallurgical fumes, evaluation of partical recovery equipment, practical and economical small foundry and coke oven emission controls and a multitude of other perplexing problems.

An industry must be alert to the possibility that it is contaminating the air—atomic power plants have set the pace in precautions—and the public must become better informed. In Los Angeles it is smog; New York, smaze (smoke-haze), and El Paso smust (smoke-dust). Your home town has its own air pollution problems, different from others, and with many unanswered questions for science.

Super Conductivity

by Wilber Dekker, Sr. Phys.

Superconductor is the term applied to a material which loses all electrical resistance at low temperatures. This effect was discovered some fifty years ago, quite unexpectedly. Since then, some 25 elements and 250 alloys or compounds have been found to show this property.

Little research has been done until recently because of improper laboratory facilities and techniques needed to achieve these low temperatures. Since helium has a boiling point in the neighborhood of four degrees Kelvin, liquid helium was chosen to be the coolant used to lower the temperature of the material to the superconductor state. Techniques have advanced such that liquid helium has been offered for sale, and it will be shipped anywhere with insured safe delivery.

Resistance decreases in most conductors as the temperature decreases; however, this holds only until the temperature reaches the neighborhood of ten degrees Kelvin, then the resistance is no longer a function of temperature. For superconductors, at this temperature, the resistance drops to zero and the resistance of nonsuperconductors remains constant. Of course, the characteristic curves shown in figure 1 are relative and each material has a different curve depending on purity of the metal. If the curve is extrapolated to zero degrees Kelvin, a pure crystal would have zero resistance.

The behavior of each member of the family of superconductors is quite different. The critical temperature is defined as that temperature for which the resistance drops to zero. This temperature is usually below ten degrees Kelvin.

Now consider the magnetic behavior of a superconductor when it is in the superconductivity state. It is perfectly diamagnetic. Again, however, a critical field must be defined because at a certain field strength the sample changes from the superconductive state to the normal. This value of the field is called the critical field. (See figure 2).

From the graph it can be readily seen that a material can be changed from the superconductivity state to the normal state by raising the temperature above the critical temperature, or increasing the field above the critical field. This property lends itself for application to the computer field.

An interesting property is observed if a strip of superconductor is placed in a field as in figure 3. Since the strip is diamagnetic, the magnetic lines of force are bent around the sample. The field near the ends could exceed the critical field if the field is carefully controlled to produce this effect. This would mean that the ends are in the normal state and the center still in the superconducting state.

This effect has actually been photographed by placing a thin plate

(*Continued on page* 26)

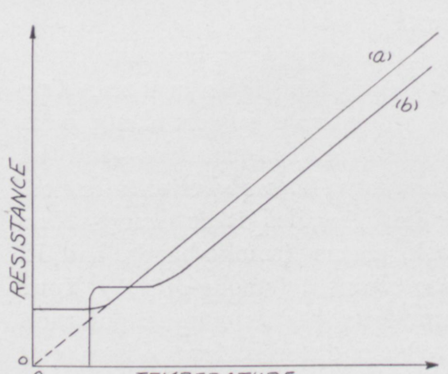


FIGURE 1

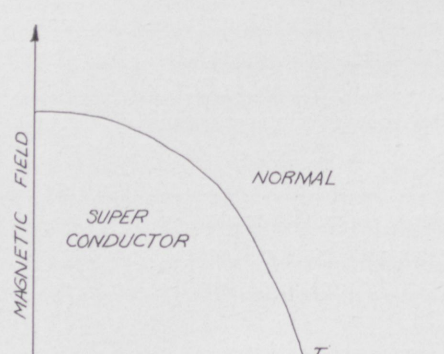


FIGURE 2

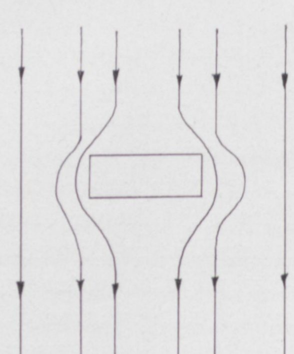


FIGURE 3

Research and Development

by Ned Hannum, Jr. M.E.

MAGNETOHYDRODYNAMICS

Prospects for commercial electric power generation, through the revolutionary magnetohydrodynamics system, advanced significantly with a recent announcement that 205 kilowatts of power had been produced in a new MHD generator at the Avco-Everett Research Laboratory, Everett, Mass. This is 20 times greater than the power output achieved when the project was first revealed late in 1959.

At the same time it was disclosed that two additional electric utility companies had been added to the ten which originally joined Avco in the MHD power studies, and the budget for the 1961 experiments has been tripled to $1,200,000.

Magnetohydrodynamics is probably the most exciting area of development in power generation today. A little more than a year ago ten utility companies, three of them in the American Electric Power System, entered into an agreement with Avco for a research program for the application of MHD to the mass generation of electric energy which could improve the efficiency of power plans by as much as 40 per cent.

This program has yielded results more favorable than were ever expected at the end of 1959. The original idea, first investigated by Michael Faraday some 150 years ago has been carefully tested against today's more sophisticated knowledge of high temperature gas properties as a result of Avco's intense space exploration program. This exciting idea has stood up well in the analytical and experimental work completed this year, and studies continue to affirm that the MHD power system promises considerably higher efficiency at reasonable capital costs.

The new Mark II geneartor now in operation at the Avco-Everett Research Laboratory is believed to be, by far, the most advanced generator in the country. Dr. Arthur Kantrowitz, Avco vice president and director of the laboratory, said the new generator, after further development, will be capable of producing upwards of 500 kilowatts of power for the time periods necessary to evaluate engineering problems associated with the system.

The basic difference between an MHD generator and the present conventional electric generator is that part of the costly steam turbine cycle would be eliminated and much heavy equipment would be unnecessary.

The principle of MHD has been known since early in the 19th century when Faraday discovered that electricity could be made by moving a coil of wire with respect to a magnetic field. This, in essence, is how commercial electricity is produced today. A moving magnetic field driven by a steam turbine generates electricity in a fixed armature. Electric utilities today burn coal or other fuel to heat water into steam which drives the turbine.

In the MHD system, the burning coal, oil, or atomic energy would heat a gas to such temperatures that it would become ionized and a conductor of electricity. This hot gas would be forced through a magnetic field and would produce electrical power directly in a static circuit.

Avco has been studying MHD, both as a possible source of electric power and as a propulsion source for space vehicles, for the past three years. Some of the scientists at the laboratory have been conducting experiments in these fields for more than ten years.

One of the major problems that has been solved was that of material vs temperature. Temperatures in excess of 4,000 degrees F. are required before combustion gases can become conductors of electricity. With this requirement, it was necessary in Avco's original power cycle to preheat the combustion air in excess of 3,000 degrees F. for efficient operation of the MHD plant. Materials capable of withstanding temperatures high enough to preheat the combustion air have not been developed.

To solve this problem, Avco scientists, in cooperation with AEP, studied power cycles where the combustion air is enriched with oxygen before being fed to the preheater and combustion chamber. The use of oxygen reduces preheat requirements to the point where a con-

(*Continued on page* 26)

OBS. OF SUCCESS

(*Continued from page* 11)

thorough technical knowledge is indeed helpful, but more basically, the ability to reason and obtain a logical answer from information, facts, and data available is absolutely essential. A good manager utilizes many sources of information such as: personal contact with his operators, personal inspection of equipment and material, data from staff personnel, and cost and quality reports. Since the varied sources may produce conflicting information, personal investigation is quite often the rule in determining an answer to the problem. But obtaining a logical answer is not alone sufficient. The real key is correcting the problems so that they do not recur and that some tangible results are shown in costs or quality. This is what the manager is in business for.

Although most of the time staff personnel or operators will do the actual work, it must be emphasized that it is always the production manager's responsibility to initiate any changes and likewise his responsibility to see that any program is satisfactorily completed. These responsibilities cannot be delegated.

Perhaps a beter concept of a production manager's responsibilities and daily duties can be obtained by examining a typical production problem.

One example could be a loss problem; one involving the overusage of one chemical. Frequently the first indication of this type will appear in the monthly cost statements. The manager's first step is to determine where in the process the error is being made. Operating records, chemical analyses, and inspection reports can be very helpful; however, a lead may result by discussing the problem with one of the operators. In this particular case an automatic control instrument is out of calibration causing the overusage. Simply resetting the instrument may accomplish the correct formulation, but the experienced production manager will ask himself such questions as: "What caused the calibration of the instrument to change? What check can be made on a regular basis so that this problem won't recur? Was the performance of the finished product adversely effected during the time of the poor control? Was this something that a well-trained operator would have reported?"

Although each of these questions follow-up, the possibility of shipping poor quality finished product to the customer is of primary concern to a production manager. Since a staff engineer is normally available to assist in quality problems such as this, a call to him will resolve the question of product performance and provide a guide if further action is necessary.

Next in importance is finding the basic cause of the problem. Since an automatic control instrument is involved, the aid of the maintenance foreman would be solicited to determine if the mechanical failure was the result of operator mistreatment, poor maintenance, or just normal wear. If the answer is normal wear, then the solution entails the repair of the instrument and establishing a frequency of inspection to eliminate any chance of this particular problem recurring. However, if operator mistreatment occurred, a program of re-training the operator may be necessay. In this case the manager, himself, would undertake the job of re-training.

In any type of production problem many possibilities and alternatives exist. Best results can be obtained by first finding the basic cause and then deciding on the corrective action necessary. Only by attacking the problem in this way can the manager be assured that the problem will be truly corrected and that it will not catch him unaware again.

As can be seen from the discussion thus far, the job of a production manager includes many different duties and responsibilities. Althongh in an article of this length it is impossible to discuss each responsibility separately, some general conclusions should be drawn as to the knowledge and personality traits necessary for success in the field of Production Management.

In simplest terms, the foremost requirement is the ability to work with and get along with people in all walks of life. This ability cannot be achieved by reading a text book, but rather must be gained through experience. An excellent starting point for this experience can be extra-curricular actifities in college, and after graduation, by participation in community affairs.

Secondly, a functional skill in communication is needed. This, of course, includes the ability to express one's ideas and thoughts orally as well as in written reports and letters. Courses in public speaking, debating, letter and report writing provide the fundamentals, but again the practice of these fundamentals in varied extra-curricular activities provides the polish that is desirable.

Thirdly, an orderly thought process is essential. This entails the attainment of a logical answer from an assortment of facts and figures. Engineering and mathematics courses are excellent in developing this thought process.

Finally, a thorough knowledge of the fundamentals of mathematics and engineering is needed. With the rapidly expanding technology of today's business world, it is impossible to acquire in college the specialized technical training that will be necessary in industry. But a basic understanding of mathematics and the engineering sciences is the essential foundation for the specialized technical training which each company provides for its production managers.

Thus the success of a Production Manager depends upon his ability to combine the ingredients of people, equipment, and raw materials in such a way as to produce a quality product at the least cost, and deliver it when the customer wants it. Seeking to attain this, I have found, provides immense job satisfaction and never the thought "When will 5 o'clock be here," but rather "Where has the time gone-"

Library Notes

By Carson Bennett and Winifred Kitaoka

TEN COMMANDMENTS OF HUMAN RELATIONS
By Carl S. Winters

I. THOU SHALT LOVE PEOPLE, NOT JUST USE THEM.

The greatest thing in the world is a person.

The greatest thing about a person is his motive, and the greatest motive is love.

II. THOU SHALT DEVELOP THY UNDERSTANDING.

"If every man's care were written on his brow, how many would our pity share, who bear our envy now."

III. THOU SHALT COMPLIMENT MORE THAN CRITICIZE.

You had better cover your neighbor's fault with a cloak of charity.

You may need a circus tent to cover your own.

IV. THOU SHALT NOT GET ANGRY.

If you are right you don't need to.

If you are wrong you can't afford to.

V. THOU SHALT NOT ARGUE.

It's no use to win an argument and lose the people.

Beware of the attitude which says:

"In matters of controversy, my attitude is fine. I always see two points of view. The one that's wrong and mine."

VI. THOU SHALT BE KIND.

You had better be kind to people you meet on the way up, they are the same people you meet on the way down.

It's nice to be important but it's important to be nice.

VII. THOU SHALT HAVE A SENSE OF HUMOR.

A sense of humor is to a man what springs are to a wagon. It saves a lot of jolts.

VIII. THOU SHALT SMILE.

No man is ever fully dressed until he has a smile on his face.

"Powder your face with sunshine,
Put on a great big smile.
Make up your eyes with laughter
Folks will be laughing with you in a little while.
Whistle a tune of gladness.
Gloom never was worthwhile.
The future's brighter when hearts are lighter,
So smile, smile, smile."

IX. THOU SHALT PRACTICE WHAT THOU PREACHEST.

One example is worth a thousand arguments.

X. THOU SHALT GO TO SCHOOL TO THE HEADMASTER OF THE UNIVERSE, THE MASTER OF MEN, THE SECRETARY OF HUMAN RELATIONS — NAMELY, JESUS CHRIST. HE IS THE GREATEST LEADER OF MEN THE WORLD HAS EVER KNOWN.

PREPARING FOR MARRIAGE

Since most young men contemplate marriage sometime in their lives, and since the curriculum at Rose is very full and does not permit time for a course in marriage, we thought it appropriate to devote a part of this month's article to books dealing with marriage.

June is just around the corner, Commencement will soon be behind you, and the month of June being traditionally the month for weddings; we believe those who are contemplating marriage should have accurate information about this vital step. We recommend the following list of books:

Stone, Hannah M.
A Marriage Manual, a practical guide to sex and marriage.

Strain, Frances Bruce
Marriage Is for Two, a forward look at marriage in transition.

Tashman, Harry F.
The Marriage Bed, a new awareness of the needs and desires that draw couples together or drive them apart.

Velde, Theodoor H. Van De
Ideal Marriage, its physiology and technique.

(*Continued on page* 27)

SOLID AND LIQUID FUELS

(*Continued from page* 13)

thrust per unit time. It is constant developments in mixing and casting techniques that account for some of the increases made in recent years in specific impulse levels. Until recently, (1959), the average specific impulse had a range of only 180 to 240 sec.[12] However, by refining existing techniques and practices in manufacture, the specific impulse level shold rise to a value of around 280 to 300 sec. by 1964. (The average specific impulse is now 250 sec.) This advance alone would mean a 30% increase in payload capacity for any given vehicle.[13] In answer to this you might say, surely, but the F-1 will be developed fully by 1964 and liquid propellants will produce almost 1.5 million pounds of thrust while the solid propellants are only developing .5 million pounds. However, Aerojet is reportedly developing a solid booster engine which will develop in excess of 1 million pounds of thrust for a period of over 30 sec.[14]

Reliability, which plays an important part in any military or outer space role, is one of the major points of a solid fuel rocket engine. After the initial development stage, the reliability of a solid fuel rocket is very nearly 100%. This is supported by the fact that Minuteman was fired eight times with eight successes while still under development. Pershing was tested seven tives—seven successes. The Navy's Polaris has been fully flight tested 73 times, including 10 launchings from beneath the sea.[15] Other programs, too, are having essentially the same success while still in the early development stages. Most of this reliability again comes from the fact that very thorough mixing of the propellant constituents under carefully controlled conditions results in a highly homogeneous fuel.[16] Simplicity, also, is a big factor in reliability. Contrast the solid propellant engine consisting of a chunk of propellant, a casing which acts as a pressure vessel for the engine, and a nozzle with the maze of piping, turbines, pumps, valves, and metering devices which are actually needed for the operation of a liquid propellant engine. It can easily be seen that the system reliability will invariably be higher for the solid rocket than for the liquid engine because of the decreased number of components. (The reliability of a system is defined as the product of all the reliabilities of the individual components of the system).

An inherent advantage, as mentioned before, of solid rockets is that they have high density fuel. This is particularly suited to applications where the volume available is limited for a particular thrust level. The high density feature also provides a high propellant mass fraction where the technique of case bonding is used. However, present day binders contain carbon which is undesirable as a burning constituent. This lowers the propellant mass fraction and, in turn, lowers the exhaust velocity of the engine.[17]

One of the most outstanding features of solid propellants is the cost. Whether it be the cost of development, operation, or ground support equipment, the maximum payload boosted per dollar spent is done by solid propellants! For instance, the Scout solid-propellant rocket was conceived, developed, and launched with a 150 lb. layload in quantities of eight at a cost of only 15 million dollars. The same project using liquid propellants but designed for a payload of only 50 lb. would cost approximately 150 million dollars.[18]

One of the prime drawbacks of the solid propellant system is the need for heavy combustion chambers which, at present, must be built heavy in order to contain the pressure of the system. The use of titanium as an alloy has alleviated this problem somewhat, however, in the more recent development programs. Still another problem caused by high pressures and temperatures is creep of the propellant charge toward the rear of the combustion chamber after extended firing periods. Also, thrust-vector control is an impossibility since the engine is an integral part of the rocket structure itself. Therefore, in place of the gimbal type guidance as on liquid rockets, some system of retro rockets must be used.

In conclusion, we might ask ourselves a pertinent question. Will future spacecraft be powered by solid or liquid propellants? The answer is that both solid and liquid fuels will be used extensively to power future craft into orbit.

At the present time, the trend is to use powerful liquid propellant boosters for initial stages and solid propellant final stages. I believe that this trend will continue for some time. Certainly, too, it is not beyond the realm of possibility that we may have recoverable initial stages so that all we need to do is refill them with propellants for another boost to the edge of space. What about the useless, burned out final stages of the solid propellant engine? With some slight modifications, they could be made into storage bins for space gear or, for that matter, into living quarters, thereby providing a small but comfortable space station!

1. G. D. Brewer. *Solid Rockets,* Astronautics, Vol. 5 No. 11, November 1960, p. 164.
2. F. M. Fulton, *Canned Liquid-Rocket Engines* ,Astronautics, Vol. 4, No. 10, October 1959, p. 37-8.
3. W. R. Corliss, *Space Propulsion System Profiles,* Astronautics, No. 4, No. 9, September 1959, p. 24.
4. J. L. Sloop, *Propellants and Combustion,* Astronautics, Vol. 4, No. 11, November, p. 45.
5. Ibid., p. 45.
6. Ibid., p. 74.
7. Martin Goldsmith, *Liquid Rockets,* Astronautics, Vol. 5, No. 11, November 1960, p. 169.
8. Howard Seifert, *Chemical Rocket Fundamentals,* Space Technology, (John Wiley and Sons, Inc., New York), Copyright 1959.
9. P. L. Nichols Jr., *Propellants and Combustion,* Astronautics, Vol. 5, No. 11, November 1960, p. 60.
10. J. M. Flournoy, *Free Radical Fuels—A Tough Problem,* Astronautics, Vol. 4, No. 10, p. 106.
11. Y. C. Lee, *Liquid Rockets,* Astronautics, Vol. 4, No. 11, November 1959, p. 148.
12. J. I Shafer, *Solid Rocket Propulsion,* Space Technology, (John Wiley and Sons Inc., New York), Copyright 1959.
13. I. E. Tuhy, *Solid Rockets,* Astronautics, Vol. 4, No. 11, November 1959, p. 47.
14. Ibid., p. 146.
15. G. D. Prewer, *Solid Rockets,* Astronautics, Vol. 5, No. 11, November 1960, p. 164.
16. Ibid, p. 164.
17. Ibid., p. 164.
18. Ibid., p. 166.

PLASMA

(*Continued from page* 16)

been sprayed with these units. The high impact velocity results in a strong bond at the working surface. This technique is of great importance today in the rocket field when the material problem is quite severe. Another application of these units would be ultra-high cutting and welding torches.

Chemical reactivity could be enhanced due to the high temperatures present in the plasma. Reactions that are too endothermic to proceed at room temperature or moderately high temperature might react at the temperatures available in a plasma. Also, if one of the reactants is the gas used to produce the plasma, a greater supply of dissociated atoms might be made available to increase the rate of reaction.

Perhaps our greatest source of power in generations to come will be atomic fusion. The first step along the road to the perfection of this process is the achievement of the ignition temperature which is in the neighborhood of 50 million degrees. The machine that is proposed to achieve this is Top Toy III. It is a forty-foot pipe with three successively smaller chambers. A plasma of heavy hydrogen is pumped into one end. The plasma is then squeezed together by a magnetic field in the first section and put into the second stage which compresses it further. Top Toy III, located at the Lawrence Radiation Laboratory in Livermore, California, has achieved about 30 million degrees for a thousandth of a second on these two stages. It is hoped that the third stage can increase the temperature to the ignition point. At this point the fusing of the nuclei will give off enough excess energy to sustain the reaction and produce extra power.

The second step is the perfection of a machine that can run continuously on its own feedback energy. The third and final step is a fusion machine that can turn out more power than it needs to run its own magnets. Such a machine running on heavy hydrogen extracted from sea water would be the last word in power production.

Republic Aviation has recently developed a magnetic pinch plasma engine. This engine may pave the way for a new source of power for space rockets and steering of space exploration craft. The essential idea behind the engine is the production of a jet thrust from an electric current. The gas used is nitrogen. The compression chamber where the electric arc occurs is shaped and constructed such that a cylindrical magnetic field is set up around the plasma. This so called pinch effect drives the plasma out the rear with a tremendous velocity.

Bell Aircraft corporation has made a plasmajet generator that is designed to test materials for future satellites and space craft. Its main idea is to use the energy released by the plasma as it returns to the gaseous state as a means of creating a high temperature. They have achieved temperature in the neighborhood of 40,000 degrees F and expect to reach 50,000 degrees F if they can solve the cooling problem. Present models use a water jacket around the hot area, but water cooling isn't expected to be effective at much higher temperatures as even these models have a tendency to melt.

Sperry Gyroscope Company has used a plasma as a conductor that generates radio energy at very high frequency. In their generator the plasma is formed by aiming a very small stream of electrons through rarified hydrogen held in place by an electromagnetic field. These electrons then hit the hydrogen atoms with enough force to knock them apart and create a plasma of electrons and ionized hydrogen. It is called a gyro-electric plasma as the resulting plasma travels in a circular path.

Plasma also has almost unlimited possibilities in the field of research. It could conceivably be used to generate a source of completely dissociated atoms that could be used to study recombination rates without the disturbing side effects of the atomic parent. This system might also be used to evaluate the role of catalysts in reactions involving this recombination. A plasma might be used to study the kinetics of ion recombination, charge-transfer reactions, and the kinetics of electrically excited molecules and atoms. As a source of free radicals, it might be useful in the rapidly expanding field of free-radical formation and trapping. A plasma betatron has been proposed in which plasma would be used to inject, guide, and accelerate charged particles. A rotating disc plasma similar to the one used by Sperry could be used as an energy storage system that is more suitable than present means. Also, since recent studies indicate that radiofrequency waves from stars are related to plasma oscillations, research on plasma may some day help explain radio noise from space.

Many people have compared the discovery of plasma to that of combustion. In view of the tremendous strides gained in combustion research since the start of the century, it is not impossible to speculate upon the same for plasma in the years to come. Perhaps what combustion has been to the past, plasma may be to the future.

RESEARCH AND DEVELOPMENT

(*Continued from page* 21)

ventional material such as stainless steel can be used. The new cycle yields performance and economics comparable to those of the original air cycle.

This use of an "oxygen cycle" now means that regenerators (preheaters) currently available commercially can be employed in the MHD system, and it will not be necessary to design a new regenerator.

Now that auxilliary components of the MHD power plant already exist, only the generator itself requires further development.

In the generator now being used by Avco, the plasma, or hot gas, is provided by a combustion chamber similar to a rocket thrust chamber which burns a mixture of kerosene of alcohol and gaseous oxygen "seeded" with powdered potassium salts to make the plasma a better electrical conductor. The plasmas enter the generator at about 5,000 degrees F.

SUPER CONDUCTIVITY

(*Continued from page* 20)

of glass in contact with the sample and reflecting polarized light from the glass. By the sample being diamagnetic, in places, the lines of force can not penetrate the glass, but in places where the sample is in the normal state the lines of force can penetrate the glass. This causes the plane of polarization to rotate in the areas of the normal state. By viewing the sample through an analyzer the degree of rotation can be determined. Thus the areas of magnetization can be made to appear dark and the unmagnetized portion light by rotating the analyzer.

Of course all of this research is carried on with the superconductor in the presence of a magnetic field. From these photographs of the patterns more can be learned on how a material changes from the normal state to the superconductive state.

The cryoton is a four terminal device in which a magnetic field, produced by passing a current through the input terminals, controls the resistance in the two output terminals. This is the device that will lend itself to the design of more compact computers. By spraying the proper materials on a suitable nonconductor the cryoton can be made easily and quickly. Allowing for leads and heat dissipation it is estimated that about one million cryotons can be packed into a volume of one cubic foot. The cryoton can be made to function as a memory or switching unit for computer use. As shown before, the change from superconducting state to the normal is very distinct and rapid. The time for changing states is in the neighborhood of the millimicrosecond, which means that more complex problems can be solved which no computer today is fast enough or complex enough to solve.

These uses and ideas from research in low temperature physics are but a few of the many projects that are now in progress. So in the future more useful devices will be available as this rapidly expanding field unfolds.

LIBRARY NOTES

(Continued from page 23)

Polatin, Phillip
Marriage in the Modern World, positive approaches to successful marriage.

Koos, Earl Lomon
Marriage, an introduction to marriage for young engaged couples.

Bainton, Roland H.
What Christianity Says About Sex, Love and Marriage.

Baber, Ray E.
Marriage and the Family.

Kelly, The Reverend George A.
The Catholic Marriage Manual.

Popenoe, Paul
Modern Marriage, a handbook for men.

* * * * *

FROM THE BOOK SHELF

Einstein on Peace, Edited by Otto Nathan and Heinz Norden

"Einstein was not only the ablest man of science of his generation, he was also a wise man, which is something different. If statesmen had listened to him the course of human events would have been less disastrous than it has been."

This verdict, from the preface to this book by Bertrand Russell, sums up the importance of this first collection of Albert Einstein's writings on war, peace and the atom bomb.

Much of the material in this book, including many personal letters, is here published for the first time.

An Illustrated History of France, by André Maurois

This is generally regarded as the best one-volume history of France, and has been abridged to allow for the many attractive illustrations—a number of them in full-page color.

Maurois' history covers the cultural, and political aspects of the French character as well as the history of the country.

Metropolis, 1985, by Raymond Vernon

Beginning with the visible present, Mr. Vernon lays bare the essentials of the economic history of the New York Region. He shows how the industries grew out of one another, its advantages and disadvantages for different kinds of business and industry. He analyzes the problems besetting the multitude of local government in the area and the crisis of commuting and rapid transit services.

Finally he projects the *Metropolis of* 1985, picturing it as all the infinitely complex forces of its history to date indicate it will be.

Chance and Providence, by William G. Pollard.

Dr. Pollard is a physicist and the Executive Director of the Oak Ridge Institute of Nuclear Studies, Tennessee. Since 1952 he has been an ordained minister of the Episcopal Church.

With a stake in the field of both science and religion, he is qualified to deal with an age-old problem—the guidance or intervention of God in a world of scientific law. On the one hand, he sees the activity of God as revealed in the Bible and by theological interpretation through the centuries; on the other, certain natural scientific laws. For generations the area between has been a battleground among the religiously and the scientifically minded.

He explains the basis of the merger of the Bible idea of providence with the view of science.

The Progress of a Crime, by Julian Symons

For something in a lighter vein—a mystery!

Hugh Bennett, twenty-two years old, was a reporter of a small-town paper. His assignments were usually dull and local, and he dreamed of getting up to London someday, to a job on a national paper.

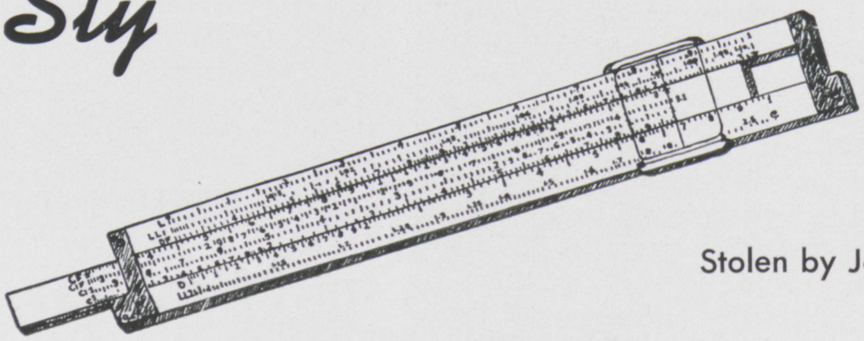
When he was assigned to cover a Guy Fawks Night story, it looked as if it would be another routine assignment.

And on Guy Fawks Night as the flames of the bonfire shot into the air, the tavern owner lay stabbed to death.

Hugh, on the spot, was both witness and reporter. Then, he meets a girl named Jill Winter whose brother is mixed up in the murder.

This is a story which will take hold of you till the very honest end.

Sly Droolings



Stolen by Joe Grumme, Soph., Phys.

Conscience gets a lot of credit that should really belong to cold feet.

* * *

Hear about the new deodorant called Vanish? It makes you disappear and everybody wonders where the odor is coming from.

* * *

The apple of every man's eye is the peach with the best pair.

* * *

"But darling, this isn't our baby."

"Shut up, its a better buggy."

* * *

Chem. Prof: "This fluid turns blue if your unknown is basic, and red if the unknown is acid."

Student: "Sorry, but I'm color blind. Got anything with a bell on it."

* * *

"Miss Jones," said the exasperated professor, "The quotation is 'All men are created equal,' and not 'All men are made the same way'."

* * *

Teacher: (trying hard to unfasten coat for little pupil) "Did your Mother hook this coat for you?"

Pupil: "No, ma'am, she bought it."

Joe: "I stayed in a hotel that had 25 rooms and no bathrooms."

Moe: "Incredible."

Joe: "No, uncanny."

* * *

Father rabbit: "What's junior so happy about "

Mother rabbit: "He's learned to multiply today!"

* * *

Then there was the bowlegged cowgirl who had a hard time keeping her calves together.

* * *

Two Indians had watched with much interest the building of a lighthouse off the rocky west coast. When it finally was completed they sat and watched it every night. A thick fog came rolling in one night and the siren blew continuously.

"Ugh," grunted one Indian. "Light shine — bell ring — horn blow — but fog come just the same."

* * *

Her dainty foot brushed a potted flower, upsetting it. She looked at the spilled dirt gravely, then raised her childlike eyes to the sedate face of the minister and said, "That's a hell of a place to put a lily."

* * *

Some females think that low-cut evening gowns are indecent. Others are stacked.

Two guinea pigs stood watching a rocket thunder off the pad carrying their friend guinea pig to certain death.

Guinea pig 1: "Isn't it awful?"

Guinea pig 2: "Don't feel so bad, it beats cancer."

* * *

CE: "How'd you puncture your tire?"

ME: "Ran over a bottle of milk."

CE: "Didn't see it, huh?"

ME: "Naw, the kid had it under his coat."

* * *

Housemother to ME: "Did you take a bath last night?"

ME: "No! Is one missing?"

* * *

And then there was the freshman who thought a logarithm was a forester's song.

* * *

The little girl was entertaining the visitors while her mother was getting ready. One of the ladies casually remarked to the other, "Not very p-r-e-t-t-y," spelling the word.

"No," retorted the child, but awfully s-m-a-r-t."

* * *

One can of paint to another: "Darling, I think I'm pigment."

* * *

Co-ed: "Where did you learn to kiss like that?"

Ch.E.: "Siphoning gas."