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Rose Technic Staff
Rose-Hulman Institute of Technology

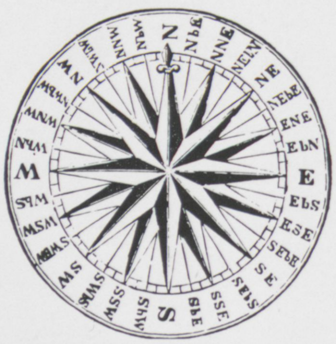
Rose Technic

October 1966

Hyperbaric Oxygenation

Go Westinghouse, Young Man!

A modern fable with technical overtones.



Once upon a time there was a young senior in college named Jack who couldn't decide about his future.

He wanted to do something worthwhile after graduation.

But there were so many things to do, it was hard to decide. He could go on to graduate school, or join the CIA, or volunteer for social welfare service, or participate in a protest movement . . . or he could enter the business world.

Many of Jack's friends urged him to steer clear of big industry.

"There are no challenges in air-conditioned offices," they warned.

And it was a challenge Jack wanted — the kind of challenge his forefathers faced on the frontiers.

Then he met a Mr. Greeley.

Mr. Greeley recruited college students for Westinghouse Electric Corporation. He was a kindly man to whom Jack opened his heart.

Mr. Greeley described to Jack the exciting things being done by Westinghouse all over the world.* Jack was fascinated and asked many searching questions about the world's 21st largest corporation. At the end of an hour, Mr. Greeley advised Jack:

"Go Westinghouse, Young Man."

Jack did.

The first few weeks were difficult. There was so much to learn.

Jack was to discover that at Westinghouse, learning was a way of life, that a career with Westinghouse was one long process of education and re-education.

Later Jack was permitted to decide which of six big groups he would like to join.** Jack selected the Westinghouse Electric Utility Group.

With the Electric Utility Group Jack learned about water processing, about power generation, about underground distribution, and many other things. Jack had not realized how important to the survival of modern man is the world of electric utilities.

It was hard work. Sometimes after a particularly trying day Jack would get discouraged. Then he'd remember the warnings of his friends, back at college. And he'd wonder whether he had done the right thing.

Then came Jill. Pretty, intelligent, warmhearted Jill. Jack had met Jill at the drinking fountain in the Utility Group Water Province Department.

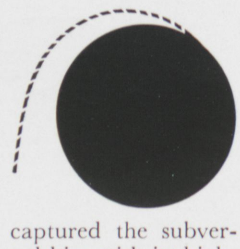
Jill was an engineer with Westinghouse (Editor's Note: Women are welcome at Westinghouse, an equal opportunity employer).

Although the work became more and more difficult and the hours longer, Jack with Jill at his side persevered.

Then came an assignment to join a team of Westinghouse engineers and scientists. The team was being sent to an underdeveloped nation in a faraway land to help rebuild a large coastal city.

Jack and Jill's assignment: Help build a power plant that would use nuclear fuel. (Nuclear fuel lasts longer than coal or oil. And it's cleaner.) Energy from the nuclear plant was used to change salt water from the nearby sea into fresh water that the poor people of this country could use as drinking water.

Working late one evening on the job site, Jack caught someone in the act of sabotaging the construction of an extra-high-voltage distribution system. This system would bring power from the nuclear plant hundreds of miles into the inland areas of the country.



After a dramatic chase through the winding streets of the city, a chase in which the international police and CIA participated, Jack captured the subversive agent. A grateful nation presented him with its highest award.

Finally, the project was completed. It was hard work but it was good work. Thanks to the Westinghouse team, millions of people would live better.

The citizens of the country were grateful. They wanted Jack and Jill and the others to stay . . . offered them more than their present salaries as an inducement . . . but Westinghouse fringe benefits more than offset this offer.

At the airport, where a sad but affectionate crowd of citizens gathered to see them off, Jack turned to Jill and asked:

"Will you marry me?"

Jill smiled and said: "I will if you promise to let me join you on other equally important turnkey projects that Westinghouse is coordinating in some of the major cities in the United States."

Jack promised, and they lived happily ever after.

Moral: Awaiting you at Westinghouse are challenges, hard work, building block education, adventure, some travel and, yes, even romance.

You can be sure if it's Westinghouse

For further information, please contact: L. H. Noggle Westinghouse Educational Center, Pittsburgh, Pa. 15221.

*UNDERSEA EXPLORATION MASS TRANSIT WATER DESALTING AEROSPACE TRAVEL AUTOMATED PARKING GARAGES PROGRAMMED LEARNING TOTAL-ELECTRIC CITIES

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IN THIS ISSUE

HYPERBARIC OXYGENATION

Ever since the late 19th century, the importance of above barometric pressure has been recognized for its potential usefulness as a theraputic tool. Today, the race is on to design, build, install, and test hyperbaric oxygenation units. Tom Hakes describes the tool and its use starting on Page 8.

ELECTRO-ACOUSTIC ANALOGY OF AN AUTOMOBILE MUFFLER

The use of electromics to describe and simulate physical systems is finding many more applications daily. Roger Hybeck describes one such use in his article which begins on Page 14.

COVER NOTE

This month's cover is senior Phil Fassnacht's representation of the article "Hyperbaric Oxygenation."

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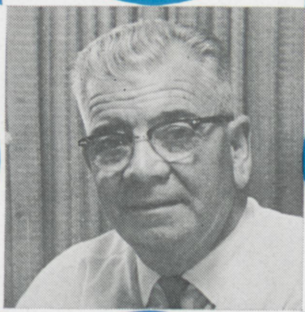
ADMISSIONS AND PLACEMENT, COMMON GROUND

DIRECTOR OF ADMISSIONS AND PLACEMENT



PROF. PAUL HEADDY

Layout by Denny Randle

Often the question is asked "Isn't it unusual having a combined office of Admissions and Placement?" Yes, as a matter of fact it is. Yet, if one studies the two areas carefully it becomes so obviously logical that it really seems strange that the combination is so rarely found.

Actually, each phase of the office function complements the other. This is a service organization in which the relations aspect is of major importance. The public served by both Admissions and Placement are overlapping and so intricately involved that it is sometimes impossible to see how they could operate efficiently if they were separate offices.

For example, the *student public* which it serves should be well known by the Placement officer. Who in the college can know the family and pre-college background of a student better? To a successful Industrial recruiter this is valuable information. On the other hand, who can better present to the prospective student and his parents, the earning and growth potential in college and after? This has been a great boon to college recruiting as well as a motivating factor for student success in a rigorous academic program.

Of course the *employer public* is just as important. Annually, this office serves at least five hundred firms, of all sizes and kinds, in one way or another. Nearly two hundred recruit actively on the campus; more would attempt it if it were physically possible and economically feasible. Many of these contribute funds and laboratory equipment. Others maintain scholarships which amount to thousands of dollars each year. They are all looking for well educated engineers and scientists, and they know where to find them. As one representative said in a long-distance telephone conversation when asked what kind of an Engineer he was looking for. "I don't give a d - - -, I just want another Rose Man!"

The *faculty and administration Public* is a third one served by the combined offices: First, we bring in the excellent raw material for the faculty to mould into well-rounded, educated young men, ready to take on the responsibilities of modern-day industry. The administration looks to us to bring in young men who are not only academically capable, but who are also responsible citizens who can carry on the traditions that have been set by other Rose Men—another one of the publics this office serves — the *Alumni Public*.

In this latter respect we feel a strong obligation to seek out capable individuals for each new class so that each can take his place in helping to maintain the high standards of excellence which Rose Men have set in the world of education and industry.

In conclusion, this office offers itself as a liaison office for the entire operation of the Institute. Each representative from Admissions and Placements attempts to present a proper image of excellence to the various publics of Rose. In all contacts it is our aim to demonstrate that Rose is a college where there is real concern for each of its clients and each of its students.

Better Grades In Less Time

That's right, by following the simple steps given here you may actually be able to raise your grades and at the same time study less. But before we start, let me go on record as saying that there is no replacement for studying. If you simply won't study, you may soon win an all expense paid trip from Uncle Sam.

A careful look at the approach we take to studying may reveal a most important time saver. Don't dawdle when you begin to study. Jump right in and start to work. If you definitely don't feel like studying, then don't. Get a date or go into town. Get away from your room and forget about your problems. When you return, you will be in a much better mood and will probably accomplish more than if you had spent the whole time studying.

Another step in cutting the time spent studying is in the field of problem solving. Too often, we become so concerned over one problem that we fail to do the others. It would be much better to see a friend for the answer to a problem we find especially difficult than to spend all night just doing one problem.

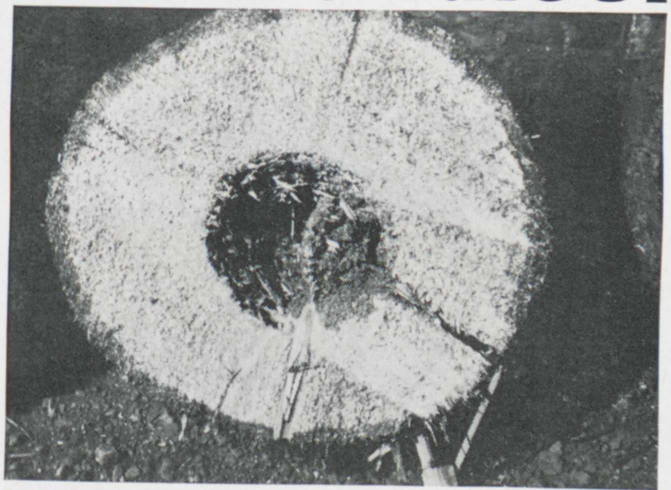
Another aid to more productive studying is a feeling of competition. Compete with someone else of your own caliber to see who can get the best grades. You'll find you can study much better if you've got some money riding on the outcome of the next test. A good way to cut down the time required to get prepared for a test is by taking good notes. To help this, become interested in class, try to think ahead of the prof and know what he is going to do before he does it. You may surprise yourself with your own intelligence.

Lastly, the best method of getting more knowledge out of each "study hour" is to exam your own method of study. For two or three weeks, keep track of all time spent studying. If you're honest about it, you will find that much of the time you thought you were studying was just time spent thinking about studying.

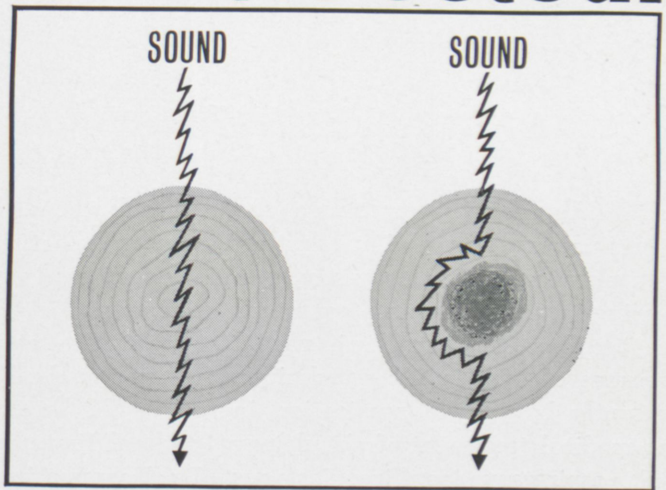
Just remember, if you don't study, it won't be long until you won't have to.

Got an idea?

Detroit Edison's interested.



1. Edison engineer, Dick Popeck, wanted to find a more effective method of determining the amount of pole decay.



2. Dick's idea: Measure the time required for sound to travel through a pole. Sound takes longer to traverse a decayed pole.

3. Transistorized circuitry was designed. And a Sonic Pole Tester was built and tested.

4. Ed Hines, Director of Research, (left) discusses patent coverage with inventor Dick Popeck.

New ideas grow at Detroit Edison. The picture story here shows the progress of one, from its conception through its development, to finalization.

The development of the sonic pole testing device* has benefited the company and the young inventor both economically and professionally. The device helps Detroit Edison serve the electric industry's customers better and more economically.

Uses for the sonic pole tester range from the examination of wooden railroad bridges to the determination of the soundness of standing timber.

Detroit Edison's forward looking management . . . its engineering and research facilities . . . along with its liberal patent policy . . . make it an ideal place for the young man with ideas.

If you are interested in putting your ideas and energies to work—write to George Sold, The Detroit Edison Company, 2000 Second Avenue, Detroit, Michigan 48226, or better yet, visit him when he interviews on the campus.

*U.S. Patent Applied for

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HYPERBARIC OXYGENATION

by TOM HAKES

Layout by Tom Trueb

Author Tom Hakes is a Senior Electrical Engineering major from Greenwood, Indiana. He is active in I.E.E.E. and Lambda Chi Alpha fraternity. This is his first appearance in the Technic.

HO (Hyperbaric Oxygenation) involves the exposure of living matter, both plant and animal, to an oxygen bearing atmosphere at pressures greater than the atmospheric partial pressure of oxygen. The technique presently has useful application in the medical treatment of circulatory and respiratory insufficencies, gas poisoning, anaerobic infections, and others. A sealed chamber similar in nature to the decompression chamber used by the Navy in the treatment of Caisson disease (the bends) is required for the application of oxygen at high pressures—the expense and complexity of the equipment and the technique accounting for the fact that the use of HO therapy has not yet entered the realm of common knowledge.

CURE ALL

HO has not always been an entirely scientific affair. Some (meta-) physicians of past centuries turned to air as a cure all. Its use was rationalized by the same dogma that proposed leeches, devils, etc. as medical tools; but while these physicians were unable to prove that pressurized air was the panacea, they did succeed in initiating the study of engineering and theory that led much later to scientific HO. The first recorded use of a hyperbaric chamber was in 1662 by Henshaw in England, and in the United States J. L. Corning reported his experiments with compressed air in 1891. There began in the late 1920's in this country a series of charlatanish financial ventures, once again using compressed air as the cure all; but the fad died out after protests from several medical authorities. In the 1950's HO became an accepted medical tool first through the efforts of Dr. Boerema in the Netherlands and at present is the object of intensive research by many others.

The value of HO derives from Henry's Law which states that an increase in the partial pressure of a gas increases its solubility in a liquid. Consequently oxygen can be transported to the cells as a physically dissolved molecule as contrasted to the limited amount of oxygen which is transported as oxyhemoglabin at atmospheric pressures. For example: breathing 100 per cent oxygen at 3 atmospheres increases the effective arterial oxygen tension about 20 times over normobaric condition, thus the red cells are carrying only a very small portion of the oxygen present.

It was the preceding set of circumstances which allowed Dr. Boerema to "lower the level of hemoglobin in young pigs to 0.4 percent, exchanging the blood by plasma or by macrodex. The animals breathing oxygen at a pressure of three atmospheres in a high pressure tank lived for 45 minutes with a level of hemoglobin not compatable with life at normal atmospheric pressure. They were alive practically without any hemoglobin (0.4 per cent) for fifteen minutes. During all this time the ECG showed no pathological changes, the circulation and blood pressure remained spontaneously normal." ("Life Without Blood" by Dr. Boerma)

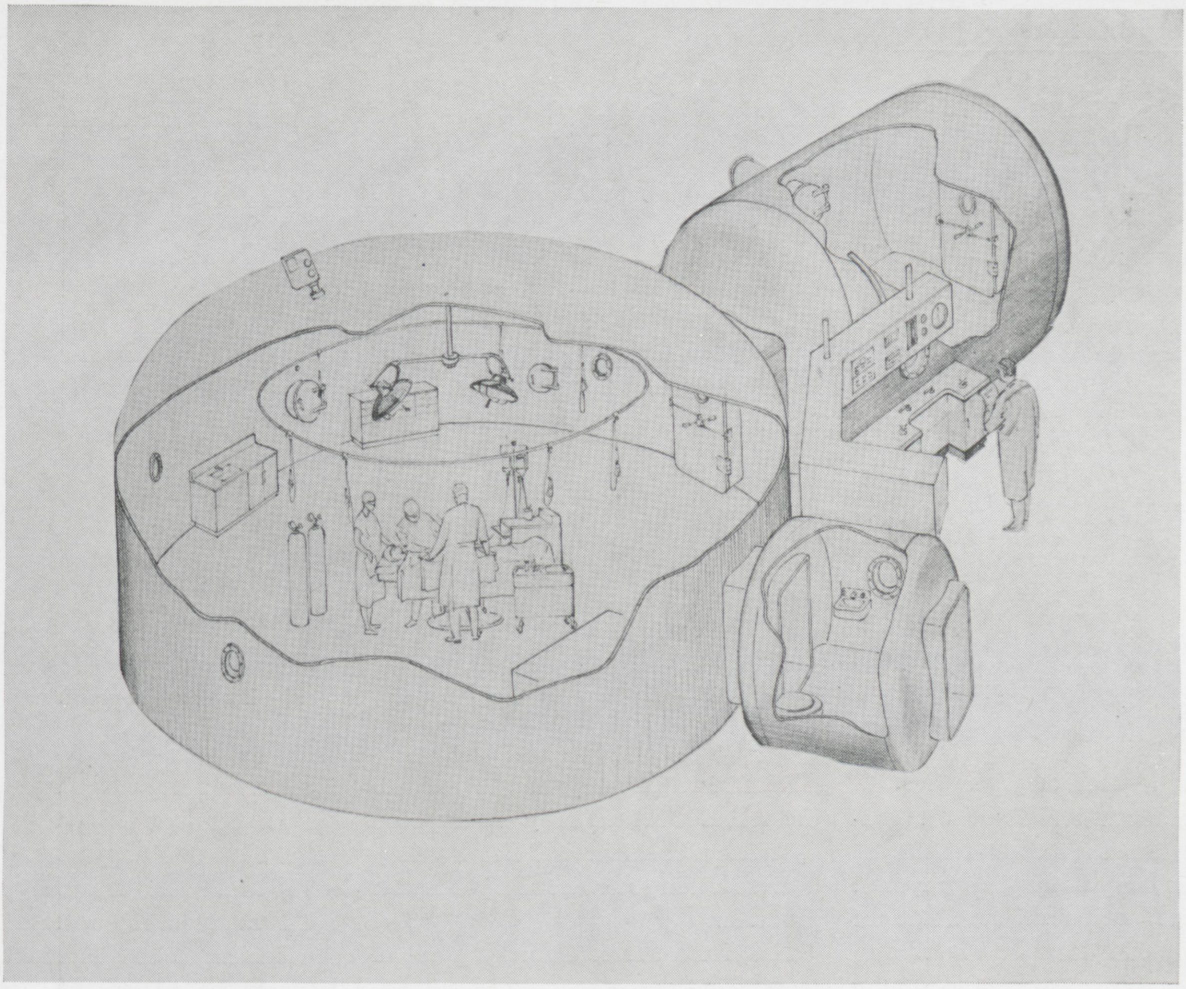
It was further, the same phenomena which allowed Dr. Boerema and others to place rodents and dogs underwater within the confines of a hyperbaric chamber and by raising the oxygen pressure sustain life in this submerged condition for periods ranging from a few minutes to several hours.

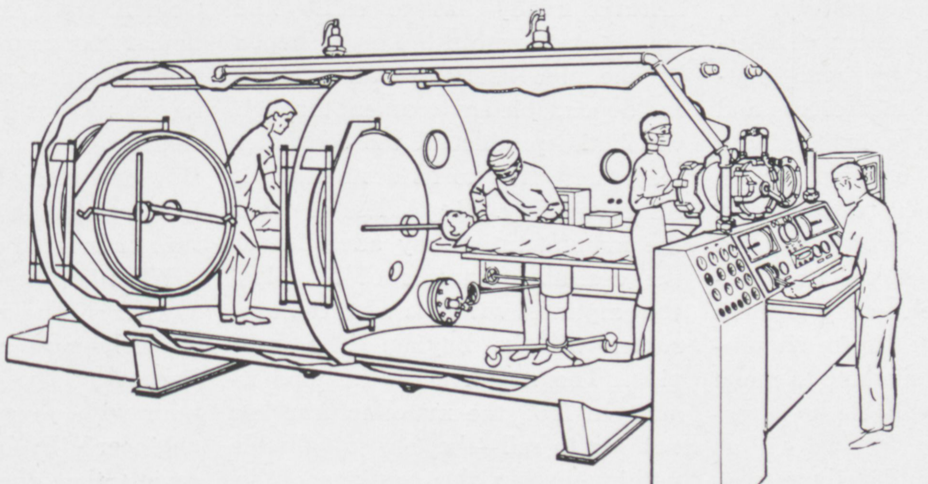
The potential scope of HO as a medical tool can be seen by a listing of the conditions in which HO presently offers the opportunity to treat in a more effective way.

CIRCULATORY INSUFFICIENCY
- Traumatic arterial injury
- Cerebrovascular accident
- Myocardial infraction
- Perpheral vascular diseases (ulcers, etc.)
- Decubitus ulcers
- Frost-bite
- Burns
- Pedicle skin grafts
- Intestinal obstruction
- Fractures with marginal blood supply

POISONING
- Carbon-monoxide poisoning
- Barbiturate poisoning
- Cyanide poisoning

(Continued on page 32)





TOP—BETHLEHEM HYPERBARIC OXYGEN THERAPY ROOM

BOTTOM—WYLE LABORATORY'S HYPERBARIC OXYGEN CHAMBER

GUEST EDITORIAL

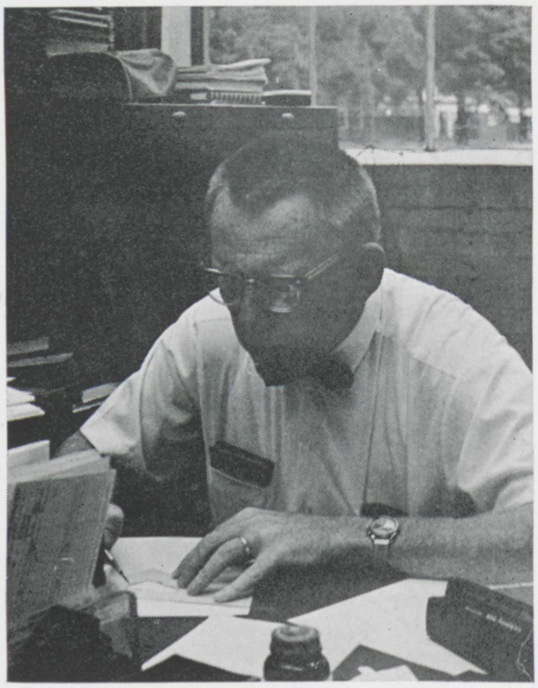
THINK NEGATIVE!-TOO

by DR. DENNIS SAPP

Associate Professor of

Civil Engineering

Layout by Bill McCord



Dr. Sapp at work.

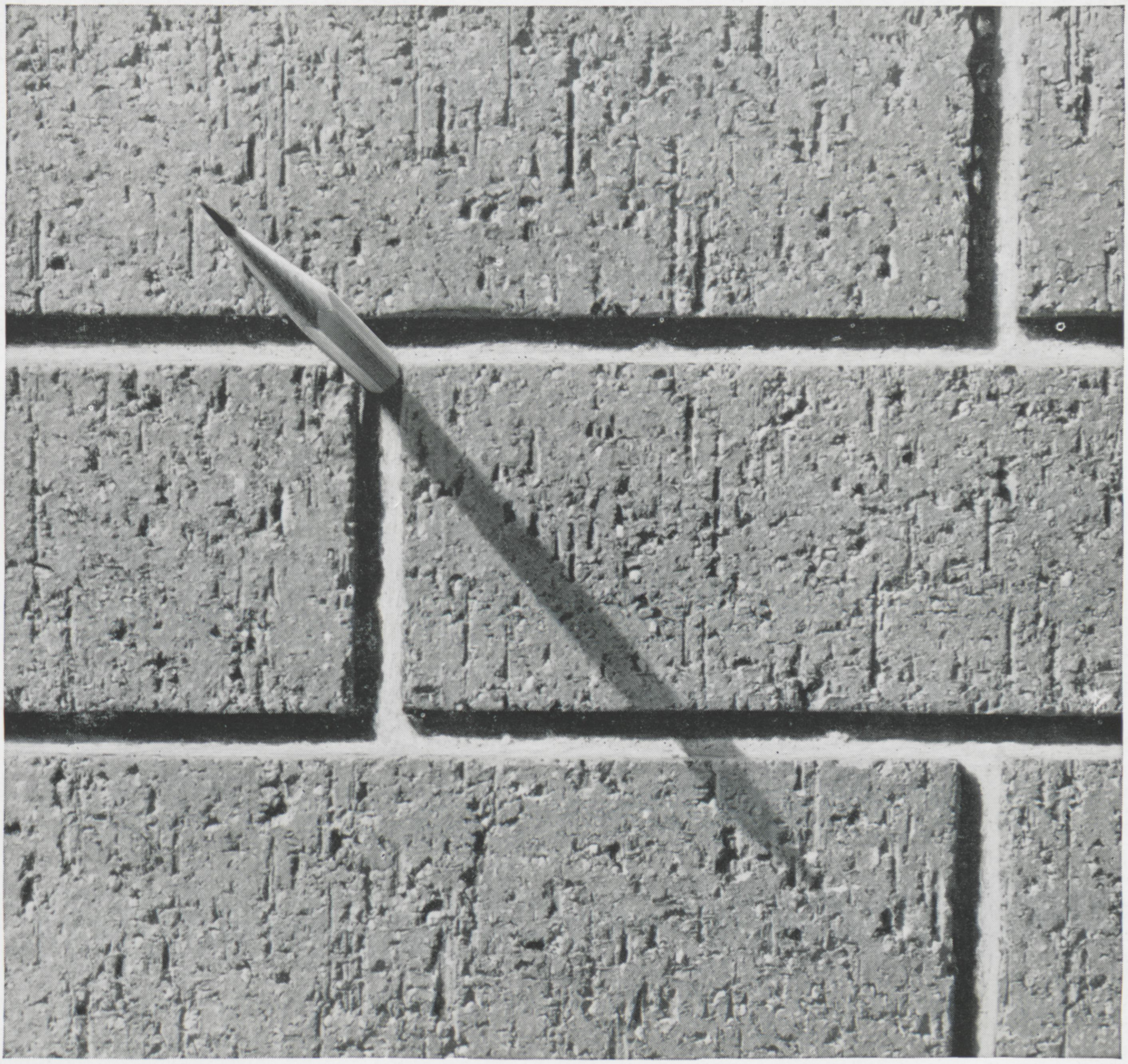
Consider a piece of pipe. What is important about it? Is it the material of which it is made? Its shape? The relationship among its physical dimensions? It could be made of lead, glass, cast iron or aluminum, shaped round, square or oblong, and its manufacturer could boast about its particular attributes, such as low cost, strength, lightness of weight or resistivity to various fluids which it might be called upon to convey. Or, it may have a combination of attributes brought about by amalgamating various material ingredients and dimensions to yield a light, strong and durable piece of pipe, or an extra heavy, corrosion resistant one. Also, it may have been subjected to a myriad of functional and performance tests which testify to these particular attributes. If so, its producer will not be reluctant to make this information available to a potential consumer. In fact, he will go to great lengths to distribute particularly favorable results. In his literature will be found various tables, charts, diagrams, and verbal explanations describing a piece of pipe that is the result of years of research and experience. The manufacturer is proud of it. And rightly he should be. He is able to predict with reasonable certainty its performance when subjected to most of the tortures which may be imposed by nature or man. He has a ready built solution to someone's particular problem.

But, from the consumer's point of view, what is really important about this piece of pipe? What is *he* interested in? What is *he* buying?—THE HOLE DOWN THE MIDDLE! —And is this not what the manufacturer really has to sell? The empty space within the pipe, shaped by the pipe itself into an efficient and dependable environment through which the product of the consumer may safely flow to its destination, is his commodity. Regardless of what the manufacturer may advertise as the desirable features of his pipe, the emptiness within is what the consumer will be buying. The anti-pipe. The negative of the pipe itself. In fact, the manufacturer has *nothing* to sell—the, oh, so valuable nothing within the confines of his highly researched and tested piece of pipe.

And so it is with most of the endeavors of an engineer. It is his job to shape some environment or to create some device which will, in some way, benefit his client in particular, and mankind in general. The physical existence of the handiwork itself is not important to society, but the effects it will have on the personal lives and happiness of its members, are. The traveling salesman not fundamentally interested in the intricacies of the internal combustion engine under the hood of his car. He wants to get from A to B. The physical size and allowable stresses in the cables supporting the roadway he drives along, over the Golden Gate, are also of no particular concern to him. He just wants to get across. One reason teflon is nice is because it produces such a saving in labor in the kitchen. But, how many housewives are really interested in its molecular structure or method of manufacture?

What is it we are really trying to say here? The pipe user doesn't particularly care about the engineer? Perhaps. The salesman and the housewife never even think of the engineer? Probably. But, are we saying that these folks are of no concern to the engineer? No! In fact, just the opposite is the intent. The effect a creation has upon the user is of paramount importance to tht creator and is the most important source of feedback into a design that is available. The engineer who

(*Continued on page* 22)



Requirements and Development

Designing with PSI

Edited from Western Electric Engineer
by Frank Nigh

The effect of high pressure on the properties of metal was first noted by P. W. Bridgman in 1912. The pressures used ranged up to 180,000 psi. One of the effects noted was that under these conditions the plastic flow was much more extensive than that normally encountered before rupture.

The same year Bridgman also published a paper dealing with the fracture of rods subjected to radical pressure along portions of their lengths. In this work the peculiar effect termed "pinch-off" was first revealed. Pinch-off is the phenomenon by which a radical hydraulic pressure of sufficient intensity causes a rod to sever with a tensile type of fracture, even though the rod may be compressed axially.

Having already developed piston-cylinder equipment for generating fluid pressures up to 450,000 psi, Bridgman found it relatively simple to incorporate a tensile testing setup in which movement of the high-pressure piston encountered one of the grips holding the test specimen and moved it so as to cause elongation. By measuring the pressure in relation to the stroke of the piston he could determine the final plastic behavior of the part at a given pressure. It was characteristic of Bridgman's test that the environmental pressure was not constant but rather increased linearly with the extension of the part. This condition obtained because he depended upon the compressibility of the fluid to allow the piston to move sufficiently to elongate the specimen. In general, this period, which culminated in Bridgman's receipt of a Nobel prize in 1946, was extremely fruitful in that it provided much fundamental data relating material behavior to pressure. Since that time a number of other workers have duplicated and improved on the Bridgman techniques of deforming metal under pressure.

INTRODUCTION

By the use of high-pressure techniques, ways have been found to make metal parts of improved quality at reduced cost. Similarly, complex parts have been made in a single operation in cases in which several operations were previously required.

Although in one sense all metal forming involves the use of high pressures (because high contact forces are needed to move the material plastically), high-pressure metal forming is characterized by the use of high forces to alter the basic formability of the material. As described in the above material, the fact that such alteration is possible has long been known as a laboratory phenomenon; however, until recently the phenomenon has not been developed as an industrial process. Now as a result of recent developments high-pressure forming includes a variety of processes that are designed to take advantage of the changes that occur in metals when they are subjected to enormous pressures.

PROPERTIES OF METALS UNDER PRESSURE

The degree of deformation, or the measure of ductility, can be taken to be the ratio of the original cross-sectional area of the rod to the area of the neck of the deformed specimen. As shown in Table 1, the increase in ductility so measured varies considerably with both the kind of metal and the pressure employed; however, in particular cases such as that of copper and certain types of steel the increase in ductility can be remarkable.

At the same time the metal is not softened in any sense of the word; in fact, metal deformed under pressure can become harder and stronger

(*Continued on page* 25)

ELECTRO - ACOUSTIC ANALOGY OF AN AUTOMOBILE MUFFLER

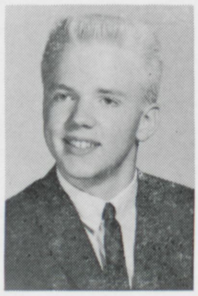
by

ROGER HYBECK

Sr. E.E.

Layout by Johnson and Stephen

Roger Hybeck is a native of Cleveland, Ohio. He is a senior electrical engineering student. He is a member of Lambda Chi Alpha and I.E.E.E.



The fundamentals of Electrical Engineering are a powerful tool for understanding a physical system. Through an electrical-circuit analogy one can apply electrical-circuit theory to a physical system. This guides his thinking and understanding of that system.

Once one becomes familiar with a particular analogy, he can draw the electrical-circuit diagram of a given system. This gives him a schematic representaton of the system which helps him visualize the concept of its operation. With the system drawn in a schematic form, he can very easily write the differential equations to describe it. Also, he can apply the network theorems he has learned from electrical-circuit theory.

In the laboratory one can set up an electrical-circuit to simulate a physical system. In this way he learns about the response and capability of a given system without actually building it.

By use of an electro-acoustic analogy we can learn how an automobile muffler attenuates reciprocating engine noise. The first step is to understand the analogy between the electrical-circuit and the acoustical-circuit. By comparing the following differential equations we can see the similarty that exists.

Electrical-Circuit

$$v = Ri$$

$$v = L\frac{di}{dt}$$

$$v = \frac{1}{C}\int i\,dt$$

Acoustical-Circuit

$$p = R_a u$$

$$p = L_a\frac{du}{dt}$$

$$p = \frac{1}{C_a}\int u\,dt$$

v—voltage
i—electrical current
R—resistance
L—inductance
C—capacitance
p—pressure
u—volume flow
R_a—acoustic resistance
L_a—acoustic inductance
C_a—acoustic capacitance

Looking at these equations, pressure is analogous to voltage. These variables are often known as "across" variables because they are measured with respect to a reference (atmospheric pressure or an electrical ground). Also, from these equations, volume flow is analogous to electrical current. These variables are often known as "thru" variables because they measure the flow of some quantity (m^3/sec. or coulombs/sec.).

The constants Ra, La, and Ca in the above equations describe the acoustic elements. Figure 1 shows the analogy between the electrical elements and the acoustical elements.

The acoustical resistor has more forms than the narrow slit. Generally, acoustic resistance is associated with the dissipative losses occuring when there is a viscous movement of gas through a fine-mesh screen or through a capillary tube.

The numerical value of Ra depends on the pressure vs. volume flow characteristic curve of the device. Most likely this curve will be nonlinear as the v-i curve is for a transistor. Therefore, the acoustical resistance (the slope of the p-u

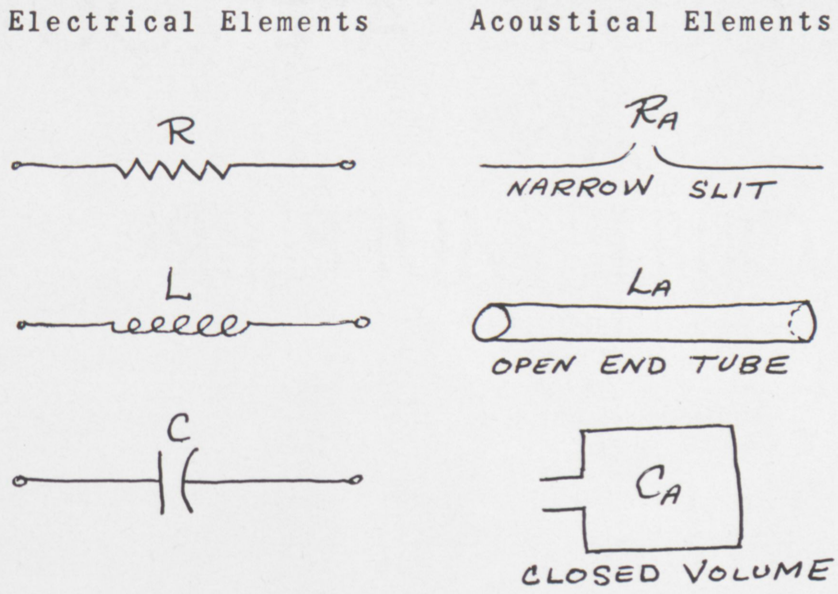


Figure 1. Analogy between Electrical and Acoustical Elements.

curve) will depend on the operating point.

An expression for acoustic capacitance and acoustic inductance can be derived from physical relationships assuming small incremental changes in pressure and volume flowabout an operating point. The results of such a derivation are:

$$C_a = \frac{V}{g_o c^2}$$

$$L_a = \frac{g_o l}{A}$$

V—volume of element
g_o—ambient density of air
C—speed of propagation
l—length of tube
A—cross-sectional area of tube

Capacitors and inductors are energy storage elements. The electrical capacitor stores potential energy in the electric field between its plates, while the acoustical capacitor stores potential energy in the "pressure" field within the closed volume. The electrical inductor stores kinetic energy in its magnetic field while the acoustical inductor stores kinetic energy in its "velocity flow" field.

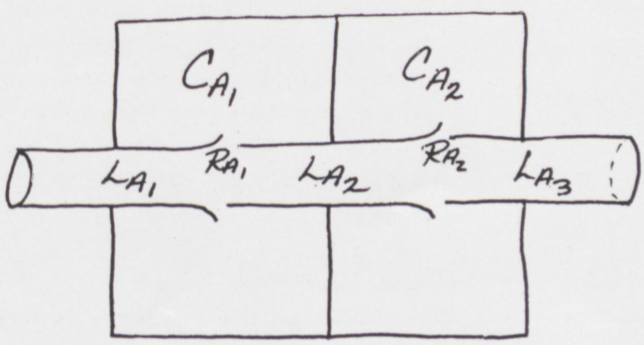
Now that the electro-acoustic analogy has been developed, lets use it to explain how an automobile muffler works. The automobile muffler has a twofold purpose. It must attenuate reciprocating engine noise (A.C. pressure waves) while still allowing exhaust fumes (D.C. pressure) to flow through. This means that complete attenuation will not be possible.

A pictorial of a simplified automobile muffler is shown in Figure 2a. The electrical-circuit diagram shown next to it in Figure 2b can be drawn from inspection of the pictorial.

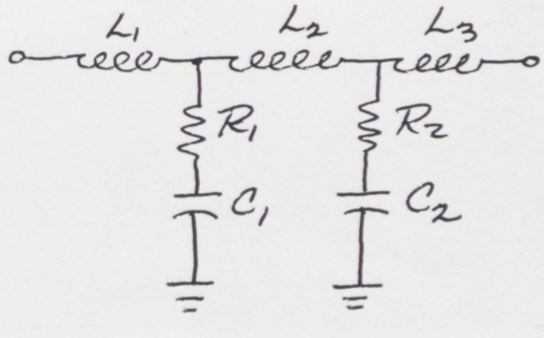
The electrical-circuit in Figure 2b, is known as a low-pass filter. It passes D.C. and low frequencies while attenuating high frequencies. Therefore, the automobile muffler is a low-pass acoustical filter. The dimensions of its acoustical elements can be designed so that the muffler will pass subaudible frequencies while introducing high attenuation for the audible frequency range.

The concept of the low-pass filter can be visualized if one recalls the frequency characteristics of an inductor and capacitor. The inductor acts as a short circuit to low frequencies and as an open circuit to high frequencies. This effect can be visualized in an acoustical inductor (tube). The low frequency flow passes through easily while much more pressure is needed for high frequency flow. The capacitor acts as an open circuit to low frequencies and as a short circuit to high frequencies. This effect can be visualized in an acoustical capacitor (closed volume). The low frequency flow builds up pressure while the high frequency flow passes through.

Looking at the low-pass filter in Figure 2b we can see that the inductors will pass the low frequencies but not the high frequencies. Therefore, the high frequencies flow through the capacitors to ground.



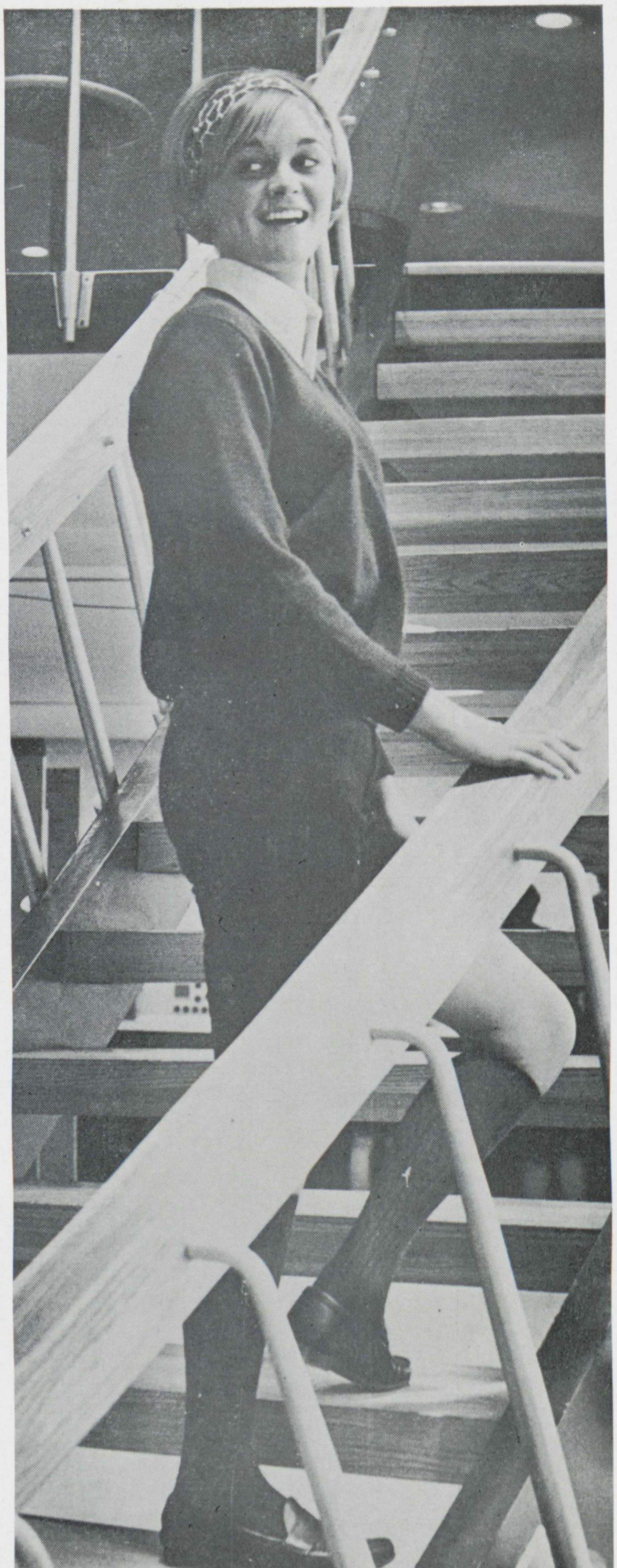
a. Automobile Muffler



b. Low-Pass Filter

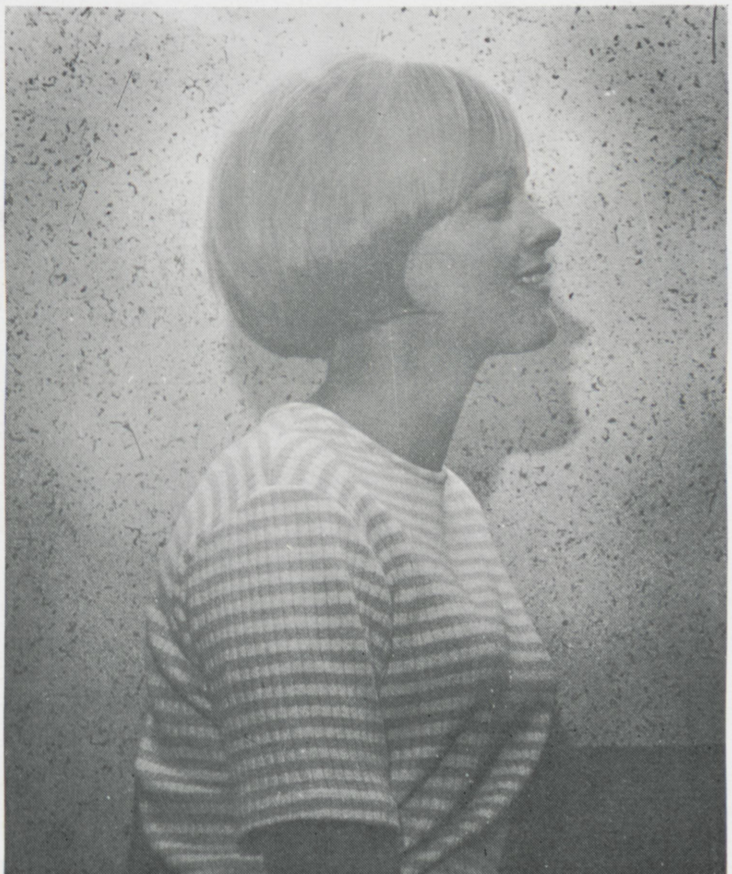
Figure 2.

COMING



GOING

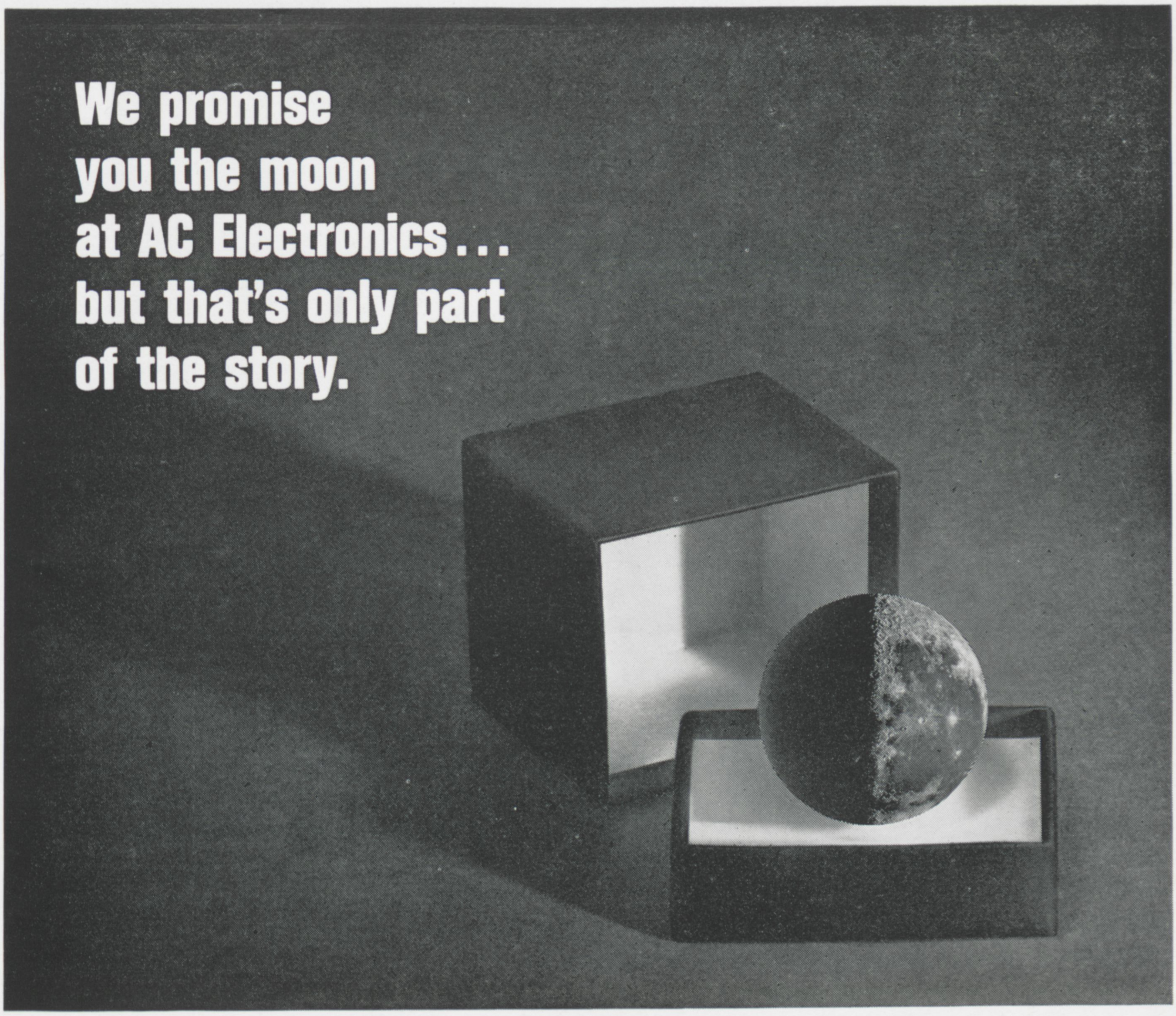
OCTOBER MISS TECHNIC



ELLEN DE RUYTER

Coming, going, or from any angle Ellen De Ruyter is an eye-filling Miss Technic. Ellen is a freshman at Indiana State majoring in elementary education. She was born in Holland and lived in Europe for 12 years, but now Columbus, Indiana is her home. As a hobby, Ellen enjoys skiing on both water and snow. She is blond, 5′ 8″, and 34-22-34 in the appropriate places. Need we say more?

Pictures by Rupp


We promise
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but that's only part
of the story.

ROSE'S FOOTBALL FUTURE

Author Gary Meek is a senior whose home town is Indianapolis. He is majoring in mechanical engineering and is a member of Lambda Chi Alpha fraternity.

by GARY MEEK

Layout by Marty Goodwine

At last, Rose Poly's football reputation is changing. Once the playground of any sandlot football player Rose's campus is facing a football revolution. Predominantly consisting of freshmen Rose's past teams showed inexperience or perhaps even the lack of "football savvy". However, with the coming of Coach Dick Martin three years ago Rose once again started to recruit players; the result of which was last years "kiddie corps" which helped lead the Engineers to their first winning season in nearly a decade.

With a year's experience the "corps" is no longer "kiddies", but is filled with a growing desire to put Rose back on the road to football recognition. With this goal in mind the players came back the first week in September to prove that last year's season was no fluke. Under the direction of Coach Martin and the line coach Leo Kelly, who has been put on as a full time member of the coaching staff, the football team is training for what is to be a most grueling and hopefully a rewarding season.

Without any seniors this years team is Captained by three juniors; Terry Joyce, Benny Bradburn, and John Shambach, all of whom were standouts on last year's team. The lack of seniors has put the team to no serious deficit in that next year's team will be basically the same.

This year's freshmen found it different than previous classes with sophomores and juniors solidly in starting positions. However, due to the lack of depth some of the freshmen will get quite a bit of game experience this year. Among the top standous in the frosh class are Jim Bumgardt, Bill Gurley, Chuck Boesenburg, and Mike Newburg.

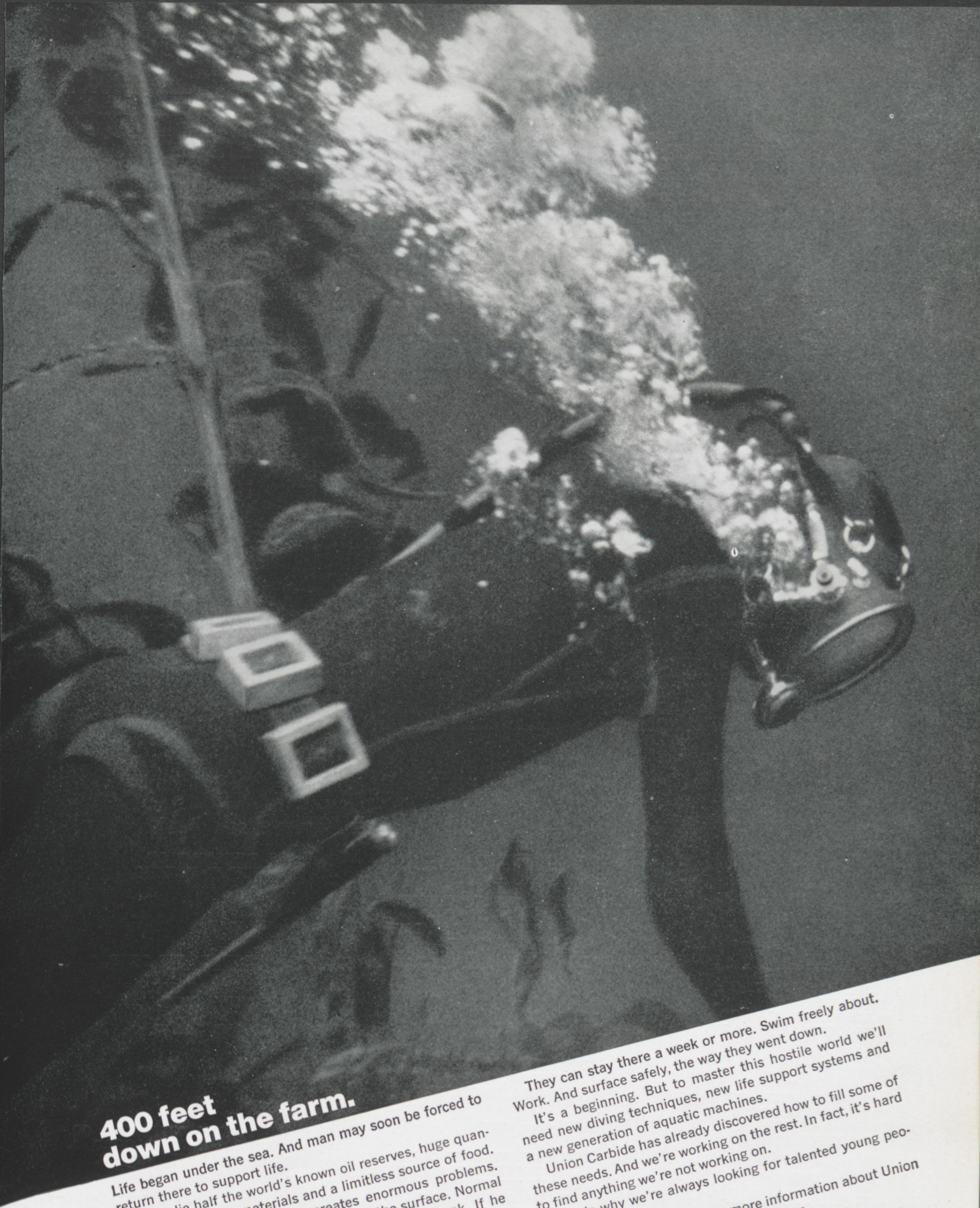
Rose's offensive and defensive units will be essentially the same as last year's team with two main exceptions. Bill Lewis, a standout defensive star and Gib Bosworth, an excellent quarterback have parted via graduation and although their shoes will be hard to fill, this year's team hopes to make up for their absense in spirit and desire. Benny Bradburn and Charlie Hills have stepped in to try to fill the quarterback position while Steve Mueller and Fred Valenti are trying to plug Bill Lewis' defensive linebacker spot.

The entire defensive backfield, which had one of its best seasons in years last fall is back with Tom Vetters, John Jacobi, and Charlie Hills sharing the safety positions while Jerry Novotny, Terry Joyce, and Benny Bradburn work out as corner backs. A year's experience has also improved our defensive line. This year's line is led by Jack Mehok, Pete Doenges, Gordon Higbee, and John Shambach all of whom go both ways on offense and defense.

The backfield although not as experienced as last year, but with a much greater potential, has two year veteran flanker back, Mike Mefford, snaring passes with sophomore ace Lonnie Minnarich punching out yardage on the ground. The new addition to the backfield was moving Fred Valenti, a defensive end last year, to fullback. Fred runs hard and is likely to be a double threat to opposition this fall.

If the team is expected to have any weaknesses, they are in its passing game. It is going to be difficult to replace a quarterback of the experience and caliber of Bosworth, but the team expects to have these problems ironed out once it gets a couple of games under its belt.

In conclusion it looks as though Rose's football future has become increasingly brighter since the coming of the new look in athletics at Rose. Rose no longer is going to lay down and be laughed at on the athletic field, but, as was evidenced by last year's team, Rose Poly is going to *fight back*! ! ! !



400 feet down on the farm.

Life began under the sea. And man may soon be forced to return there to support life.

There lie half the world's known oil reserves, huge quantities of other raw materials and a limitless source of food.

But at 400 feet, working creates enormous problems. Pressures are 13 times greater than at the surface. Normal air mixtures transform man into a senseless drunk. If he surfaces too quickly, he dies in agony.

Yet men are at work there now. Union Carbide's Ocean Systems Inc. brings them down in a new kind of diving bell; supplies them with "air" that is 80% helium, special breathing gear and a pressurized cabin to live in.

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It's a beginning. But to master this hostile world we'll need new diving techniques, new life support systems and a new generation of aquatic machines.

Union Carbide has already discovered how to fill some of these needs. And we're working on the rest. In fact, it's hard to find anything we're not working on.

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

Your placement office has more information about Union Carbide. An equal opportunity employer.

UNION CARBIDE

THE DISCOVERY COMPANY

THINK NEGATIVE!—TOO

(*Continued from page* 10)

neglects this fact from his thinking is unconsciously reducing himself from a benefactor of mankind to a mere manipulator of physical laws and mathematical symbols. It is true that he must be an expert in doing these "positive", tangible chores, but his very philosophy of life must be one which has the benefit of man somewhere near its core. And, this philosophy must necessarily carry over into his daily acts as an engineer. He has to consider society and its input into his design.

In the Civil Engineering Department here at Rose, we began offering a new course last year entitled, "Civil Engineering Design and Synthesis" (C.E. 407). It was our hope, when thinking about this course, that we could create one which would emphasize, in some way, the ideas just discussed. That is, we hoped to present an approach to C.E. design based on the requirements of the environment which was proposed to be altered. We wanted to emphasize the valuable input society has for our design problems. It is a last quarter senior course and contains students who are fairly well versed in the fundamentals of the various aspects of component design and are ready to meet the more general and complex problem involved in the design of a complete system. Last year we conducted a study of the local airport, Hulman Field*, with the hope that a certain amount of realism could be brought into the classroom. We believe the project was as successful as it could be considering only one quarter was allowed for its completion. The boys prepared a preliminary report and presented it twice, once to the students at Rose and once to group consisting of a representative of the local Board of Aviation Commissioners, the guest speakers who had made presentations to the class earlier, and other interested local people who had participated in some way in the project. It was well received by nearly everyone present. Since the presentation, we have heard several remarks about the report, from different people concerned with the airport environment, ranging from "very good" to "very bad." Some errors were noted and many differences in opinion were expressed. All of this indicates to us that the report was at least read with some interest. We believe this is good, although incidental to the purpose of the course so far as Rose Polytechnic Institute is concerned.

With regard to a topic for consideration this year, a few have been mentioned. We could treat the problem of the beautification of Terre Haute's waterfront; or, the traffic flow through the city; or, the problem of making the Wabash river navigable; etc. There really are an unlimited number of projects which could be initiated. We consider it most important, however, to select real situations involving real people and their attendant socialogical and environmental problems.

*Guest Editorial, ROSE TECHNIC, May, 1966, p. 28.

OCTOBER INTERVIEW SCHEDULE

Monday, 10th

BELL TELEPHONE LABS
A. T. & T. LONG LINES
INDIANA BELL
WESTERN ELECTRIC CO.

Tuesday, 11th

NORTHERN INDIANA PUBLIC SERVICE CO.
MUELLER CO.
ALLIED CHEMICAL CO.
McDONNELL AIRCRAFT

Wednesday, 12th

NATIONAL STEEL CORP.
HAMILTON COSCO, INC.
TEXAS GAS TRANS.
CTS CORPORATION

Thursday, 13th

GRANITE CITY STEEL
EATON YALE & TOWN
GULF RESEARCH & DEVELOPMENT CO.
GULF OIL CORP.
JONES & LAUGHLIN STEEL CORP.

Monday, 17th

THE BENDIX CORP.—MISHAWAKA DIVISION
BENDIX PRODUCTS—AUTOMOTIVE DIVISION
THE BENDIX CORP.—PIONEER CENTRAL DIV.
THE BENDIX CORP.—PRODUCTS AEROSPACE
THE PROCTOR & GAMBLE CO.

Tuesday, 18th

GENERAL MOTORS CORP.
UNION BAG-CAMP PAPER
THE CINCINNATI GAS & ELECTRIC CO.
COLUMBIA RECORDS DIV.

Wednesday, 19th

GENERAL MOTORS CORP.
INLAND STEEL CONTAINER
INLAND STEEL CO.
INDIANA & MICHIGAN ELECTRIC CO.

Thursday, 20th

GENERAL MOTORS CORP.
J. I. CASE CORP.

Friday, 21st

ALL DIVISIONS OF GENERAL MOTORS

Monday, 24th

PERFECT CIRCLE CORP.
GOODRICH-GULF CHEMICALS INC.
U.S. STEEL CORP.
E. I. DUPONT DE NEMOURS & CO.

Tuesday, 25th

DUPONT
ANDERSON. CLAYTON & CO.
INTERLAKE STEEL CORP.
SINCLAIR REFINING CO.

Wednesday, 26th

DUPONT
UNION CARBIDE CORP.—MINING & MATERIALS AND LINDE DIVISIONS

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moon man? moon talk!

Imagine hearing from the Man on the Moon!

You will. And the first American voice that speaks to earth from moon will arrive by the help of a Motorola transceiver.

Each of the 8 major phases of the historic Apollo space mission which will carry the first American astronauts to the surface of the moon—from pre-launch checkout... through moon landing and exploration . . . to earth return—will receive the critically important support of Motorola electronics equipment.

But back to moon talk. Enroute to the moon—a Motorola Up Data Link on board the Command Service Module will receive mission data from earth. When the Apollo astronaut speaks to earth from the moon, a Motorola transceiver will help send his voice to us. A small Motorola-designed backpack antenna associated with the communication system will relay his words to LM (the Lunar Module that lands the astronauts on the moon), where the transceiver assists in relaying them on to earth.

A Motorola transponder will also help provide television, voice, and digital communications . . . across 238,857 miles.

Actually—ever since the first Mercury space flight in 1961, sophisticated Motorola electronics have played a vital role in controlling, signaling, tracking, and communicating in America's manned space programs. Motorola equipment has been on every single U.S. manned spacecraft mission. *Reliably*. Official mission reports confirm that a Motorola unit has never malfunctioned or failed to operate on any of these flights.

So when the conversation gets around to "moon talks" and "moon walks," count Motorola in. And, by the way, you'll find Motorola's name on plenty of down-to-earth products, too!

TRUST THIS EMBLEM WHEREVER YOU FIND IT

MOTOROLA

R & D

(*Continued from page* 12)

than is usually the case. Again, as shown in Table 1, the true stress at fracture in the test previously described is much higher under conditions of high pressure than under normal conditions. It would thus appear that under pressure the material follows the normal work hardening curve much farther before fracture occurs.

By elongating samples under pressure and then retesting without pressure Bridgman found that the material retained the high strength developed under pressure and still exhibited greater ductility than specimens prepulled to the same hardness without pressure. This effect gives rise to the suggestion that parts made by forming under pressure would have superior quality. The real significance of this idea is economic; parts made of inexpensive materials could become equivalent to parts made of more costly materials.

In addition to the residual increase in strength, some of the historical data show that materials normally used for tools display a higher yield strength under pressure. Since some of the useful materials for parts increaes in strength to a lesser extent under the same conditions, it is evident that tool life might be increased by conducting forming operations under pressure.

Material	Pressure (Psi)	True Stress at Fracture (Lbs)	Initial Area / Area of Neck
P. W. Bridgman:			
1045 Steel	Atmospheric	176,000	2.2:1
	405,000	355,000	10.0:1
1020 Steel	Atmospheric	112,000	2.5:1
	420,000	286,000	20.0:1
Ketos'	82,000	351,000	1.3:1
Tool Steel	334,000	640,000	4.1:1
Aluminum	Atmospheric	22,000	5.7:1
	410,000	63,000	20.0:1
Copper	Atmospheric	86,000	2.5:1
	410,000	100,000	20.0:1
Brass	Atmospheric	120,000	2.1:1
	390,000	194,000	3.7:1
Tungsten	Atmospheric	300,000	1.0:1
Carbide	380,000	770,000	1.0:1
A. Bobrowsky:			
Tungsten	Atmospheric	—	1.0:1
	200,000	—	2.0:1
Beryllium	Atmospheric	—	1.1:1
	390,000	—	5.0:1
Molybdenum	Atmospheric	—	3.0:1
	270,000	—	20.0:1
L. F. Vereschagin:			
Brass	Atmospheric	—	1.4:1
	450,000	—	5.2:1
Steel	Atmospheric	—	2.3:1
	450,000	—	34.0:1
H. L. D. Pugh:			
"Mild" Steel	Atmospheric	—	3.4:1
	112,000	150,000	21.0:1
Copper	Atmospheric	70,000	3.7:1
	44,800	115,000	33.0:1

Table 1. Tensile Tests under Pressure.

Material	Pressure (Psi)	Shear Stress (Psi)
Indium	710,000	14,200
	142,000	3,550
Aluminum	710,000	45,440
	142,000	11,360
Copper	568,000	69,580
Nickel	710,000	123,540
	142,000	17,040
Iron	710,000	142,000
	142,000	18,460
Tungsten	710,000	163,300
	142,000	15,620
Chromium	710,000	174,660
	142,000	45,440

Table 2. Shear Stress under Pressure.

Unfortunately, the fatigue strength of tool materials under pressure has not been examined; however, it would be reasonable to assume that this property is also improved. Such an improvement would be very important in cold forming operations presently characterized by expensive tooling and frequent breakage.

Under high pressure the torsional shear strength and fictional behavior of metals also change. As shown in Table 2, when thin samples of different metals are twisted between

(*Continued on page* 26)

R & D

(*Continued from page* 25)

opposing anvils, an increase in the pressure exerted by the anvils results in inreases in the torsional stresses required to shear the samples; however, the amount of increase in each case depends upon the specific metal involved.

PRESSURE GENERATING EQUIPMENT

To take advantage of the unusual properties of materials under high pressure it is necessary to provide equipment capable of containing the tremendous forces required. At the same time—and this requirement is one of the more difficult aspects of high-pressure work—the equipment should also be capable of being cycled repeatedly. To these ends a number of methods are now available.

The earliest form of high-pressure chamber, a piston and cylinder arrangement, continues to be the most useful for purposes of metal forming. Of such arragements the simplest is a monoblock design consisting of an open heavy-walled cylinder filled with suitable fluid and pressurized by pistons thrust in from either end.

It can be shown that, even if the wall thickness of the vessel were increased indefinitely, the containable pressure would approach a limiting value equal to the yield strength divided by the square root of three. For the stongest available material, which has a yield strength of 300,000 psi, the maximum containable pressure in this type of vessel is less than 173,205 psi.

The situation can be improved considerably by making the vessel out of a series of shrunk rings such that a tangential compressive prestress exists at the bore before pressurizing. Yet even with this impovement limiting pressures are less than 250,000 psi. Furthermore, if the pressure vessel is to be used for production cycling, it is necessary to use fatigue strength in place of yield strength as the measure of strength. In this case the maximum usable pressure becomes only about 150,000 psi for the best possible design.

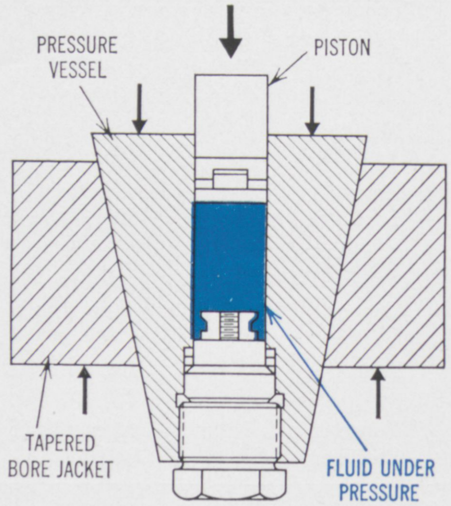


Figure 1.

To attain higher pressures it is necessary to apply a radially supporting force to the outside of the pressure vessel. Bridgman found a way of supplying the required support by using a tapered bore jacket. As shown in Figure 1, the tapered jacket was forced down onto a pressure vessel designed with a matching taper on its outside surfaces. By coordinating the application of this support with the rise in pressure inside the vessel he was able to develop fluid pressures up to 450,000 psi.

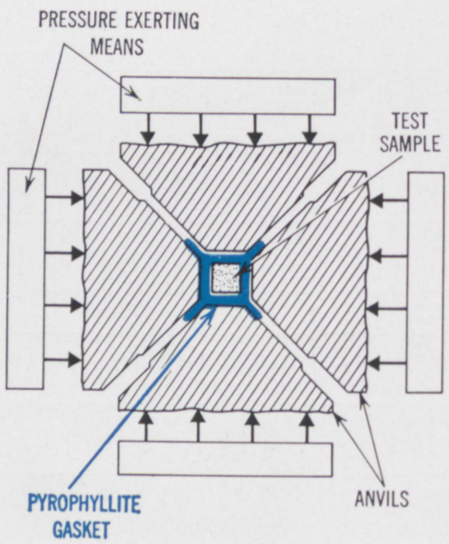


Figure 2

Although it is very useful, this type of equipment suffers from the difficulties involved in coordinating the increase in the radial pressure with that of the fluid pressure. In addition, variations in friction between the tapered members are hard to overcome.

On the other hand, the application of high pressure need not utilize fluid. The pressures can be made possible by compressive forces, which are concentrated over a small area at the point of application and spread out quickly through the conical configuration behind the sample; thus the overall stresses are not large. This concept is the principle of "massive support" developed very effectively by Bridgman. Although the particular equipment described is not used in metal-forming operations, it does serve to point the way toward effective designs utilizing this principle.

Another type of pressure-generating equipment that might possibly be applied to metal forming is the multiple-anvil press. This apparatus, which was used in the early work to synthesize diamond, is used extensively today in materials investigations, particularly those in which high temperatures as well as high pressures are required. As shown in Figure 2, the equipment consists of four or more truncated pyramidal anvils that can be driven together by hydraulic cylinders to enclose and apply pressure to a central volume in the shape of a tetrahedron or cube. Initially, the anvils are separated by a pyrophyllite gasket shaped to line the closure space and enclose the test sample. Pyrophyllite has the ideal

(*Continued on page* 28)

R & D

(*Continued from page* 26)

properties of becoming compressible and ductile under high pressure and also of having an extremely high coefficient of friction — the latter property allowing it to maintain its sealing position without extruding outward. In addition, pyrophyllite is machinable and an excellent insulator or heat.

A NEW PRESSURE VESSEL

To form the more difficult materials it is desirable, nevertheless, to have a vessel capable of cycling repeatedly up to 500,000 psi. Such a vessel has recently been developed incorporating many of the outstanding features of the higher-pressure equipment. The new vessel can also be as easily loaded and unloaded as the simple piston-cylinder device.

As shown in Figure 3, the new pressure vessel is primarily a relatively thin-walled cylinder made of hard materials. The particular cylinder diagrammed has a two-inch bore and a seven-inch working length. To support this chamber a number of radical segments are mounted to its outer surface and held in place by a thin press-fit ring. The whole assembly in turn is enclosed by a shrunk-ring jacket that will contain a pressure of 60,000 psi with fatigue. In addition, to support the ends of the chamber and prevent high fluid pressure from "pinching off" the chamber wall, conical members are provided at the top and bottom. The lower one is threaded into the outer jacker, and the upper one is made to act as a hydraulic piston. Finally, passageways are drilled through the upper cone to allow fluid to pass from the region just above the high-pressure chamber out to the large jacket.

In operation of this pressure vessel, the inner chamber, into which the part of test sample is placed, is filled with fluid, and a hydraulic press is used to force the upper piston into the top of the chamber. As the action of the piston increases the pressure of the fluid, the chamber tends to expand and thereby permit fluid to leak past the close-fitting piston. This fluid flows through the special passageways out to the containing packet, where the fluid applies pressure to the outside of the radial segments and to the top of the conical end support. The segments and the end support in turn transmit the pressure inwards to the inner chamber, which closes down on the piston to stop further leakage.

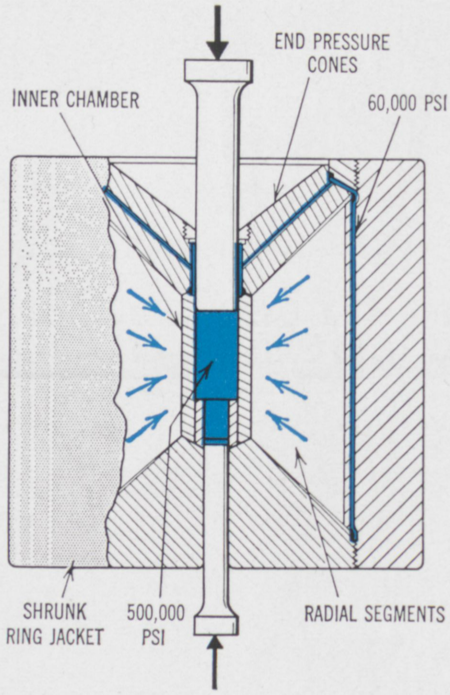


Figure 3.

Since the supporting fluid pressure in this design acts over a large area while the high-pressure fluid within the working chamber acts on a couparatively small surface, equilibrium can be maintained with small jacket pressures. For the particular apparatus shown, for example, the jacket pressure does not exceed 60,000 psi when the working pressure is 500,000 psi. Furthermore, the inner cylinder expands and contracts by only a slight amount that is well within the elastic limit of the material. The limiting factor in the design is thus the compressive strength of the piston.

CONCLUSION

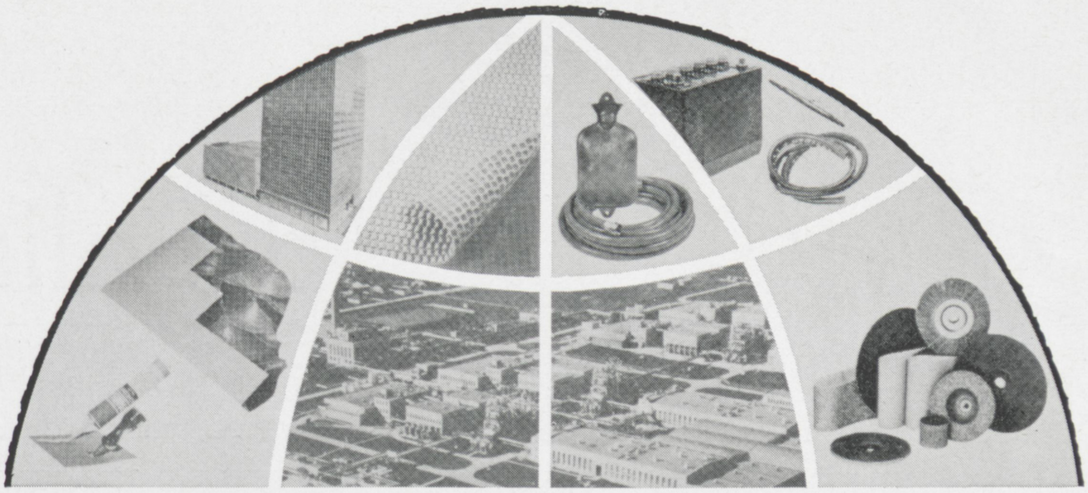
In summary, the major advantage of high-pressure metal forming lies in the ease with which otherwise separated operations can be combined not only can greater deformation be produced in a single operation, but also different areas of a part can be shaped simultaneously by hydrostatic pressure. Thus some very complex shapes can be made at comparatively low cost. And, of course, improved material strength is almost always obtained as a result of the use of pressure.

Although much progress has been made in the field of high-pressure metal forming, considerable development effort is still required. In particular, research will be of great value in the following areas:

1. Development of long-life seals for very high pressures.
2. Investigation of fluid viscosities and solidification characteristics under pressure.
3. Investigation of the strength and fatigue properties of tool steel under high pressure.
4. Thorough study of the properties of materials after deforming under pressure.
5. Evaluation of the friction properties displayed by material within a high-pressure environment.
6. More extensive and varied tests of ductility under pressure to obtain formability data.

With the proper completion of work in these areas the future of high-pressure forming seems unlimited. Applications for the new processes are numerous, and more are suggested each day.

Aside from the potentially large use of high-pressure forming techniques, the new development prevents the materials engineer with a new and very fundamental approach to forming. He is no longer limited by the handbook values of elongation or reducation of area. By the use of suitable pressure he can select the level of dutility he needs for the particular job at hand. Even more important, he now knows the absolute level and directionality of the stress field that must be applied to the workpiece to form a desired part. With this knowledge the materials engineer is armed with a very powerful technique for working out process design details.



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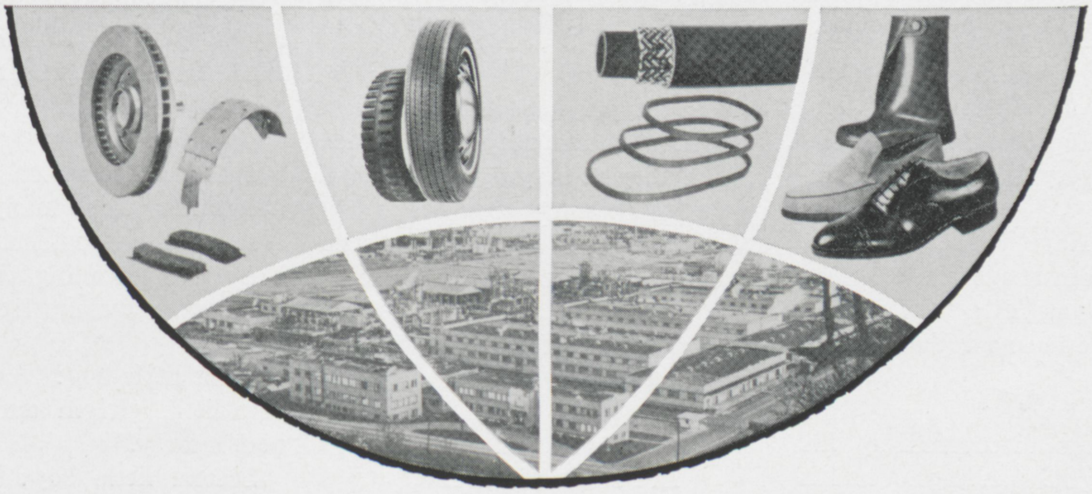

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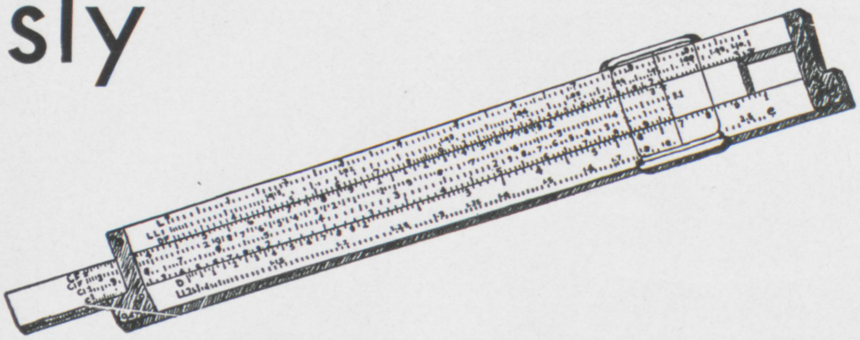

droolings

Stolen by Tony Tietz, Soph. Chem.

"Young man," said the professor to the student who kept on interrupting, "are you trying to instruct this class?"

"Certainly not sir," said the student."

"Well, then don't talk like an idiot."

* * *

1st Viet Nam Vet.: "And there we were on top of that hill, fighting for our very lives, odds 200 to one!"

2nd Viet Nam Vet.: "Boy that must have been rough."

1st Viet Nam Vet.: "You said it. That was the meanest Viet Cong I ever saw.

* * *

A M.E. was discovered by his wife one night standing over his baby's crib. Silently she watched him. As he stood looking down at the sleeping infant, she saw in his face a mixture of emotions that she had never seen before—rapture, admiration, doubt, despair, ecstacy, incredulity. Touched and wondering alike at his unusual parental attitude and the conflicting emotions, his wife with her eyes glistening, arose and slipped her arm around him. "A penny for your thoughts," she said in a tremulous voice.

He blurted out: For the life of me, I don't see how anybody can make a crib like that for $3.49".

* * *

EE: "Why don't you like girls?"

ME: "Because they're biased."

EE: "Biased?"

ME: "Yes, every time I got out with them it's bias this, bias that, bias something else, until I'm plumb broke."

* * *

I tried to kiss her by the mill
One starry summer night,
She shook her head and sweetly said,
"No, not by a dam site."

* * *

Most people have some sort of religion—at least they know which church they're staying away from.

* * *

Judge: Young man, you've been accused of stealing a lady's petticoat.

Young man: But judge, it was my first slip.

* * *

Both women and pianos
Are similar in brand,
Some of them are upright
And some of them are grand.

* * *

As long as there are final exams, there will be prayers in our schools.

* * *

A Humanities prof was crossing the campus one day when a tremendous storm blew up. As he hurried for shelter, a bolt of lightning hit a tree not ten feet away. He stood stunned for a moment and then shaking a defiant fist skyward shouted triumphantly, "Ha, you missed."

* * *

It was rough crossing the English Channel and the spray was flying over the decks. The captain called down, "Is there a macintosh down there big enough to keep two young ladies warm?"

"No," shot back a voice, "but there's a MacPherson willing to try."

* * *

"Beg your pardon, but aren't you an engineering student?"

"No, it's just that I couldn't find my suspenders this morning, my razor blades are gone, and a bus ran over my hat."

* * *

Pressure from local draft boards has influenced so many students to take officer commissions that the old vets are calling the new Lieutenants' insignias "Hershey Bars."

* * *

First little boy: "I don't like the new little girl in our block. Her neck's dirty."

Second little boy: "Her does?"

* * *

Maybe if we young people can hollar loud enough at the graft and corruption in the world today, there might be some left when we take over.

* * *

"We've gota case of beriberi up here, what'll we do with it?"

"Give it to the Engineers. They'll drink anything."

* * *

Prof: "A wise man doubts everything. Only a fool is positive of everything he says."

Student: "Are you sure of that, sir?"

Prof: "Positive."

* * *

C.E. "Is there any lunch in the refrigerator?"

E.E. "No. Not a drop."

HO

(*Continued from page* 9)

INFECTION
- Gas gangrene
- Tetanus
- Zynergistic gangrene
- Anaerobic infection in general

RESPIRATORY INSUFFICIENCY
- Pulmonary edema
- Acute wet lung from trauma
- After pneumonectomy
- Severe pneumonia
- Apnea neonatorum
- Hyaline membrane

OTHER
- Caisson disease (the bends)
- Shock
- Radiotherapy

A singularly important place for HO appears assured in surgery since the method can significantly increase the work time available by allowing blood loss or arrest of focal circulations. "Since high concentrations of oxygen in cells potentiates their susceptability to radiation, the effect being greater in cancerous than in normal cells, HO has proved useful also as an adjunct in radiotherapy. The value of the technique in CO poisoning can be attributed to the ability of oxygen to vigorously facilitate CO unbinding from hemoglobin, allowing its elimnation through the lungs.

In gas gangrene, the technique reestablishes oxygenation of tissues and circulatory competence, thereby inducing a cyclical improvement. It is not clear why HO is useful in tetnus, since the anerobic clostridia are dead by the time the disease is manifest; concentrated oxygen appears to give general support in this instance." These are a few of the applications with many others, as is evident from the list, too numerous to discuss here.

NEW CHAMBERS

Until very recently operations and tests of HO have taken place within chambers that were originally designed for other purposes. There has of late, however, been a radical change in this situation. As medical interest has increased in this new therapeutc tool, the interest of industry has kept pace and at present chambers are being manufactured and further developed by Wyle Laboratories, the Linde Company (a division of Union Carbide) and the Bethlehem Corporation (a division of United Aircraft). Several of these chambers are seen in the accompanying illustrations. Chambers range from large built-in units to small portable chambers, though at present a flexible type installation is preferred since new developments will rapidly obsolete anything too ponderous.

As for conditions within hyperbaric chambers, a patient can withstand 24 hours at 2 atm. of air without adverse effects but at 3 atm, a limit of 2 hours is usually imposed. Overexposure to oxygen at high pressures is toxic and while the mechanisms which cause this toxicity are not yet fully understood though they are the subject of many investigations. There are other problems such as how the pressure affects equipment and the peculiar acoustics which intensify the slightest sound. There is danger of fire or explosion and hence all auxillary equipment (ECG, oscilloscopes, pressure controls, etc.) must be located outside the chamber. There is the effect of the oxygen rich atmosphere on the medical staff and the fact that anesthetics behave differently under these conditions. However, the solutions to these problems are only a matter of time and experience and present no major barrier to HO.

There is at present much work being conducted, using laboratory animals, at higher oxygen pressures (6-8 atm. of pure oxygen). There is work involving the exposure of plants, bacteria, and fungi to HO. High oxygen tensions inhibit the growth of a wide variety of microorganisms and possibly incapacitate the enzyme systems of higher plants. These are areas where little or nothing is known of the responsible mechanisms and in most other aeas only preliminary research has been done. The potential value of HO is great, but remains to be assessed in each possible application.