Spring 3-1962

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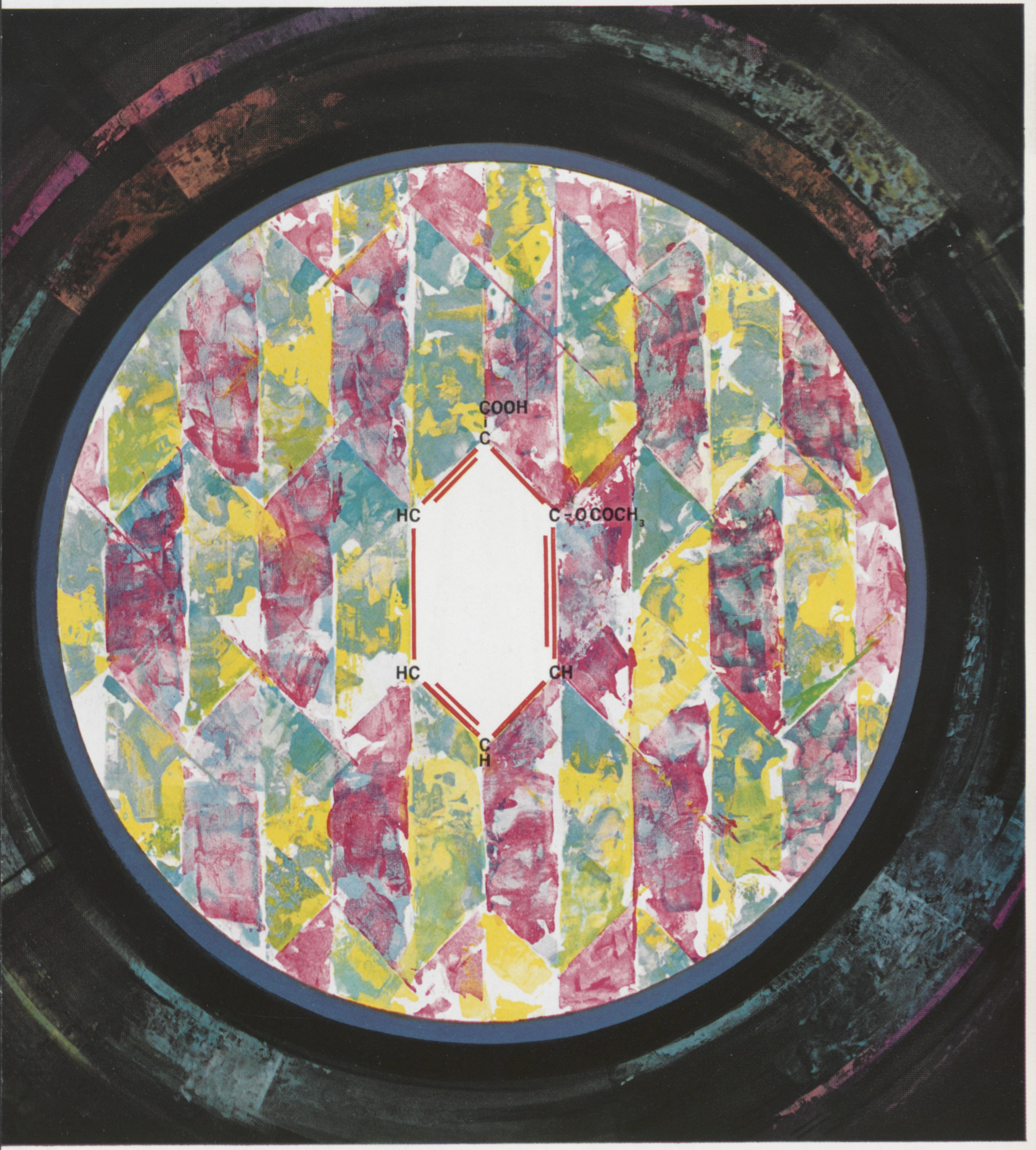
Rose Technic Staff
Rose-Hulman Institute of Technology

Rose Technic

March, 1962



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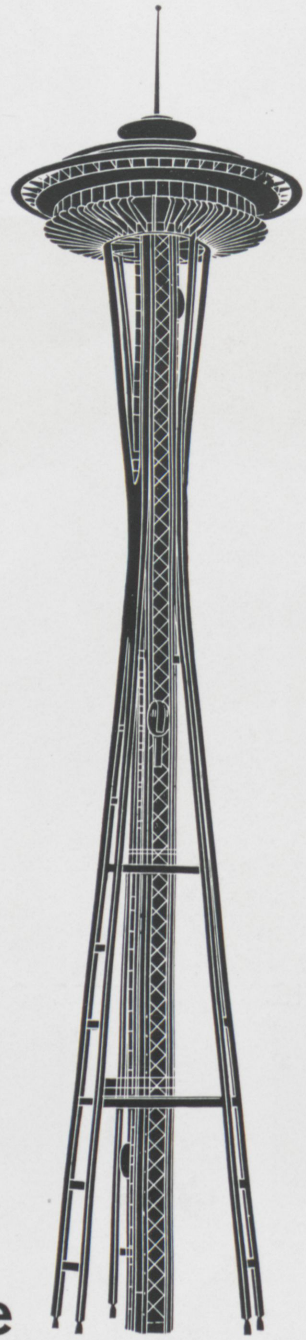
EXPLOSIVE METAL FORMING
ALCHEMY



revolution in space

This amazing structure symbolizes the outer space theme for this year's Century 21 International Exposition in Seattle, Washington. Called the Space Needle, it soars 600 feet into the air on three steel legs, tapers to a slim waist at the 373-ft. mark, then flares out slightly to the 500-ft. level, and is crowned by a mezzanine, observation deck, and a 260-seat restaurant that *revolves* slowly (one complete revolution an hour) while patrons enjoy their meals.

The Space Needle is a combination of sheer audacity and imagination with 3,500 tons of steel. Steel was chosen because it would be faster to erect, stronger per unit area, quickly available. A relatively new type of structural carbon steel called A36 was used because its greater strength (about 10%) permits higher design stresses, at the same time maintaining factors of safety, and because it could be easily welded. This is an example of the exciting materials and challenging projects engineers will find at United States Steel.

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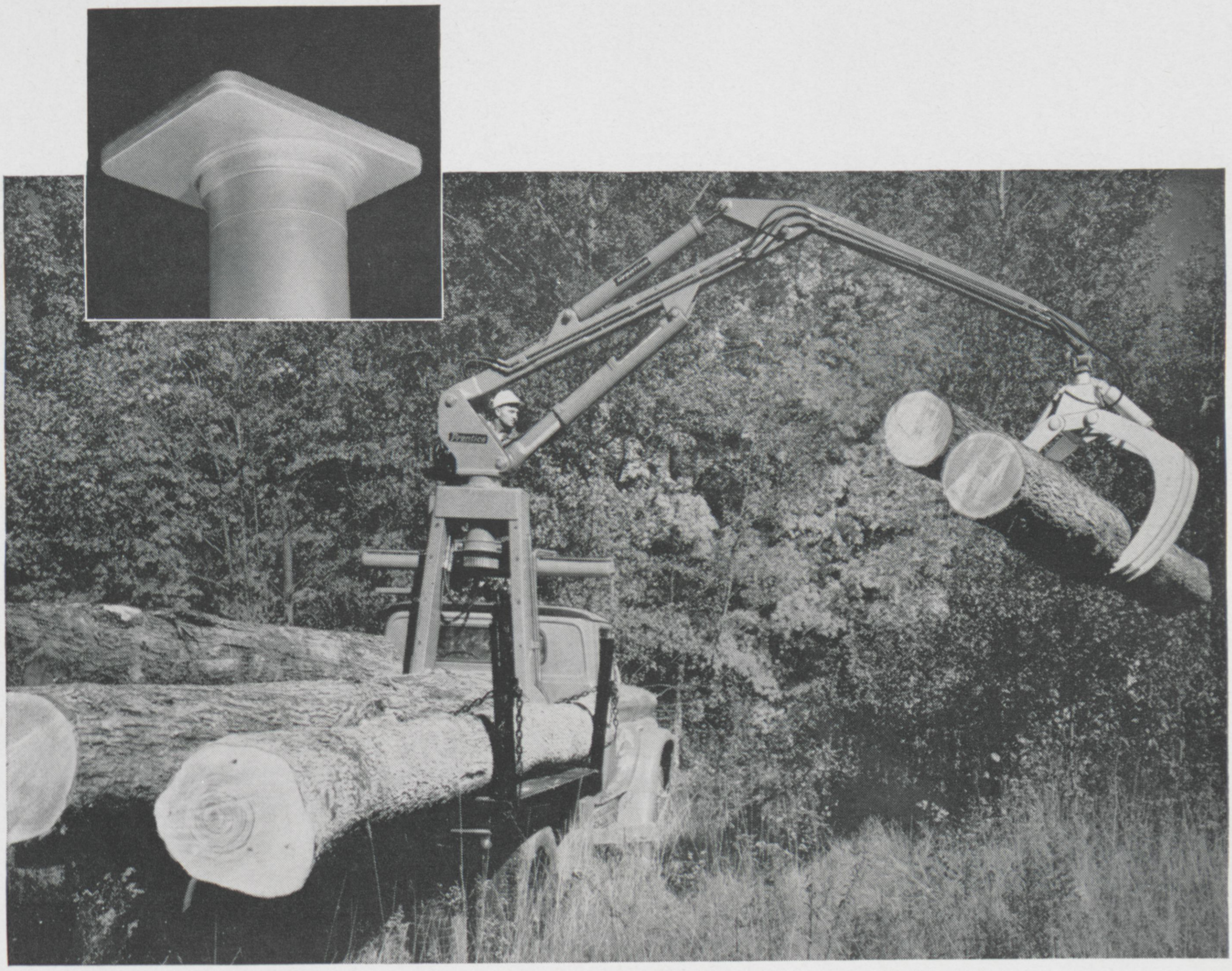

FORGED... to end field failures

This forging forms the critical stress-bearing segment of the turnpost on which a rugged hydraulic loader rotates. It must withstand the sudden high-magnitude stresses transmitted by the 17-foot boom, even in the bitter cold of northern winter logging operations. It replaced a less dependable part that had caused costly breakdowns in the field. By converting to forgings, the manufacturer ended turnpost failures.

Why did the designer look to forgings for superior strength and reliability? Because forged parts start with refined metals, uniform throughout. By hot-working this superior stock between precision dies in forging hammers or presses, the structure of the metal is improved even further. That's why forgings offer unique opportunities to improve strength-weight ratios and reduce production costs.

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When it's a vital part, design it to be

FORGED

Rose Technic

VOLUME LXXIII, NO. 6

AMERICA'S OLDEST ENGINEERING COLLEGE
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1891-1962

MARCH, 1962

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Contents

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The Periodic Table lists all the known elements of the world we live in . . . more than half of them used by Union Carbide

This is the world of Union Carbide

Millions of people have used such Union Carbide products as PRESTONE anti-freeze, EVEREADY flashlights and batteries, or PYROFAX bottled gas. But the major part of Union Carbide's output is in basic materials, employed by more than 50,000 industrial customers to fill everyone's life with useful things.

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It is men and women working together to provide new and better materials that gives full meaning to Union Carbide. And the people of Union Carbide, backed by 128,000 stockholders, will go on producing the necessities and conveniences that will help keep our standard of living the highest in the world.

Periodic Chart ©Welch—Chicago

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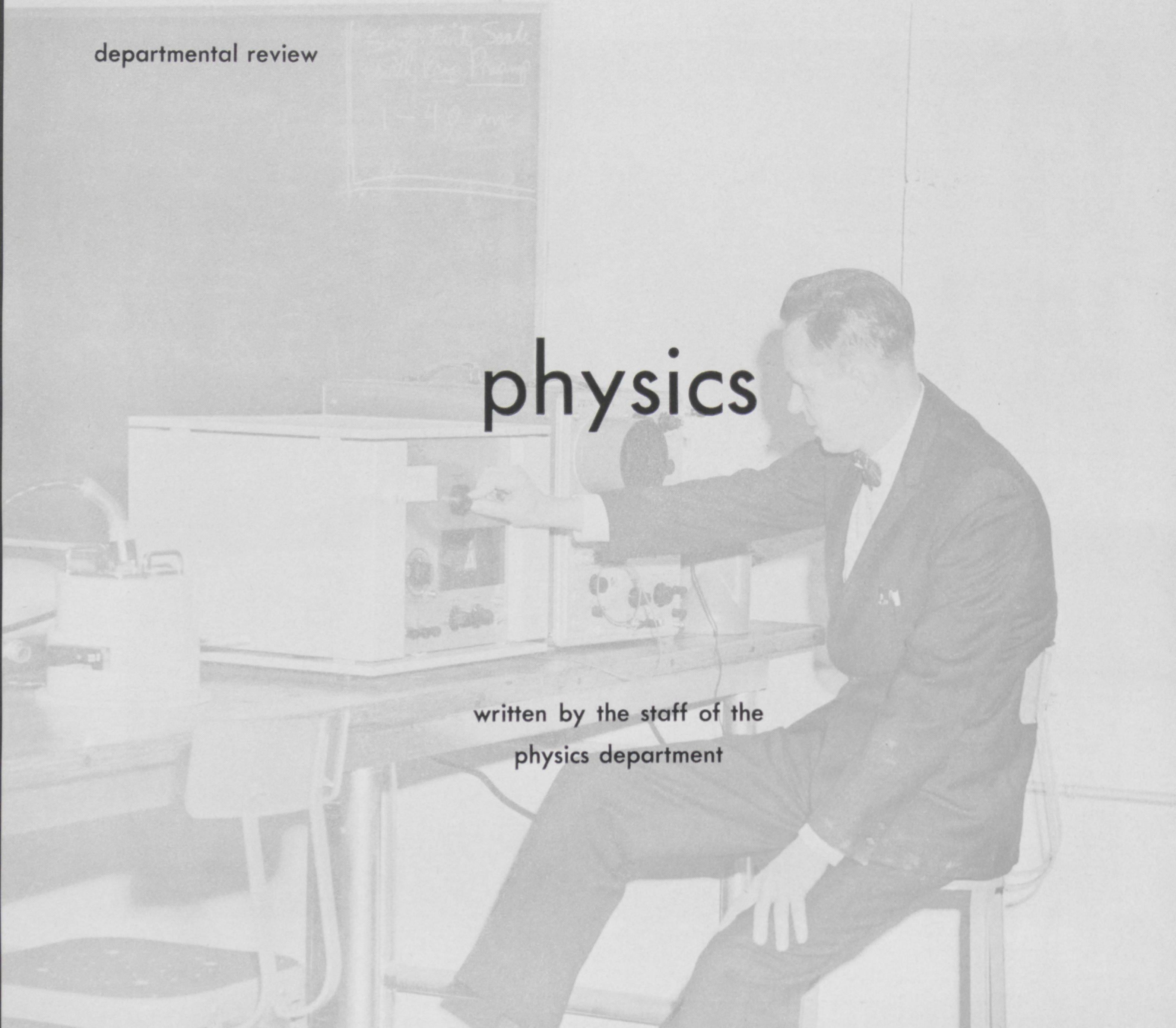


physics

written by the staff of the physics department

"DEPARTMENTAL REVIEW" is a series of articles written by members of the faculty at Rose. Each month a different department will describe for you the nature of their curriculum, some history of their profession, and what a student in their department might expect after graduation.

Because satisfaction during years of undergraduate study is so highly depedent on the proper choice of a curriculum, this series is designed to differentiate between the various fields of study at Rose and help the present and prospective student make his choice. Therefore it would be wise to consider the facts presented by these authors before making your selection of an undergraduate field of study.

In the past fifty years the subject matter of physics has expanded enormously and in the past twenty years the activities of the physicist have diversified considerably. These remarks must then of necessity be of such generality that they will not apply to all physicists nor to all fields of physics.

The long range objective of the physicist is that of discovering basic unifying principles which will make, what appears on the surface to be an extraordinarily complicated physical universe, one that can be readily understood and controlled. He has faith that such unifying principles do exist, and his success thus far has encouraged him in this belief. As an example we might take Newton's Universal Law of Gravitation which makes the complicated motions of the planets in the solar system readily understandable.

The physicist tries to approach any specific problem in the most basic way possible. Because his emphasis is on *understanding,* he will deliberately choose for study the simplest possible system. It is very often one of no immediate practical importance. The physicist will try to explain the behavior of this system in terms of what he considers to be the most elemental of natures building blocks — the electron, proton, neutron, etc. If he is able to deduce the principles which govern this simple system, i.e. can discover how these basic particles interact with each other, he is confident he can, with suitable modifications, apply these principles to more complicated problems. It is this fundamental approach to problems that has in the past distinguished the physicist from his fellow scientists. For example, generally speaking, the chemists have been more interested in discovering (with considerable success) new useful compounds, than in understanding the basic nature of the interaction of atoms.

Any problem of interest to the physicist is almost invariably attacked simultaneously on two fronts. Theoretical physicists — a group of people well grounded in physics, and having an active imagination disciplined by an extensive training in mathematics, will attack the problem by devising a theory for the system. This simply means they will make certain guesses as to the kind of particles which make up the system and to the manner in which these particles interact. From these hypotheses they will deduce, with the aid of mathematics, some of the physical properties such a system should have. The experimental physicists — a group of people with considerable ingenuity, patience and a flair for designing and putting together apparatus, will try to carefully measure all of the physical properties of the system, particularly those properties which are predicted by the theory. The experimental results are then compared with the predictions of the theory. If they agree, the theorist is happy and tries to extend his theory to other systems. If experiment and theory do not agree, the theorist tries to modify his original hypotheses so that his theory and the experimental results are compatible. Once a theory is developed the predictions of which agree in every instance with the experimental results, the physicist feels he has discovered the principles which govern the behaviour of the system.

Most present day students have grown up in what might be called th post A.B. era of physics. It is a different attitude and atmosphere than that which existed in the pre A.B. era. In the pre A.B. period, the work of the physicist was completely unknown to the lay public. Industry, with very few exceptions was unwilling to support his endeavors or even to risk hiring him. This attitude was prevalent in the face of some rather remarkable achievements of the physicist. On the experimental side we might cite the discovery of the electron, proton, neutron, x-rays, natural radioactivity, cosmic rays, isotopes, artificially induced radioactivity, transmutation of elements, and nuclear fission. On the theoretical side we might site Maxwell's electromagnetic theory of light, Einstein's special theory of relativity and Schoedinger and Heisenberg's invention of quantum mechanics.

The development of the atomic bomb and its use at Nagasaki and Hiroschima produced a revolutionary change in peoples attitude toward the physicist. Industry whose foresight was suddenly improved by the dazzling light from the atomic bomb rushed to hire him. The government furnished him large sums of money to aid him in his research. Many new converts came to worship this idea of a fundamental approach toward understanding the physical universe. We witnessed the surge of physical chemistry, biophysics, medical physics, space physics, and atmospheric physics. Perhaps the most astonishing convert of all is that most practical of all souls, the engineer, who may today be found — albeit somewhat self consciously — doing fundamental research. Engineers are among the "Johnny's come lately" to the field of research. Very few engineers were awarded the doctorate in engineering prior to World War II. We mention this not because we resent the intrusion of the engineer into basic research (on the contrary we welcome converts with open arms) but merely to point up the fact that the physicist was doing research many years before it became popular and will still be doing it long after the lucrative government research contract his disappeared from the scene. For basic research is the life blood of physics.

Our current catalog at Rose shows the undergraduate curriculum here is designed to provide a strong basic program in the various fields of classical physics — mechanics, heat, electricity and magnetism, optics and acoustics and to achieve a better than average understanding of the subject matter of modern physics — statistical mechanics, kinetic theory, atomic and nuclear physics, and quantum mechanics. Because experimental physicists outnumber theoretical physicists approximately 10 to 1, laboratory work is stressed and included in our curriculum, our labs in electrical measurements, nuclear measurements, physical optics and atomic physics. Although the physics curriculum is intended to serve primarily as a preparation for successful graduate study, a careful study of the new catalog which will be coming out shortly will reveal that our new curriculum is the most flexible of all the curricula listed by the degree granting departments. For those students who are inclined to seek a career in industry immediately upon graduation, our new pro-

(*Continued on Page* 25)

nuclear power for peace

Jack Hobbs
Jr. Chem.

Since the inevitable beginning of the nuclear age by the dropping of the atomic bomb on Japan in 1945, man has become aware of the tremendous force which is held within the atom. Into what directions should research and technical development push the future use of nuclear energy? The pacifist suggests that nuclear energy be pushed into areas of industrial use, health research, and conversion to power for propulsion, heating, and electrical purposes; into areas which would lead to peaceful coexistence and the deterring of war.

In any peaceful use of nuclear power a means must be devised by which to produce this tremendous release of energy; and most of all a means of controlling this energy must be found. The scientists, Hahn and Strassmonn, who were the first to split the atom, were not aware of the problems involved in the release and control of a larger quantity of energy which today results from our increased knowledge of the atom. Let us now look at the development of the device with which man has learned to domestically control the atom and its tremendous energy.

It was discovered prior to World War II that if neutron bullets were shot at atoms of the element uranium, the nucleus of the uranium atom would split apart or fission violently with the resulting release of an enormous amount of energy. For example, the fission of one pound of uranium is equivalent to the burning of 1500 tons of coal.

There is, however, one problem which opposes the release of this energy. The only isotope of uranium which undergoes fission is U-235, which constitutes only 1 part in 140 of uranium from natural sources. Hence, it is necessary to have expensive procedures for the extraction and purification of U-235 and as a result of this necessity, the cost of U-235 is extremely high. For example, one gram of uranium containing 90% U-235 costs $17.07 or approximately $7750 a pound.

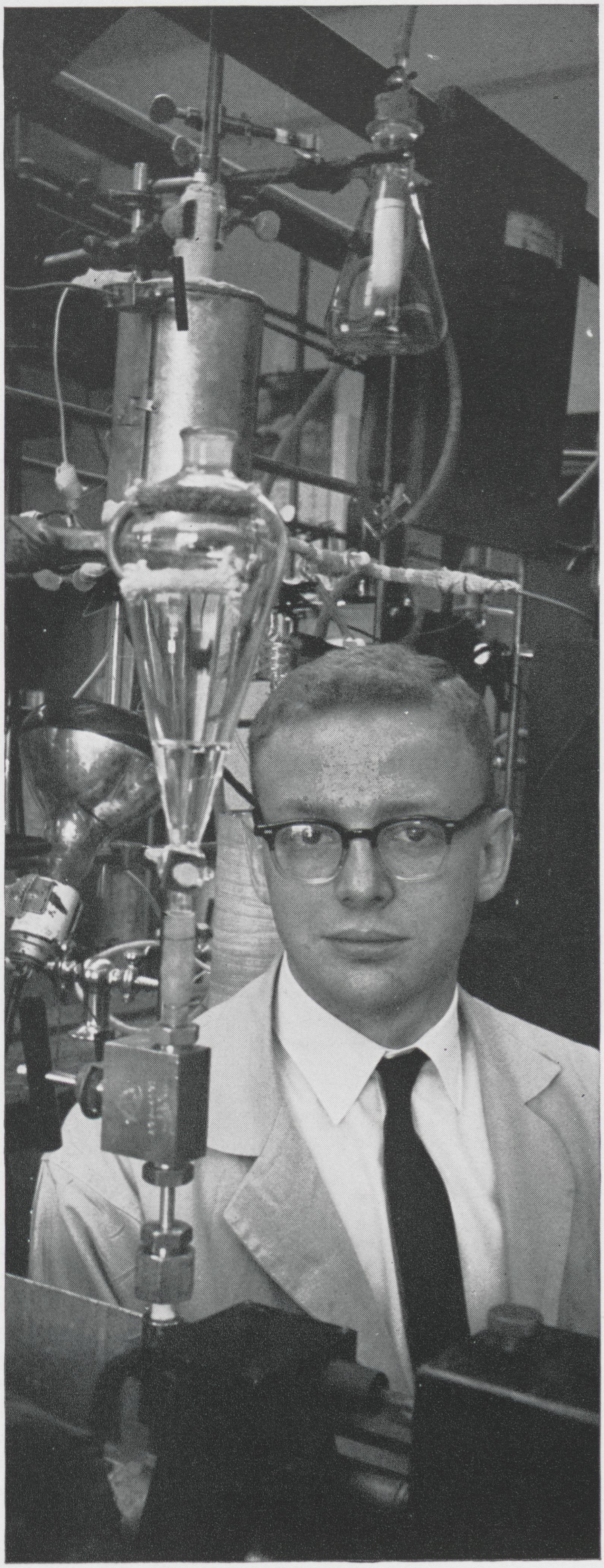
The U-235 upon splitting, releases two or three additional neutrons. Under proper conditions, some of these released neutrons will split more U-235 atoms, and the process spreads throughout the rest of the reacting mass of uranium as the number of reacting neutrons increases. This produces a nuclear chain reaction which is self-sustaining if the neutron losses within the system is not too great.

Neutrons are lost in chain reactions if they are captured by impurities within the system. Therefore, the materials used in the construction of a nuclear reactor should be of the highest purity. Also, some of the fission fragments themselves also have a desire to capture neutrons and thus poison the system. It is imperative that these fission fragments be periodically removed from the reaction.

Another source of neutron loss is the escape of neutrons from the reactor. This defect can be corrected by placing a graphite or beryllium reflector around the reactor; but this is not completely effective. The other alternative is to increase the size of the reacting mass to the point where the greater number of neutrons created within the mass do not have an opportunity to escape. Hence a critical mass is established for the fissionable material.

Thus we have seen the need for reactor; but there are a few more points of construction which must be considered. It has been found that U-235 undergoes fission at a greater rate or under a larger chance if slow neutrons are used instead of fast neutrons. Since the neutrons which result from fission are fast it is necessary to slow them down or moderate them. This is accomplihed

(*Continued on Page* 28)



Some straight talk about a career at American Oil

by Roger Fisher

"This Company recognizes the value of varied experience, and encourages you to broaden your knowledge."

Roger Fisher, B.Ch.E. from Cornell and Ph.D. candidate from Princeton is one of many young scientists and engineers at American Oil shaping the future for himself, his Company and the industry. At 26, he has earned a Fulbright Scholarship and will take a year's leave of absence to continue his graduate research on solids mixing at the University of Osaka, Japan.

"American Oil is looking for broad-gauge research people," Roger adds. "In the long run, the Company benefits as well as the professional who continues to grow in his own or in several fields of research."

Roger's present assignment at American Oil involves applied research—to plan, design, build and operate bench scale lab equipment, to study the kinetics of catalytic cracking. His is one of many diversified projects at American Oil Company. Chemists, chemical engineers, physicists, mathematicians and metallurgists can find interesting and important work in their own fields.

The ability of American Oil to attract bright young scientists and engineers like Roger Fisher might have special meaning to you. For complete information concerning career opportunities in the Research and Development Department of American Oil, write D. G. Schroeter, American Oil Company, P. O. Box 431, Whiting, Indiana.

IN ADDITION TO FAR-REACHING PROGRAMS INVOLVING FUELS, LUBRICANTS AND PETROCHEMICALS, AMERICAN OIL AND ITS ASSOCIATE COMPANY, AMOCO CHEMICALS, ARE ENGAGED IN SUCH DIVERSIFIED RESEARCH AND DEVELOPMENT PROJECTS AS:

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explosive metal forming

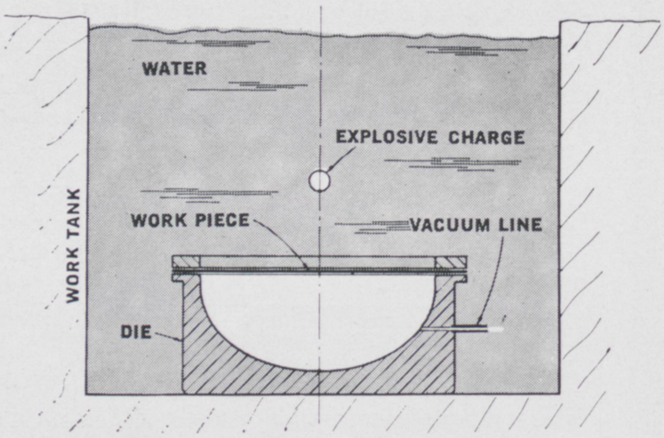


Diagram from December 1961 Issue of **Mechanical Engineering.**

Dave Rice
Soph. M.E.

For many years engineers have known that explosives could be used to deform metal. The earliest patents on the subject were taken out prior to 1900. However, only within the past few years has explosive metal forming developed into a process that is competitive with conventional methods of metal forming.

In the EMF (explosive metal forming) process, a high explosive is detonated, and its energy is transmitted through a fluid medium, commonly water, to a workpiece held on a female die. The space in the die behind the workpiece is usually partially evacuated (to 12-14 mm. of mercury) to avoid compression and heating of the entrapped air. If this were not done, it could result in burning the rear face of the workpiece and die.

The energy transfer medium need not be water, air and many other media are suitable, but from the viewpoint of cost and convenience, air and water are the most suitable. Water is superior because of its reduced compressibility and better shock-impedance matching characteristics.

In general, any homogeneous explosive of reasonable sensitivity is suitable as an energy source, such as dynamite and liquid explosives. The burning rate of low explosives is comparatively slow (hundreds of feet per second). They require confinement devices, such as presses, to get the necessary forming pressures of 100,000 to 300,000 psi. Such devices are safe and can be operated indoors.

The reaction speed of high explosives is in terms of millionths of a second. Their energy is released at a constant rate regardless of confinement. Shock fronts generated often reach several million psi and their size and shape can be regulated. However, there appear to be no major advantages from explosives with high detonation velocity. The charges needed for explosive forming work are small, ranging normally from 1/4 lb. to less than 10 lbs.

The term explosive correction is applied to the process in which an out-of-tolerance part or a preformed part is explosively deformed to its desired final configuration. Although explosive forming includes correction as a special case, in general, forming is applied to the fabrication of a part from a flat sheet material.

Explosive forming from flat sheet is a more complex process than explosive correction. It is interesting, however, to realize that, despite its greater difficulty, explosive forming from flat sheets is, over-all, a more economical process for fabricating pressure-vessel closures than the process involving conventional drawing followed by explosive correction. In the explosive forming process, as applied to the fabrication of domes, the main process steps are: explosive forming, deflanging, and explosive correction.

The surface of the initial sheet is specially prepared by grinding if the thickness tolerances are held closely. Final thickness control depends on the proper combination of explosive charge geometry, die hold-down pressure, and the initial surface preparation. The explosive forming of welded sheet is possible if the weld is of good quality, but a poor weld will not stand up.

No new metal-forming technique could so capture the imagination of engineers in dozens of different industries unless it had demonstrated superiority in many ways. Explosive forming offers the advantages of lower forming cost, no springback, decreased work-hardening, close tolerances, and increased metal ductility.

Considerable savings are realized by the elimination of tooling. For example, to produce the aluminum nose cone for a DC-8 jet airliner by assembling welding five separate pieces would have cost $131. The same part cost only $15 when explosively formed. It was possible to dispense with a series of drop hammer dies, a number of weld fixtures, an expanding mandral for shaping, and final surface finishing operations.

Springback, (the tendency of metal, particularly high-temperature alloy, to return to its former shape after forming) has always been a problem in conventional forming. When explosively formed, metal contacts the die face and stays there without springback. To overcome work-hardening of metal as it is progressively formed by conventional methods, parts must be annealed between successive forming stages. With explosive forming, work-hardening is not as great a problem as with conventional forming techniques. Consequently, the need for annealing operations is reduced.

Elimination of springback also permits much closer tolerances than were formerly obtainable, in some cases to within 0.002 inch of the die itself. Such tolerances are commonplace even in parts up to two feet in diameter. By comparison, obtaining even 0.015 inch tolerance by conventional forming would be most difficult.

Another important advantage of explosive forming is that it increases metal ductility. Certain metals can actually be stretched beyond the point that would result in breakage in conventional forming. Surface finishes, especially those produced on epoxy dies, are extremely good and have the added advantage of not requiring subsequent finishing operations to obtain smoothness.

One common misconception is that the explosion taking place in the die cavity is of such great force and intensity that a massive steel die is needed to contain it. This is not correct. By the time a shock wave having a pressure of 2 million psi at the surface of the explosive charge passes through six inches of the water-forming-medium to the metal, there is only about 30,000 psi pressure on the die face itself. Actual pressure on impact is never as high as the charge itself would lead one to believe. Consequently, the use of plastic dies is feasible. They can withstand explosive impacts. One aircraft company currently plans to change from steel dies to epoxy dies completely.

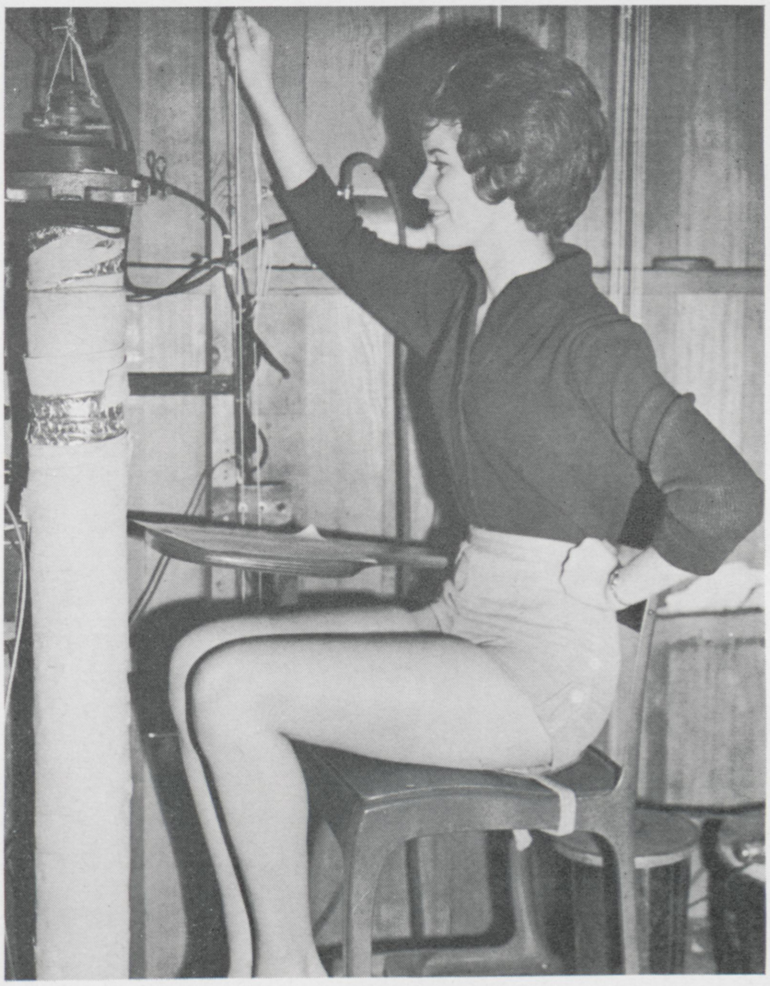
Other explosive techniques are now starting to take their place in American industry. Explosive joining and welding are of interest, but at present are considered appropriate only where normal welding and joining are either too difficult, too slow, or too expensive in terms of weight of equipment. Consider the assembly of a space station in orbit. It would certainly be an attractive weight saving to use high explosives for the welding proces rather than carry the full welding system into orbit.

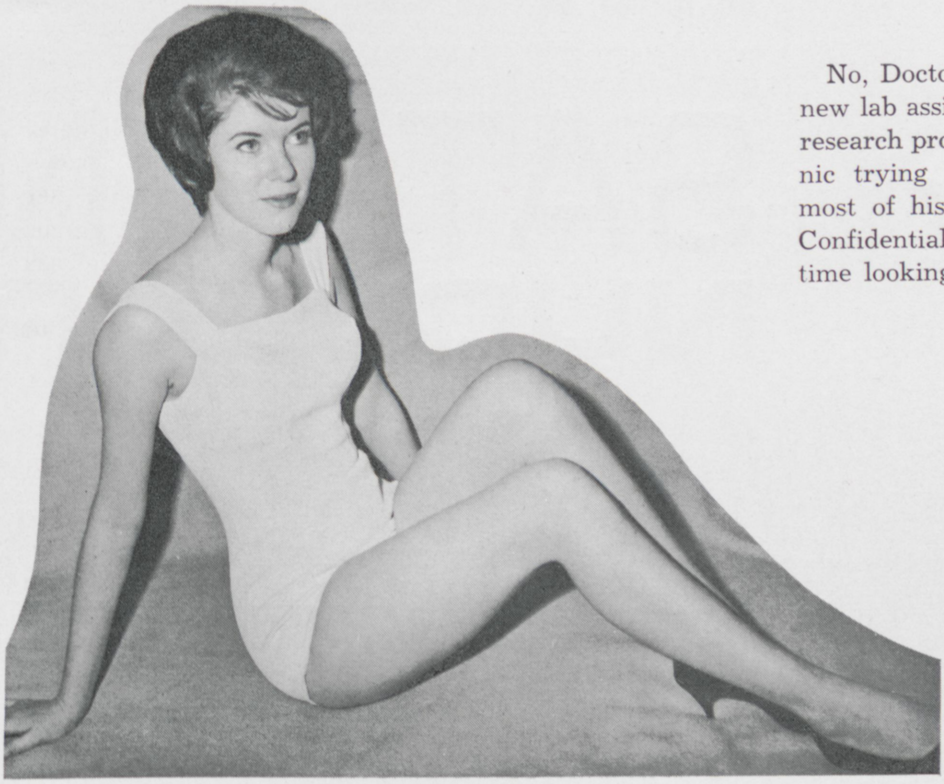
In the last three years explosive forming has come of age. It has progressed from an experimental curiosity to a modern industrial technique which is taking its place in many branches of industry.

miss technic for march

The Rose Technic is proud to present Miss Carol Shonfield as Miss Technic for March. Carol hails from Terre Haute having graduated from Wiley. Presently she is a sophomore AOPi pledge, majoring in Elementary Education. She is five feet seven inches tall in a bathing suit, tipping the scales at 115 pounds. Carol has bright blue eyes, brown tresses and a ready smile for her friends. For those mathematicians who only enjoy numbers, Carol has a few . . . namely 35-22-36.

Extracurricularly Carol likes to draw, dance, and go to parties.





No, Doctor Meeks doesn't have a new lab assistant helping him on his research project. It's just Miss Technic trying to see what he spends most of his spare time looking at. Confidentially, I'd rather spend my time looking at Carol!

JT3D

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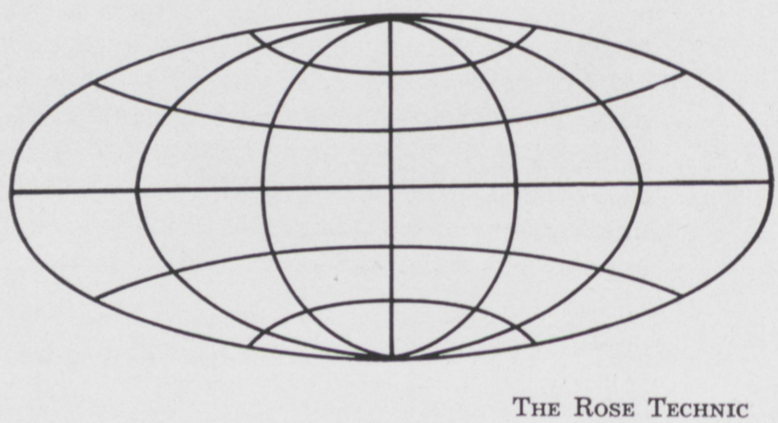


research & development

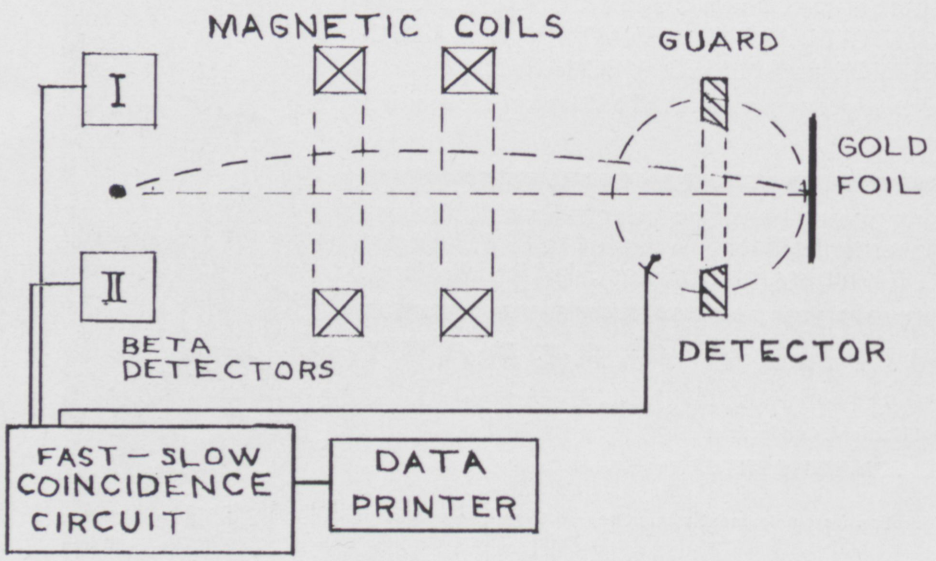
by Feature Staff

BETA DECAY

There have been many experiments done in nuclear physics concerned with the violation of the Law of Parity. All the law says is that when we have a disintegration of a particle, nature doesn't distinguish between left and right, or has scattering equally in all directions. Dr. Ralph Llewellyn, an assistant professor at Rose, recently received his degree by approaching the problem with a new slant.

Using the unstable isotopes Au^{198} and Hg^{203} as a source of electrons and beta particles, and a magnetic spectrometer to guide the electrons to a micro-thin gold foil target as his basic layout, short of the detectors and complex data equipment, he proceeded on the basis of his breakdown of the situation. Only electrons could strike the target because the higher energy particles were blocked by a guard and the lower energy particles wouldn't travel that distance in the magnetic field. The law which is to be disproved would indicate that we should have parity in the spin direction of the nuclei of the source. The Au^{198} breaks down to a Hg^{198} atom, emitting a negative beta particle and about 0.96 mev. in kinetic and "other energies." A gamma ray results with 0.41 mev. energy and, its direction being influenced by the spin of the nucleus, collides with an electron releasing it from orbit. The spin of the electron is indirectly decided by the spin of the nucleus of its source.

Using the Mott Scattering Theory, a detector was placed about 30° from the reflecting surface to pick up the most electrons reflected in any direction. This runs simultaneously with the beta detector and if the two are detected within 30×10^{-9} second of each other, the Fast-Slow Coincidence Circuit, as Dr. Llewellyn calls it, records one digit on the counter, the total of which is printed every fifteen minutes before changing to the opposite beta detector. This process was repeated many times and the correspondence was made between the number detected using beta detector I and the number using beta detector II. By this method Dr. Llewellyn showed that there was a definite "preferred" spin direction of the electrons. Therefore, there was a preference held by the nuclei as to spin direction. This disproved the Law of Parity.



DODGE TURBO DART

Chrysler Corporation has been testing a production model of a gas turbine powered automobile. It has been speculated that, in order to get back into the huge volume automobile business along with Ford and G.M., Chrysler may decide to produce from fifty to seventy-five of these gas turbine cars for marketing, to test public response.

George J. Huebner, Jr., Chrysler's executive of engineer-research, drove a specially designed Dodge Turbo Dart from New York to Los Angeles to determine cross-country characteristics of Chrysler's turbine engine.

The fuel mileage was 17 mpg at

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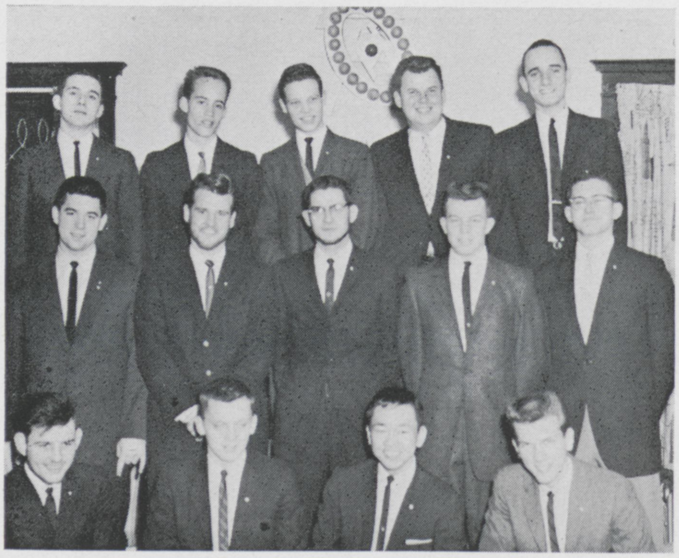


THETA XI PLEDGE CLASS
Bottom Row: Dick Blakely, Bill Holt, Tom Yoshida, Warren Foy
Second Row: Dave Miller, Sam Swan, Barry Lucht, Jim McCoskey, Nick Bradley
Third Row: Kenny Tompson, Mike Donahue, Tom Evans, Bob Steder, Dave Nancrede.

LAMBDA CHI ALPHA PLEDGE CLASS
Bottom Row: Norm Schuld, John Diefenbaugh, Don Endsley, Mars Gralia, Lowell Hardwick, John Kuhn
Second Row: Andy Szilagyi, Phil Halt, Bob Blahut, Ron Turaski, Curt Pease, Toby King
Top Row: Dave Cameron, Allen Stanley, Dale Barkley, Howie Alm, Steve James, Steve Watson.

greek briefs

Up all night, running the wheels off their cars, diets consisting of hot dogs and cokes, and amassing a less than normal amount of time spent studying—these are the prices fraternity men pay for keeping their fraternities strong. This year's rush weekend was no exception, but they would have it no other way . . . . Monday morning the rewards are great . . . . there is no time when they are more proud to be part of Rose's Greek system.

On these pages are the men who pledged Sigma Nu, Theta Xi, Lambda Chi Alpha, and Alpha Tau Omega. The *Technic* would like to extend its congratulations to each of these men.

The *Technic* also congratulates the fraternity men who worked so hard on a rush that concluded in the pledging of the men on these pages; men who will not only perpetuate fraternities at Rose, but keep them what they are today, four organizations we will be proud to look back on in years to come.

ALPHA TAU OMEGA PLEDGE CLASS
Top Row: Dick Oroz, Terry Fenimore, Roger Long, John Steinmann, Ron Chapman, Rich Reeves, Mike Wadsworth
Middle Row: Grady Wallace, Jim Howenstine, Bob Barr, George Wagner, Jack Cox, Jim Doolittle
Bottom Row: John Frischkorn, Evan Johnson, Hal Coon, Ron Gesell, Jim Copeland.

SIGMA NU PLEDGE CLASS
First Row: Bob Parks, Alan Gordon, Ron Galbraith, Bill Sims, Rand Overdorf, Larry Jackson, Bob Clark, Dave Gerstenkorn
Second Row: Jim Dorsey, Bill Roemler, Bob Barnett, Chuck Miller, Chuck Baker, Dave Hussing, Mike Francis, Virgil Roberts, Gus Carroll
Third Row: John Cushman, Dave Hall, Jeff Griggs, Ed Holt, Bill Everson.

alchemy

Lindley Ruddick
Soph. Chem.

Alchemy, often defined narrowly as the art of changing base metals into gold and silver, was in reality a grandoise system of philosophy. It embodied a field of human beliefs and ideas vast in range and extending in time over a thousand years. The spectular attempts to raise the base metals to perfection of gold, by transmutation, were merely of interest in so far as they might afford material evidence of the truth of a philosphical system which was concerned alike with the formation of inanimate substance and the still more formidable mysteries of life. The arbitrary and uninformed operations of mercenary goldmakers were nothing more than a debasement of the real alchemy.

No definite origin can be ascribed to alchemy. The alchemists often called themselves the "son of Hermes" and ascribed the origin of their Hermetic art to the Greek god, Hermes the Thrice-Great. Probably the curious blend of beliefs and ideas upon which alchemy was based came mainly from primitive forms of religion, magic, and general modes of thought. The usual imagined home of alchemy is Egypt, or Khem; and it is said that the art was transmitted to Islam under the name of al Khem, and thence to the Western world as alchemy. Alchemical ideas appear also to have risen in China long ago about the fifth century B.C. in close association with the philosophical and religious system of Taoism.

Alchemical reasoning and experimental procedures were based upon a complex, confused mixture of ideas, beliefs, and theories. It is usually assumed that the fundamental physical theory of alchemy was that of the Four Elements. Although accredited to Aristotle, in its essentials it was recognized both in India and Egypt so early as the fifteenth century B.C., and the Chinese system of Five Elements is equally old. Even farther back in time, the theory of the Four Elements was probably conceived as a development of a primitive way of thinking depending upon a distinction between opposites. Aristotle's theory postulated the existance of four fundamental properties or qualities of all material bodies: the hot and the moist with their contraries cold and dry. These abstract qualities gave rise by conjugation in pairs to the four elements: earth, air, fire, and water of which all matter was held to be composed in different proportions.

Transmutation was an obvious consequence of this theory. For example, when the coldness of water was replaced by heat the cold wet water changed into the hot wet air, the air like or gaseous steam. Another outcome of the theory was the idea of prima materia or original matter from which all bodies were formed and into which they might again be resolved. A further development, arising perhaps in the early centuries of the Christian era, was the conception of a transmuting agent capable of promoting the change of one kind of material into another. This imagined material became known as the Philosopher's Stone.

So were evolved the two principle postulates upon which the deductive reasoning of alchemy was mainly based. From the idea of the unity of matter flowed the further assumption that this stone, the "medicine" of the base metals, would also act as the medicine of man. In the form of Elixir Vitae or Red Tincture the stone was depicted as an agent for curing all human ills and giving longevity of life.

This begins to give us the first idea of the extraordinary power that motivated the alchemists in the elusive and never ending search of the philosopher's stone, in the course of which they made many incidental observations of a chemical interest. In order to know that the philosopher's stone did not exist, it was indespensible that every substance accessible be examined in the best scietnific method of the time.

The men who were attempting to turn base metals into gold had no conception that there was only one well defined material called gold. To them there was all sorts of gold, some good and some bad; but all were gold. Gold was something shiny, heavy, yellow, untarnishable and resistant to fire.

This brings to the foreground the question; how did the alchemist know when he had gold? There are two known tests that the ancients used; the test of the touchstone and the test by fire. The gold was rubbed on a hard black stone and its quality was judged from the color and extent of the yellow streak that was produced. The professional goldsmith would also have the delicate sense that would make him suspicious of anything that did not look of feel right. Next in importance was the test by fire.. It was based on the observed fact that pure gold does not change regardless of how long it is heated. This test would rule out any alloys that were composed chiefly of a base metal. However slight oxidation of gold was tolerated at a very high temperature by their standards.

A third possibility was the measurement of the specific gravity of the metal. The high specific gravity of gold could not be duplicated by any alloy known to the ancients. Of course any practical man would reject any metal that seemed too light.

It is quite evident that it was much easier for the alchemist to prepare "silver' for there are many white alloys of about the same density as silver, but there are very few yellow alloys and none are anywhere near as dense as gold. The early alchemists tried methods of preparing white and yellow alloys by fusion and also by coloring the surfaces of the metal. They also tried more elaborate methods involving the use of distilled substances. The first two methods are easier to comprehend, but the latter method was the source of most of later alchemical techniques.

The alchemy of China is primarily concerned with the prolonging of life. The idea of a drug which could act as an elixir of immortality is found in Indian literature before 1000 B.C. Gold or the Chinese was not a medium of wealth but an impreshiable substance, and so the whole emphasis of the Chinese alchemists was upon the making of gold as a substance to confer longevity or immortality to the body.

As mentioned before the Islam Empire made contributions to the art of alchemy. The Imams were the spiritual and secular heads of Islam. Under them the sciences flourished. Abu Musa Jabir was one of these pupils under the direction of the sixth Imam. He is reported to have lived in the eighth century A.D. He attempted to separate the "elements" and having done so, he mixed them in specified numerical proportions. This was to form the elixir which was to be aplied to the metal. Transmutation should then take place.

Jabir assigned to each substance a specific number. For example, gold was assigned the value 1 and elixir 5. The power of each treatment is denoted by a special fraction. Thus a sublimation was worth 1/50 and fusion 1/200. He then worked out equations on this basis, for example,

$$(\text{gold})\ 1 \times (\text{fusion})\ 1/200 \times 1000 = (\text{elixir})\ 5$$

The conclusion reached is that one thousand fusions should convert gold into elixir. Although this reasoning is very shaky, we can see in it an important step in the development of the science of chemistry. It was called the method of the balance and it vigorously emphasized the importance of quantitative considerations and must have involed careful weighing.

During the Middle ages alchemy made its center to Europe. The medieval alchemist was in most cases a cleric. This was not due necessarily to any connection between religion and alchemy, but because the majority of those who were at ease with books were clerics. He would have had a thorough education which meant that he read and wrote Latin. the language that all nations used for their learned works. He might have taken to alchemy for various reasons. A man of scientific tastes in the Middle Ages and the choice of being a medical man, an astronomer, or an alchemist. So the type of mind that is today directed towards chemistry was directed toward alchemy. Others were attracted by the marvelous prospect of turning base metals into gold. He would not have been able to go out and buy any alchemical books as the art of printing had not been perfected. He would have probably copied or have copied one or two alchemical manuscripts that someone would loan him.

The first attempts to follow the "recipes" contained in these manuscripts seem to have been almost invariably unsucessful. At some stage he would meet an older alchemist who, when he knew him to be a man worthy of the secret, told him something that enabled him to understand the alchemical books and begin the long search for the stone. The alleged reason for the secrecy was the harm that could befall man if it fell into the wrong hands. For the philosopher's stone meant the possession of unlimited wealth and the power of prolonging life indefinitely.

Obviously no good man would entrust this secret to anyone not well known to him, and further security was insured by the alchemist's oath. The true alchemist never sold the secret for money and it was only imparted by him to a disciple after the latter had sworn that he would not reveal it except to one man only whom he knew to be worthy of it and who was set on the gaining of knowledge, not riches.

It is often taken for granted that alchemy at some stage of its career developed into chemistry. The actuality is that one part of alchemy became with little change one part of chemistry, and the part that was so transferred was its laboratory technique. Thus alchemy is distinguished from chemistry by first its purpose and secondly by its method. The purpose of alchemistry was the perfection of all things and especially metals. The purpose of chemistry is the gaining of knowledge concerning different kinds of matter and the use of this knowledge.

The true alchemist, not the mere multiplier of metals, sought to complete a scheme of things in which God, the angles, man, animals, and the lifeless world all took their place, in which the origin of the world, its purpose, and end were clearly visible. Such an object is clearly unattainable by science, for it includes the objects of science, philosophy, and religion.

Research & Development

(*Continued from page* 16)

an average speed of 52 mph using various blends of Diesel oil, gasoline, white gasoline, and jet fuel. Best results seemed to be obtained from the Diesel fuel which averaged 6 to 8 per cent better than regular gasoline. (In 1958, a Chrysler turbine averaged 19.8 m.p.g. using only Diesel fuel).

According to Mr. Huebner, if present research efforts are continued, fuel consumption can be improved by 20% while power and efficiency can be substantially increased. Shrinking of the size and weight of the engine due to increased efficiency will bring additional savings.

The Turbo Dart uses a new type of movable nozzle which directs the stream of hot gases to the turbine wheel at various angles according to the driving requirements.

Outside of its power system, the Dodge Turbo Dart is relatively the same as the present product. However, it is foreseen that the Torqueflite transmission now being used will have to be better adapted to the turbine engine.

Top speed of the Turbo Dart is 115 mph.

MASERS

For many years scientists have sought methods of producing microwaves of very high frequencies. New vacuum tubes and simiconductors have been developed; but their successes have been limited. New promise, however, has recently arisen with the development of the first molecular-beam maser by C. H. Townes, of Columbia University.

The term maser is an acronym derived from "Microwave Amplification by Stimulated Emission of Radiation". All atomic systems posses discrete energy levels. When a light wave of a certain frequency strikes an atom it forces the atom to raise its energy level. Thus, the energy of the wave is transferred into potential energy within the atom. If this excited atom is again struck by the light wave, it can be stimulated to lower its energy level thus releasing its stored energy. Moreover, this released energy is a wave in phase with the original. This fact provides a method of multiplying the intensity of a light wave.

Figure 1. illustrates the growth of a light wave by stimulated emission. If we have a light wave traveling from left to right that strikes the first of a series of excited atoms, it will stimulate the atom to lower its energy state and thus release a wave which is in phase with the original. These two waves then superimpose to form a stronger wave which then intersects the next atom. This process continues down the line each time increasing the strength of the wave. If the atoms are then rejuvinated by an outside source, a steady source of coherent waves of the natural frequency of the atoms is produced. Light waves are normally similar to noise. That is, they are a random mixture of many frequencies and they fluctuate randomly from moment to moment. This is due to the random variation of various energy levels in the many different atoms in the source. However, the maser produces a strong coherent wave of a definite frequency. Thus, it is similar to a tone of sound.

If an activated gas is thus placed in a tube, whose length is a multiple of half the natural wave length of the atoms, and if the ends of the tube are closed with reflecting plates, it is possible to produce standing waves similar to sound waves in a closed tube. The wave will be amplified by the excited atoms and it will in turn excite atoms of low energy states. If our outside source keeps the number of excited atoms greater than the number of unexcited atoms, the wave will grow in magnitude to a desired level. By changing the tubes length, we can pick out the atom's natural frequency we wish to amplify.

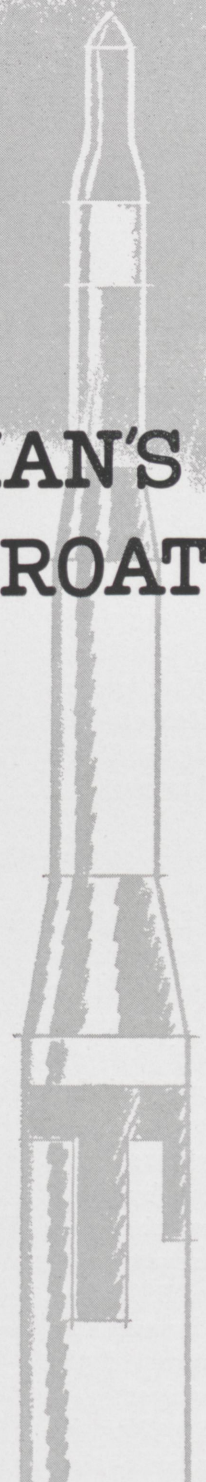
If our reflecting end plates are semitransparent, some of the standing wave will pass though. Also the semitransparent plates will filter out the extraneous frequencies. The result is a directed beam of a single high frequency.

Although masers are still in the developmental stage, many practical uses can be forseen. The communication field has long awaited a source of high frequency waves of this type. Such waves will provide more possible comunications bands.

Masers also apparently have the property of being able to produce waves of very little dispersion. Thus, they can be focused on very distant targets. This will be very useful for communicating with satellites. Also, since there is very little dispersion it will be possible to transmit energy to a target with high efficiency. Therefore masers are opening a whole new field of power transmition.

It is thus evident that far more will be heard of masers in the future. Vast experimental programs are now being formed. This may well be the field for the aggressive engineer.

℞ FOR MINUTEMAN'S "SORE THROAT"



● Minuteman was plagued with a chronic "sore throat."

Existing nozzle liner throat materials wouldn't withstand Minuteman's tremendous solid-fuel rocket blasts with temperatures exceeding 5400 °F.

Allison metallurgists went to work on the problem.

They tried oxyacetylene spray coating—but maximum attainable temperature was too low for the coating materials required.

Next, electroplating was tried—but the coat bond was poor, the surface rough.

Then, Allison laboratories came through with advancements in the application of plasma-sprayed tungsten.

Here was the solution. The dense, sound "plasmatung"© coating passed its solid-fuel firing tests with no erosion, guttering, or nozzle pressure drop!

Metallurgy is but one field in which Allison is scoring significant advancements. We currently operate laboratories for virtually any requirement—space propulsion, physical optics, radio-isotope, infra-red, solid state physics, physical chemistry, direct conversion, heat transfer, physics of liquid metals, phase dynamics, fluid dynamics and rocket propulsion, to name a few.

Our engineers and scientists working in these basic science and development laboratories solve the problems associated with our business and . . .

Energy Conversion is Our Business

ALLISON DIVISION GENERAL MOTORS CORPORATION

libary notes

by Carson Bennett

and Winifred Kitaoka

The World of Books
is the most remarkable creation of man
Nothing else he builds lasts.
Monuments fall,
Nations perish
Civilizations grow old and die out
And after an era of darkness
New races build others,
But in the world of books are volumes
That have seen this happen again and again
And yet live on,
Still young,
Still as fresh as the day they were written,
Still telling men's hearts
of the hearts of men centuries dead.

Clarence Day

We recently added to our reference collection the ten-volume set of Grove's *Dictionary of Music and Musicians.* We have felt a need for "something" in the area of music for a long time, and we feel sure this will help to answer any question that may arise in music or of musicians.

* * *

Have you noticed our philosophy section "bulging" with new books? We have been adding many new titles in the philosophy section and we thought we should call it to your attention. This "bulge," of course, is prompted by the new course being offered in Philosophy. These are some of the new titles:

A History of Philosophy, by Frederick Copleston, in 6 volumes. The author introduces the general reader and the student to the various philosophers and philosophical schools in their historical setting and in the light of their connection with other systems and branches of knowledge.

The Basic Writings of Bertrand Russell, edited by Robert E. Egner and Lester E. Denonn. This volume attempts to present Bertrand Russell's more definitive essays from 1903. The anthology demonstrates not only the growth and development of the author's own mind, but also that of public knowledge and opinion in the last sixty years.

Being and Nothingness, by Jean-Paul Sartre, an essay on phenomenological ontology. Translated with an introduction by Hazel E. Barnes. Here Sartre discusses human consciousness and the nature of the world in which it is involved.

What Man Has Made of Man, by Mortimer J. Adler. This book raises issues of increasing importance in our growing atomic age, dealing with the relation of science and philosophy, and the paradoxical position of psychology in contemporary culture.

There are many more new titles which we simply list:

Distinguish to Unite, by J. Maritain

New Directions in Psycho-analysis, by M. Klein.

Freud, the Man and his Mind, by R. L. Schoenwald

Psychology in the Soviet Union, by Brian Simon

Imagination and Thinking, by P. McKellar

Explorations in Communication, by E. S. Carpenter

Reason and Revolution, by H. Marcuse

Philosophy of Scientific Methods, by J. S. Mill

Men and Morals, by I. W. Riley

American Thought, M. R. Cohen

Essays in Pragmatism, W. Jones

Logic and Knowledge, Bertrand R. Russell

A History of Russian Philosophy, by V .V. Zenkovskii

* * *

FROM THE NEW BOOKSHELF

Catch—22, by Joseph Heller

"A novel like no other you have ever read."

It has its own style, its own rationale, and its own extraordinary characters. It moves back and forth from hilarity to horror. It is outrageously funny and srangely affecting and totally original.

It is set in the closing months of World War II, in an American bomber squadron on a small island off Italy. Its hero is a bombadier named Yossarian, "who has decided to live forever even if he has to die in the attempt."

The Man from Nowhere, by Roy MacGregor-Hastie

(*Continued on Page* 26)

Physics

(*Continued from Page 7*)

gram permits choosing a substantial number of electives in the other science and engineerng departments. The broad background which is possible to attain in this manner is generally considered quite valuable in industry, where it can be well used in the applied laboratories, and in the advance design and development sections.

Students who are considering a career in physics are urged to leaf through several issues of "Physics Today," a periodical on file in the library. From the advertisements in this magazine you can get a good idea of the many different areas of science and industry for which physicists are being recruited. A few examples taken from these advertisements are as follows: Plasma physics, astrophysics, meterology, ionosphere physics, magnetic hydrodynamics, acoustics, optics, reactor theory. The January 1960 issue of this magazine has an excellent series of articles which describe the role and training of physicists in various industries. There is also in this same issue some interesting statistics dealing with the education and employment of physicists which offers more detailed information than it is possible to include here.

There still remains in physics a great number of problems to be solved, many new and exciting discoveries to be made, many new useful concepts to be invented, and many new principles to be evolved. Physicists can be justly proud of their accomplishments. Among their ranks are some of the world's greatest original thinkers and most ingenious experimenters; men like Galileo, Newton, Faraday, Maxwell, Roentgen, Rayleigh, Thomson, Michelson, Bragg, Planck, Einstein, Bohr, Millikan, Compton, Schoedinger, Heisenberg, Pauli and many others. Physics has an illustrious past and an equally promising future. I urge all those bright young students of the freshman class who find physics interesting to seriously consider making physics a career.

Library Notes

(*Continued from Page 24*)

Here is a first full account of Nikita S. Khrushchev's fantastic rise to power—of the struggles and intrigue that brought him from a peasants' hovel to supreme leadership of the Soviet Union. In addition, the book offers a detailed and fascinating portrait of Khrushchev—the bald, rotund, gesticulating, loud man who is the heir to Lenin and Stalin. The author, for years an outstanding Kremlin correspondent, also explores the degree to which we can co-operate or even negotiate with Khrushchev and reports numerous personal conversations he had with the Soviet leader.

The Horizon Book of the Renaissance

What was the Italian Renaissance? The question lights up a chaotic series of images in the mind of the student of history—color, violence, romance, intrigue, brilliance, explosive changes — the Renaissance had them all. It is called the "age that formed the Western World."

Horizon presents a comprehensive word-and-picture portrait of Renaissance Italy.

Journey into Crime, by Don Whitehead

The author of *The FBI Story* presents a chronicle of crime around the world, culled on an eight-month tour from Washington to Ankara, from Scotland Yard to Saigon.

Some of the characters in this caravan of twenty-one true cases are:

The Japanese who invited eighteen to a lethal tea . . .

The handsome San Franciscan who robbed banks to keep his credit rating . . .

The proper Britisher who literally destroyed his victims . . .

The Hungarian whose only crime was patriotism . . .

Sometimes frightening, always fascinating, the crimes Don Whitehead details show that although the "scene of the crime" may determine its execution, love, money, and politics remain the universal motives.

Nuclear Power

(*Continued from Page* 8)

by using certain amounts of moderating materials in the reactor. Some of the more important moderators are graphite, beryllium, hydrogen and deuterium (heavy water).

In spite of the fact that a minimum amount of neutron absorbing impurities is desired in the system. In this manner the total number of free neutrons is controlled and the fission process does not get out of bounds. These necessary impurities are in the form of control rods which are usually made out of cadmium or born steel.

There results from the fission reaction a very intense radiation which is extremely dangerous and even lethal if one is subjected to large doses. It is necessary to enclose the reactor with protective shielding composed of several inches of lead and many feet of concrete, the thickness of which depends upon the design and power output of the reactor.

There is a tremendous amount of heat produced in the reactor, and it is necessary to have adequate heat removal substances in order to prevent the intenal structure of the reactor from melting or undergoing other transformations. The coolant is usually a common substance such as water and air or specially selected materials such as liquid sodium and some organic materials. There is one problem which is met when using coolants such as water and that is the contamination of the water by the fission process. This results in the problem of what to do with this water which carries with it the fission fragments and radioactive wastes. The radioactive materials are processed or removed from the water in a very costly method and a great expense.

Nuclear energy is transformed into useful power by extracting the heat produced in the reactor during the fission process and using this heat to produce steam which in turn can be used as heat or to turn a turbine and produce electrical power. This power can be then used to drive ships, heat buildings, and light our homes.

At present the world is faced with a dwindling supply of coal, oil, and natural gas and we can be sure that some time in the future this supply will finally run out. This fact can be realized when one sees the number of new industries and the growing amount of fuel needed to supply them. The consideration that the fission of one pound of U-235 will produce energy equivalent to the burning of 1500 tons of coal, makes the application of nuclear energy seem very attractive. However, it isn't as easy as it looks because there are other factors to consider. The prime factor is the economic cost, which includes such considerations as availability of fuel, capital costs, and operation costs.

Thus we have seen how technology has battled with the problem of the control of nuclear energy. Man has created the problems of the nuclear age and it is up to man to find ways of using his discovery for the betterment of mankind. We can be sure that the nuclear reactor is surely a step in this direction.

Kodak beyond the snapshot...

(random notes)

Deep in lacquer

That our name is never seen on a can of lacquer doesn't mean we aren't in it pretty deep.

Our newest cellulose ester for the lacquer formulators has the butyrylated, acetylated cellulose chains running much shorter than heretofore. This results in higher solubility, which means less solvent needed. It also means poorer film strength, but that's OK. A butylated urea-formaldehyde resin, included at the right proportions in the formulation along with the proper catalyst, will cross-link to the cellulose acetate butyrate during the drying of the coating. To provide a point of attachment on the cellulose chain, we restore one out of 12 of its hydroxyls. This condenses with the butoxy groups of the butylated urea-formaldehyde polymer to split out butyl alcohol.

Thus the short chains that are more soluble in the can become very much less soluble in the finish of a table on which some gay dog has set down the cup that cheers. No longer need a drop of lotion spilled on the dresser trouble the conscience of a good woman.

In these days of epoxies, silicones, methacrylates, polyesters, etc., why do we monkey with cellulose? What a silly question!

For one thing, we have shown how admixture of cellulose acetate butyrate can improve them all.

For another, cellulose is by far the world's most abundant high polymer. It is formed by sunshine.

The happy eye

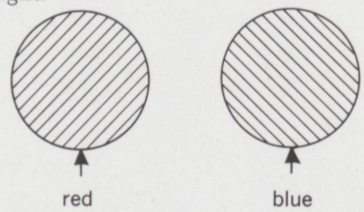
This is the *Kodak Carousel projector.* It projects slides. Carousels symbolize carefree abandon. Care lest slides jam can be abandoned. Gravity feeds them. Gentle gravity. Slides are automatically lifted back to 80-slide storage tray. Pushbuttons at end of long cord advance slides, reverse, even refocus. (Latter is largely for kicks. Slides get prewarmed not to pop out of focus.) See Kodak dealer for exact price.

First, though, consider the picture below. It's an experimental viewing device. An image is projected on a translucent screen. No matter how sharp the original picture, the simple machinery behind the screen can *always* improve the sharpness. It integrates out optical noise. It also makes the screen more pleasant to stare at. Some very purposeful staring is being done today.

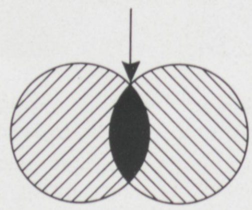
Our long research on human vision has more than happy-time slides in mind.

Overlap in black

What would you say to a photographic paper that comes out red or blue—depending on the color of the exposing light.



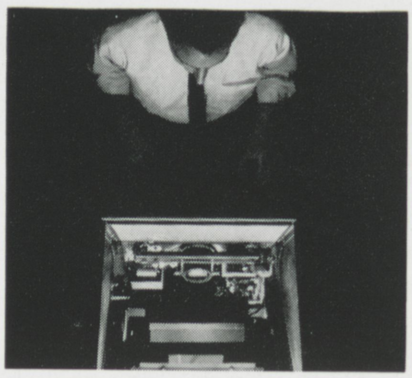
and black where they overlap?



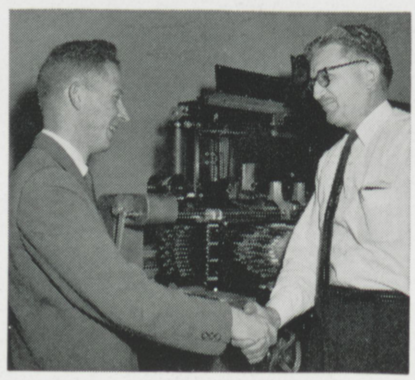
We are currently advertising around in various technical journals like *Geophysics, Materials Research and Standards,* etc. to ask if anybody would be interested in buying some rolls of paper like that for experimentation. It might be useful in interpreting the readings of certain kinds of instruments. You never know till you ask.

Note: Whether you work for us or not, photography in some form will probably have a part in your work as years go on. Now or later, feel free to ask for Kodak literature or help on anything photographic.

CELLULOSE TECHNOLOGY NEEDS GOOD PEOPLE



VISUAL ENGINEERING NEEDS GOOD PEOPLE



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One of a series . . .

Interview with General Electric's Dr. J. H. Hollomon
Manager—General Engineering Laboratory

Society Has New Needs and Wants—Plan Your Career Accordingly

DR. HOLLOMON is responsible for General Electric's centralized, advanced engineering activities. He is also an adjunct professor of metallurgy at RPI, serves in advisory posts for four universities, and is a member of the Technical Assistance panel of President Kennedy's Scientific Advisory Committee. Long interested in emphasizing new areas of opportunity for engineers and scientists, the following highlights some of Dr. Hollomon's opinions.

Q. Dr. Hollomon, what characterizes the new needs and wants of society?

A. There are four significant changes in recent times that characterize these needs and wants.

1. The increases in the number of people who live in cities: the accompanying need is for adequate control of air pollution, elimination of transportation bottlenecks, slum clearance, and adequate water resources.

2. The shift in our economy from agriculture and manufacturing to "services": today less than half our working population produces the food and goods for the remainder. Education, health, and recreation are new needs. They require a new information technology to eliminate the drudgery of routine mental tasks as our electrical technology eliminated routine physical drudgery.

3. The continued need for national defense and for arms reduction: the majority of our technical resources is concerned with research and development for military purposes. But increasingly, we must look to new technical means for detection and control.

4. The arising expectations of the peoples of the newly developing nations: here the "haves" of our society must provide the industry and the tools for the "have-nots" of the new countries if they are to share the advantages of modern technology. It is now clearly recognized by all that Western technology is capable of furnishing the material goods of modern life to the billions of people of the world rather than only to the millions in the West.

We see in these new wants, prospects for General Electric's future growth and contribution.

Q. Could you give us some examples?

A. We are investigating techniques for the control and measurement of air and water pollution which will be applicable not only to cities, but to individual households. We have developed, for example, new methods of purifying salt water and specific techniques for determining impurities in polluted air. General Electric is increasing its international business by furnishing power generating and transportation equipment for Africa, South America, and Southern Asia.

We are looking for other products that would be helpful to these areas to develop their economy and to improve their way of life. We can develop new information systems, new ways of storing and retrieving information, or handling it in computers. We can design new devices that do some of the thinking functions of men, that will make education more effective and perhaps contribute substantially to reducing the cost of medical treatment. We can design new devices for more efficient "paper handling" in the service industries.

Q. If I want to be a part of this new activity, how should I plan my career?

A. First of all, recognize that the meeting of needs and wants of society with products and services is most important and satisfying work. Today this activity requires not only knowledge of science and technology but also of economics, sociology and the best of the past as learned from the liberal arts. To do the engineering involved requires, at least for young men, the most varied experience possible. This means working at a number of different jobs involving different science and technology and different products. This kind of experience for engineers is one of the best means of learning how to conceive and design—how to be able to meet the changing requirements of the times.

For scientists, look to those new fields in biology, biophysics, information, and power generation that afford the most challenge in understanding the world in which we live.

But above all else, the science explosion of the last several decades means that the tools you will use as an engineer or as a scientist and the knowledge involved will change during your lifetime. Thus, you must be in a position to continue your education, either on your own or in courses at universities or in special courses sponsored by the company for which you work.

Q. Does General Electric offer these advantages to a young scientist or engineer?

A. General Electric is a large diversified company in which young men have the opportunity of working on a variety of problems with experienced people at the forefront of science and technology. There are a number of laboratories where research and advanced development is and has been traditional. The Company offers incentives for graduate studies, as well as a number of educational programs with expert and experienced teachers. Talk to your placement officers and members of your faculty. I hope you will plan to meet our representative when he visits the campus.

A recent address by Dr. Hollomon entitled "Engineering's Great Challenge — the 1960's," will be of interest to most Juniors, Seniors, and Graduate Students. It's available by addressing your request to: Dr. J. H. Hollomon, Section 699-2, General Electric Company, Schenectady 5, N.Y.

GENERAL ELECTRIC

All applicants will receive consideration for employment without regard to race, creed, color, or national origin.