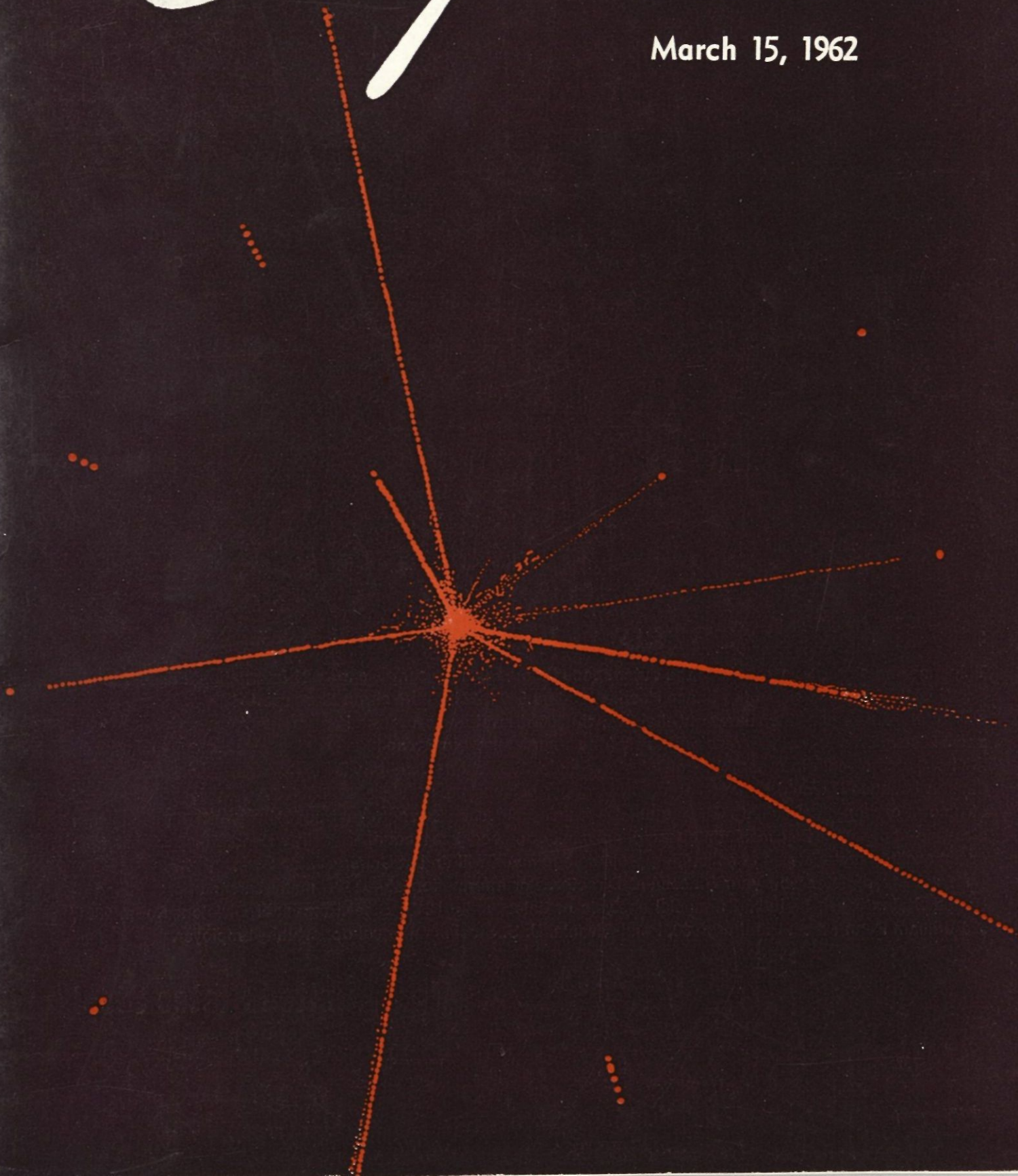
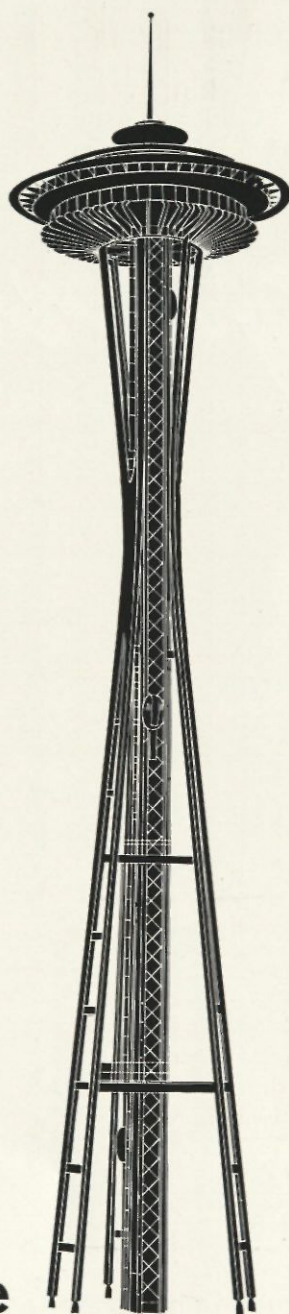


COLORADO

Engineer

March 15, 1962





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.

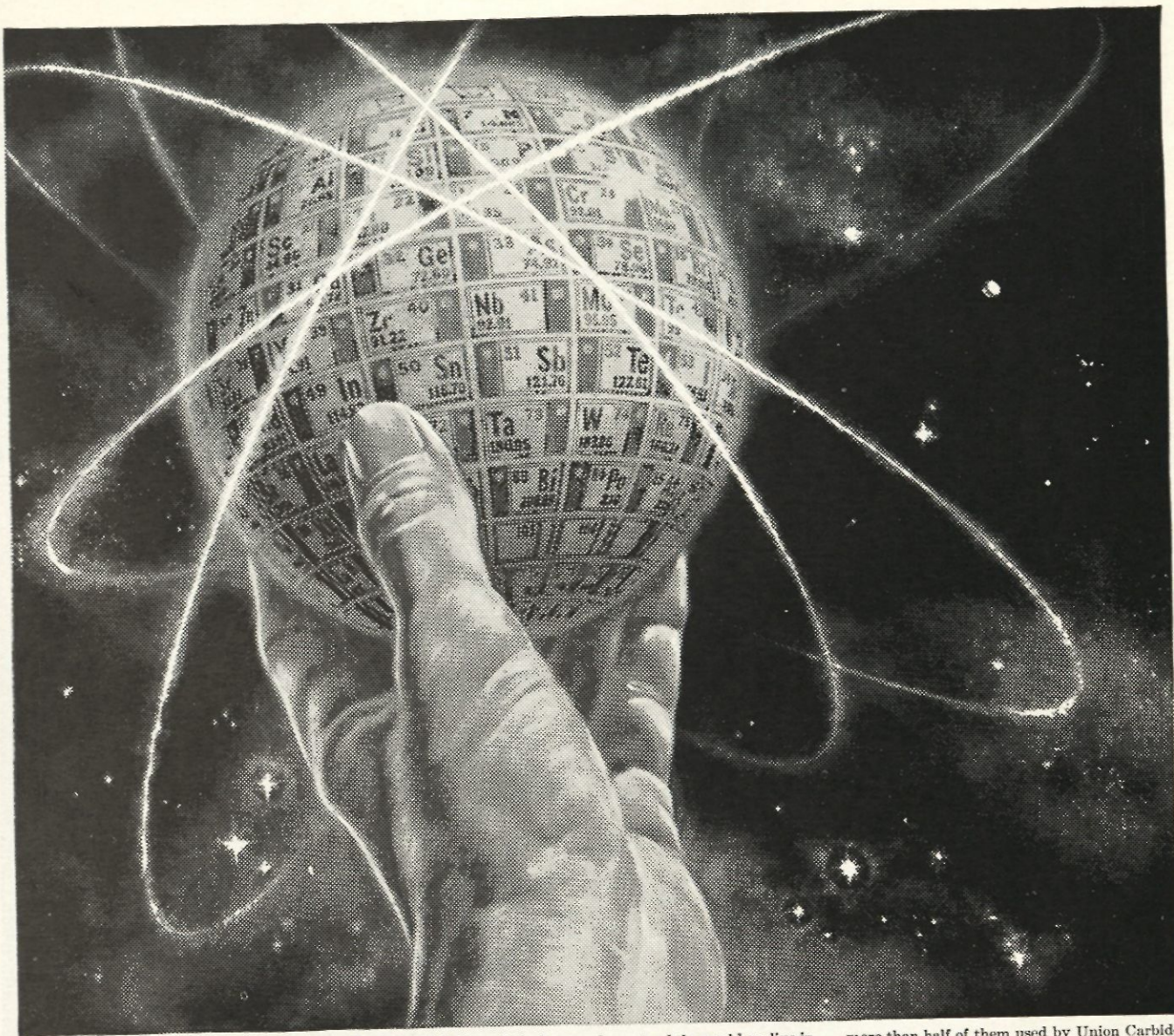
The Space Needle is a combination of sheer audacity and imagination with 3,500 tons of steel. Steel was chosen because it would be faster to erect, stronger per unit area, quickly available. A relatively new type of structural carbon steel called A36 was used because its greater strength (about 10%) 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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The Periodic Table lists all the known elements of the world we live in . . . more than half of them used by Union Carbide

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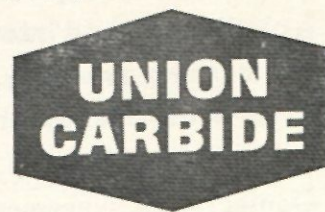
The 70,000 people of Union Carbide operate more than 400 plants, mines, mills, laboratories, warehouses, and offices in the United States, Canada, and Puerto Rico. With these vast resources and skills, and the help of 35,000 suppliers, they create a variety of products in the fields of metals, carbons, gases, plastics, and chemicals.

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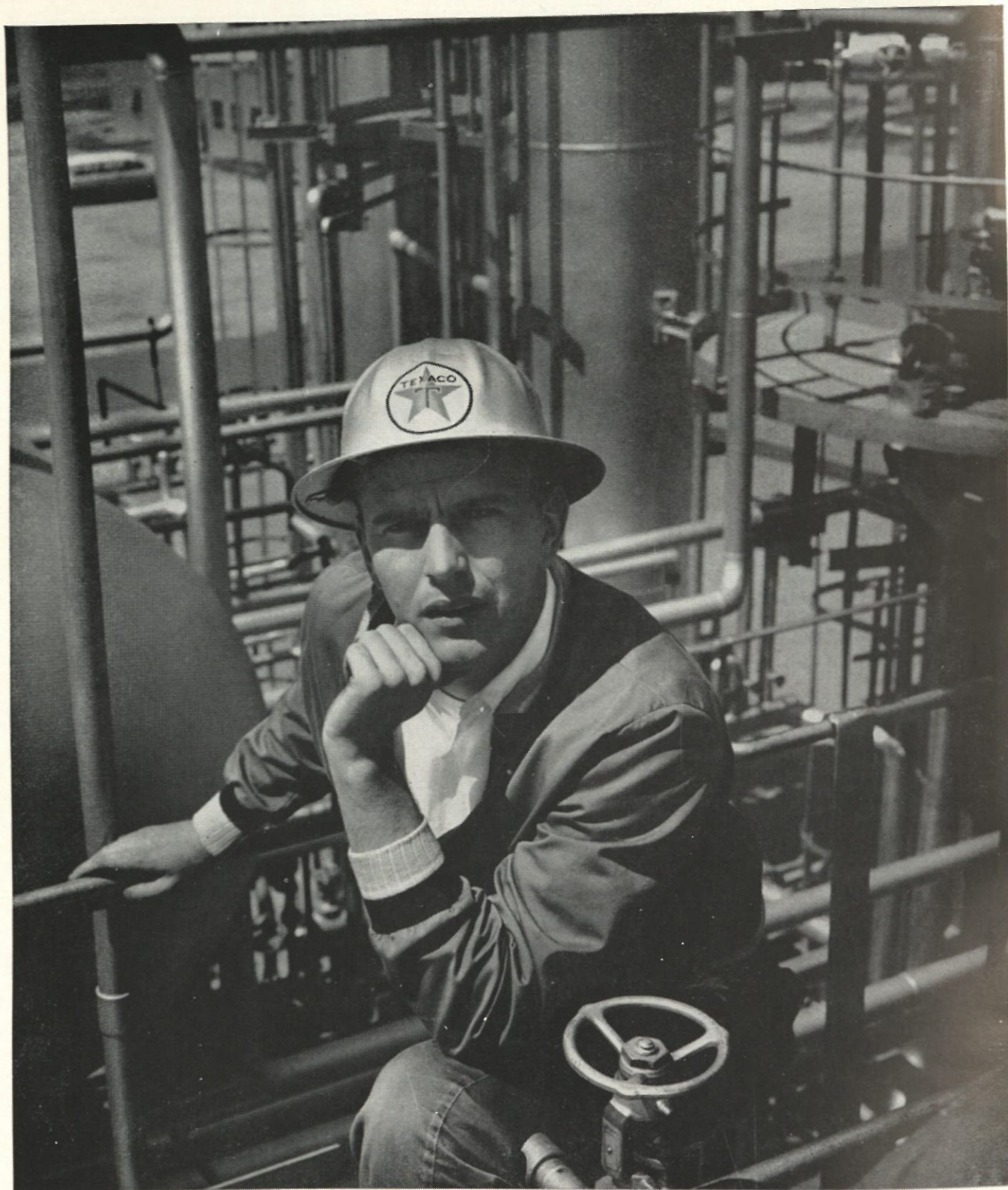
Periodic Chart ©Welch—Chicago

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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?

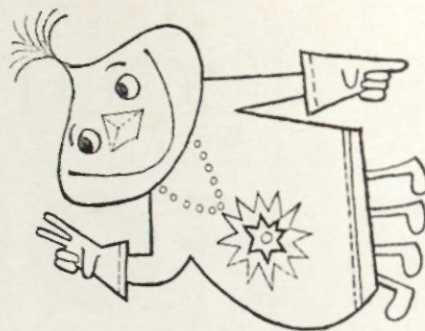
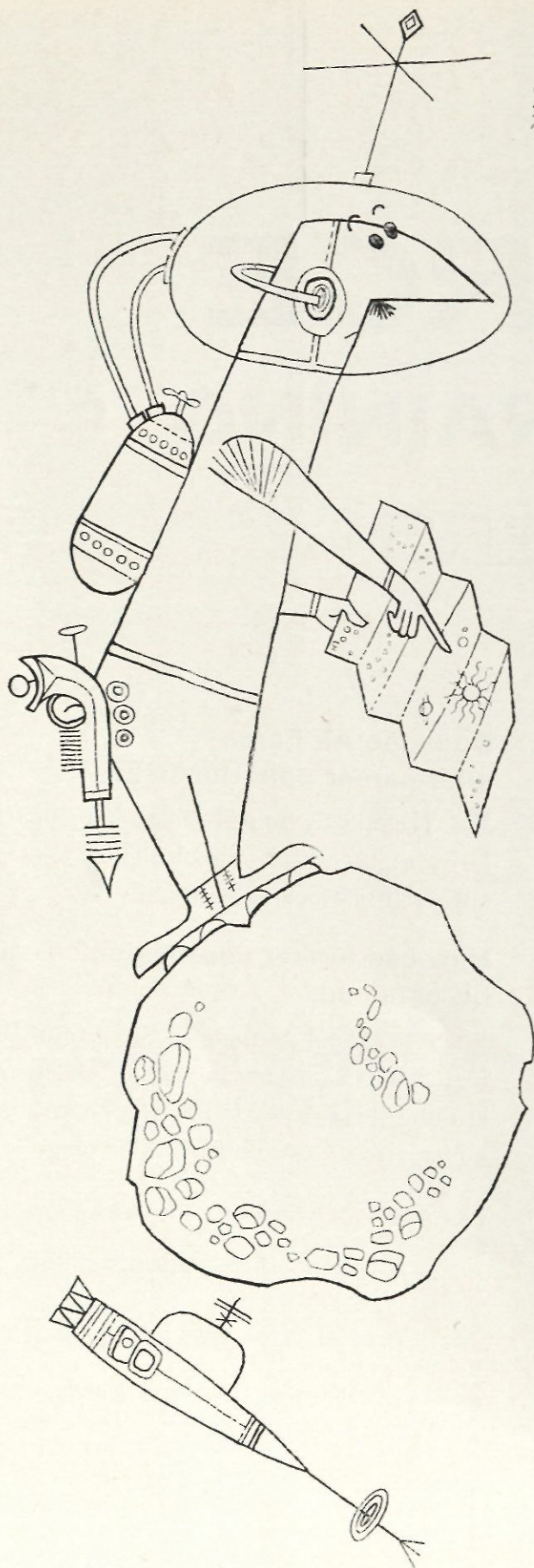
Yes. Technically trained officers have a particularly bright career outlook. They have good opportunities for graduate study.

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.



how far is "way out"?

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UNIVERSITY OF COLORADO, BOULDER, COLORADO

VOLUME 58

NUMBER 3

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Cover: A typical star identified as protons and occasionally as alpha particles or as slow mesons.

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Editorial

Why should anyone think that engineers need a strong background in humanities? How in heaven's name can humanities make you a better engineer? Surely no one believes that Shakespeare is going to help you to design a better airplane. Why study Plato? Whoever heard of a philosophical bomb. An engineer has no need for these things; he works with materials not humanity. All an engineer has to do is to plug the right things into the right formula and turn the crank until his answer pops right out. That's the beauty of the scientific method. In short, engineers are machines, and what good is humanities to a machine?

I hope everybody who reads that considers it ridiculous. If they do, then I can stop this editorial now. Unfortunately, there are many people who would consider that paragraph utterly ridiculous stated in such an exaggerated form. However, when asked for their views on, "the engineer and the humanities," they will present essentially that same argument in what they consider a more plausible form.

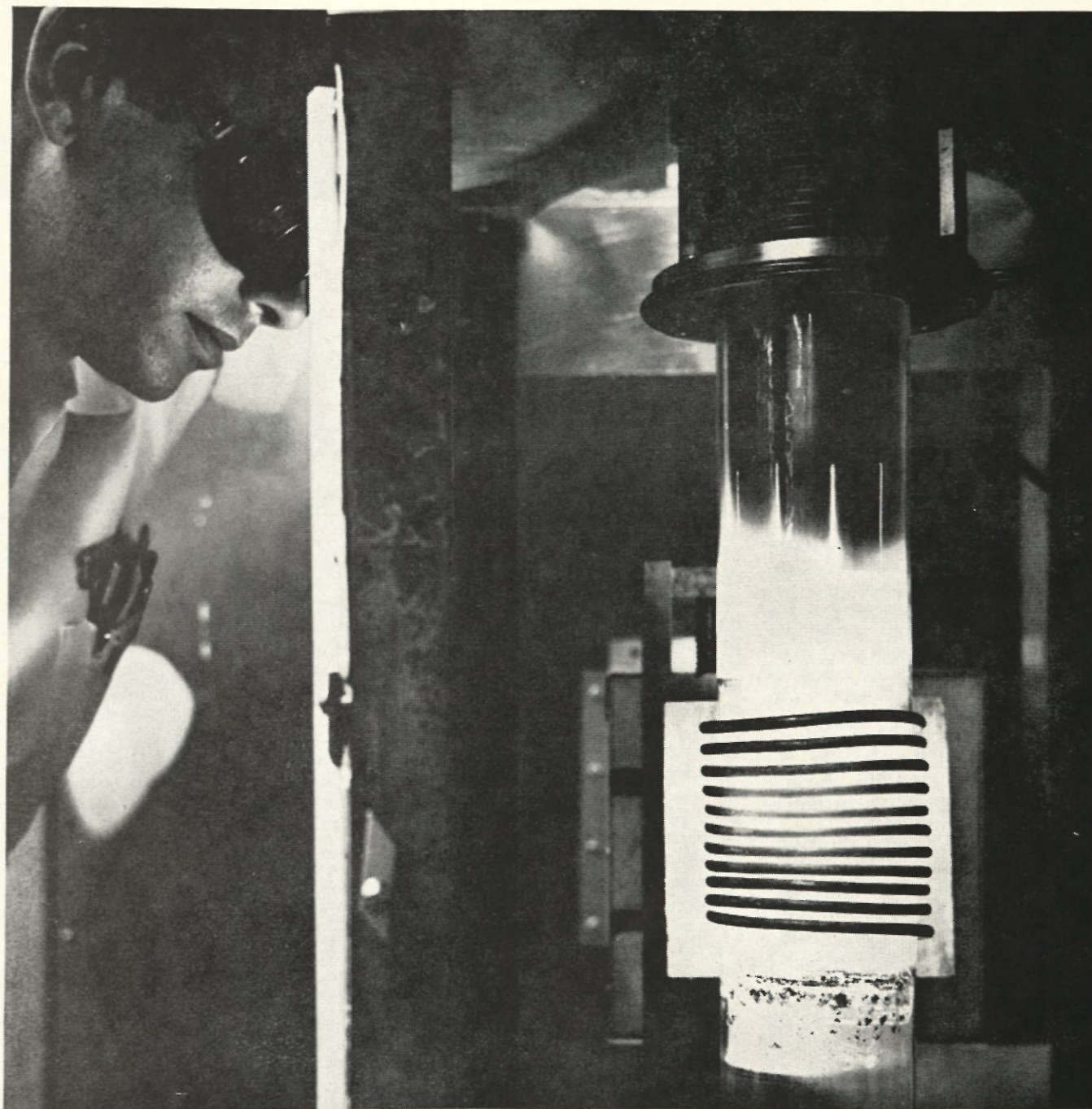
If engineers were nothing more than machines, then there would be nothing wrong with that first paragraph. This doesn't happen to be the case. Engineers are professional men, and as such should have several reasons for acquiring a good background in humanities.

The first of these and probably the most practical is that society expects a professional man to be "well educated" this is a very general term and means different things in different contexts. But one thing it almost always includes in its meaning is the idea of a broad background. Therefore, the professional engineer will be expected to have a "well rounded" education. At first glance it may not seem too terrible to the engineer if he doesn't live up to expectations. But to the contrary, it may be quite important. Many times the man in charge of personnel of a firm will not be an engineer even though his firm uses a lot of them. Yet he is the man who determines the rate at which an employee will advance. And though it is said, it is also true, that many times the selections made by this man are not on the basis of the specific ability of the person but on the basis of how impressive he was in the last interview (formal or informal). To be impressive in an interview one needs a strong, general background, as interviewers have a tendency to be unconcerned with your specific field.

Another reason that an engineer should be interested in acquiring a broad background lies in the fact that the good engineer must be a creative person. But the process of mental creation is a demanding one, and many times one finds himself in a rut. Often at times like this by diverting one's attention to other problems of a less technical nature, such as some of the philosophical problems one encounters in humanities, he can get his mind to run in other channels. When he turns back to the original problem — "voila" it's solved.

The third and least practical but what should be the most convincing reason is: humanities is fun. Matching wits with such men as Plato, Descartes, Dante, and others is a challenging proposition. When you finally see what they are driving at, the satisfaction gained far surpasses any gotten from solving a text book engineering problem. If the kind of thinking that is needed to understand these people doesn't appeal to you then you should probably go back to turning your crank, but if one day a machine is invented to turn it faster and better *instead* of you, don't be surprised.

Lowell Brooks



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SUBNUCLEAR

JIM TOEVS

When Ernest Rutherford discovered the atomic nucleus in 1911, he opened the door to a field of science that has both founded and destroyed basic laws of classical physics. As Rutherford pictured the nucleus, it was composed of protons and electrons. The negatively charged electrons cancelled the charge of an equal number of protons, accounting for the extra nuclear mass with no charge. Greater accuracy in mass measurements disclosed an error in the theory, causing J. Chadwick to introduce the concept of the neutron in 1932. The mass of the positively charged proton was found to be the equivalent of 1,836 electrons, and the mass of the chargeless neutron is equal to 1,838 electrons.

Thus, the group of subnuclear particles consisted of four members: the proton, neutron, electron, and photon, which carries the energy of light. The subnuclear family seemed complete until closer examination showed that beta-ray (electron) emission from nuclei did not conserve energy and angular momentum. This dilemma had only one solution: the introduction of a particle having no charge, little or no mass, and the ability to carry energy. Called the "neutrino," this particle's existence was predicted by Enrico Fermi, but not confirmed until 1956. Because of its small mass and absence of charge, the neutrino was almost impossible to trace. Nuclear theory stated that neutrinos should react slightly with protons, forming neutrons and positrons (negative electrons). This reaction was finally pinpointed by F. Reines, C. L. Cowan, Jr., and others at the Savannah River plant of the Atomic Energy Commission. The cross-section, or probability of occurrence of this proton-neutrino interaction was found to be in the order of only 10^{-20} as large as the average

cross-section of other nuclear reactions, thus explaining the difficulty of neutrino observation.

The addition of a fifth particle to the nuclear family, the positron (mentioned above), was a result of observation of radiation from rare proton-rich nuclei. When the proton turned into a neutron, it emitted a particle identical to the electron except for its charge, which was positive. Quantum mechanics established a law requiring every particle to have an anti-particle if the existence of the positron was to be recognized. This caused much speculation throughout the world of science. It was suggested that anti-particles could be put together to form "anti-matter," which possibly would have negative gravity, and, if it were to come into contact with positive matter, both would be converted into energy. Fantasy turned into reality when the Wilson cloud chamber caught a positron-electron collision. The decay product was a pair of gamma rays.

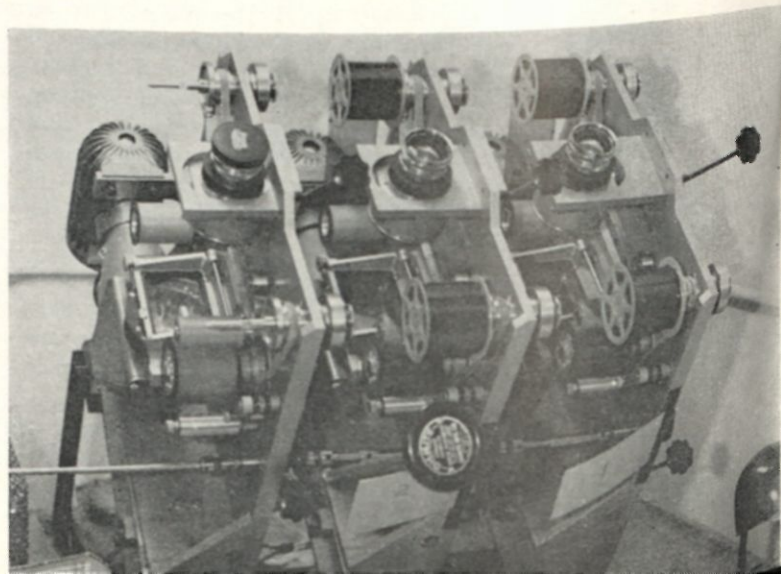
The anti-particle law, called the law of particle symmetry, was partially verified with the artificial production of anti-protons in October, 1954. E. O. Lawrence and E. Segre used the Berkely bevatron in the experiment, which indicated an interaction cross-section twice as great as the cross-section of the positive proton interaction. This indicates that the forces involved in the antiproton interaction are twice as strong as the

forces involved in the proton interaction. The Berkely bevatron was used again in 1957 to confirm the existence of an anti-particle. B. Cork, G. R. Bambertson, and others passed antiprotons through solid matter and produced antineutrons, helping to confirm the law of particle symmetry.

In 1935, H. Yukawa attempted to explain nuclear forces. These are the exceedingly strong forces that act only over a short distance, holding the nucleus together in spite of the strong repulsive forces (electric) of the protons. Yukawa predicted the existence of a particle with a mass about two hundred times as large as the electron's mass. Yukawa thought that these particles exist inside the neutron and proton, are responsible for the neutron's magnetic moment, and account for the forces that hold the nucleus together. Particles fitting this description were observed as components of cosmic rays in 1937 by J. C. Street and E. C. Stevenson. These particles, originally called mesotrons, are now called mesons. They were found to exist in all three electric states: positive, negative, and neutral. This fact stimulated the charged meson field theory, in which the transfer of mesons from protons to neutrons is responsible for the energy exchange between the nucleons (protons and neutrons).

Further complicating the nuclear picture was the discovery that mesons broke the law of reversibility of inter-

PROJECTOR FOR SCANNING STEREOSCOPIC BUBBLE-CHAMBER PHOTOGRAPHS



Jim Toevs is a sophomore in Engineering Physics. This is his second year of participation in the Superior Student Program.

PARTICLES

actions. By this law, any reaction in which the nucleus could be made to emit a meson should have the same cross-section as the reverse action which is causing the nucleus to absorb a meson. Experiments showed, however, that meson absorption rate was much less than the meson emission rate. More precise investigation revealed that the mass of the emitted particle (pi-meson) was 273 electron masses, but the mass of the absorbed particle (mu-meson) was only 207 electron masses. The absorbed particle, then, was a decay product of the emitted particle, and, differing from its parent particle, it would not interact as readily with the nucleus.

Recent experiments have added more to the growing complexity of the once-simple field of nuclear physics. The new particles are the heavy positive, negative, and neutral K-mesons, all having a mass of about 965 electron masses, and the various "hyperons," with masses greater than the neutron masses. Hyperons are hybrid particles, formed when one of the pi-mesons combines with a nucleon. The hyperons decay into some form of nucleon and meson, and the mesons decay into some combination of electron, positron, photon, or neutrino. These particles and their antiparticles have been both artificially produced and found in cosmic rays.

The members of the hyperon group are the lambda, sigma, and cascade hyperons. These unstable par-

ticles all seem to be involved in the behavior of nuclei if sufficient energy is added to the nuclei. This became evident in 1953, when hyper-fragments were discovered in emulsions of high-energy cosmic rays by M. Danysz and J. Pniewski. Since then, the hyper-fragments have been produced in several particle accelerators. In these hyper-fragments, a nucleon in a normal nucleus is replaced by a hyperon, causing the nucleus to become highly unstable and energetic. In most cases, the hyperon decays in a few millionths of a second, and the nucleus returns to normal.

If a neutral lambda hyperon replaces a neutron in the nucleus, then the story is quite different. The nucleus turns into a "hypernucleus," and becomes quite lively. When the lambda particle decays, the nucleus explodes with one strong (fast) interaction. This shattering effect begins a shower of weak (relatively slow) interactions and decays. Weak interactions do not obey the laws of normal interactions, causing scientists to believe that they are a fourth force of nature. By November, 1959, hyper-nuclei had been made out of the seven lightest elements by meson bombardment.

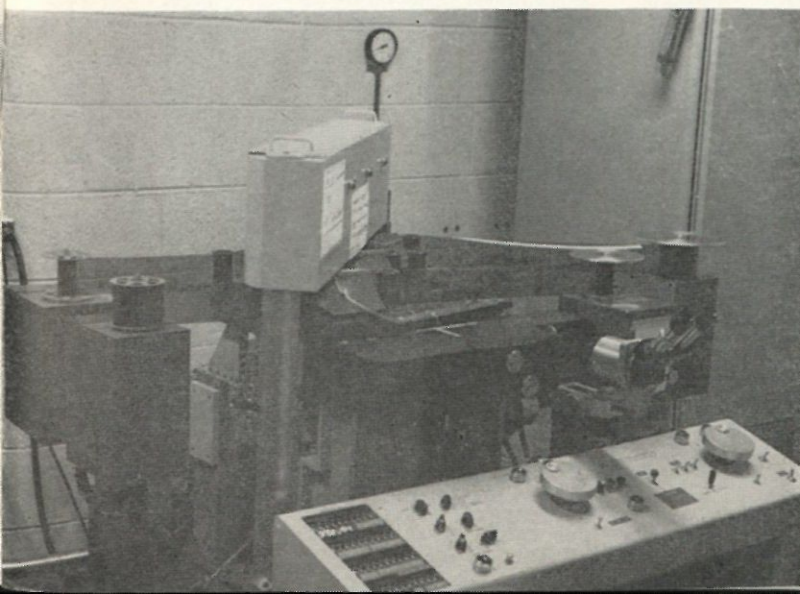
Here at the University of Colorado, a group working with Prof. Frank Oppenheimer is studying these new unstable elementary particles under a grant from the National Science Foundation, by compiling data that

has been collected at several labs throughout the world. One of the experiments they are undertaking involves studying films taken by Wilson Powell at the University of California Radiation Laboratory. Prof. Oppenheimer's group is trying to determine the cross-section of the nuclear scattering of the lambda particle. In addition, they are collaborating in an experiment to find the probability that a lambda particle's decay will follow a certain one of the various patterns it can take.

Work on this problem begins with the bevatron, the high-energy accelerator at the University of California Radiation Laboratory at Berkeley. Here, protons are accelerated in the bevatron to an energy of 5 bev (billion electron volts). The stream of protons is directed at a proton-rich target such as paraffin, polyethylene, or liquid hydrogen. The proton-proton reaction produces high speed (700 mev) negative K-mesons. These in turn are directed into a thirty-inch bubble chamber filled with freon and propane, in which the K-mesons produce a variety of hyperons.

A bubble chamber is an instrument with which one can observe the tracks of an ionized particle. In the chamber, a gas is cooled and liquefied, then brought almost to a boil. At this point, the chamber is rapidly expanded, dropping the pressure below the boiling point of the liquid. In the instant before the whole chamber boils, bubbles will form only along the path of a charged particle, such as a proton or an electron. At this instant, lights are flashed and two stereoscopic cameras take photographs which yield much information about the mass, charge, and energy of a particle.

In the lambda hyperon study, the charged particles are the negative K-mesons. At their high speed, their half-life will seem much longer because of the relativistic time effect. To slow them down so they will decay or interact within the bubble chamber, they are passed through a one-inch copper plate, which slows



DIGITIZED MICROSCOPE
FOR RECORDING
COORDINATES OF
BUBBLE-CHAMBER
TRACKS ON
IBM CARDS

them down to 300 mev. Once in the chamber, the K-mesons either decay into various combinations of pi-mesons or interact with nucleons to form hyperons. A negative K-meson can interact with a proton to form the desired lambda hyperon and a neutral pi-meson. The lambda hyperon then decays in various ways, usually into a negative pi-meson and a proton, but occasionally into an electron and a proton.

The pictures of the bubble chamber sequence are sent to Prof. Oppenheimer's laboratory for analysis. Here, a machine optically follows the tracks of the lambda hyperon's decay products. The coordinates of six to ten points on the track in both stereoscopic views are recorded on IBM cards. The stage of the examining microscope has a six-inch travel and the x and y coordinates can be determined to an accuracy of within two microns.

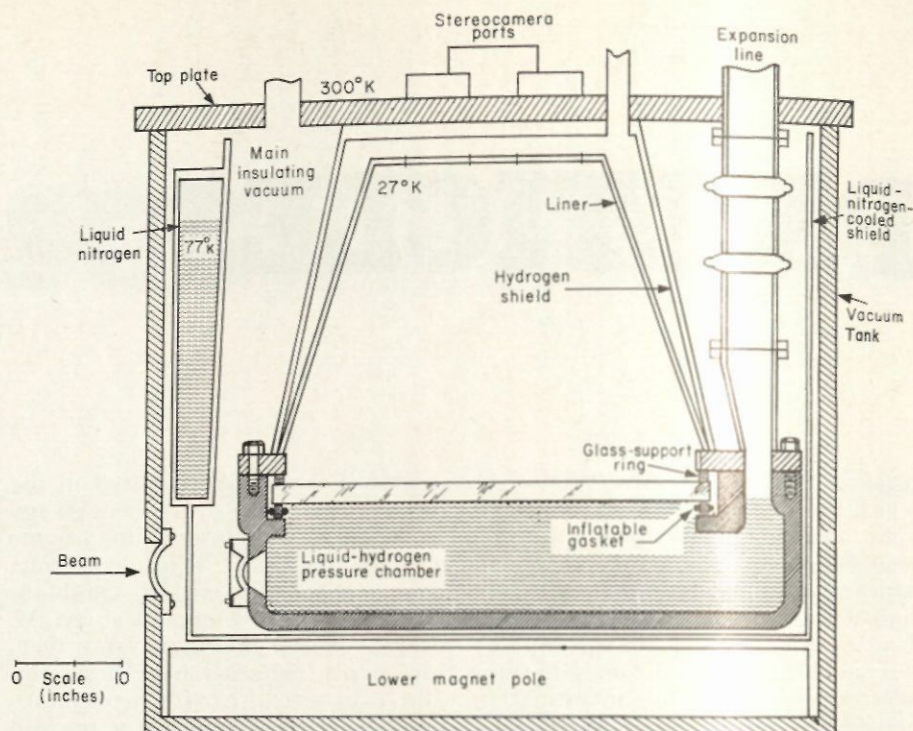
The IBM cards are then fed into a computer, which finds the momentum of each particle, and the angle between each track. By assuming a mass for each particle, the ingoing and outgoing energies can be checked to see if energy has been conserved. By repeating this process thousands of times and analyzing the results, the scattering and decay cross-sections of the lambda hyperon are determined.

An example of one of the results of this kind of study is some work which has been done at several labs throughout the country in the past few months, in which very detailed studies were made of a reaction in which a negative pi-meson hitting a proton yielded three additional pi-mesons. The careful study showed that three of the outgoing pi-mesons stick together for a very short time (10^{-23} seconds), indicating the existence of still another subnuclear particle. In this we see that studies of the type being carried on here at the University of Colorado are adding more to both the growing family of subnuclear particles and the increasing complexity of nuclear physics.

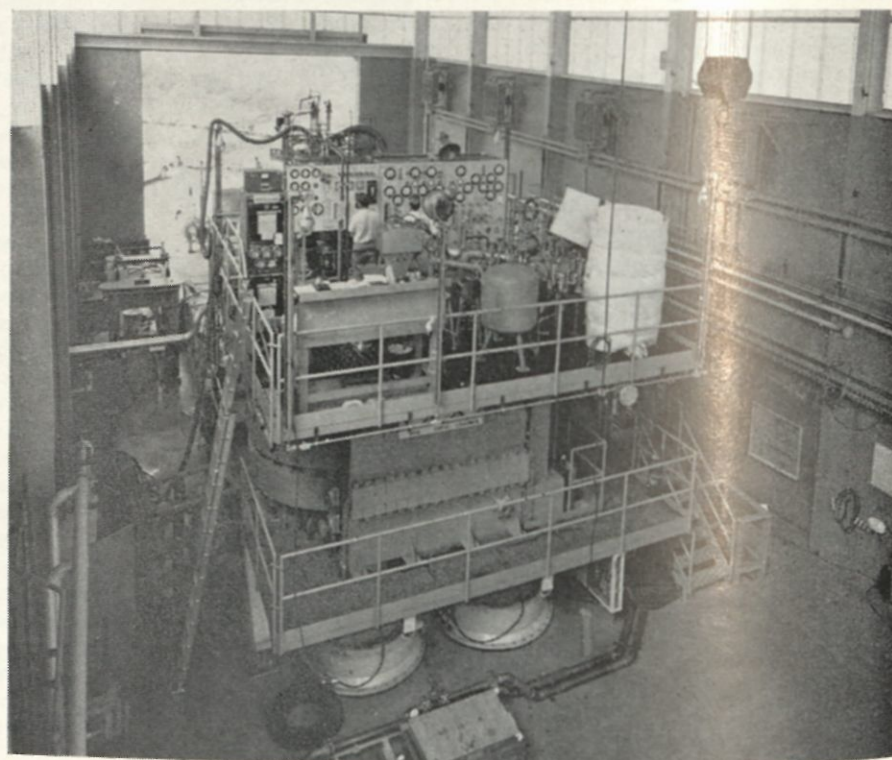
By mid-1963, about a fifth of the nation's 5,477 radio stations may have automated their broadcasting operations. For about \$6,000, stations can buy equipment that permits them to tape and then air 18 hours of music, disc jockey chatter and other programs without touching a phonograph record.

Electronics

McGraw-Hill publication.



72 INCH BUBBLE CHAMBER—BERKELEY, CALIF. (below) AND SCHEMATIC SKETCH (above)



Aluminum was used to roof the Washington Monument seventy-five years ago.

Home Building Trends

★ ★ ★

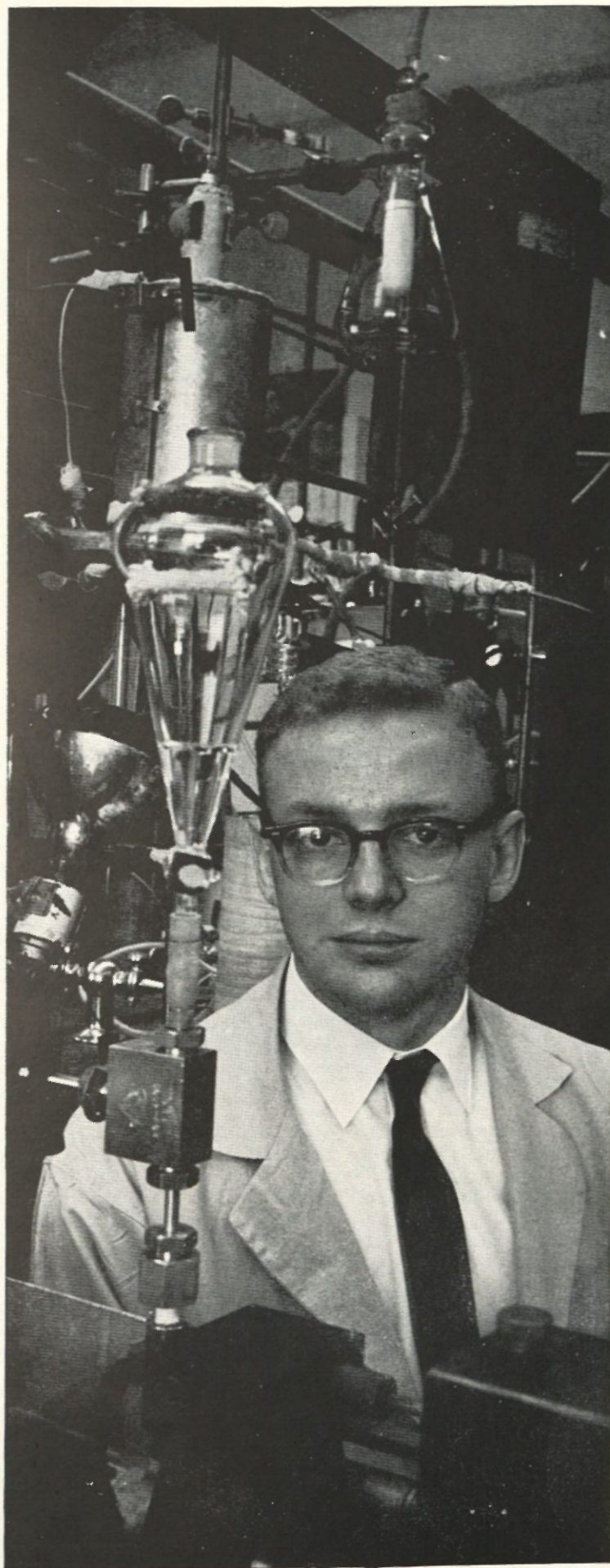
The famous St. Joachim Church of Rome still has its original aluminum roof applied in 1897.

Home Building Trends

The Indian Ocean island of Mauritius plans using the force of its customary four- to twelve-foot waves to generate electricity. A lagoon would be dammed and natural wave action allowed to fill it. Then, when the tide goes out, water would be run back into the ocean through turbines, generating electricity.

Power

McGraw-Hill publication.



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.

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STUMPTAIL MONKEY WALKING BIPEDALLY

BIPEDALISM

DAVID PARKHURST

Why do you walk on two legs and not four? Probably you do it because you are human. But why do humans walk on two legs; that is, bipedally? This is the object of a study being carried out by Dr. Gordon W. Hewes, associate professor of anthropology at the University of Colorado.

The origin of bipedalism is connected with evolution. Many people think that the theory of evolution says that man is descended from apes like those that live today. This idea seems ugly to them, and they will not accept evolution as fact. Biologists and anthropologists, however, do not believe that man is descended from modern ape types, but that both man and the modern ape are descended from a common ancestor which was farther back on the evolutionary scale than either one. At any rate, man's ancestors did pass through ape-like stages.

The acquisition of bipedalism is considered by most anthropologists to be one of the most important changes in human evolution. If bipedalism is so important, one may

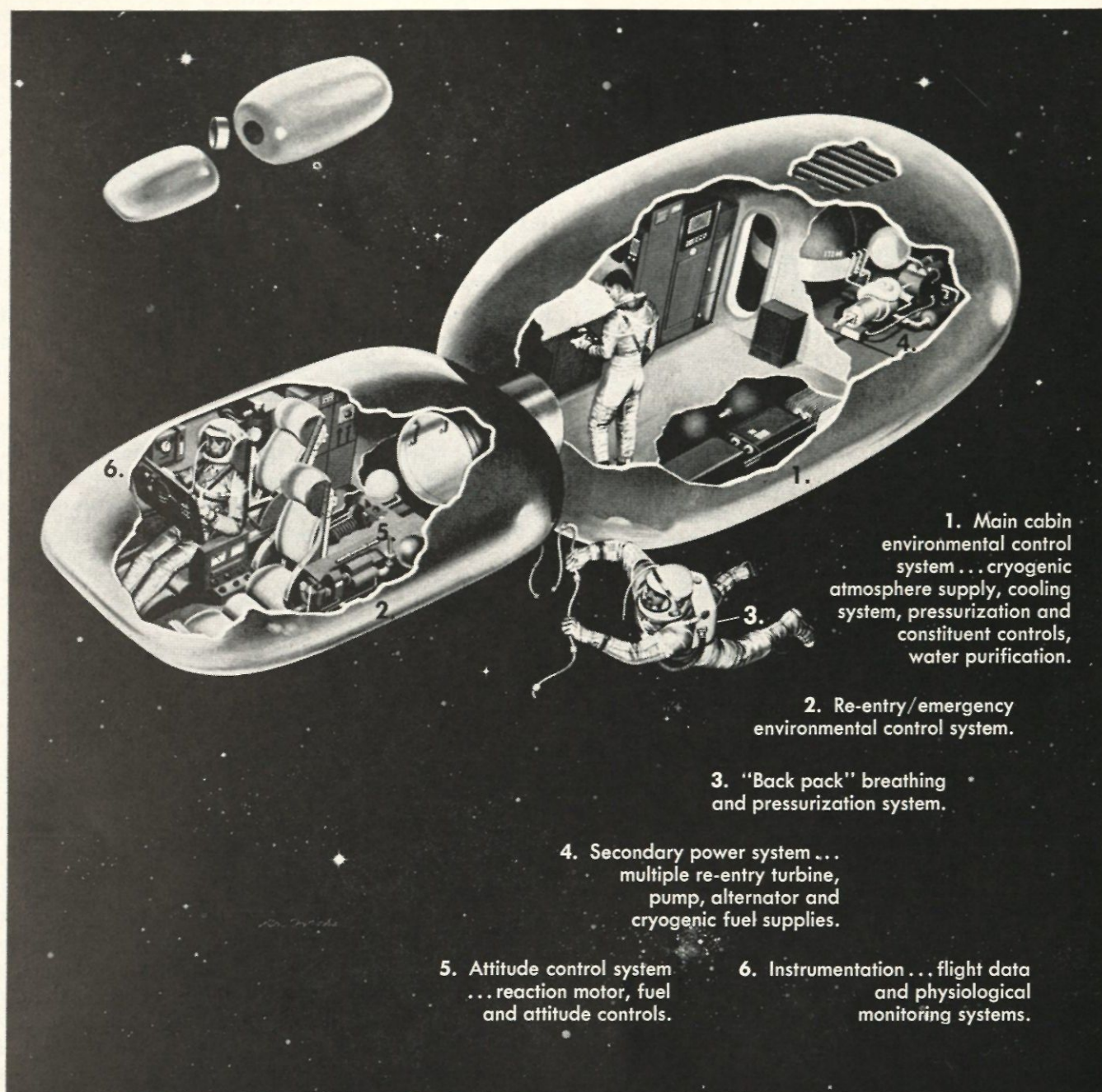
ask why birds are not more advanced than they are. One answer is that their bipedalism was developed much earlier than ours and for a different reason — increased ground speed. Aside from the birds, other animals such as bears, monkeys, and modern apes occasionally walk on their hind legs, but this behavior is exceptional, not habitual.

For man and his ancestors, bipedalism has had many advantages. Because the level of the eyes is raised, ability to see at a distance is improved. The hands are freed for carrying objects, using weapons and tools, etc. Our speech ability may also be a result of the moving of the head to the top of the shoulders. In order for animals to change by evolution, either a new trait must have advantages or an old trait must have disadvantages. For our ancestors to develop bipedal locomotion, then, it must have been advantageous in their environment for hundreds or thousands of years. Skeletons of man-apes have been found in which the pelvic area is adapted for upright walking, but the brain is small. Since a large brain is necessary for tool and weapon use and the like, the idea that this pelvic adaptation led to bipedalism can probably be disregarded.

Dr. Hewes' hypothesis is that our ancestors began walking upright because it freed their hands for carrying food. For this to result in an evolutionary change, however, it must have had advantages. Dr. Hewes believes that, due to a change in environment at some time, our ancestors began to depend on eating carrion. Perhaps they moved into regions with a marked seasonal drought which caused a scarcity of their usual plant foods, and they found they could satisfy their hunger by eating bits of meat left from kills by carnivorous animals. It has been pointed out that vultures and hyenas eat carrion on the spot; but vultures can fly and hyenas can run much faster than primates, so they are not in much danger. This is somewhat supported by the observation that in Africa today, baboons sometimes eat meat from carcasses during the dry season when plant food is scarce.

During the past few years Dr. Hewes has studied three monkeys, which, like men, are members of the group called the primates. One of these, a young male stump-tail macaque, often walked bipedally when given food pieces the size of apples or larger. While this proves nothing (Continued on page 45)

David Parkhurst is a sophomore and a convert to applied math from anthropology. He is participating in the Superior Student Program of the College of Engineering.



Manned space flight requires reliable and efficient thermal and atmospheric systems plus secondary power equipment. Complete, integrated systems (such as those pictured above) are under study at Garrett's AiResearch Manufacturing Divisions. Their design reflects 20 years of leadership in airborne and space systems, including NASA's Project Mercury life support system.

Other project areas at Garrett include: solar and nuclear power systems for space applications; electronic systems, including centralized flight

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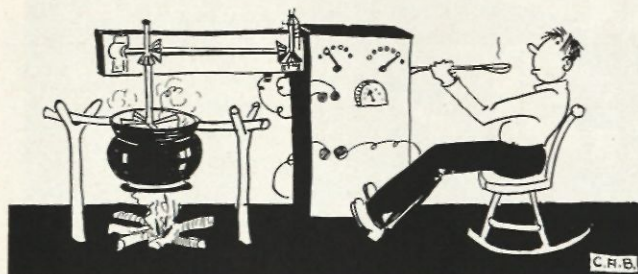
For further information about a career with The Garrett Corporation, write to Mr. G. D. Bradley in Los Angeles.



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OUR BRAVE WORLD

(REPRINTED FROM
THE OKLAHOMA STATE ENGINEER)



PEARCE'S

"If You Live near a City, You Live near a Pearce's"

In Account with:

Date: August 1, 1956

John F. Cummings
213 Huron Road
Cleveland, Ohio

DATE OF PURCHASE	BALANCE DUE
7/24/56	\$336.55
Carrying Charge	3.37
Total	\$339.92

TO OUR CUSTOMERS: The enclosed notice was prepared by modern electronic accounting machines. It has been developed as a result of Pearce's continuing efforts to improve service and reduce operating expenses. These savings we can then pass along to our customers. Enclosed with this notice you will find a check that has been filled out in the amount of the last figure entered in the balance-due column of your statement. Please sign this check and return it to us within ten days. **THIS CHECK HAS BEEN CODED TO YOUR NAME, ADDRESS, AND ACCOUNT NUMBER. PLEASE DO NOT FOLD, SPINDLE, OR MUTILATE IT.**

Albert Roe, Credit Manager

PEARCE'S

"If You Live near a City, You Live near a Pearce's"

Date: September 1, 1956

In Account with:

John F. Cummings
213 Huron Road
Cleveland, Ohio

BALANCE DUE AUGUST 1, 1956	\$339.92
Carry Charge	3.40
Balance Due	\$343.32

Apparently you have overlooked your last month's statement. The enclosed statement indicates a balance overdue us. Please sign the enclosed check and return it to us within ten days.

Carrying charges of one per cent per month are charged against unpaid balances. Accounts not paid in full within 90 days from purchase are automatically turned over to our branch collection agency in your area.

Sincerely,
Albert Roe,
Credit Manager

213 Huron Road
Cleveland, Ohio
September 4, 1956

Albert Roe, Credit Manager
Central Credit & Accounting Office
Pearce's

Dear Sir:

Apparently your new electronic accounting machines have short-circuited or something. Anyway, I keep getting statements for \$336.55 plus carrying charges, an amount that I paid in full on July 24, 1956, the same date on which I charged these purchases. Needless to say, I would deeply appreciate it if you would make these machines stop threatening me with turning over my unpaid bill to a branch collection agency.

My suggestion would be to extract my account from the machine until you can get this matter straightened out.

Yours truly,
John F. Cummings

Central Credit and Accounting Office
Pearce's
September 14, 1956

John F. Cummings
213 Huron Road
Cleveland, Ohio

Dear Mr. Cummings:

We have re-run your account through our machines and can find no record of a payment made on July 24. Our change-over to electronic accounting was com-

pleted on July 26, two days after you claim to have made this payment, and our engineers inform me (1) that the machines are not adjusted to allow for a bill to be paid on the same date that charges are made, since the statistical probability of such an occurrence is only one in 96,000; (2) that because of the number of circuits involved and other highly technical reasons, it would be impractical at this time to extract your account from our machines; and (3) that because your payment was made by personal rather than coded check, there is a possibility that it has been credited to another account. Will you, therefore, send us at your earliest convenience your canceled check and receipt?

Sincerely,
Albert Roe

•
213 Huron Road
Cleveland, Ohio
September 19, 1956

Albert Roe, Credit Manager
Central Credit, et cetera, et cetera

Dear Mr. Roe:

Since your letter of September 14 suggests either (a) that you doubt the payment of my bill on July 24 or (b) that you entertain certain reservations about my sanity, I am enclosing photostatic copies of my canceled check and receipt. The originals, for reasons that should be obvious to you, are now in a safe-deposit box, which I rented this morning.

I am not surprised that you cannot find a record of my payment since the girl who made out my receipt was apparently very confused. When I appeared in the Cleveland credit office and asked her to add up my duplicate charge slips, her expression reminded me of the look I once saw on the face of a bonus baby who had gone to sleep off second and had the pick-off worked on him. When she came out of it, she said she didn't know anything about this job, that they'd just transferred her from Pre-Teen Panties and told her to stall people off until closing time because on the 26th they were converting to some central accounting office. She asked me what did I want to pay my bill NOW for, and I said because I was circumventing Pearce's exorbitant carrying charges. She said she didn't know what circumvent meant. I said that figured and would she please add up my charges and take my money and write me out a receipt. She said she should have taken that job at Halle's, even if it had been a straight commission proposition.

This mix-up has now cost me \$5.24 for photostat, a deposit box, and postage, not to mention several hours of my time, which I could have put to better use in a number of other ways. I only mention this casually because I hope you can straighten this matter out before I am forced to start billing you.

Yours truly,
John F. Cummings

Central Credit and Accounting Office
Eastern Division
Pearce's
New York 16, N.Y.
September 24, 1956

John F. Cummings
213 Huron Road
Cleveland, Ohio

Dear Mr. Cummings:

This is to inform you that I have just employed three girls to examine the accounts of all the John F. Cummings in our files. I have also contacted our Western Division, asking them to run the same check in their office, though it may be some time before we hear from them since they have not yet converted to electronic accounting. In short, we are doing everything in our power to clear this up as expeditiously as possible. Meanwhile we deeply regret any inconvenience you have been put to. Might I be permitted to add that our carrying charges not only are well within the legal maximum as established by law but also compare favorably with interest rates charged by competing organizations and with current bank rates.

Yours truly,
Albert Roe

•
213 Huron Road
Cleveland, Ohio
September 28, 1956

Albert Roe, Credit Manager
Central Credit, etc.

Dear Mr. Roe:

I have recently devoted two hours to a study of your letter of September 24. What I miss is any nice, clean acknowledgment that my canceled check and receipt were in order. I would appreciate a clear yes or no from you on this point.

I didn't say your carrying charges didn't compare favorably. I just said they were exorbitant.

Convey my congratulations to your Western Division.

As ever,
John F. Cummings

•
213 Huron Road
Cleveland, Ohio
October 5, 1956

Mr. Albert Roe, Credit Manager
Central Credit, etc.

Dear Mr. Roe:

Your public relations department may be interested to know that as a result of the bill that I received yesterday, my wife and I are no longer on speaking terms. When she saw it, she wanted to know why, if I'd paid this, I kept getting a bill. I said because I'd paid it the same day I'd run up the charges, and your machine hadn't been wired for payment the same day, because

some other machine had concluded that the statistical probability of anybody's ever pulling such a thing was remote. She said trust me to perform the statistically improbable, and why hadn't I waited to be billed, the way a normal person would have. I said that the procedure had seemed logical at the time, and she said naturally, that was how my mind worked, and little wonder I was instructor at a run-down municipal college instead of being out in the real world making a real living. Spend fifty dollars to save five, that's Johnny Cummings, she said. I told her to stop worrying because a Mr. Roe and three girls were working night and day to straighten it all out. There was a lot more, but what I am trying to emphasize is that the situation around here is pretty acute, and something of a positive nature has to be done about it. At the risk of being judged an anachronistic and a brake on industrial efficiency and socio-economic progress, I suggest that one way to get this monster of yours off my back would be to code a check in the amount of my October bill and run it through the machine. Otherwise, by 1964 I am going to owe you \$918.76, \$582.21 of which is going to represent those carrying charges of yours that compare favorably.

Yours,
John F. Cummings

Central Credit and Accounting Office
Eastern Division
Pearce's
New York 16, N.Y.
October 11, 1956

John F. Cummings
213 Huron Road
Cleveland, Ohio

Dear Mr. Cummings:

Because our machines are coded to your signature and because it would create certain accounting problems, I regret that your suggestion of October 5 is impractical. There is, however, another solution. If you remit another check for the amount due us, as indicated on your October statement, your account would be cleared until such time as we have found our error, when we would refund this amount to you. Hoping that you will find this procedure reasonable, I am enclosing a coded check in the amount of \$346.75. Meanwhile, our organization joins me in regretting your recent marital difficulties.

Sincerely,
Albert Roe

Albert Roe, Credit Manager
Central Credit, etc.

My Dear Mr. Roe:

If at this time I were to send you a check for \$346.75, your accounting problems would be even more acute than they are now. On the first of the month I make monthly payments on a mortgage, a car, an FHA home-

improvement loan, a TV set, a suds-saving automatic washer, a store-more freezer, and a clean-burning electric range. With what remains, I feed a family of four, operate a car, contribute generously to all local utilities, maintain a modest interest in three insurance companies, do my bit for the A.M.A. and the A.D.A., and buy enough clothing so that we can leave the house without being arrested for indecent exposure. In other words, if I sent you a check for the amount that blasted machine says I owe you, you could recap a Goodyear Suburbanite with it.

John F. Cummings

Central Credit and Accounting Office
Eastern Division
Pearce's
New York 16, N.Y.
October 22, 1956

Mr. John F. Cummings
213 Huron Road
Cleveland, Ohio

Dear Mr. Cummings:

I regret that you cannot see your way clear to straightening out your account by paying the balance due us as of October 1. However, I have just requisitioned a staff of 20 girls to check all the Cummings accounts in our files. It will take us some time to complete the check, of course, since these accounts number better than 18,000.

Sincerely,
Albert Roe

213 Huron Road
Cleveland, Ohio
October 25, 1956

Dear Mr. Roe:

What do you mean, "straightening out your account by paying the balance due us as of October 1?" As soon as I can find a lawyer who is interested in a case against a computing machine, I am going to put my canceled check and receipt, together with an estimate for expenses, time wasted, and anxiety suffered, in his hands. By a curious coincidence, my claim is going to total exactly \$346.75 plus costs and a carrying charge of 18 per cent per annum.

John F. Cummings

Central Credit and Accounting Office
Eastern Division
Pearce's
New York 16, N.Y.
October 31, 1956

Mr. John F. Cummings
213 Huron Road
Cleveland, Ohio

Dear Mr. Cummings:

In regard my letter of October 22, I did not intend to

imply that you owed us \$346.75 but only that this amount still appears on your account; and I wish to reassure you that with 30 girls now working on this matter, I am sure we can straighten out everything without recourse of legal action. I cannot avoid thinking that your decision is hasty; such action would be lengthy, expensive, and of no advantage to either party.

Sincerely,
Albert Roe

Cell 64 Municipal Jail
Cleveland, Ohio
November 12, 1956

Albert Roe, Credit Manager
Central Credit, etc.

Dear Mr. Roe:

You will note my recent change of address. I effected to move three days ago, after a conversation with two men from your collection agency, in the course of which I swung on one of them with the poker from my fireplace set. So they booked me in here on the charge of assault. Since then a character has been around, offering to go my bail for a hundred bucks on the barrel-head, as he so colorfully puts it. This being the middle of the month, I have declined his generous offer and elected to sit this waltz out.

My wife is naturally very upset. My wife is a woman who worries about what the neighbors will think. Yes-

terday she tried to borrow \$1,000 to go my bail, but they told her that my credit rating has been changed from A-1, superior, to F-6, very unreliable. I also understand that my salary is to be garnisheed beginning December 1. You may be able to deduce that everything is finally in the hands of a lawyer. He says that on the surface he thinks at least seven articles of the Bill of Rights have been violated. He says we ought to be able to take Pearce's for at least \$20,000. I am delighted, therefore, to pass the word along to you that you will be hearing from him shortly. I trust that this time you will not consider my decision too hasty.

Yours,
John F. Cummings

Central Credit and Accounting Office
Pearce's
November 19, 1956

Mr. John F. Cummings
213 Huron Road
Cleveland, Ohio

Dear Mr. Cummings:

I am very happy to inform you that we have finally found our error. I trust that this information will reach you at your home address, since I have just instructed our Cleveland collection agency to drop charges against you.

(Continued on page 45)



PROGRESS in Engineering

DENVER our central engineering office

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To customers from the Gulf Coast to the Canadian Northwest, Stearns-Roger provides every needed service through one responsible source...one contract.

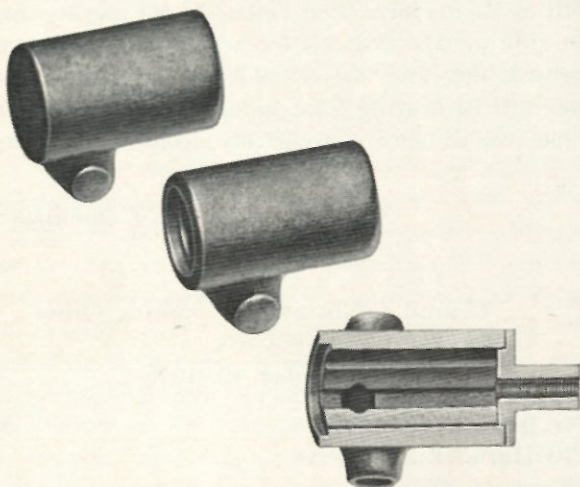
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Malleable Castings...Shortest and Most Economical Route to Quality Products



Eliminate Waste Metal

Why pay for 2.8 pounds of metal... then machine out and scrap 1.2 pounds of the center? Changing this snap coupler to a Malleable iron casting with a cored center reduced initial cost 31 cents and cut the first interior machining operation by 72 per cent (subsequent operations were up to 25 per cent less expensive, too). Through expert use of cores in parts that require interior design details, your Malleable foundry puts metal only where it is needed.



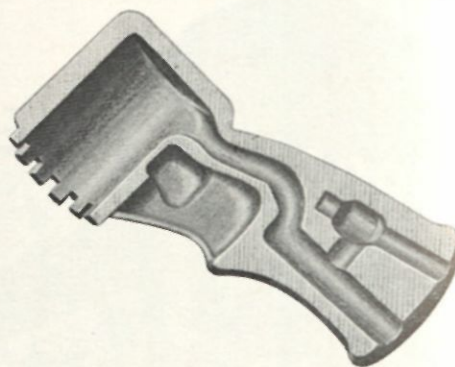
Eliminate Machining

With Malleable you often get the finished part right out of the mold. This Malleable sprocket is used without machining or hardening on the teeth. It replaces a flame cut steel plate to which a hub was welded. Remember, you can get equal or better quality at lower cost with Malleable.



Eliminate Assembly

How much can you save on a simple little hanger like this? Plenty, when you have to cut, bend, punch and weld, including all the handling involved... and when you're using 60,000 pieces a year. Converted to a Malleable casting (with cored hole and better design), this simple part looks better, works better, costs less... because it's Malleable.



Eliminate Surplus Weight

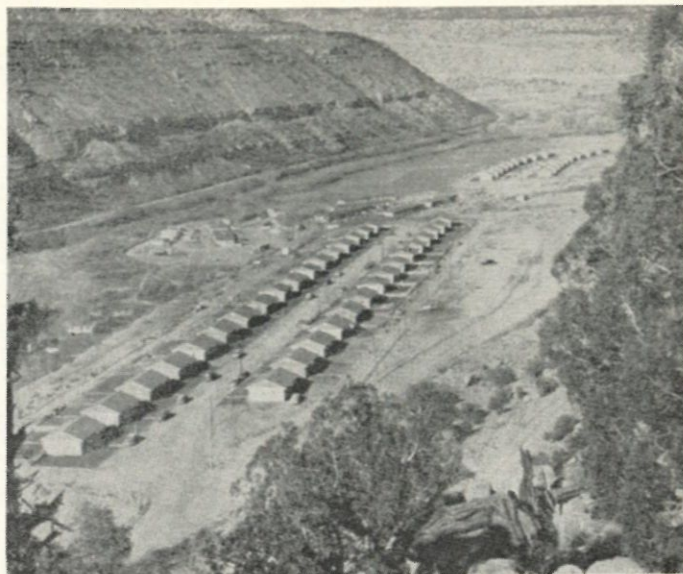
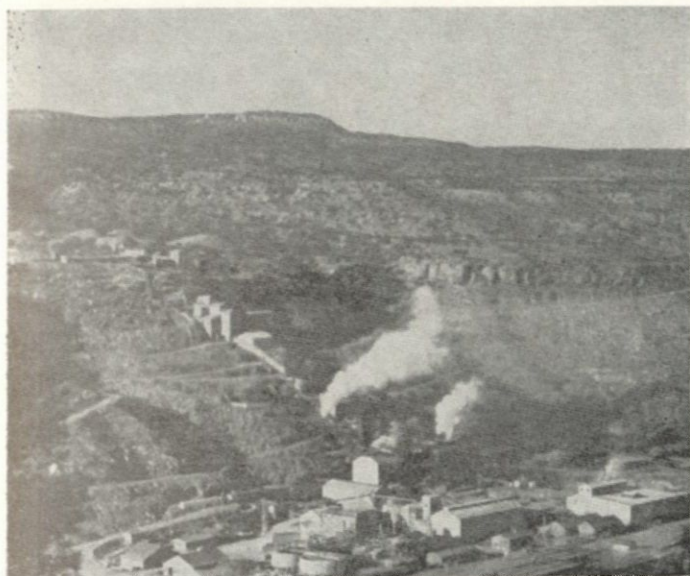
You don't need to beef up parts until they're needlessly heavy just to eliminate failure during use. For example, this pneumatic impact wrench cuts metal, breaks welds, splits nuts and shears bolts. At one time, breakage of the pistol grip housing near the impact area was a serious problem. A change to Malleable solved the problem by providing maximum strength in thin sections. When your parts need a high fatigue ratio, remember that Malleable ranks high among commonly used metals.



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COLORADO



INDUSTRIES

The Colorado Plateau is an arid tableland covering some 180,000 square miles and reaching into five states: Colorado, Utah, New Mexico, Arizona, and Wyoming. This area is the hunting ground of modern-day man for one of his most highly prized elements — uranium. Independent prospectors and companies, incessantly seeking the compounds that contain this element, sell the uranium-bearing ores to privately owned and operated mills which produce a highly concentrated product of uranium oxide (U_3O_8). They in turn deliver the uranium oxide under contract to the Atomic Energy Commission whose headquarters are located in Grand Junction, Colorado. Assays are taken at Grand Junction which determine the weight and exact chemical composition of the uranium oxide that was sent to determine the price that will be paid for the concentrate. The uranium oxide is then sent to other AEC plants and contractors east of the Rockies where it is further processed to become uranium metal or hexafluoride (hexafluoride is used in a type of gaseous diffusion plant).

With this in mind, we can look into the industry in question. This is the independent mills which change the uranium-bearing ores into a highly concentrated uranium oxide. One of the most important mills in Colorado, in terms of the tonnage of

ore that can be processed in one day, is owned and operated by the Union Carbide Nuclear Company. This mill is located at Uravan, Colorado, and represents an interest that is worth almost ten million dollars when you take into account investments and expenditures.

When a load of ore is first received at the mill at Uravan, it is weighed and then dumped into an ore bin. The ore is then sent from the ore bins on conveyor belts through various crushing and sampling equipment where it is ground into a mixture of smaller-sized particles. These particles are then screened to assure uniform size for the later processes.

DENNIS POWERS

Chemical reagents such as salt are then added to the ore; a mixture of these ores and salts is then fed into huge roasters which are several stories high. After the roasting operation, the ores are then treated in large wooden leaching tanks. During this leaching process, the uranium is dissolved by a combination of solutions. The uranium is then precipitated by further processing operations. The uranium precipitated is then filtered and dried. This precipitate is a bright canary yellow in color and is packed in steel drums for delivery to the AEC as the desired uranium oxide concentrate.

Uravan lies in the beautiful San Miguel Valley, right in the middle of the rich carnotite ore bodies (one

of the uranium-bearing minerals) of the Colorado Plateau. One-half of the townsfolk are employees and their families of the United Carbide Nuclear Company. The corporation owns all of the community buildings except the school. This, however, in all rights is a typical "up-to-the-minute" American community.

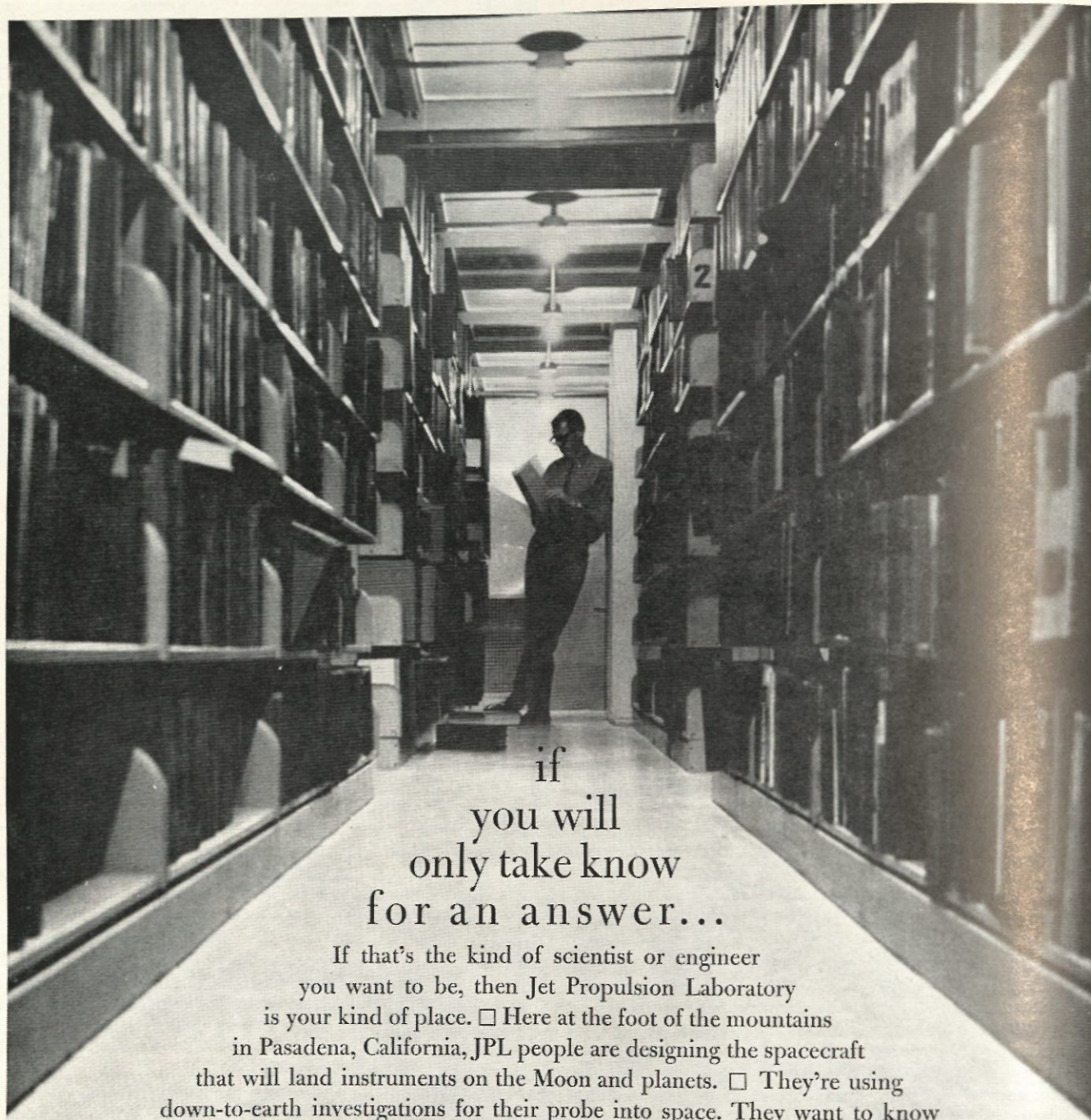
Employees at Uravan can participate in a low-cost health and accident insurance plan, which includes both occupational and non-occupational benefits. There is a company savings plan and a pension plan to which they don't have to make any contributions.

Besides the ore-refining plant at Uravan, the United Carbide Nuclear Company also owns another large mill at Rifle, Colorado; is presently engaged in a multi-million dollar building program that includes two new processing mills at Rifle and Maybell, Colorado; and operates two ore-receiving stations and chemical upgrading plants at Slick Rock, Colorado, and Green River, Utah. As can be seen, this company is engaged in almost all aspects of obtaining uranium from this area.

Prospective employees can obtain more information on the work of the United Carbide Nuclear Company by writing the Personnel Manager, c/o the United Carbide Nuclear Company, Grand Junction, Colorado.

Photo Left: View of ore treatment plant at Uravan from mesa overlooking a part of San Miguel Valley.

Photo Right: One of the newer settlements of company housing in the San Miguel Valley.



if
you will
only take know
for an answer...

If that's the kind of scientist or engineer you want to be, then Jet Propulsion Laboratory is your kind of place. ☐ Here at the foot of the mountains in Pasadena, California, JPL people are designing the spacecraft that will land instruments on the Moon and planets. ☐ They're using down-to-earth investigations for their probe into space. They want to know what the Moon is made of. If there's life on other planets. They *have* to know. They will know. ☐ If *you'll* only take know for an answer, then discover the many disciplines involved in other-world exploration. Write today for your copy of "Missions Into Space/Jet Propulsion Laboratory". ☐ All qualified applicants will receive consideration for employment without regard to race, creed or national origin/U.S. citizenship or current security clearance required.



JET PROPULSION LABORATORY

4800 Oak Grove Drive, Pasadena, California

Operated by California Institute of Technology for the National Aeronautics and Space Administration

COMPUTER



Dr. Louis J. Gerstman (left) and Dr. J. L. Kelly, Jr., of Bell Telephone Laboratories, listen to a tape recording of synthesized speech which was produced by an electronic digital computer. The computer is fed, on punched cards, the names of speech sounds which make up an English sentence. It processes this information and produces synthesized speech in digital form on a magnetic tape. This tape is converted—on the machine behind Kelly and Gerstman—into a $\frac{1}{4}$ -inch magnetic tape suitable for playing on an ordinary tape recorder.

BILL ROBBINS

Computer, a word of mystery and wonderment. Only a few short years ago the word computer was closely allied with space ships, ray-guns, and Buck Rogers in the 25th century. Today we have entered the space age—but only with the help of that marvel, the computer. Just what is a computer? What does it do? What will it do in the future? And many other such questions are on the tongues of the uninformed. Here I will attempt to answer a few of these questions from the layman's point of view.

First we must establish a fact. A computer is not a mysterious device operated by witchcraft or black magic. It is a device that behaves according to basic mathematical concepts which will solve complex problems in a relatively short time. The problem may or may not be mathematical in nature. Hence, to understand a computer's function one need not be a psychiatrist nor a neurospecialist—just be an average individual with an understanding of basic mathematics. A computer cannot solve a problem that a good mathematician couldn't solve. It goes without saying that the computer would be a little faster. For instance, computers of the missile age are able to make 10 million or more basic computations (such as addition) in one second. A good mathematician would take a little more than 2500 hours to do the same job—and that is without a coffee break.

Basically there are two kinds of computers, the digital and the analog. From these basic units, logic machines, simulators, and other high speed problem solving devices have been built.

The first of the basic units, the digital computer, is probably the older of the two, at least in a recognizable form. As might be expected a digital computer is a device that works with exact numbers. All problems are reduced to a series of additions that are performed at a very high rate of speed. The computer, in turn, produces a numerical answer that is as accurate as the least accurate figure used in the computation. There may be older machines that could be classed as digital computers, but the abacus, which dates back to ancient times, in the hands

Bill Robins is a Senior in Electrical Engineering. He is here on the Naval (NESEP) Program.

of a skilled operator may be considered to be a high speed digital computer. Today, however, we think of a digital computer as an electronic monster with automatic information feeders that produces an automatically typewritten answer. This stereotyping is a product of our society. The machine may or may not be an "electronic monster"; however, the skill of a trained operator can make it perform properly.

The analog computer, on the other hand, is a device that uses shaft rotations, distances, voltages, or some other measurable quantity to represent the information of a problem. The answer, in turn, is also represented by a measure of this same quantity and it must be translated into a meaningful answer. One might argue, therefore, that the analog computer is at least as old as the digital computer. For instance, the first time-measuring device was a twig stuck in the ground, and as the shadow cast by the twig moved, a passage of time was indicated. This "clock" fits the definition of an analog computer. The accuracy of any analog computer depends upon its refinement; however, its lack of precision is more than compensated for by its relative simplicity. A slide rule is an example of an analog computer familiar to most people. Its accuracy is preported to be directly proportional to the operator's ability; however, its use is somewhat limited to basic computations and is of little value in solving differential equations. It should be mentioned here that both the analog and the digital computers have fantastic speeds and both can be constructed and programmed to solve differential equations as well as algebraic and numerical problems.

The first step in the solution of a problem is recognizing precisely what the problem is. This may sound trivial particularly when compared with day-to-day living, but when problem recognition is applied to something like the national economy or space travel (one seems to be proportional to the other) it becomes obvious that the problem at hand may not be immediately obvious. After the problem is defined though, it must then be translated into the language of the computer. These two steps alone often take more time than the computer will take to solve the problem, which, by the way, is the next step. When the solution becomes available, it then has to be interpreted. Even this brief outline sounds outrageously complicated, but when one takes into consideration that literally years of work can be reduced to hours of work then the

value of the computer becomes apparent.

What about the so-called "think machine" and the "logic devices" that are publicized from time to time? Will my boss eventually be an electronic device? Or even worse, will I be replaced by a push-button? One must remember that these machines were made by men to be operated by men and without men the machines are helpless. Computers are tools to be used by man to analyze situations, solve problems, and determine issues; however, the final decisions must be made by man.

Some of the "stunts" computers have been up to lately seem somewhat amazing. Therefore, a few of these "stunts" will illustrate the vastness of the horizon for the world of computers.

Carolling Computers

A method of producing synthetic speech in response to the typing of phonetic symbols on a keyboard has been developed by Bell Telephone Laboratories. The device can be made to "talk" in monotone or by introducing a varying pitch and timing parameter more natural inflection and phrasing may be obtained. The computer can also be made to sing. Although this last feat is amazing, it is not too startling to the people of the CU campus, as our own Engineering Math Department has demonstrated the ability of their computer to play Christmas carols.

Computers can do more than sing and talk. They can more than solve problems. Computers have been used to aid in designing concert halls. By properly programming a computer as to the size, shape, and acoustical conditions of a proposed concert hall one can simulate what happens to sound waves as they bounce back and forth across an imaginary room. Tape recordings of speech and music are fed into a digital computer that has been programmed to act upon these sounds just as the floor, the walls, the ceiling, etc., of the imaginary auditorium. The computer produces an output tape that is listened to over several loudspeakers distributed in various places in a free-space room (a room which does not produce any sound reflections of its own). If the sound is not satisfactory, the computer can be reprogrammed to simulate a different room shape or wall material, and the sound can be processed again for these different acoustics. In this way, the acoustician can design a hall in which music and speech originating on the stage can be heard with maximum enjoyment throughout the hall. This same scheme can be used to improve the

acoustics of existing halls either by designing minor changes or by the addition of artificial reverberation designed specifically for the given auditorium using the computer techniques.

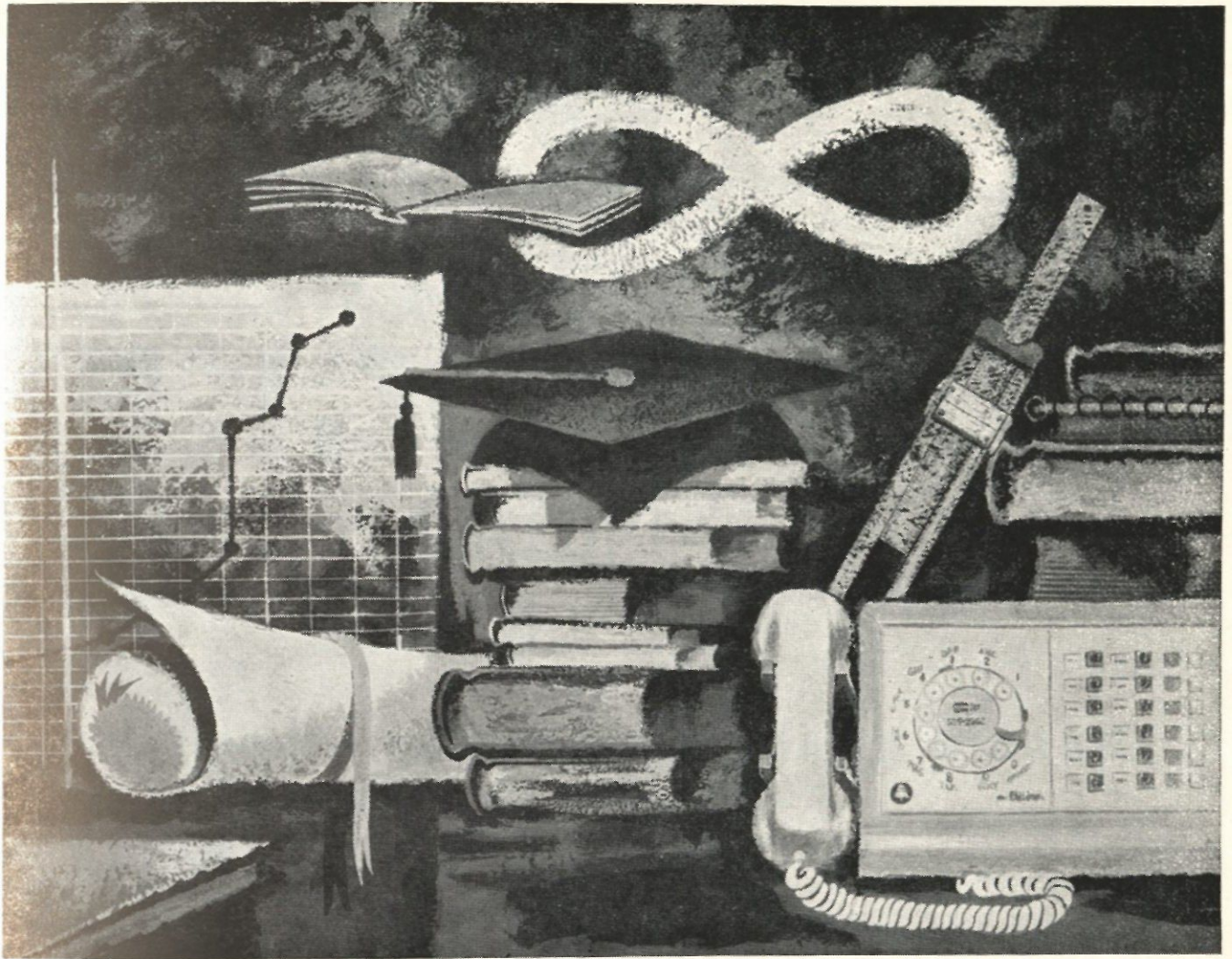
Computers are now being used to design computers. About a year ago the first computer built from complete wiring information and parts lists furnished by another computer was shipped to Ascension Island, near the target area of the Atlantic Missile Range. The computer is to be used in connection with target tracking tests for NIKE-ZEUS, the U. S. Army's anti-missile defense system. The entire logic network of the digital computer, consisting of 47 sub-assemblies, was built from wiring diagrams, assembly information, and parts lists produced by a specially programmed, general purpose digital computer. In addition, manufacturing information produced on the computer, can be converted into a control program for an automatic wiring machine, which would do the actual assembly work. Initial experiments on the aspect of the program indicate that automatic wiring of the mechanically-designed computer is feasible.

The instructions also specified the pins to be interconnected, the size and length of wire to be used in connecting them, and the wire paths to be followed for minimum path length. Any special-purpose logic packages to be used in a subassembly were also specified by the computer. After the wiring information sheets were completed, a complete parts list including logic packages, externally wired resistors and capacitors, and necessary wire was prepared by the computer.

A few of the present uses of computers have been touched on; however, the list is endless and it is growing every day. As miniaturization improves, the feasibility of a portable data processing unit will become a reality. Talking machines for people unable to talk and reading machines for the blind are very real possibilities. Super simulators will simulate every motion, action, and environmental element for any type of a training mission. The uses of computers will only be limited by the velocity of electromagnetic energy propagation and the imagination of man. And, you know something?—Man has a pretty fantastic imagination!!!

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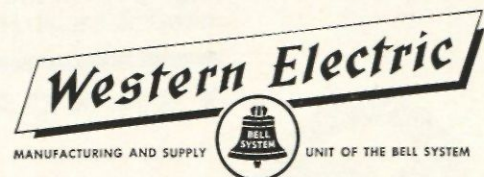
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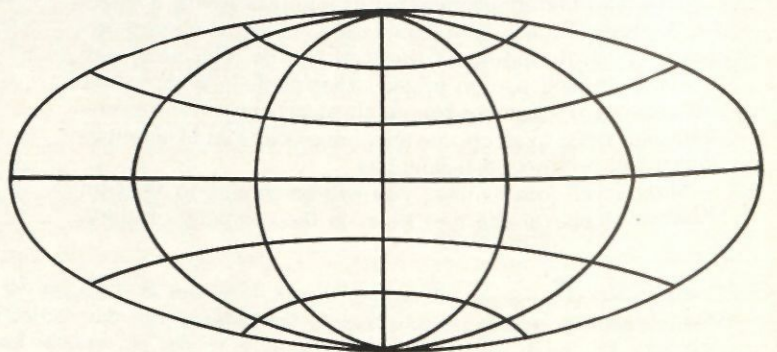
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THIS

TODAY



A LARGE MIRROR

Corning Glass Works has fabricated the world's largest piece of fused silica—62 inches in diameter and 11 inches thick. The giant glass disc will be the primary mirror in a new precision telescope.

The U.S. Naval Observatory will construct the telescope at its Flagstaff (Arizona) Station. The instrument is the first large reflective telescope designed especially to determine distances and movements of stars up to 600 trillion miles from the solar system.

Fused silica is a relatively new material and it is one of the purest known to man. Its shape will not alter from extreme temperatures because of its practically zero expansion rate. Therefore, as a telescope mirror material, fused silica assures distortion-free images.

The large mirror was made at Corning's Bradford, Pa., plant and is now being precision-ground and polished by Davidson Optronics, West Covina, California. The telescope is to be finished in July, 1963.

The telescope will enable astronomers to observe deep space probes and distant satellites in addition to its application to basic research in positional astronomy.

The "seeing" capacity of the telescope will increase man's ability to measure motion and determine the position of celestial bodies a hundred times. The instrument is expected to provide new information on the candle power of the red and white dwarf stars as well as important clues to the physical properties and evolutions of these objects. The instrument is designed to provide photographs of unprecedented clarity and detail.

The secondary reflective piece in the telescope will be a smaller fused silica disc—36 inches in diameter and 6 inches thick.

NEW SOURCE OF ELECTRICITY

General Electric scientists have recently produced electrical power using a principle that they call "electrohydrodynamics" or "EHD." The work is being done under contract to the Air Force's Aeronautical Systems Division. The principles of EHD have been established for a long time, but it is believed that General Electric is the first to produce more electricity than was supplied previously from outside sources.

In an experimental generator, air was forced through a corona discharge

field and was ionized. Electrons were drawn off in the area of the corona fields and ions were pushed downstream by neutral atoms to a collecting grid where they were combined with electrons again. The electron flow from the corona through a circuit to a collecting grid constituted an electrical current.

The EHD concept is similar to the more familiar magnetohydrodynamics, "MHD," generator although it uses a different principle. An MHD generator produces a current by passing ionized gas through a magnetic field. The EHD system theoretically will produce more power per pound at higher voltages than MHD systems.

A net output of 1.4 milliwatts at 170 volts was generated by the EHD system during the experiments. The output increased with the velocity of the air flow. A small amount of power was fed to the corona ring as an exciter.

Experiments showed that as the velocity of the air flow increased, causing more electricity to be generated, the amount of externally-supplied electricity—used to excite the corona ring—was replaced. Only one-tenth of a milliwatt was still being supplied externally when the 1.4 mil-

JOE CAYER

liwatts was being produced through EHD.

EHD is used in much the same way as MHD. It converts energy, having successfully changed kinetic energy of a moving gas into electricity. Because of its high voltage, EHD may be used as a source of power for the high voltage ion engines being developed for long-range space flight propulsion, according to scientists.

FASTER X-RAYS

The Eastman Kodak Company has introduced to the market what is believed to be the fastest industrial X-ray film in the world. The emulsion is an improved Kodak Industrial X-ray Film, Type F, whose speed has been increased by 30 to 50 per cent.

According to a company spokesman, the film should provide a substantial increase in speed of the film with no apparent change in contrast, fog, or graininess. The range of speed increases obtainable is dependent upon the particular combination of radiation and type of intensifying screens employed.

The new film is designed for use with industrial fluorescent screens and is specially adapted to industrial radiographic exposures where the thickness of the specimen slightly exceeds the capacity of radiographic equipment to make direct or lead screen exposures.

SPACE NEWS

A new discovery will save the government substantial money, labor, and materials. Research scientists at the AC Spark Plug plant in Milwaukee, Wisconsin, have discovered a way of stopping the effects of oxidation in gyroscopic instruments used in internal guidance systems for ballistic missiles. Even infinitesimal amounts of oxygen in bearing lubricants could deliver a knockout blow to a precision manufactured gyroscope. One of the research scientists said that he knew of no organic lubricant on the market that was completely oxygen free.

Deposits of a varnish-like material were showing up on gyroscope bearings. The sticky, viscous substance collected on precision-made ball bearings the gyroscope wheel was mounted on. These wheels run at a speed of about 12,000 rpm, and can only be given a minute quantity of lubrication.

To alleviate the problem, the gyroscope is evacuated to an almost perfect vacuum that is equivalent to atmospheric conditions at about 100 miles from earth in outer space. The chamber is then filled with "purified" helium. Helium is used because of

its inherent capability of cooling the rapidly spinning gyroscope wheel and because of its low friction quality. However, the helium is still loaded with enough oxygen to cause trouble even after the purification. Oxygen molecules are also absorbed by the materials used in making the gyroscope. The scientists found that the fastest and most economical way to get rid of the oxygen is to burn it out. The life of the gyroscope is three to four times greater than it was.

Previous to the discovery that oxygen in the lubricant was causing the varnish-like deposits, all research had been aimed toward the bearing itself. While there were serious attempts to analyze the lubricants, the exceedingly low concentrations of the oxygen causing lubricant degradation had not been considered.

MINIATURE CIRCUIT BREAKER

A glass-encapsulated, temperature sensitive circuit breaker for the protection of shaded pole and permanent split-winding types of electrical motors has been introduced by Sylvania Electric Products Inc. Sylvania calls the new breaker the Thermo-Break. It is air tight and gas filled to allow fast heat transfer between the motor winding and the breaker. The Ther-

mo-Break is 1.26 inches long and 0.3000 inches in diameter.

The breaker requires no insulating sleeve and can be varnish-dipped with the motor windings. Metallic case grounding is eliminated because the wire leads require only two connections and they are compatible with motor winding wire.

The glass-enclosed Thermo-Break consists of two mounting posts upon which the electrical contacts are located. One contact is mounted directly on a post; the other is mounted at the junction of the armature bimetal and current-carrying bimetal (see diagram).

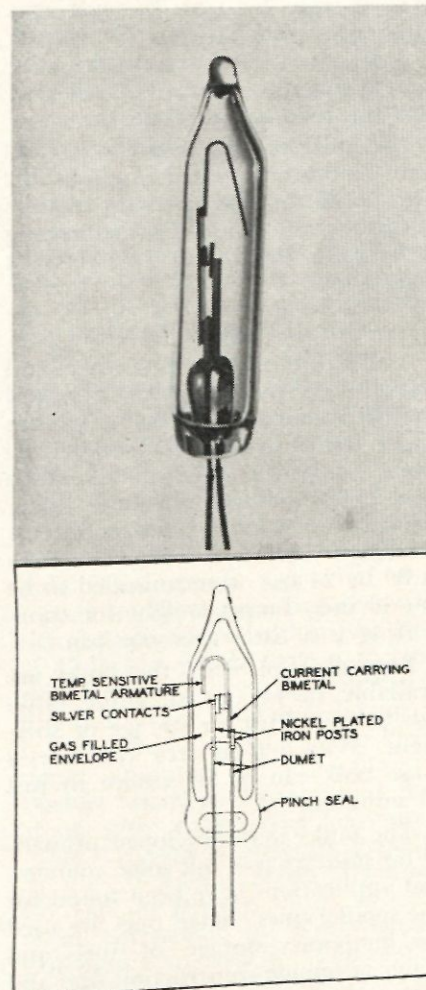
Under normal current flow, the lower bimetal forces the contacts together because of the normal operating temperature of the motor. If the motor should overheat, the high expansive side of the armature bimetal will force the armature against the glass envelope driving the contacts apart and breaking the circuit. The reverse takes place as the motor cools. This cycling will continue until the electrical overload is removed; thus, the motor or component is protected against excessive temperatures which could cause burnout.

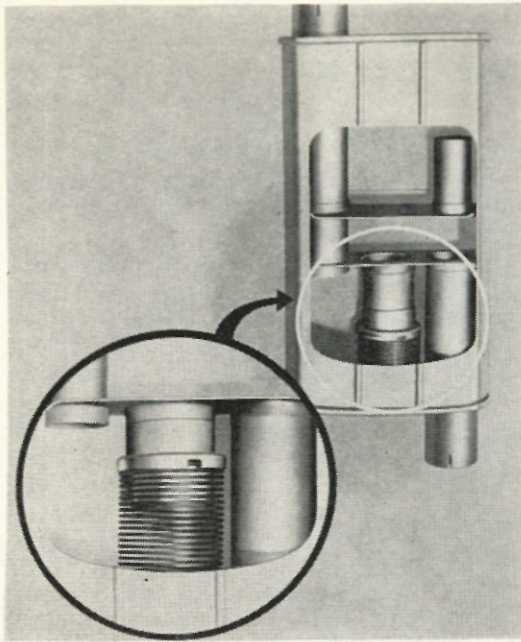
RADIATION SHIELDING

The Atomic Energy Commission has developed concrete mixes specifically designed for radiation shielding. The work was done by AEC engineers at the Oak Ridge National Laboratory. The study was made because, according to researchers, "the widespread use of concrete as a radiation shielding material has established a need for mix design criteria primarily oriented toward shielding problems."

An "idealized formula" given by the researchers is: cement volume plus water volume plus aggregate volume equals Total Volume of Concrete. "The simplicity in use of the total volume formula," the investigators say, "lies in the fact that there is a definite relationship between the cement-to-aggregate ratio and the water-cement ratio."

A barytes concrete—"designed according to these criteria"—was investigated at Oak Ridge National Laboratory, the study says. Relative effectiveness of dry aggregates, aggregates plus cement, and cured concrete were compared "through thermal-neutron flux, fast-neutron dose, and gamma-ray dose measurements behind slab configurations." Attenuation was measured for the aggregate, the aggregate plus cement, and for the barytes concrete. According to the AEC report: "Comparison with attenuation calculated on the basis of removal cross sections for the meas-





NEW TYPE OF MUFFLER

ured chemical compositions showed satisfactory agreement."

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JET-FLO MUFFLER

The first 100 per cent stainless steel auto muffler is now being made. It should alleviate the annual \$75-million dollar muffler corrosion problem. Hayes Industries Inc., of Jackson, Michigan, is making the newly designed muffler of a special stainless steel called MF-1. This steel was developed by Allegheny Ludlum Steel Corporation for muffler applications.

The new muffler, only about one half the size of conventional mufflers, uses a new technique to deaden the engine's roaring sound. Hayes Industries calls this their Jet-Flo muffler. It weighs a little more than seven pounds and is made completely of steel.

The stainless steel muffler is different in that it has moving parts. It has a special stainless steel spring which operates on exhaust pressure. The spring adjusts automatically as driving demands dictate. Conventional mufflers are pre-tuned when made for the car and model. The Jet-Flo muffler adjusts itself at "idle," at turnpike driving, or anywhere between, giving maximum gasoline economy and minimum exhaust noise.

The spring action pulses with engine pressures. The greater the engine pressure, the wider the spring action. The extremely narrow openings between the spring coils at low rpm act as an effective sound attenu-

ator, while the continuous vibration of the "valve" tends to smooth the pulsations in the exhaust gas. Thus, it again reduces the sound level in the system.

More important is the fact that at higher rpm, when more volume of gas is exhausted, the valve will automatically open wider to provide a large passage for the exhaust gas. This means that an effective silencer at low rpm is not permitted to become a source of excessive back pressure for turnpike driving.

The muffler has been both field and laboratory tested successfully. The Jet-Flo muffler carries a lifetime warranty to the original owner as long as he owns the vehicle on which it is installed.

COLLAPSIBLE TANKS

A collapsible fabric tank made and marketed by the Goodyear Tire and Rubber Company is 10,000 gallons larger than any previous rubberized fabric container. The tanks, which hold 75,000 gallons, were built under contract to the West German Defense Ministry. The tank covers an area of 89 by 24 feet when unrolled to be put in use. Empty weight for transporting is a little over one ton.

Regardless of size—the tanks are available in various sizes—the tanks can be rolled up for storage or shipment. With a clear area available, a large tank can be in service in just 15 minutes.

The tanks were developed primarily for military use, but some commercial applications have been found for the smaller ones. Small ones are used for temporary storage of fuels and water at remote construction sites and



COLLAPSIBLE FUEL TANK

for draining oil during servicing of huge electrical transformers. Truck operators carry two way loads with dry cargo in one direction liquids on the return. Among commodities being hauled in the tanks are fruit juices, liquid sugars, printers ink, and liquid fertilizers.

The tanks are fabricated from special nylon material treated to stop seepage or vaporization. For fuel service, they avoid collection of explosive vapors by remaining in contact with the fuel on all sides so that voids cannot form. Plastic liners are used with stainless steel fittings to insure against contamination by the rubber lining when edibles are handled.

ALGAE ABANDONED AS SPACE DIET

Algae, once considered the first choice for space ship menus, has now been all but abandoned as an outer space edible.

The reason is that algae, among other things, would turn man a bright yellow color. The Space Age Spinach has an excess of carotene, say aerospace company scientists, the substance which gives a carrot its color.

Air Force estimates say algae might provide up to about 30 per cent of the diet, but even then the travelers might tend to turn technicolor.

Algae will still be used on deep space missions to absorb carbon dioxide and to give off fresh oxygen. But spacemen had best limit their munching.

Aerospace

Theory: A hunch with a college education.

ALUMNI NEWS

THERESA STEPHEN



MARVIN J. GREER, B.S. (C.E.) 1932, has been recently appointed to the position of area development engineer for the Denver Development Office of the U.S. Bureau of Reclamation Region No. 7. Greer is returning to the bureau after resigning in 1958 to become the chief engineer for the Van Sickle Associates, Inc. While with Van Sickle, he was in charge of planning and designing the Taqueri River Navigation project in Brazil and studied for the Lower Falls Hydroelectric Project on the Caroni River in Venezuela for the Venezuelan government.

A veteran of years of planning, designing, and engineering experience, Greer is replacing Joseph M. Barrett. Greer was first employed with the bureau in 1935 in connection with the Colorado-Big Thompson reclamation project. Later he precisely surveyed the 13.1-mile Alva B. Adams tunnel and received a certificate of merit. The tunnel was excavated from two headings which met under the Continental Divide to an alignment of within five-eighths inch. In 1950 he transferred to the Denver Region 7 office.

Greer has many major projects to face since the Denver Development Office is in charge of planning for the Narrows unit on the South Platte River, the Fryingpan-Arkansas diversion and Trinidad projects in southern Colorado, and the Wheatland project in southeast Wyoming.

An honor graduate of the University and a veteran of World War II, Greer resides at 2203 E. Dartmouth Circle, in Englewood with his wife and their two sons.

LEONARD TULIN, B.S. (C.E.) 1950; M.S. (C.E.) 1952; has received a \$35,600 National Science Foundation grant to study the reaction of reinforced concrete structures under intermittent loads.

Along with C.E. Associate Professor Kurt Gerstle, Tulin, an associate professor in the department of Civil Engineering at the University, is studying the properties of concrete and steel to find a theory by which engineers can predict on paper the life of a reinforced concrete structure.

Tulin and Gerstle explain that a reinforced concrete structure, such as a bridge, can be rendered useless over a period of time with heavy loads rolling over it.

Presently engineers design such structures with a large enough "safety factor" to insure the bridge will stand a certain number of years before having to be replaced. The same principle is being applied to buildings and highways according to Tulin.

Tulin has been associated with the Department of Civil Engineering since 1951. In 1951, he was an instructor in the department and then in 1953 he was promoted to an assistant professor.

This present award is not the first for Tulin. In 1958, he was awarded the National Science Foundation science faculty fellowship to study at Iowa State College in 1959.

HERBERT M. COULSON, B.S. (E.E.) 1941, currently President of the Colorado Engineering Council, which represents 20 engineering and scientific organizations within the State of Colorado which have a membership exceeding 5000 is a Registered Engineer in the State of Colorado. He is a member of A.I.E.E., the Professional Engineers of Colorado, the Pueblo Engineers Society, and numerous other engineering activities.

Mr. Coulson is presently President of the Mountain States Machinery Co. Inc., in Denver, which sells electrical equipment in Wyoming and Colorado. An ardent supporter of alumni organizations, he is a past

member of the Engineering Development Foundation at the University.

Mr. Coulson, his wife, Kay, and his daughter, Karen, reside at 675 Estes in Lakewood, Colorado. His daughter is a senior at Lakewood High School and is considering attending the University of Colorado in 1962.

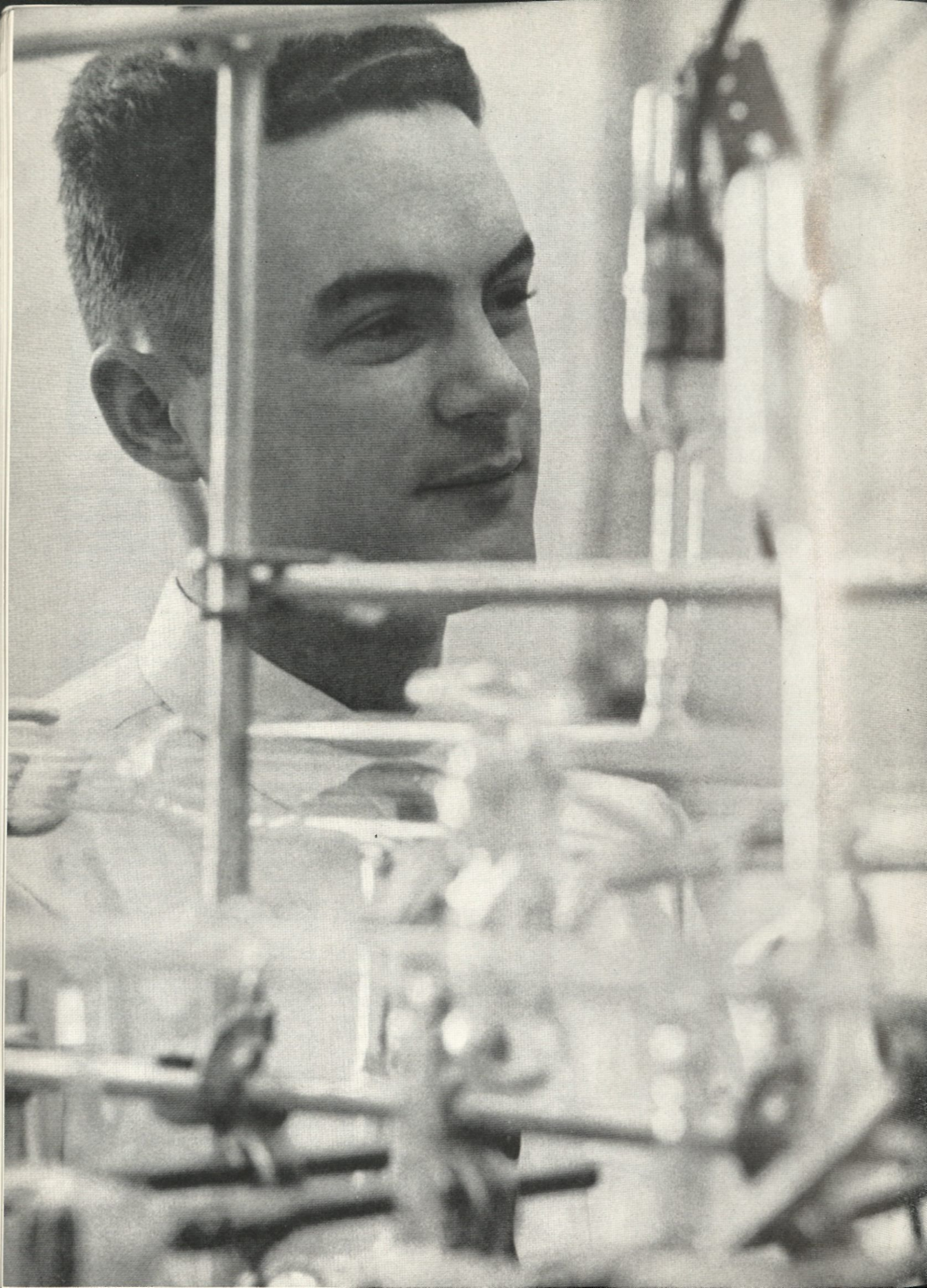
PROFESSOR BENJAMIN H. SPURLOCK, M.E., 1950, and his wife, attended a heat transfer conference in London, January 8-12. The London meeting was a continuation of the second International Heat Transfer Conference held at the University last summer. Spurlock presided over a discussion session dealing with heat transfer within container systems.

Since 1950, Spurlock has been a professor in the College of Engineering and is presently the acting head of the University of Colorado Mechanical Engineering Department. In 1953 he served as the honorary chairman of the American Society of Heating and Ventilating. In 1955 he was invited to lecture and serve as consultant to the College of Engineering in Baghdad for the following year.

ROBERT B. ECKEL, B.S. (M.E.) 1947, has been Division Liaison Engineer in the Automotive Assembly Division of Ford Motor Company since last July. This division is charged with the responsibility for motivating the responsible departments to correct problems, thus increasing customer satisfaction and reducing warranty and policy expense.

Eckel resides in Dearborn, Michigan, and is active in church and civic affairs.

Upon his graduation in 1947, he was with the Engineering Department of GMC Truck and Coach Division of General Motors Corporation.





Edward M. Davis, Jr. (B.S.E.E., Carnegie Tech '55; M.S., Cal Tech '56; Ph.D., Stanford '58) is directing micro-electronic device development at IBM's Poughkeepsie, New York Laboratories.

DR. DAVIS AND MICRO-DEVICES

When Dr. Edward M. Davis was working for his bachelor's degree, miniaturization was a novelty. Today, with the transistor and the printed circuit commonplace, micro-miniaturization is one of the newest challenges in electronics. Ed Davis is helping to meet that challenge.

Today's computer operations take only millionths of a second; tomorrow's may accelerate to billionths. In a billionth of a second, however, even light can travel only about a foot, and the physical size of an electronic circuit may slow its operation critically. The answer is in micro-electronics where complete circuits are packaged on minuscule substrates, and each transistor may occupy less than a thousandth of a square inch.

Since early in 1961, Ed Davis has been in charge of an IBM engineering project exploring the parameters of advanced micro-devices. His work may very well help establish the technology of future computers. Equally important, he and his colleagues are already gathering significant knowledge in the advanced study of solid state electronics.

A basic approach is encouraged at IBM. Whether in research, development, manufacturing, or programming, the IBM scientist and engineer are encouraged to go to the heart of the problem. The IBM representative interviewing you on your campus will be glad to discuss with you the opportunities in any one of these fields. All applicants will receive consideration for employment without regard to race, creed, color or national origin. Your placement office can make an appointment, or you may write, outlining your background and interests, to:

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The Double Based Diode

PHILLIP D. OLBERT

If you were a production engineer in a vegetable cannery, would you station an employee at the end of the canning line with a little sequence counter to tabulate the number of cans produced? Of course not; you would devise some sort of automatic counter, and thereby eliminate a large expense and source of error.

Many engineers today, however, use methods almost as crude as that illustrated above for some purposes, simply because they are not familiar with more advanced techniques. The problem of switching electrical currents is a good example. Relays have long been outdated for many switching applications, yet they continue to be used for purposes for which they are completely unsatisfactory.

The object of this article is to briefly describe a device that will perform a switching operation in a fraction of the time required by a relay, will virtually never wear out, and is very reliable.

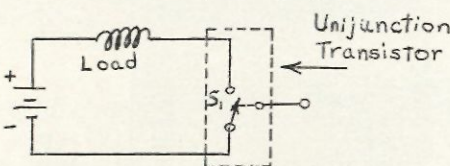
Ever since the development of the transistor in 1948 there have been a growing number of semiconductor devices appearing on the market. One of these devices which appeared about 1957 was the double base diode, more popularly known as the Unijunction Transistor. This device was designed specifically as a switching element, and as will be seen, makes an excellent switch for many applications.

General Description

The Unijunction Transistor is a three terminal semiconductor device which utilizes some very non-linear electrical characteristics for achieving its switching function.

A simple model that might facilitate understanding the transistors

operation could be the following circuit. The switch represents the transistor, and as shown, is turned on by a positive voltage pulse. It will be shown later how the circuit may be adjusted so this pulse needs only to be of a relatively low magnitude.



Analytical Description

Certain electrical characteristics of the transistor resemble closely those of a conventional junction transistor. Other characteristics resemble those of a tunnel diode, while still other characteristics seem to be unique to the unijunction device. Here we will consider only those characteristics relevant to the use of the device as a switch.

The unijunction transistor's switching characteristics are relatively easy to explain.

Let the distance from the emitter to base-one equal l_{e1} , distance from emitter to base-two equal l_{e2} , and distance from base-one to base-two equal l_{12} .

Now, if a positive d.c. voltage V_{b2} is applied with no emitter current the bar of N-type silicon will act as a linear voltage divider. This means that the voltage at the emitter junction will be given by

$$V_{ejet} = V_{b2} \frac{l_{e1}}{l_{12}}$$

If V_e is less than V_{ejet} the emitter junction will be reverse biased and the only emitter current present is $I_e = -I_o$, where I_o is the value of reverse biased leakage current.

When the value of V_e is raised sufficiently that $V_{ejet} \leq V_e$ a fairly large forward biased current will flow

across the emitter junction. This current appears in the bar primarily in the form of holes which are swept toward base-one. The presence of the holes in the emitter to base-one region lowers the resistance of this region and therefore a larger part of V_{b2} is developed from base-two to the emitter. This means of course that V_{ejet} is lowered and so I_e increases. The net result is a negative resistance region in which V_e decreases as I_e increases.

It is seen from the input curves that there are three major regions of operation. 1. The cutoff region where $V_e < V_{ejet}$. 2. The region of

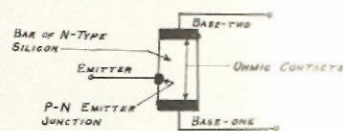


Figure 1 Cross sectional construction of a Unijunction Transistor

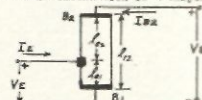
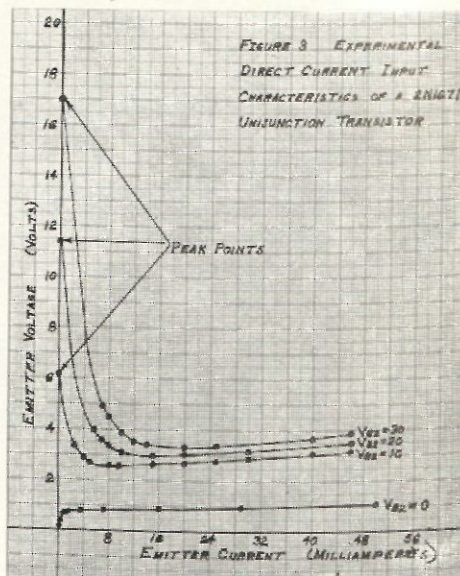


Figure 2 Definitions of Voltage and Currents for a Common Base-VBE Configuration



Philip D. Olbert is a Senior in Electrical Engineering.

high negative input impedance. 3. Small positive input impedance region or saturation region.

The mechanics of the first two regions have been previously explained. The saturation region may be explained as follows: The incremental input impedance is given by*

$$r_e = \frac{dV_e}{dI_e} \quad (1)$$

and for the forward biased condition

$$r_e = \frac{dV_{ejet}}{dI_e} \quad (2)$$

As I_e is increased it may be visualized that a point is reached at which the increase in V_{ejet} , caused by ΔI_e , bal-

ances the decrease in V_{ejet} which results from a larger part of V_{b2} being developed in the region I_{e2} . Beyond this "balance point" the ΔI_e term

dominates and the result is a fairly constant value of $r_e \approx 20$ ohms.

From the preceding discussion it is readily seen that a fast, reliable, and efficient switch may be devised using the unijunction transistor.

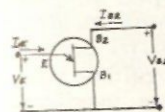


Figure 4 Schematic representation of the Unijunction Transistor

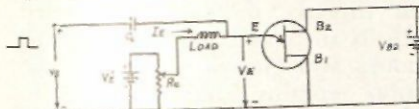


Figure 5 A delay circuit

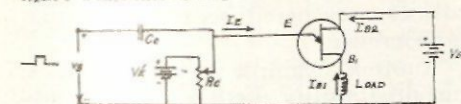


Figure 6 A unijunction switching circuit with load in base-emitter circuit

Referring to the above circuit it is seen that if V_e is adjusted to a point just below the peak point determined by V_{b2} (see Figure 3) it is only necessary to "pulse" the junction with a small voltage to switch on the transistor. The current through the relay is then limited only by the load resistance, the conducting value of V_e , and the amount of R_e in series with V_e and the emitter.

$$I_e = \frac{R_{load} + R_{es}}{V_e - V_e^1} \quad (3)$$

If a large value of I_e is desired it is usually desirable to choose V_e^1 as near the peak value as possible in order to reduce the series value of R_{es} necessary in the circuit.

To "turn off" the transistor the emitter current must be reduced to

*d stands for partial derivative.—Ed.

**We used a capital Sigma since our printer did not have the lower case.—Ed.

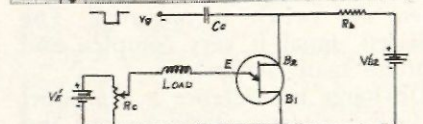
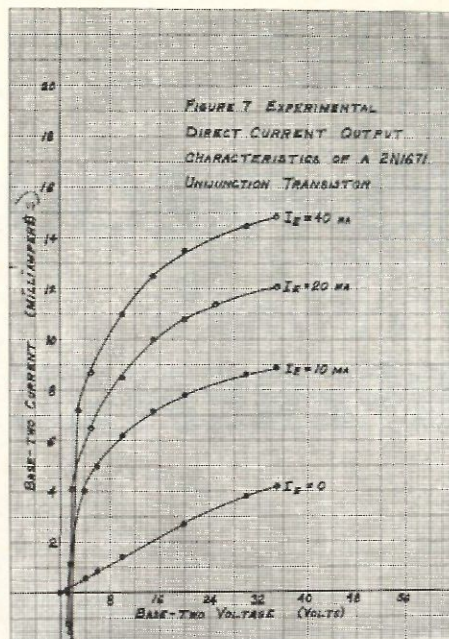


Figure 8 A unijunction switching circuit utilizing negative pulses for activation

zero. This may be done in one of two ways: a large negative value of V_e of the order of V_e^1 may be applied momentarily, or the emitter circuit may be literally opened in some fashion.

If a somewhat larger value of load current than I_e is desired, the following circuit may be used, providing the load will tolerate a certain level of bias current.

Now the load current I_{b1} , is given by

$$I_{b1} = -(I_e + I_{b2}) \quad (4)$$

To a first approximation from Fig. 7

$$I_{b2} = C + KI_e \quad (5)$$

Now (4) becomes

$$I_{b1} = -(I_e + C + KI_e) \quad (6)$$

Where C and K are positive numbers and may be evaluated from Figure 7.

It may be possible that only negative gate pulses are available to turn on the switch. In this case if the gate is applied to the circuit in the following manner, satisfactory switching should be obtained. (Fig. 8)

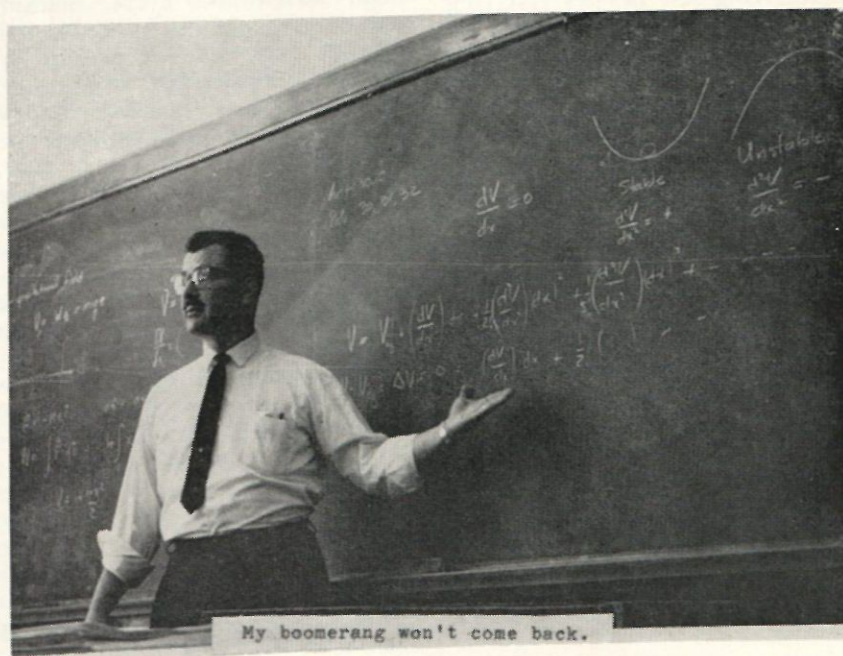
Effectively what happens is the peak point of Figure 3 is momentarily lowered by the amount $V_g \frac{I_{e1}}{I_{12}}$ allowing $V_{ejet} < V_e$.

In conclusion, the unijunction transistor is a semiconductor device having quite abrupt characteristics which lend themselves well to switching operations. The transistor switch may be turned on and off by fairly short pulses, and in actual operation will be very stable and reliable. The unijunction device is commercially available in various sizes ranging from maximum values of $I_e < 50$ milliamperes to I_e of the order of amperes.

Aluminum was used to roof the Washington Monument seventy-five years ago.

Estimates are that 22,000 tons of aluminum were used in 1952 for building material purposes. Just three years later this consumption sky-rocketed to 450,000 tons. It is predicted that by 1965, one million tons of aluminum will be manufactured into building products, the bulk of it going into aluminum siding.

Home Building Trends



RADIO FREQUENCY INTERFERENCE

CHARLES
W. McAFEE

Recently, engineers and technicians of the Air Force Missile Test Center at Cape Canaveral watched the intermittently erratic behavior of their test missile as it streaked across the Atlantic. There was no immediate explanation for the behavior, but similar irregularities had previously been traced to an increasingly common source—radio frequency interference, known commonly as rfi. Such was again found to be the case. A taxi-cab dispatcher in Miami was transmitting a signal that interfered with the missile guidance system, causing the missile to stray from its pre-planned trajectory while the dispatcher was transmitting.

Instances such as this are occurring more and more frequently. As the quantity of electrical apparatus being operated increases, more and more stray signals are radiated into the atmosphere. These signals interfere with the reception of desired signals by a receiving set. Besides receiving the desired signal, a device may receive many unwanted signals, some of which are sufficiently strong to cover the desired signal and foul the system.

Any electrical apparatus is a potential source of rfi. A light switch, an automobile starter, or even a length of wire that is subjected to a signal of its resonant frequency may become a source of radiation.

These sources can be broken down into four classes: 1) switching; 2) discharges; 3) radio-frequency leakage; and 4) harmonic generation.

Interference radiation due to switching may occur at any switching device, such as a common electric stove or a heating pad. Rfi caused by switching results when arcing oc-

curs across the switch terminals as when the switch is operated. The radiated signal is very complex and contains many harmonics.

Discharge interference is a product of such apparatus as fluorescent and neon lamps. Signals containing harmonic components are radiated from the glow discharge tube four times during each a-c cycle, which means that 240 new signals are emitted each second from a tube operating on a 60-cps line. Carona discharge is emitted from high-voltage transmission lines. Discharge interference is often apparent when an automobile radio passes near neon signs or transmission lines.

Radio-frequency leakage is a result of inadequate shielding of generators such as induction heaters and oscillators operating in the radio-frequency range.

Harmonic interference is caused by generators which produce non-sinusoidal waveforms. Every non-sinusoidal wave contains harmonic components, and these harmonics are emitted as interference. Since no generator produces a perfect sinusoid, every transmitter and oscillator is a source of rfi.

The problem posed by rfi has been recognized since the advent of radio. However, suppression techniques were not developed until automobiles began to be equipped with receiving sets. It was then necessary to reduce the interference due to the generator, ignition system, and front-wheel bearing friction. Rfi caused no great concern, however, until the numerous complex electronic defense systems of World War II came into use. These systems greatly increased the number of rfi generators, and at the same time the increased sensitivity of the equipment caused it to be more susceptible to interference. Even though the seriousness of the problem was

recognized during the war, few attempts were made to do anything about it because of the urgent need for rapid development and production of new electronic equipment.

Since the war build-up, the complexity of rfi has increased much more rapidly than have the methods and techniques of suppressing it. Every day more incidents directly attributable to rfi occur in communications and guidance systems.

For instance, interference in airline communication systems has been traced directly to passenger-carried apparatus such as battery-driven dictaphones and electric shavers. The question remains unanswered as to whether or not the recent airline collisions occurred because of similar interference.

Another example is the increasing incompatibility between radar and microwave communications. Microwave receivers pick up extensive interference in the form of harmonics and spurious emissions from radar transmitters.

Many other incidents occur, ranging in seriousness from the mysterious opening of a radio-operated garage door to the premature destruction of a missile.

Attempts are being made, especially by the military, to curtail the rfi problem. The Army Signal Corps is establishing a multi-million dollar installation to study equipment compatibility under simulated field conditions. The data obtained in this study will be analyzed and used to develop new manufacturing and operational techniques. The Federal Communications Commission maintains a network of long-range detection stations, a means by which the FCC can track the interference to its source.

The military, in conjunction with civilian concerns, has established de-

(Continued on page 46)

Charles McAfee is a Senior in Electrical Engineering.



DEAN'S COLUMN

CHARLES A. HUTCHINSON

When in December I wrote the material for this column in the January issue, I wrote in hope and anticipation. All our hopes were centered in the 1962 session of the State Legislature, to be convened in January.

Now it is early February and the Legislature is nearly through with its labors. All present indications are that the "Long Bill," carrying the all-important authorization and funding for the Engineering Sciences Center will be passed.*

I am assuming that the battle is won. Now we have a new lease on life—indeed, it would be accurate to say that we are beginning a new life.

You were told in Larry Huston's excellent article in the January issue of the **COLORADO ENGINEER**, and in my column in the same issue, some of the history of our effort and of the vital necessity of our project. I shall not repeat here. I shall add one piece of information that was not included in our earlier reports.

This item has to do with Engineering enrollments. Everyone knows that undergraduate registrations in Engineering colleges have been declining nationally in the last three or four years. A part of this shrinkage seems to have been due to the lack of a good "press" for engineering achievements, in contrast to the glamorous acclaim that has been accorded to the accomplishments of science in the space age. Also, engineering education has of necessity become more rigorous, and the word has spread that there are easier ways of acquiring a degree.

Here at the University of Colorado we have perhaps accentuated the national trend by two policies. First, we have made a sincere effort, in our Pre-College Advising Program, to steer into other lines of study those applicants whose chance of success in

engineering seems low. Second, we have insisted on higher standards of scholastic achievement.

These policies are yielding results. The failure rate in the basic courses is diminishing at a surprising rate, and the work of the Scholastic Deficiency Committee is also being lightened. All of this makes for better engineers, and more efficient use of the State's resources, human and financial.

Recently, I received a preliminary report of a national survey by the Engineers Joint Council on new freshman enrollments in engineering, 1961 against 1960. The nation as a whole shows a new decline of 2.8 per cent. Of the nine regions reported on, six showed continuing decline, three an increase. Of these latter, the mountain region, comprising eight states, had 70 per cent of its increase accounted for by the University of Colorado—our increase in freshman over last year was 14 per cent.

We believe that our Superior Student Program has been one factor in helping us to turn the corner, to reverse the trend. We are continuing and strengthening this activity.

Another bit of news — important news — has just come in. Dr. Franklin Essenburg has accepted the position of Chairman of the Department of Mechanical Engineering, to take over the office next year. Dr. Essenburg is thirty-seven, a native of Michigan. He has bachelor's degrees in Mechanical Engineering and Law, Master's degrees in Physics and Engineering Mechanics, and the Ph.D. in the latter field, all from the University of Michigan. He is currently Professor of Engineering Mechanics at the Illinois Institute of Technology in Chicago, and has also been on the faculty of the University of Michigan. His publications have been in the field of

elasticity and plasticity. Dr. Essenburg is married and has two children.

Associate Professor Clinton L. Conner, Assistant Dean of Engineering at the Denver Extension Center, has resigned, as of 31 January 1962. He has been on leave for the past two years with RCA in the Philadelphia area. He has now accepted a position with the Planning Research Corporation, with Operations Research Looming large in his future. During Professor Conner's absence, his duties have been most capably handled by Associate Professor Paul E. Bartlett.

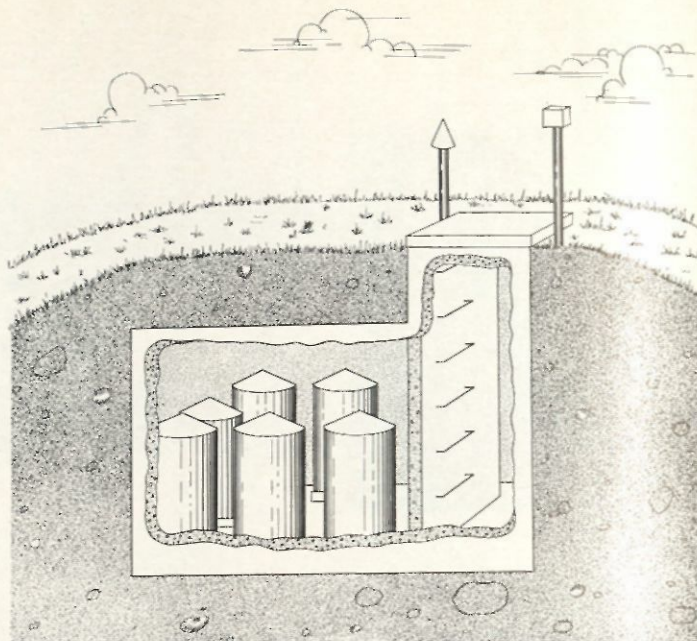
Mr. Charles A. Dedi has been appointed Administrative Assistant in the office of the Dean. Mr. Dedi, who lives at 4480 Laguna Place in Boulder, is a retired Colonel in the United States Army. This, a staff rather than an academic post, was recommended in the Self-Study of the College a few years ago. It is hoped that Mr. Dedi will gradually take over some of the non-academic chores that now harass faculty members.

I want to take whatever space is left to say "thank you" to all—students, faculty, alumni, and friends of the College who have helped us so generously in spreading the word of our needs with respect to new facilities. We know we have had magnificent help, but we have no way of identifying every person who has lent a hand. I have written a letter of gratitude to everyone whose name is on my list—and it is a long list!—but, lest I inadvertently miss someone, I take this means of expressing the heartfelt gratitude of the entire College for a task well-done. We are sure that the years just ahead will demonstrate that your confidence is not misplaced.

*At the time of publication, the Long Bill had already been passed, and signed into law by the Governor.

Life In A Fallout Shelter

LOWELL BROOKS



As the tension in the cold war grows, so does America's interest in the family fallout shelter. Various types of shelters have been constructed and tested for effectiveness against radiation fallout. Concurrently scientists have been working hard to find out how long it would be before one could venture out of his shelter into the cold, desolate, radiation-filled world. At the same time, there have been many hot debates as to whether one would be normally justified in refusing to let his neighbor into a shelter that was already filled to capacity. But very little has been said about whether or not a human could survive two weeks in a little hole in the ground. Leaving aside the question of psychological factors, could one maintain suitable living conditions inside a shelter with only a hand operated fan for ventilation? With this question in mind, family-size underground fallout shelter at the National Bureau of Standards with six simulated "occupants" has served for a study of ventilation, heat, humidity, and air conditioning problems connected with such shelters. The study, sponsored by the Office of Civil Defense, was conducted by P. R. Achenbach, F. J. J. Drapeau, and C. W. Phillips of the NBS mechanical systems laboratory.¹

The "occupants" appearance was such that they could hardly be confused with humans. However, four of the six had the heat emission characteristics of an average seated and quiet adult. These were known as the 400-Btu/hour occupants. A fifth, known as the 600-Btu/hour occupant, was so designated because he was presumed to be exerting himself, cranking the blower of the ventilation

system for the shelter. The sixth, a 200-Btu/hour "occupant" simulated a child. Data were taken on the environmental factors that affect the habitability of a shelter, and the comfort and well-being of its occupants. Observations were made at regular time intervals of temperature, humidity, ventilation rate, and heat exchange during periods of occupancy up to 14 days.

"Occupants"

Each "occupant," made of galvanized steel, consisted of a cylindrical "body" 22 inches in diameter and about 40 inches high, topped by a conical, pointed "head" 51½ inches high. A 200-watt light bulb at reduced voltage served as the heat source in each of four 400-Btu/hour occupants and the one 200-Btu/hour occupant, while a 660-watt resistance heater at reduced voltage served the 600-Btu/hour occupant.

A snug-fitting wrapper of closely-woven fabric was fitted over the body of each, gathered into folds over the head, and sewed together at the top. Water was dripped onto the gathered fabric at the top and spread over the exterior surface by wick action. Some of the air rising from these fabric surfaces probably had a moisture content comparable to that of the exhaled breath of a human being. Each occupant was supported in a pan, 2 feet square and 2 inches deep, for collection of excess water. Pans and occupants were then mounted on cinder blocks.

For purposes of temperature measurement, five thermocouples were soldered to the "body" of each occupant; and one additional thermocouple was attached to the "head" 3 inches from the top.

The Shelter

The shelter to house the occupants over the test period was constructed on a well-drained site on the NBS grounds, in accordance with plans in Bulletin MP-15 of the Office of Civil Defense. A pit 13½ feet wide, 16 feet long, and 7 feet deep was dug. Exterior dimensions were 12 by 9½ by 7½ feet high, not including the hatch. The shielding wall was 8 inches thick, leaving a main room 8 feet square. About 12¾ cubic yards of concrete were used for the structure, corresponding to a total weight of about 49,600 pounds.

Hot asphalt was applied to the exterior of the walls and roof as a moisture barrier. Backfill was placed in layers about 18 inches thick and tamped thoroughly to obtain layers about 12 inches thick and of the proper density. Dry ice, placed between the layers, served to remove excess heat absorbed by the excavated earth during storage on the ground surface. This technique helped to shorten the preconditioning time of the shelter. The entire area was then graded and covered with sod so that there was an earth cover 2¼ feet thick over the roof.

Apparatus

The test apparatus used for this study included the following:

(1) A thermocouple system for measuring the temperature of the concrete in the walls of the shelter, in the adjacent earth to a distance of 4 feet from the walls, and in the undisturbed earth at a greater distance.

(2) A specially designed air washer for conditioning the ventilating air to the selected dry bulb and dew point temperatures, and for regulating the flow of air. It consisted of a duct

with four water sprays, which bathed the internal walls. There was enough evaporative surface to saturate the air at the water temperature. A sump at one end collected the excess water for recirculation, and incorporated a float-controlled water feed for make-up. Air from a nearby instrument building was forced through the washer, and then successively through an electric reheater, a measuring orifice, the supply line to the shelter, and the shelter itself by a centrifugal blower. The air flow rate was controlled manually at the blower outlet by an adjustable damper. The direction of heat exchange between supply line and ambient air depended on whether the outdoor temperature was above or below the air temperature in the supply line. For summer tests, the air supply line was well insulated and covered with an aluminum wrapper to reduce the heat transfer and prevent entry of moisture into the insulation. For a winter test a part of the line was packeted with crushed ice to maintain the desired temperature.

(3) Temperature and humidity elements for measuring the condition of the air entering the shelter and at various stations inside the shelter. An electric heater at the washer outlet was controlled by a temperature-sensing element in the supply line at the shelter entrance. Meanwhile, the chilled water temperature in the air washer was adjusted to maintain the

dew point temperature at this same location at 69°F for the summer tests and 33°F for the winter test.

(4) A water-feeding system for the simulated occupants consisting of six separatory funnels for gradual feeding of measured amounts of water through separate plastic tubes to the simulated occupants for evaporation on their surfaces.

(5) Heat flow meters to measure the rate of heat transmission at the interior surface of the shelter.

(6) Various instruments for measuring temperature, humidity, air flow rate, electrical energy consumption, heat flow rate, and solar radiation.

The Tests

Five tests of the shelter were made with variations in duration, ventilation rate, ventilating air conditions, and occupancy. Four took place when the earth temperature was near the summer maximum and one near the winter minimum. (See Table 1, below.)

Table 1. Schedule of Test Conditions Ventilating Air Supply

Test No.	Duration of Test days	Flow Rate cfm	Avg. Dry Bulb Temp. °F	Dew Point Temp. °F	Number of Occupants	Approx. Internal Heat Input Btu/hr
1	7	42	85	69	0	110
2	7	0	—	—	6	2500
3	14	42	85	69	6	2500
4	14	18	85	69	6	2500
5	14	18	35	33	6	2500

During the tests the latent and sensible heat outputs of the simulated

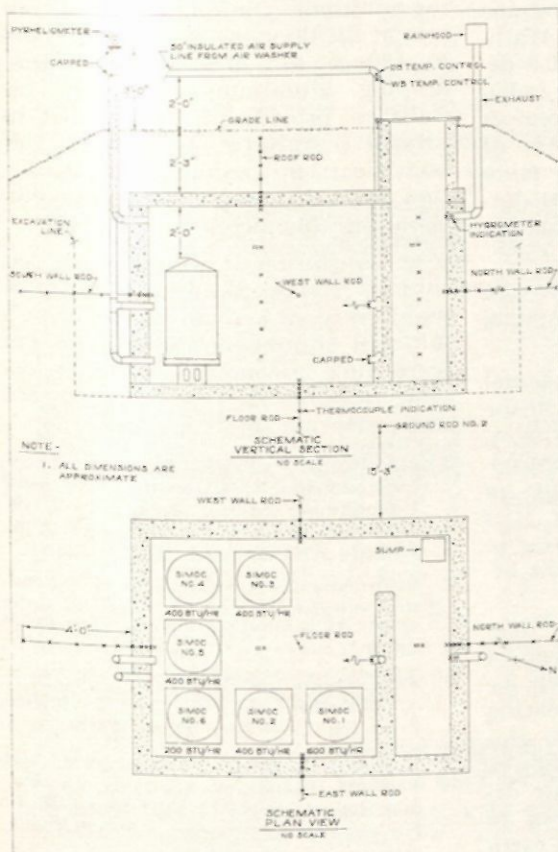
occupants were controlled, first, by adjusting the total electrical energy supplied to the heat source, and secondly, by adjusting the amount of water dripped on the fabric covering the "occupant." On the assumption that all of the water would be evaporated, the remainder of the heat would be transferred as sensible heat and the proportions of sensible and latent heat emission would attain the desired values. The "heads" were kept at temperatures ranging from 94° to 97°F.

To begin the tests, the conditioned air supply was turned on, the electric heaters in the simulated occupants were energized, and water was fed to each occupant in specified quantities.

At two-hour intervals, the temperature was taken at six stations on each occupant, and various temperature and humidity readings were taken in and around the shelter.

Temperature and Humidity

High relative humidities prevailed in the shelter during both summer and winter tests. These high readings were accounted for in the summer by the high dew point of the ventilating air, the water vapor released by the "occupants," and the small temperature differences between the air and wall surfaces. The conclusion was reached that moisture and condensation control would be a major problem in small shelters, since high humidity and condensation on the walls and on the ceiling would be prevalent



in most seasons of the year. The ceiling was considered to be the most critical surface with respect to condensation because the water would drip on everything and everybody in the shelter.

To meet this problem, the ceiling might be insulated or lined to prevent condensation, leaving the walls and floor as condensing surfaces from which drainage could be more readily controlled. Also, film-type movement of the condensate from the ceiling to the side walls would be promoted by doming or sloping the ceiling surface downward to the side walls and treating the ceiling surface with a wetting agent. Still another moisture control method would be to store a sufficient quantity of drying agent in the shelter to absorb excess moisture during occupancy.

It was learned that short-term variations in weather conditions had little effect on heat transfer below mid-height of the shelter, that is, about 6 feet below the surface of the earth. Five days elapsed before the effect of a sustained change in the weather was observed at midheight of the shelter. The daily temperature cycle was not felt much beyond a depth of one foot in the earth, which meant that the effects of this cycle were nullified before reaching as far down as the roof of the shelter.

It was also found that a longer subterranean duct to condition the supply air would be advantageous for small shelters especially for the hottest or coldest weather. The temperature gradient in the earth is in opposite directions at the warmest and coldest seasons. Thus, if the supply air were introduced through a duct installed beneath the floor, the air could be cooled in the warmest

weather and warmed in the coldest weather by heat exchange between the duct and the surrounding earth. Some dehumidification might also be accomplished during the summer in such a sub-floor duct.

The ventilation rate required to prevent condensation was related to the wall temperatures in the shelter and the dew point of the ventilating air. But on the average a ventilation rate of 3 cubic feet per minute per person could be adequate to control the temperature and prevent condensation, however at times more ventilation would be required. A ventilation rate of 3 cfm per person was ample to provide the oxygen requirements in the shelter.

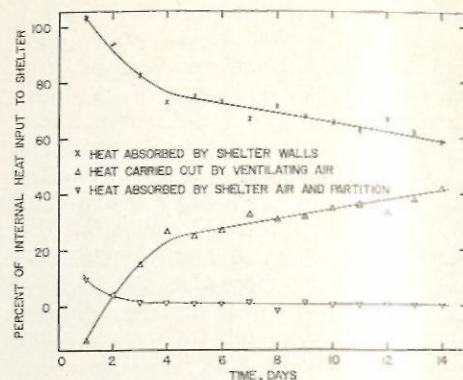
The rise of interior dry bulb temperature during the summer tests as a result of an average heat release of about 2500 Btu/hr by the six "occupants" and other heat sources ranged from 12 to 15°F. This rise probably would not create unendurable conditions in a small shelter in areas where the initial earth temperature did not exceed about 73°F.

S. H. Dole, in a paper on environmental requirements for extended occupancy of manned saellities,² has suggested that the maximum temperature of saturated air which can be tolerated by human beings continuously for 10 days ranges from 81° to 86°F. But the effective temperature in the shelter during the 14th (last) day of the third and fourth tests was about 80 degrees. For the period August 13-27, 1959, average effective temperature at the Washington National Airport was 80.3 degrees, neglecting effects of solar radiation and wind. Thus, the comfort conditions in the shelter at the end of these tests probably were no more adverse than outdoor conditions during two weeks of the 1959 summer season in Washington, D. C.

A number of factors could increase temperatures in the shelter. Among these are:

1. A higher heat output by actual living occupants than was used in the study for the simulated occupants. The output in the study approximated that for sedentary adults in normal environments. However, it is not known whether mental stress in an emergency would increase the occupants' heat production.

2. Higher earth temperatures than those in Washington at the time of the study. These could probably be partly compensated for by placing the shelter farther beneath the surface. It was found in Washington, D. C. that the earth temperature decreased about 1 degree per foot of depth about September 1 when earth



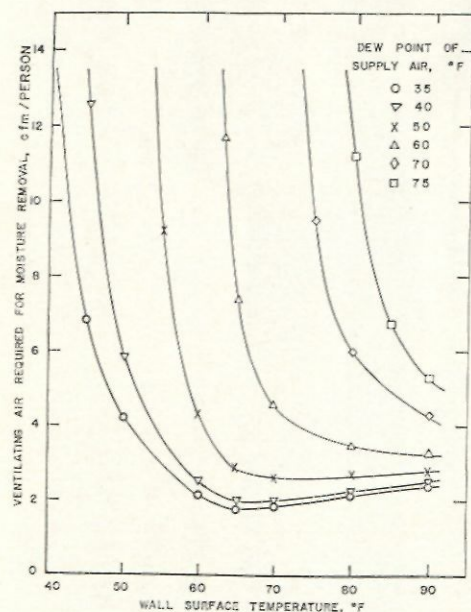
temperatures were maximum. In the hottest parts of the United States it is believed that unbearably hot conditions could develop in the summer. However, simple evaporative coolers with manually operated fans could probably provide limited cooling in hot, arid climates.

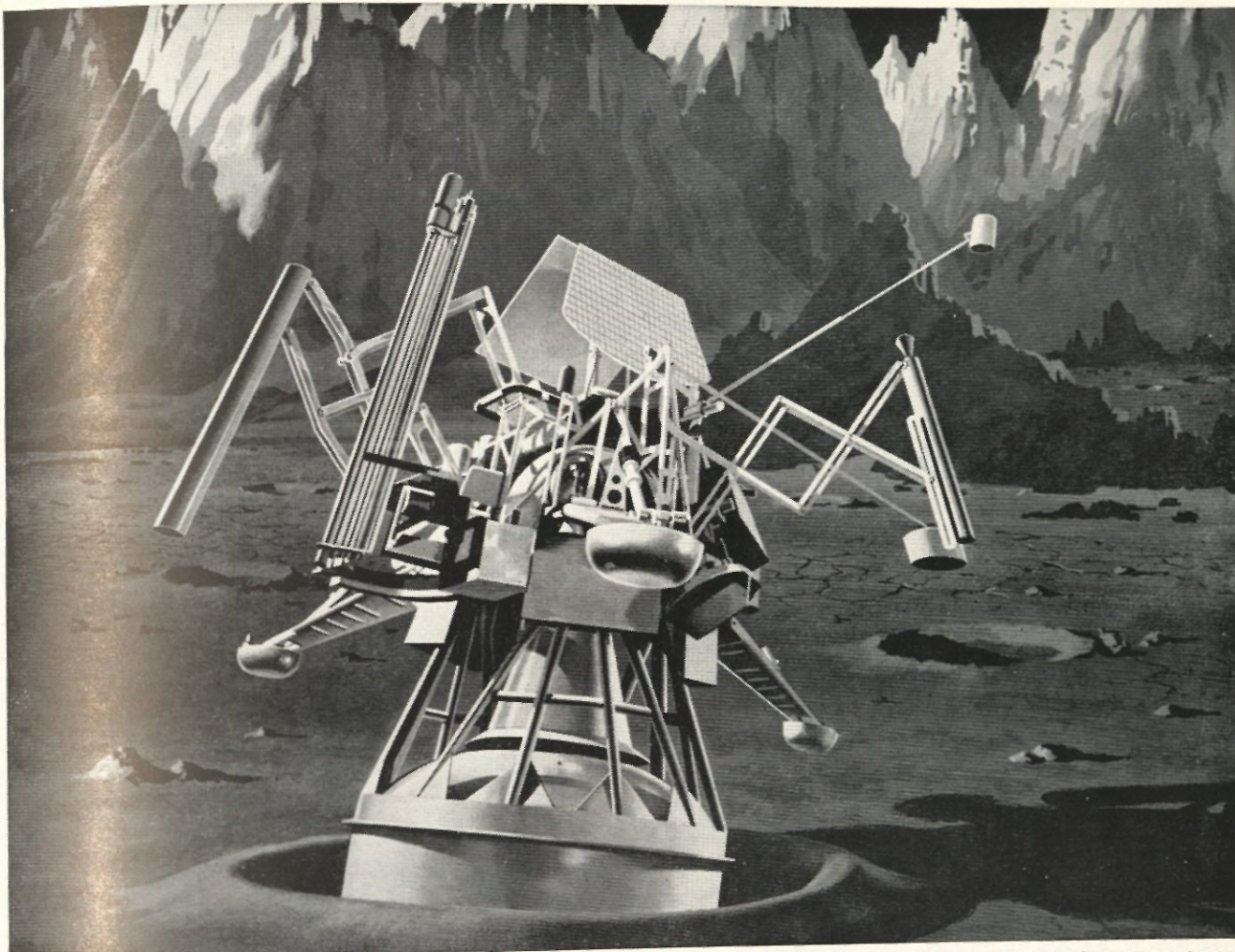
The one winter test, conducted with a steady flow of supply air at 18 cubic feet per minute and a dry bulb temperature of 35°F when the earth temperatures were about at a minimum, revealed that the shelter temperatures would not reach comfortable levels in two weeks with an internal heat input equal to that of six sedantary adults. Steps, therefore, would need to be taken to increase comfort of shelter occupants during cold weather.

It was suggested in the study that winter comfort might be improved by using a small vented heater; wearing additional clothing; placing a curtain at the doorway of the main room to reduce the area for heat loss; draping aluminum foil over the walls to provide air spaces and to present a surface for reflection of body heat; and reducing the ventilation rate, if resulting condensation could be tolerated.

In conclusion it would seem that suitable living conditions could be maintained in a small shelter with a minimal equipment. Now if we can learn how to stand looking at the same eight by eight room for fourteen days, we're all set.

1. For further technical information, see Environmental Characteristics of a small Underground Fallout Shelter, by P. R. Achenbach, F. J. J. Drapeau, and C. W. Phillips, ASHAE Journal 4, 21 (1962).
2. Environmental Requirements for Extended Occupancy of Manned Satellites, by S. H. Dole, ASME Paper 59-AV-12 (1959).
3. Temperature and Human Life, by C. E. Winslow and L. P. Herrington, Princeton University Press (1949).
4. Air Motion, High Temperature and Various Humidities—Reactions on Human Beings, by W. J. McConnell, F. C. Houghten, C. P. Yaglou, ASHVE Transactions, Vol. 30 (1924).



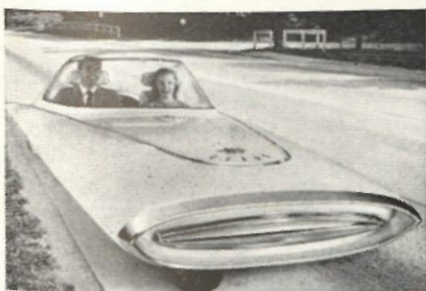


Moon crawler. Early next year, if everything goes according to plan, this spiderlike object—the “Surveyor”—is expected to land on the moon’s surface, look at it, feel it, and bite into it. It will have electronic sight and touch more

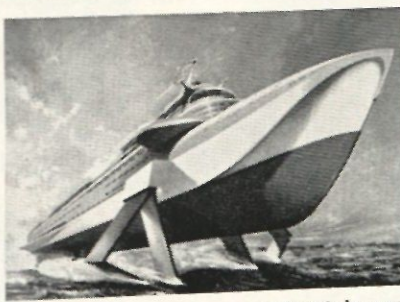
sensitive than a man’s, and will transmit to earth direct information on what the moon looks like and what it is made of. What metal will this machine need to survive the moon’s extreme cold without getting brittle? What metal

can withstand the high temperatures that occur in flight? Engineers will most likely find the answer in Nickel-containing alloys. They offer tremendous resistance to crippling super-cold, stand up in blazing heat.

How Inco Nickel helps engineers make new designs possible and practical



Gyron—dream car that drives itself. A gyroscope would stabilize this two-wheeled vehicle of the future, which envisions automatic speed and steering control. A computer would let you “program” trips on a non-stop highway. For lasting beauty, trim areas would be coated with Nickel-Chrome plating, the bright, corrosion-resistant finish.



Hydrofoil ship—a new concept in sea-going design. Now under development, such vessels are planned to travel 100 m.p.h., skim over the tops of waves like flying fish—lifted aloft by a set of underwater foils, or wings. The metal for these all-important wings? Good bet is a nickel alloy for strength, resistance to corrosion and cavitation erosion.

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BOOK

Computer Handbook

Edited by Harry D. Huskey, Ph.D. and Granino A. Korn, Ph.D. McGraw-Hill, New York, 1961. 1228 pp. plus index; 1099 illustrations; \$25.00.

The *Computer Handbook* is a comprehensive, practical reference book covering thoroughly the design of analog and digital computers and systems and their application to science and engineering. It was prepared by a group of experts including top representatives of every major computer manufacturer, as well as leaders in computer applications in the aircraft industry and in major university centers.

Technical information is presented in the handbook in sufficient detail to be useful in actual design work. Many circuit diagrams have been included as concrete examples of design principles for direct adaptation to the designer's problem. In addition, there are specific sections dealing with computer system design. For the younger engineer and for newcomers to the fields of computers and control, the handbook provides quick access to just that industrial know-how which is necessarily neglected in a modern engineering curriculum which stresses principle rather than technique.

The analog-computer sections of the *Computer Handbook* present the best modern design practice in the field of analog-computer components and systems, including general-purpose computers and representative special-purpose machines. Since analog-computer design is often intimately related to computer applications and problem-solving methods, a rather comprehensive review of analog-computer applications and methodology is included.

A large number of special computer setups and trick circuits are presented in tables, illustrated, and grouped for convenient reference. Starting with a chapter introducing the basic terminology, this section of the handbook covers the design of electronic-analog-computer building blocks; design of computer systems; significant applications of electronic analog computers; and newer techniques like dynamic-storage computation, repetitive computer techniques for statistical problems, and combined analog-digital computation. One entire chapter is devoted to

solid-state (transistor) analog-computed components and describes many new solid-state circuits. The final chapters in this section deal entirely with important analog techniques less familiar to many engineers — network-type analogies for fields, structures, and power system, and with mechanical, electromechanical, and hydrodynamic and heat-transfer computing elements.

The digital part of the handbook starts with elementary definitions, component circuits, and computing circuits such as flipflops, gates, pulse shapers, and memory devices. It discusses logical techniques, design of arithmetic units, programming, and digital computer system design. Typical systems are described and there is a chapter on applications.

Among the recent advances covered in the *Computer Handbook* are: late amplifier and multiplier circuits; new precision electronic switches; analog dynamic storage technique and automatic iterative programming; transistor amplifiers, multipliers, and function generators; computers in Random-process studies; and combined use of analog and digital machines.

Both Harry D. Huskey and Granino A. Korn are well-known consultants and lecturers on computer theory and practice. Dr. Huskey is Professor of Electrical Engineering and Mathematics at the University of California at Berkeley and is president of the Association for Computing Machinery.

Dr. Korn is Professor of Electrical Engineering at the University of Arizona and was formerly associated with Lockheed Aircraft Corporation, Curtiss-Wright Corporation and Sperry Gyroscope Corporation.

Reliability Principles and Practices

By S. R. Calabro, Director, Product Assurance Division, International Electric Corporation, Paramus, New Jersey. McGraw-Hill, New York, 1962. 364 pp. \$10.50.

"Reliability Principles and Practices" presents the fundamental concepts of reliability theory and demonstrates their application to the solution of practical reliability problems. Abstract statistical and mathematical techniques are avoided by the author and are replaced with effective reliability formulations and

mathematical models whose application is profusely illustrated throughout the text with solutions of many typical examples.

One of the book's main features is its coverage of many new developments, particularly with respect to maintainability, availability and redundancy. New formulations which combine failure rates, maintenance action rates, and maintenance time constraints are included. These appear for the first time in "Reliability Principles and Practices" and have been developed, tested, and tried by the author.

Another significant feature of the book is the development of K^2 (Kappa Square), a statistic which simplifies the preparation of time sampling plans for various confidence levels. Described also are original sampling techniques and deficiency reporting systems which reduce testing costs and facilitate early delivery of equipment.

Some typical chapters are: "An Introduction to the Reliability Concept," "Reliability Data," "Maintainability and Availability," "Reliability Sampling and Control Charting — Time Samples," "Reliability and

Availability Prediction Methods," "Principles of Reliability Design," "Management of a Reliability Program."

Design Manual for Transistor Circuits

By John M. Carroll, Managing Editor, Electronics, McGraw-Hill Publishing Company. 376 pp. plus index; 28 illustrations; McGraw-Hill; \$9.50. July, 1961.

"Design Manual for Transistor Circuits" was compiled to help the engineer in designing circuits using transistor and other semi-conductor devices. It contains a review of basic transistor and semiconductor theory, and discusses the uses of transistors in basic circuits such as amplifiers, oscillators, power supplies, and pulse circuits. There is also material on the application of transistors in equipment such as home entertainment and communications apparatus, instruments, and computers. In addition, the book includes articles dealing

BOB DAWSON

LARRY HUSTON

with basic transistor circuit design philosophy, design charts, and nomographs. Applications of newest devices such as tunnel diodes, silicon controlled rectifiers and unijunction transistors are also covered.

Advances made in semiconductors during the last three years are stressed and there are many useful circuit diagrams detailing up-to-date designs and applications. One of the book's special features is its introductory chapter (co-authored by Donald Hall, Manager, Special Products Branch, Transistor Products Group, Semiconductor Components Division, Texas Instruments, Inc., Dallas, Texas) which permits quick review of basic transistor and semiconductor theory.

"Design Manual for Transistor Circuits" is based on material which has appeared in *Electronics* magazine.

John M. Carroll is Managing Editor of *Electronics* and has been on the magazine's staff since 1950. A graduate of Lehigh University (B.S. in Engineering) and Hofstra College (M.A. in Physics), Mr. Carroll spent five years in Navy electronics and one year with the National Bureau of Standards. He is the author of several other McGraw-Hill books, among them "Transistor Circuits and Applications" and "Modern Transistor Circuits."

Electromechanical Components for Servomechanisms

By Sidney A. Davis, Consulting Electrical Engineer, and Byron K. Ledgerwood, Editor of Control Engineering, McGraw-Hill Publishing Co. 1961. 334 pp. \$11.50.

"Electromechanical Components for Servomechanism," surveys the field of electromechanical devices for use in precision servomechanisms. While rigorous in presentation, advanced mathematics is avoided and clear understanding of the physical principles is emphasized in the development of the text.

The book supplies, in easy-to-use form, the better understanding of component characteristics and performance which contemporary systems' engineers are required to have as a result of the complex systems being developed today.

Material covered in the book includes an introduction to rotating components; potentiometers; synchros; resolvers and induction potentiometers; tachometers; alternating-current servomotors; direct-current servomotors; and miscellaneous components such as Inductosyn, E-magnets, magnesyn, and Synchrotel.

Practical in its approach, the book is aimed at showing "how-to" rather

than "why." At the same time, it clearly explains the physical principles and includes numerical examples to illustrate important conclusions. Much data on commercial practice and applications is also presented.

Sidney A. Davis, a consulting electrical engineer, has worked for 15 years both as a designer of servomechanism systems and a designer of rotating components. He has taught for several years at the Polytechnic Institute of Brooklyn and is Components Digest Editor of *Electromechanical Design Magazine*.

Theory of Elasticity

By V. V. Novoshilov, Pergamon Press, New York, 1961. 460 pp. \$15.00.

The author, a leading Russian authority in the field, has recognized the growing importance of non-linear problems in modern stress-analysis and, starting from the basic ideas of strains and stresses, develops a completely general method of approach to any problem in the theory of elasticity.

He then shows how the general equations can, on certain conditions, be modified to the more familiar linear equations and illustrates sev-

(Continued on page 46)



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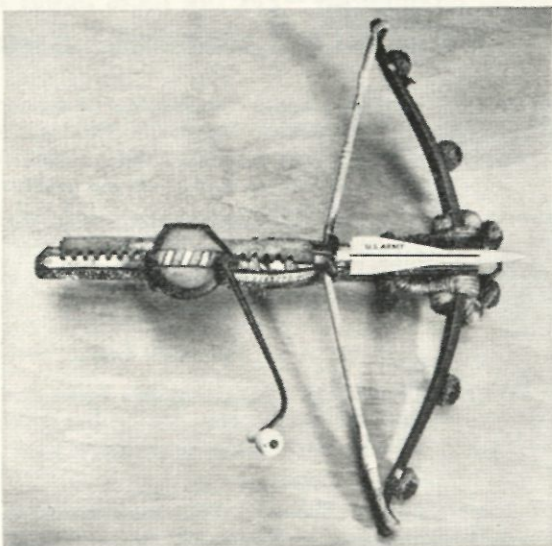
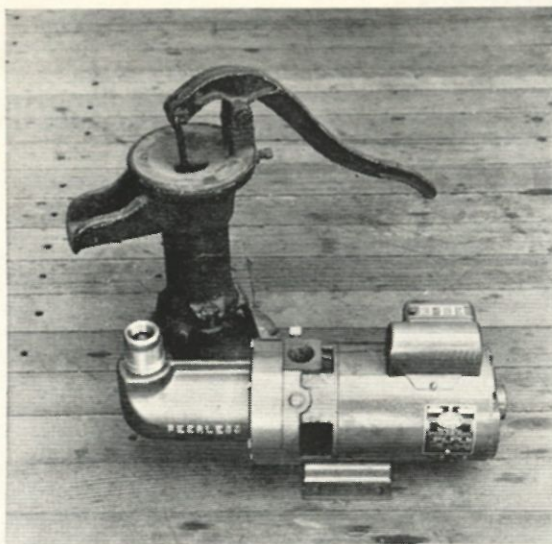
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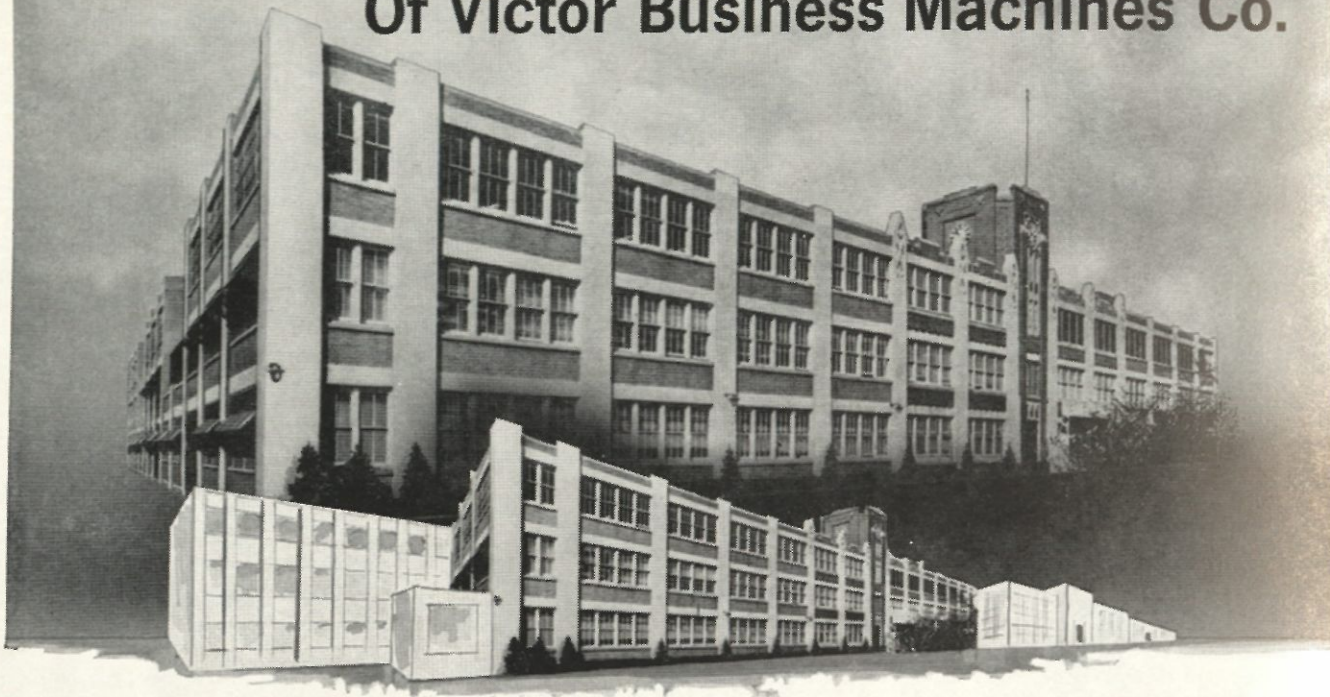
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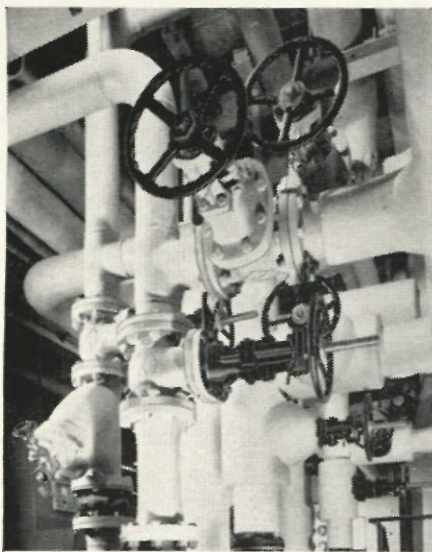
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CHICAGO "GROWTH" PLANT Of Victor Business Machines Co.



For its Newest Addition Maintenance-Cost Records Since 1924 Dictated Choice of JENKINS VALVES



For most companies, "expansion" means a completely new plant. Others have compelling reasons for keeping their facilities in one, ever-expanding plant. Perfect example of the "growth" plant is the big, architecturally attractive, functionally efficient home of Victor Business Machines Co., Division of Victor Comptometer Corporation, Chicago.

For its impressive new addition, Victor's plant engineering department recommended JENKINS VALVES for plumbing, heating, air conditioning and compressed air lines. The choice was no problem: records of valve performance and maintenance costs since 1924 clearly showed the wisdom of using Jenkins Valves.

Original cost was no factor: Jenkins Valves *cost no more* than other valves of acceptable quality. But remember this when *you* specify valves—the Jenkins Diamond trademark is positive assurance, proved in dollars-and-cents, that over the long haul you too will *save money* on maintenance and replacement cost. Jenkins Bros., 100 Park Ave., New York 17.

Architects: OLSEN & URBAIN. General Contractor: PEPPER CONSTRUCTION Co. Heating & Air Conditioning Contractor: O. A. WENDT Co. Consulting Engineers: NEILER, RICH & BLADEN. All firms in Chicago

JENKINS
MOST TRUSTED TRADEMARK IN THE VALVE WORLD
VALVES


Jenkins Bros.

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BIPEDALISM . . .

(Continued from page 12)

conclusively, it does show that primates at times walk upright to carry food, and thus supports Dr. Hewes' ideas. Another interesting bit of evidence is that when given a beef joint, it took one of the monkeys nearly ten hours to clean off the available meat and marrow (bone center). It would certainly be dangerous for a monkey, ape, or man-ape to remain near a carcass in the wild for ten hours.

Because of inadequate facilities, the research carried on so far has been quite limited. If more space becomes available, Dr. Hewes would like to carry on more extensive experiments. Monkeys would probably be used instead of apes, because, while they are further from man in the evolutionary tree, they are much less expensive; furthermore, some species of monkey are more used to life on the ground.

One possible experiment would be to divide a large group of monkeys,

around twenty or more, into two groups. Half, a control group, would be given small pieces of the vegetable foods usually given to monkeys, while the other half, an experimental group, would be given larger pieces, both meat and vegetables. If the experimental group walked upright considerably more than the control group, additional support would be provided for Dr. Hewes' hypothesis. Statistics could be taken on the size and weight limits of pieces carried, and on the distances the food was carried. A possible extension of this experiment would be to test monkeys of several species to see whether there were adaptive differences between species.

If these experiments were to be successfully carried out, the results might give direct evidence on how man became bipedal. This in turn could lead to new ideas on the development of such cultural features as speech and use of weapons and tools. This type of information is

necessary for understanding man and his development.

Reference: Gordon W. Hewes, "Food Transport and the Origin of Hominid Bipedalism," *American Anthropologist*, 63:687-710 (August, 1961).

THE SIMPLE LIFE!

Painting a fall-out shelter? If so, avoid reds, oranges and deep yellows; they are too stimulating and will stretch already taut nerves to the breaking point. Soothing and relaxing colors are light greens and light blues.

National Paint, Varnish and Lacquer Association, Inc.

Next product heading for obsolescence may be the can opener. On a new can heading for market, the housewife merely flips a tab on the lid, pulls up on it, and the top comes off.

American Machinist
McGraw-Hill Pub.

OUR BRAVE WORLD . . .

(Continued from page 17)

Our Cleveland branch informs me that three years ago you purchased one of our cheaper TV sets. I am therefore taking the liberty of having delivered to you, with our compliments, a 1957-model combination radio-phonograph TV-tape recorder. This console, which retails for \$1,499.95, is, we believe, the finest instrument of its kind on the market today, and we hope that it will partially compensate you for any inconvenience you have suffered.

You may be interested to know that we are having the manufacturers adjust our electronic machines to allow for the possibility of payments made at the same time as charges; also, that at a recent executive meeting on the coast, our Western Division voted to postpone conversion to electronic accounting until we have ironed out a few more wrinkles.

Sincerely,
Albert Roe

213 Huron Road
Cleveland, Ohio
November 28, 1956

Albert Roe, Credit Manager
Central Credit, etc.

Dear Mr. Roe:

I am replying to your letter of November 19, because my husband is temporarily a patient at Riverside Sanitarium. He seemed to be all right when I got him out of jail; but after I told him that I'd borrowed money from three local finance companies to pay this bill we were supposed to owe you and to go his bail, he took to sitting around and staring off into space.

I don't know anything about mental illness, never having had such a problem on my side of the family, but Dr. Hodgkins says that this mix-up in our bill shouldn't cause a breakdown in a normal, stable, adjusted individual. But he says it may have been a contributing factor.

I asked our lawyer about accepting the TV set, and he says just as long as I don't sign anything. It certainly is handsome, and I wish John could see it, though at the moment I'm afraid he wouldn't know what it was. Yesterday he thought he was Chancellor of the Exchequer under Charles II, and he was worried about some pension that came to three hundred and thirty-six pounds, five shillings, five pence. But Dr. Hodgkins says he'll be home by February, and out of the wood by April, provided we can cushion him against any future severe mental shocks.

Yours truly,
Mrs. John F. Cummings

PEARCE'S

"If You Live near a City, You Live near a Pearce's"

In Account with: John F. Cummings
213 Huron Road
Cleveland, Ohio

Date: February 1, 1957

DATE OF PURCHASE	BALANCE DUE
11/19/56	\$1,499.95
Carrying Charge	15.00
	\$1,514.95

TO OUR CUSTOMERS: The enclosed notice was prepared by modern electronic accounting machines. It has been developed as a result of Pearce's continuing efforts to improve service and reduce operating expenses . . .

RADIO FREQUENCY . . .

(Continued from page 34)

sign and operational standards. These standards define band width limits, frequency stability, radiation levels, and susceptibility limits for equipment that is to be used by the armed forces.

However, much work toward eliminating rfi remains to be done. The military and civilian effort should be correlated in order that information gained from tests can be more effectively distributed. Every electrical engineer and technician should familiarize himself with interference suppression techniques. Our laws should be such that the FCC would have the authority to enjoin the use of interference-generating equipment, and to force designers and manufacturers to conform to proven control methods.

Until large-scale preventive procedures are taken, rfi will pose an ever-increasing threat to our civilian and defense communications systems.

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Hickey, John E. Jr. "RFI Is Everybody's Business," *Electronic Industries*, 19 (March 1960), 131-132.

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Young, Lewis H. "Clearing the Troubled Air," *Control Engineering*, 6 (August, 1959), 25-28.

"Interference Findings Revealed," *Electronics*, 32 May, 1959, 42-43.

"Interference Problem Attacked by Defense," *Aviation Week*, 72 (June 20, 1960), 78.

"Radar is Threatening to Get in the Way," *Engineering*, 189 (June 24, 1960), 877.

BOOK REVIEWS . . .

(Continued from page 41)

eral useful applications of the theory to the solution of specific problems such as stress concentrations, tension, and simple bending and shear.

The book includes a chapter on the use and application of curvilinear co-ordinates as well as an explanatory section of tensor calculus which the author has employed in his development of the theory and in his illustrations of his applications.

The author believes that it is extremely important to bring all the many problems in the modern theory of elasticity within the reach of as

large a number of readers as possible. The presentation, therefore, has been made sufficiently simple to achieve this.

A partial list of contents includes: the theory of deformations, equilibrium of an element of volume, strain energy and certain related principles, curvilinear co-ordinates, the general formulae of the classical (linear) theory of elasticity, St. Venant's problem and the plane problem in the theory of elasticity.

Synthetic Materials from Petroleum

By A. V. Topchiev, M. F. Magiyev and T. M. Shakhtakhtinskii, U.S.S.R. *Academy of Sciences*, translated by J. Burdon, University of Birmingham, England, 1961. 136 pp. \$4.50.

This book translated from the Russian, is concerned with the problem of development of petroleum chemistry for synthesis. Information is presented about the chemical constitution of petroleum, and methods are indicated for their chemical manipulation for the preparation of various synthetic materials such as plastics, synthetic rubbers, artificial fibers, detergents, various scents and drugs, etc. The book also gives an elementary account of the fundamentals of the chemistry of hydrocarbons and their derivatives, and a description of the basic petrochemical processes (cracking, pyrolysis, platforming, dehydrogenation, polymerization, etc.) and their application to the preparation of intermediates for the manufacture of heavy organic chemicals.

Industrial Control Electronics

By Matthew Mandl. Prentice-Hall, Inc., Englewood Cliffs, N. J., 1961. 356 pp. \$10.65.

"Industrial Control Electronics" covers all the fundamental principles and practices of modern control electronic circuitry. Every aspect is taken in sequence from basic theory to actual components and equipment.

A summary and review of basic material, control signals, solid-state devices, amplifiers, and oscillators is presented first. These discussions lay the groundwork for the more advanced phases: reactors, generators, power supplies, transducers, gating and switching, motors, servomechanisms, and magnetic amplifiers. Even commercial equipment used in counting and indicating, and industrial package units are analyzed.

Standard symbols and electronic diagrams are employed throughout the book so that those who have previously studied standard electronic fundamental textbooks or who

have had practical experience in radio and television circuits will encounter no difficulty in following the discussions when referring to the schematics. Comparable industrial symbols are given in the Appendix for reference purposes, should such symbols be encountered in current literature or in field practices.

Matthew Mandl, presently lecturer in Electronic Technology at Temple University, is widely known as an educator as well as an electronics consultant for industry. He is the author of the highly praised "Fundamentals of Digital Computers," and "Fundamentals of Electronics."

PUZZLE PAGE . . .

(Continued from page 43)

It is also now noted that the 2nd position in the 1st row is 1 and that the 3rd position in the 1st row must be 7, 8, or 9. Only 8, 5, or 2 in the 3rd row-3rd position satisfies this. The problem has now been reduced to:

		3	1	X	5	3
				X	2	3
	9	5	(X+1)	5	9	
X	X	X		0	6	
X	X	X	6	X	X	
X	X	X	X	X	0	1

4. We now use for 3rd row-3rd position and 5th row-6th position the numbers, 8, 5, or 2 and 1, 4, or 7 respectively in pairs to give 9, 8, or 7 in 1st row-3rd position. The 2nd row-1st position is now multiplied times row 1 for each of the above cases. It turns out that the combination that makes 5th row-4th position a 6 is 8 for 3rd row-3rd position, 7 for 2nd row-1st position, and 9 for 1st row-3rd position. The problem is now solved:

		3	1	9	5	3
				7	2	3
	9	5	8	5	9	
	6	3	9	0	6	
2	2	3	6	7	1	
2	3	1	0	2	0	1

Electronics engineers have developed an experimental "microminiature" computer that is 150 times smaller and 48 times lighter than already existing "miniature" transistor computers it can replace. The computer weighs 10 ounces and is a little larger than a deck of cards.

Electronics

McGraw-Hill publication

Production in the chemical process industries, which includes chemicals and related products, petroleum, glass, rubber, and paper, may top 1961 by eight per cent. Although there was a sizable increase in sales in 1961, actual production inched up only about two per cent.

Chemical Week

McGraw-Hill Pub.

No wonder they come to Colorado! In the lone star state of Texas 30.8% of the homes have air conditioning compared to 3.3% here in Colorado.

Carrier NEWS BUREAU

Engineers And / Or Computers

DAVID CARSEN, Chief Engineer

CHARLES P.C. TUNG, Associate

King and Gavaris, Consulting Engineers, New York, N.Y.

(Excerpts from two of a series of articles published in *Civil Engineering*, the November 1961 and February 1962 issues.)

Until the advent of electronic computers, engineers had reason to regard themselves as indispensable factors in the design of structures. Without getting involved in semantics and what is meant by "design," we can say that while engineers may still be indispensable, much of their brain power can be efficiently supplanted by electronic computers.

Just as the introduction of steam power to replace the human hand brought about the Industrial Revolution, so the development of electronic impulses and computer logic to replace the human brain is leading to another revolution, an Electronic Revolution. The implications of this revolution are not yet completely understood by members of the engineering profession. The complete obsolescence of much of our engineering personnel can be one immediate result — unless what is occurring is recognized.

Personnel Obsolescence

Dr. Thomas Stelson, Head of the Department of Civil Engineering at Carnegie Institute of Technology, shows an educator's awareness of the impact of computers on the engineering profession. In his article, "Education for Oblivion," in the April 1961 issue of the *Carnegie Alumnus*, he states:

"One aspect of engineering practice which has had a tremendous impact on education and engineer obsolescence is the widespread use of high-speed electronic digital computers. Broad areas of graphical and computational development have become worthless overnight. Engineers, who for years developed their ability

to handle these techniques, are now displaced by high-speed computers. Unless they have the capacity and interest to grow in other directions, they are faced with the prospect of being obsolescent and of no real value to their employers or to society."

Yet even this recognition of the changing pattern of engineering practice does not begin to delineate what to expect in the near future. Wherever an engineer is now sitting at his desk and using a slide rule and desk calculator to compute fairly complex solutions to engineering problems that follow design paths controlled by standard specifications, design parameters or even assigned logical limits, it is only a question of time before most or all of his computations will be done by electronic computers.

While computer operation has advanced rapidly in both theory and practice, an adequate realization of its tremendous range has come about only recently. In the beginning we treated the computer as a simple tool and wrote programs of limited scope for individual problems. As we be-

came increasingly aware of its tremendous capabilities in contrast to the limited nature of our applications, we revised or rewrote the programs to encompass total solutions for any one type of problem. Further development soon led to the incorporation of programs for individual problems into larger components so that an entire section of a design was handled by one program.

Predictions and Conclusions

The very considerable growth in the application of computer techniques to the solution of civil engineering problems over the past five years leads one to anticipate an even more rapid expansion over the next five. This growth, however, will have more than a quantitative aspect. The successful application of electronic computers to the solution of even the most complex engineering problems must result in a comprehensive modification in the organization of the profession. To put it more succinctly, automation may become as much a problem to professional engineers as it has become to other members of our industrial society.

Program libraries, when augmented by the completion of studies now under way, will become the foundation for a new field of "computer engineering." The engineer will no longer need to compute most of his routine problems and many of his complex ones. He will need only to state these problems, and then make use of the final answers.

Training in "Computer Engineering"

For those of us who accept the premise that this new field of computer engineering will develop rapidly, certain conclusions become inevitable. Starting at the beginning with the student engineer, the colleges must bear the responsibility for initial training in computer engineering. They must teach the student not to fear the computer — as so many of our practicing engineers do today — but to use it. The timid ap-

This timely topic of engineers versus computers was analyzed by the authors with special reference to civil engineering, in a recent series of articles published in the journal Civil Engineering. The excerpts printed here, taken from the November 1961 and February 1962 issues, are hopefully oriented towards all aspects of engineering.

proach some colleges have adopted simply tends to equate the computer with the slide-rule. This is too limited. The student must be taught much more than the simple mechanism of operation. Every undergraduate engineering student must be taught programming methods. Every graduate engineering student must become familiar with the key programs that are vital to his specialty. He should become familiar with the key concepts that have gone into the perfecting of these programs, and the general areas of their application. There should be no concern here as to any particular type of computer — the basic techniques are applicable to most.

This responsibility for initial training may appear to place an undue burden on the colleges. But, if they can carry out this assignment satisfactorily, the engineering profession will find itself, in a few short years, in an enviable position — it will be supplied with a sufficient number of young engineers who are competent to bridge the gap between the past and the future.

A Three-Pronged Dilemma

A critically serious problem of the immediate future concerns many highly trained practicing engineers

who have spent years developing and refining complex design techniques only to find them outmoded by a machine. And while this burden of human obsolescence is piling up, how do we transmit the vast fund of engineering know-how to the younger engineer with the computer acting as a road-block? This second problem may not seem of immediate urgency but it can become among the most serious facing our profession. The professional societies can play a part by sponsoring discussions to seek answers for these two vital human problems.

The last part of this three-phased dilemma concerns the consulting firm itself. A computer installation, in order to be economically feasible, must be kept in continuous operation, or as nearly so as possible. For a large firm with a sufficient workload, this presents no problem. But what of the smaller or average-sized firm? Unfortunately, the initial investment in buying equipment, training personnel and developing new programs presents a real financial burden to all but the largest firms.

The answer for smaller firms must be found in another direction. One alternative is to combine financial, technical and mathematical abilities.

Several smaller firms could cooperatively organize to maintain a fully equipped computer center at a cost each could manage. If this is not feasible, another possibility for an individual firm would be to acknowledge the future of computer engineering by training members of the staff so that they can supervise the process of obtaining service from existing computing centers for the firm's projects.

As much as 35 per cent more tread wear can be expected from a new synthetic rubber derived from petroleum. For tires, the new synthetic is compounded with both natural and other synthetic rubbers. Tire mileage increase of 90 per cent reportedly is possible if a method can be developed to use the new man-made rubber alone in tire treads.

"Product Progress"
CHEMICAL NEWS

U. S. housewives spend some \$100 million a year on polish to keep floors at a high shine. Household purchases account for 85 per cent of the total polish market.

Chemical Week
McGraw-Hill Pub.

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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



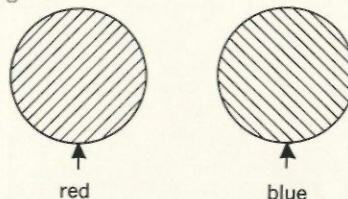
This is the *Kodak Carousel projector*. It projects slides. Carousels symbolize carefree abandon. Care lest slides jam can be abandoned. Gravity feeds them. Gentle gravity. Slides are automatically lifted back to 80-slide storage tray. Pushbuttons at end of long cord advance slides, reverse, even refocus. (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.

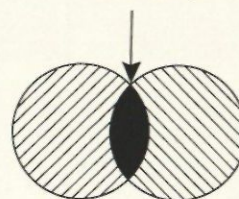
Our long research on human vision has more than happy-time slides in mind.

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.



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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.

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