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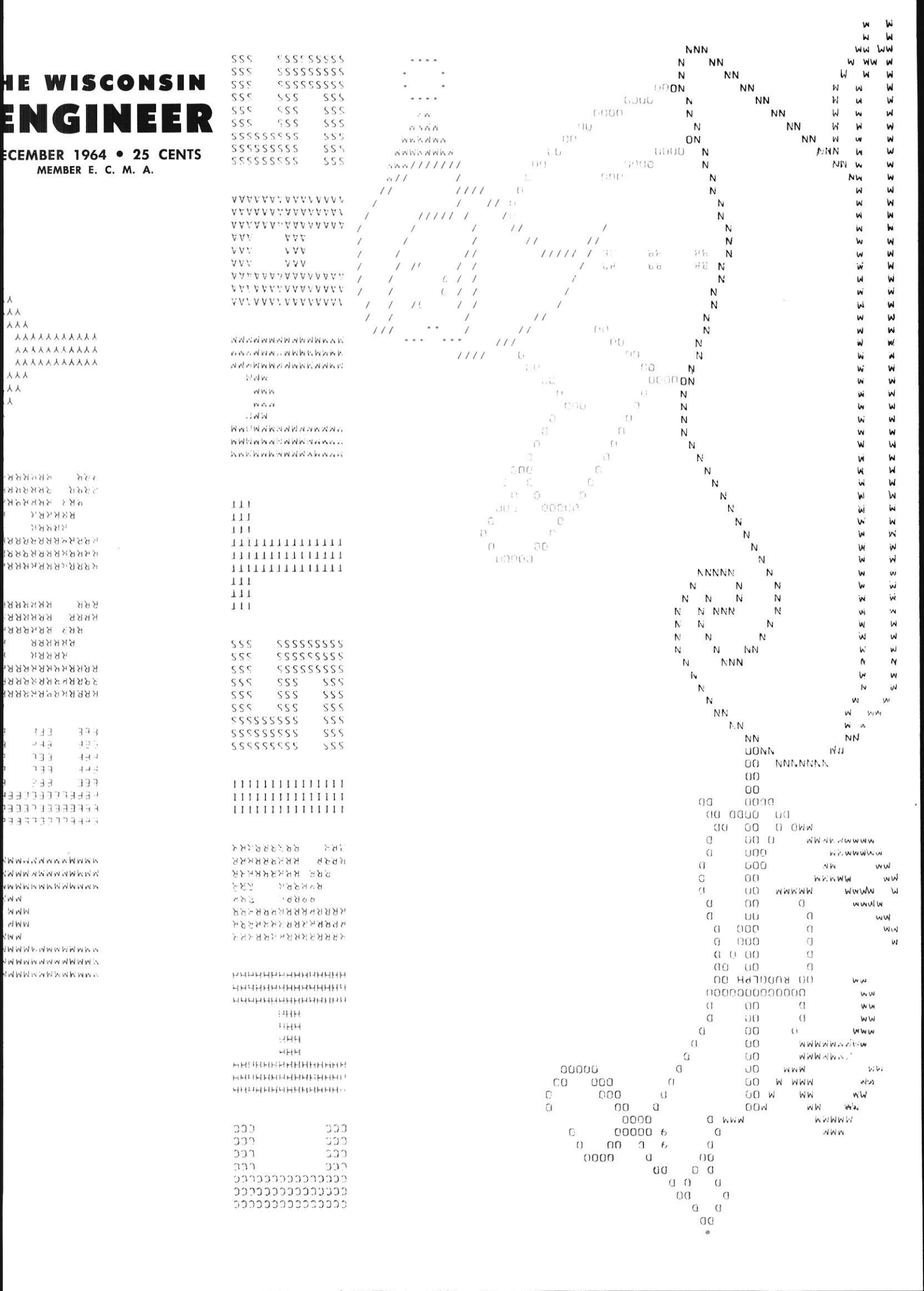
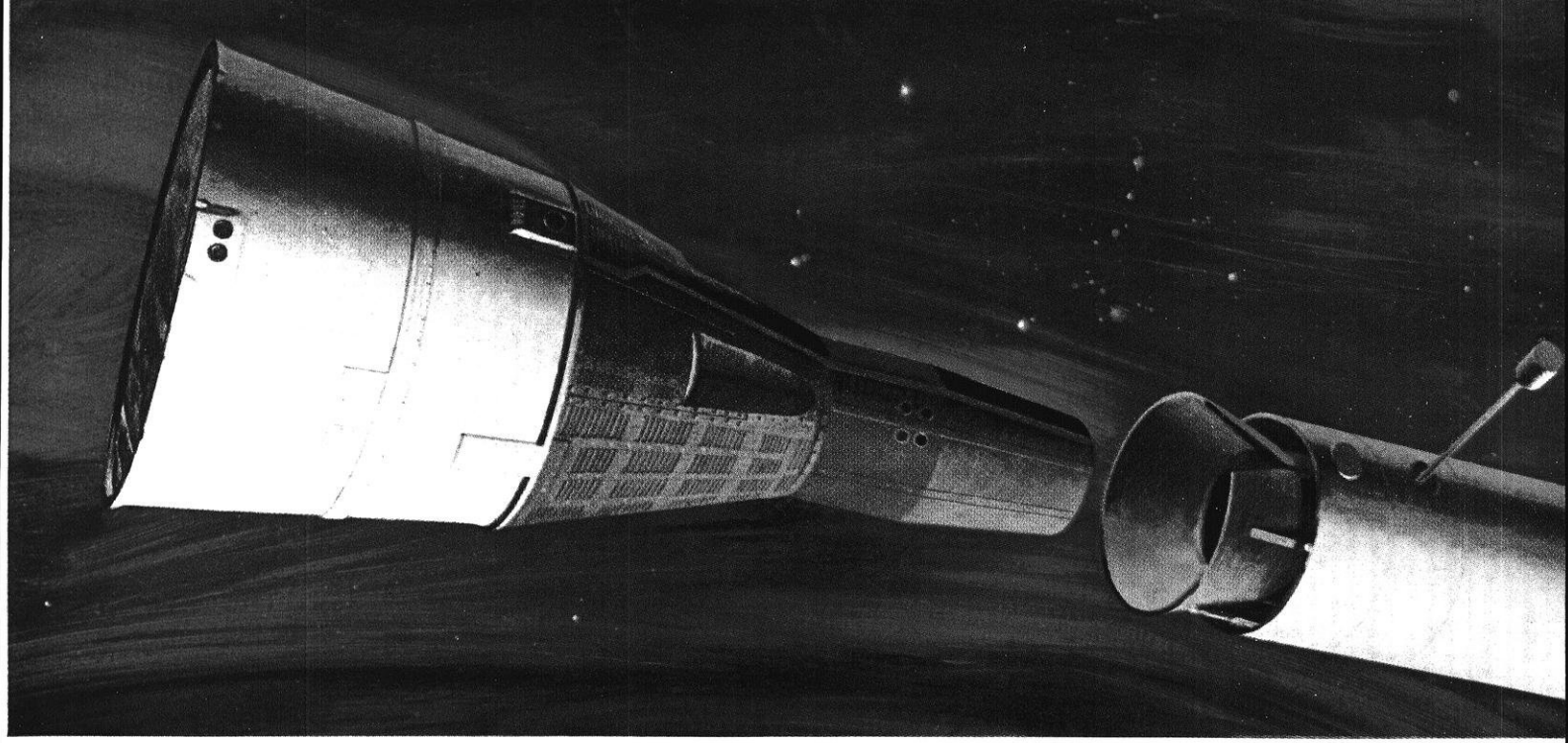
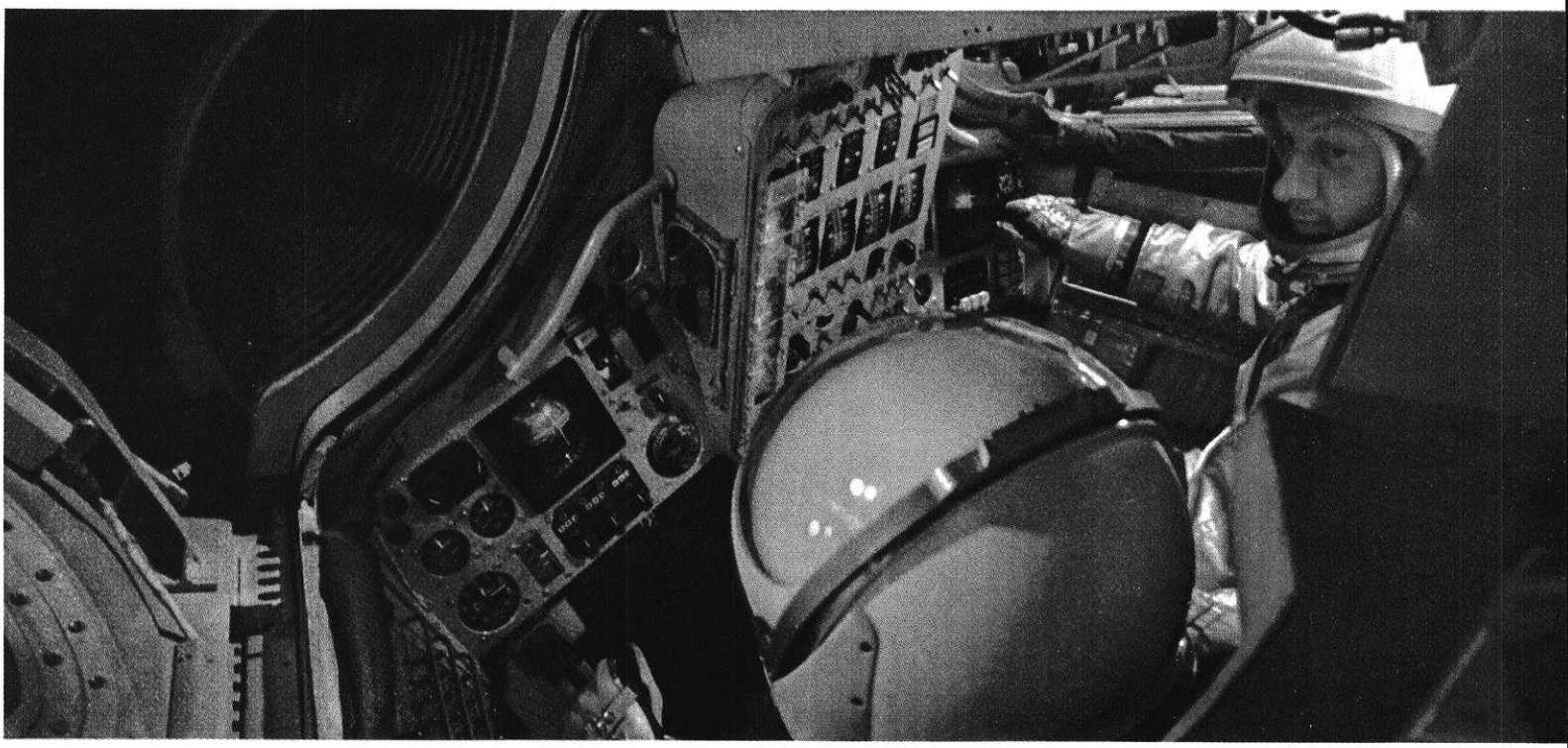
HE WISCONSIN
ENGINEER

ECEMBER 1964 • 25 CENTS
MEMBER E. C. M. A.





Moon shot rehearsal: when the Gemini spacecraft meets its target



Westinghouse radar will guide the astronauts to this meeting in outer space

When the Gemini two-man spacecraft lifts off, a dramatic dress rehearsal for the first moon trip will begin. The astronauts' mission: to maneuver their spacecraft and join it with an Agena rocket already orbiting the earth at more than 17,500 miles per hour.

A new Westinghouse radar system will guide the chase. Locating the target, the spacecraft will send out radar pulses. Computer-translated responses will guide the astronauts until the target is reached.

A vital prelude to future space travel, the rendezvous experiment will one day be routine. Meanwhile, Westinghouse is already working on other advanced radar systems for lunar landings, planet exploration, space station support and deep space missions.

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December in Brief

Here it is, Christmas already, bringing a long-awaited vacation. Lest you forget, we have a 10-day ordeal coming up in January, beginning two short weeks after our return. Anyway, have a happy holiday season and don't study all the time. Your slide rule won't get that rusty.

The editor takes a few pokes at people and things in "Across the Editor's Desk." Such holiday spirit! Nevertheless, his evaluation of a current political issue and the suggestion he makes to the Bascom Hall officials are well worth reading and thinking about.

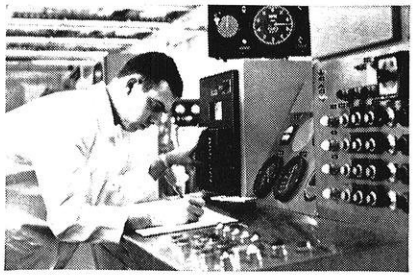
Heading up our trio of articles for this month is "An Introduction to Stereophonic Sound Recording " by William C. Boehm. Bachelor Bill, who will graduate with a BSME next month, is a native of Racine, Wis. While at UW he has been active in the affairs of Sigma Phi Epsilon, Tau Beta Pi, The UW YMCA and the Haresfoot Club. His very readable article does an excellent job of explaining the terms and processes involved in stereo recording.

Photogrammetry, an important sub-division of civil engineering is the subject of Gerald Kurtz's article on "The Geometry and Uses of Aerial Photographs." We think that all engineers will profit from reading about this interesting field. Gerald, a Senior CE and also a Theta Tau pledge, hails from Waukesha, Wis. and plans to be a highway engineer after graduation.

Norman Jahn gives us the straight scoop on that high-flying instrument of precipitation prognositcators, the weather balloon. The author of "Meteorological Balloons" is from Johnson Creek, Wis. Employment with our own UW Dept. of Meteorology inspired him to write the article, Norm tells us. He is a member of Theta Chi fraternity.

You'll no doubt welcome the return of the "Girl-of-the-Month." Those of you who have been around for several years may recognize our "BB" as the *Wisconsin Engineer's* first Girl-of-the-Month. We'll admit that we stole the idea from a national men's magazine but really thought you'd like to see a reprint of our past, particularly one that has received many compliments.

In closing, the staff and faculty advisors of the *Wisconsin Engineer* extend to our readers best wishes for a joyous Christmas and prosperous New Year.



Shhh! **Enginuity at work!**

That's Bill Emrich immersed in his work behind that Lincoln engine. He's testing new oil additive formulations, designed to make new engines produce to their potential. Yet, whatever he develops has to meet the needs of older engine models, too. You might say it's a matter of enginuity.

Bill uses several test engines: among these are a Labeco one-cylinder, a Caterpillar one-cylinder and special Lincoln and Oldsmobile engines. He tests oil additives and formulations for sludge, rust, wear and reaction to high-temperatures under severe operating conditions. His findings will help car owners to get greater mileage between oil changes, longer engine life. A most important project. Yet, Bill is only 24 years old. Just last year, he came to American Oil and is now working for Amoco Chemicals, a sister company. Bill graduated from the University of Illinois with a B.S. degree in mechanical engineering.

The need for young professional people in positions of responsibility and creativity is great. Bill happens to be an automotive engineer, but he still might be working for us had he chosen a different field—mathematics, physics, chemistry. A variety of opportunities exist here at American Oil Company.

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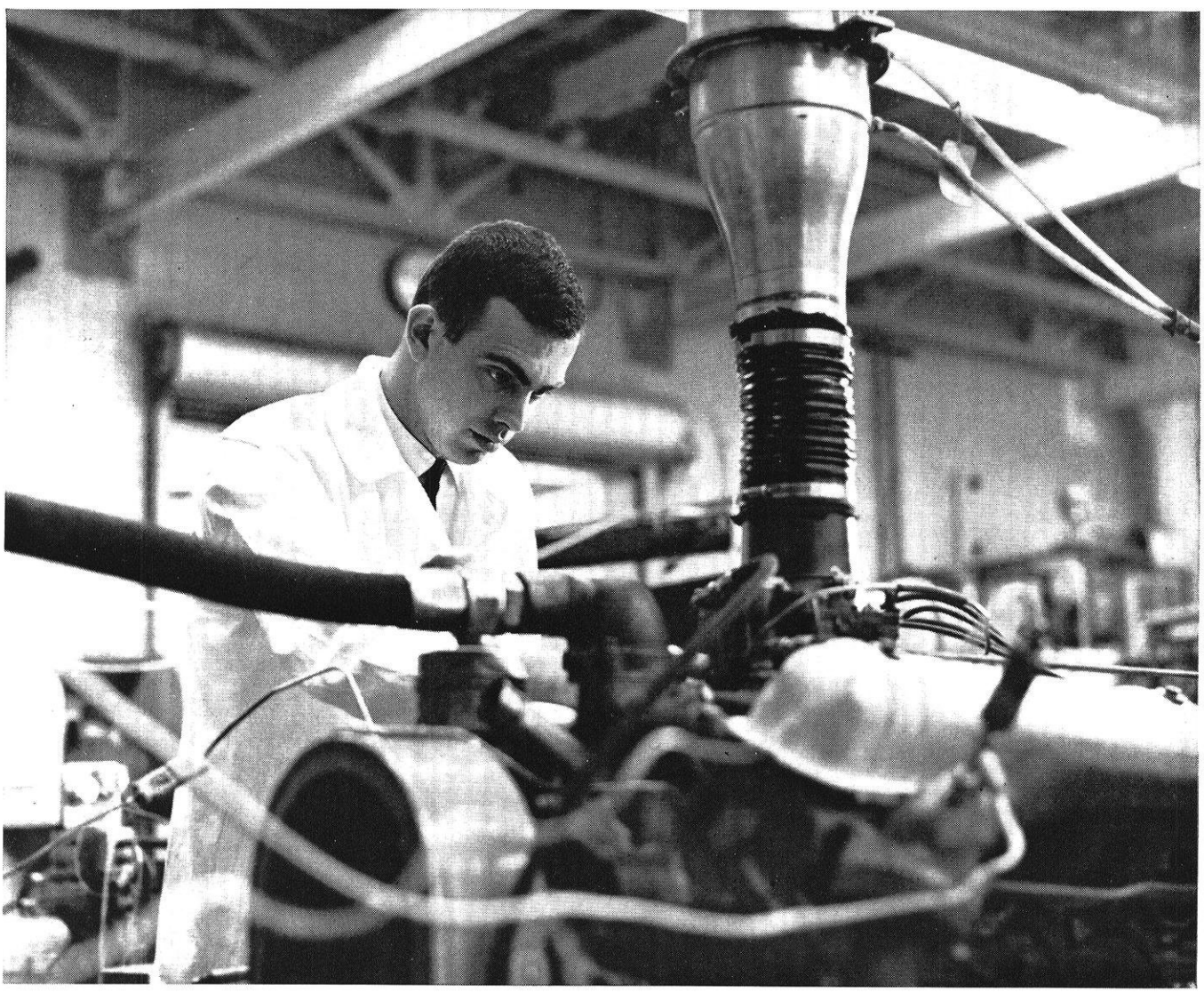

Could a U.S. firm that helped save a cotton crop abroad also have a hand in keeping Jayne Tippman's skin soft?

You'd expect that a U.S. company engaged in mining, production and marketing in over a hundred countries might have an impact on many national economies. And you'd be right. For instance, with an insecticide sold under the trade mark "Sevin," this company was largely responsible for saving a middle east cotton crop.

And when a leading chemical manufacturer's products include silicones, which have a soothing and protective effect on skin, they're bound to turn up in skin lotions, creams, and emollients. Jayne Tippman uses them to keep a glowing complexion that weather can't beat.

Cotton fields and skin lotions are unlikely markets for one company's products. Unless that company is Union Carbide.

But then, Union Carbide also makes half a dozen major plastics, along with plastic bottles and packaging films. And it's one of the world's most diversified private enterprises in the field of atomic energy. Among its consumer products are "Eveready" batteries and "Prestone" anti-freeze. Its carbon products include the largest graphite cylinders ever formed, for possible use in solid-fuel rockets. Its gases, liquefied through cryogenics—the science of supercold—include liquid oxygen and hydrogen that will be used to propel the space ships designed to reach the moon.

In fact, few other corporations are so deeply involved in so many different skills and activities that will affect the technical and production capabilities of our next century.

It's a future that glows like Jayne Tippman.

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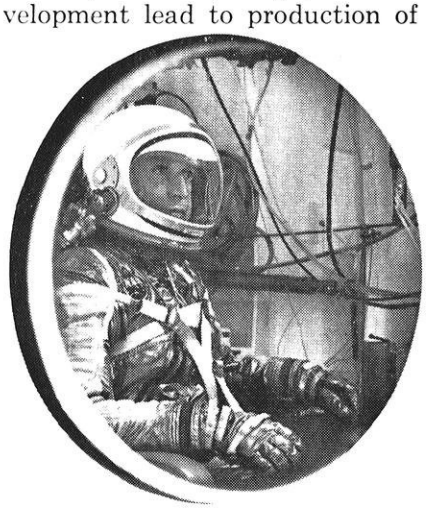

The product lines at AiResearch, Los Angeles Division, are environmental systems, flight information and controls systems, heat transfer systems, secondary power generator systems for missiles and space, electrical systems, and specialized industrial systems. In each category AiResearch employs three kinds of engineers.

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Our engineering staff is smaller than comparable companies. This spells opportunity. It gives a man who wants to make a mark plenty of elbow room to expand. And while he's doing it he's working with, and learning from, some of the real pros in the field.

If the AiResearch story sounds like opportunity speaking to you– don't fail to contact AiResearch, Los Angeles, or see our representative when he comes to your campus.

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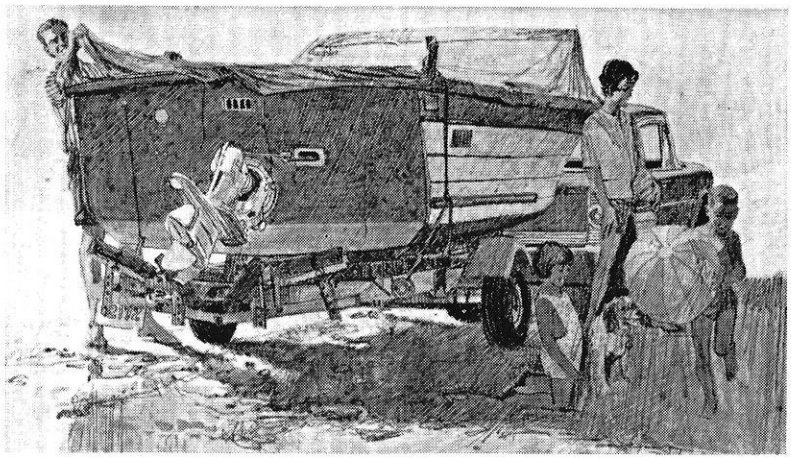

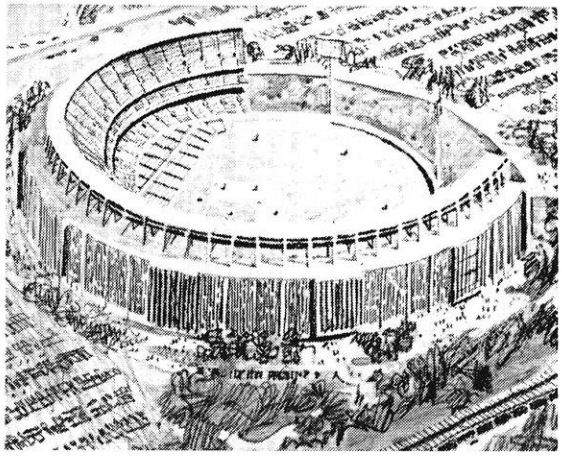

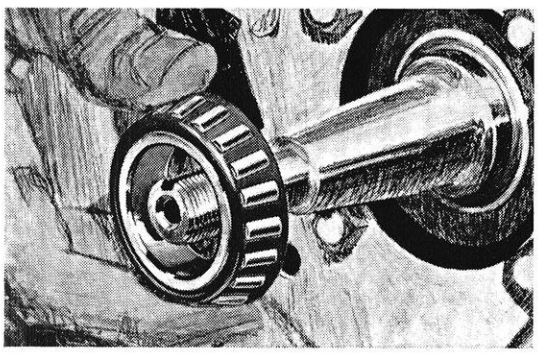

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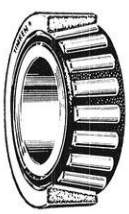

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LETTERS

ENGINEER:

Thank you for sending me the October 1964 issue of the *Wisconsin Engineer* and giving me the opportunity of reading the article on water witching by Barry A. Jens. I object to Mr. Jens' reference to H. E. Thomas' statement on the use of scientific methods of divination to obtain oil-producing wells. The author steps on numerous toes when he relates geological, geophysical, and geochemical techniques to dowsing. I trust that Mr. Jens wrote the article with tongue in cheek. Incidentally, Mr. H. E. Thomas' title is research geologist, and not branch area chief as given in the article. Outside of this criticism, the remainder of the article was well written and interesting.

Thanks again for the publication. I have enjoyed reading articles in the *Wisconsin Engineer* for many years.

C.L.R. Holt, Jr.
District Geologist
U.S. Geological Survey

(Our staff normally edits incoming articles for format only, normally presuming that the factual material is correct. We thank you for your interest in the magazine.)

ENGINEER:

I have several comments to make pertaining to your October, 1964 issue, all of which refer to page 1.

I have been a ME for over 4 years and now along comes the *Wisconsin Engineer* and calls me a Senior Civil. This is enough to make me tear up my books and quit, *but* using better judgment I will assume it was a mistake. I hope you will pacify me and say it was a mistake.

I also think you should bring your jokes back. This is one of the things that makes the *Engineer*.

I know most of you are engineers but couldn't you have your beautiful girls a little more often than once each season.

Other than this, keep up the good work.

Don Christopher
Senior M.E.

(A mistake it was, Don. We hope you're pacified and will accept our apologies. As for our jokes, we have received a torrent of requests to reactivate that feature of the magazine and did some in our November issue. The "Girl-of-the-Month" is back again, by popular demand. Thank you for your letter.)

MEMBER OF ENGINEERING COLLEGE MAGAZINES ASSOCIATED

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The Student Engineer's Magazine Founded in 1896

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THIS MONTH'S COVER

The engineer's right hand, the modern electronic computer, assists and joins the staff in wishing you a Merry Christmas. Our thanks goes to the UW Computer Center for their assistance.

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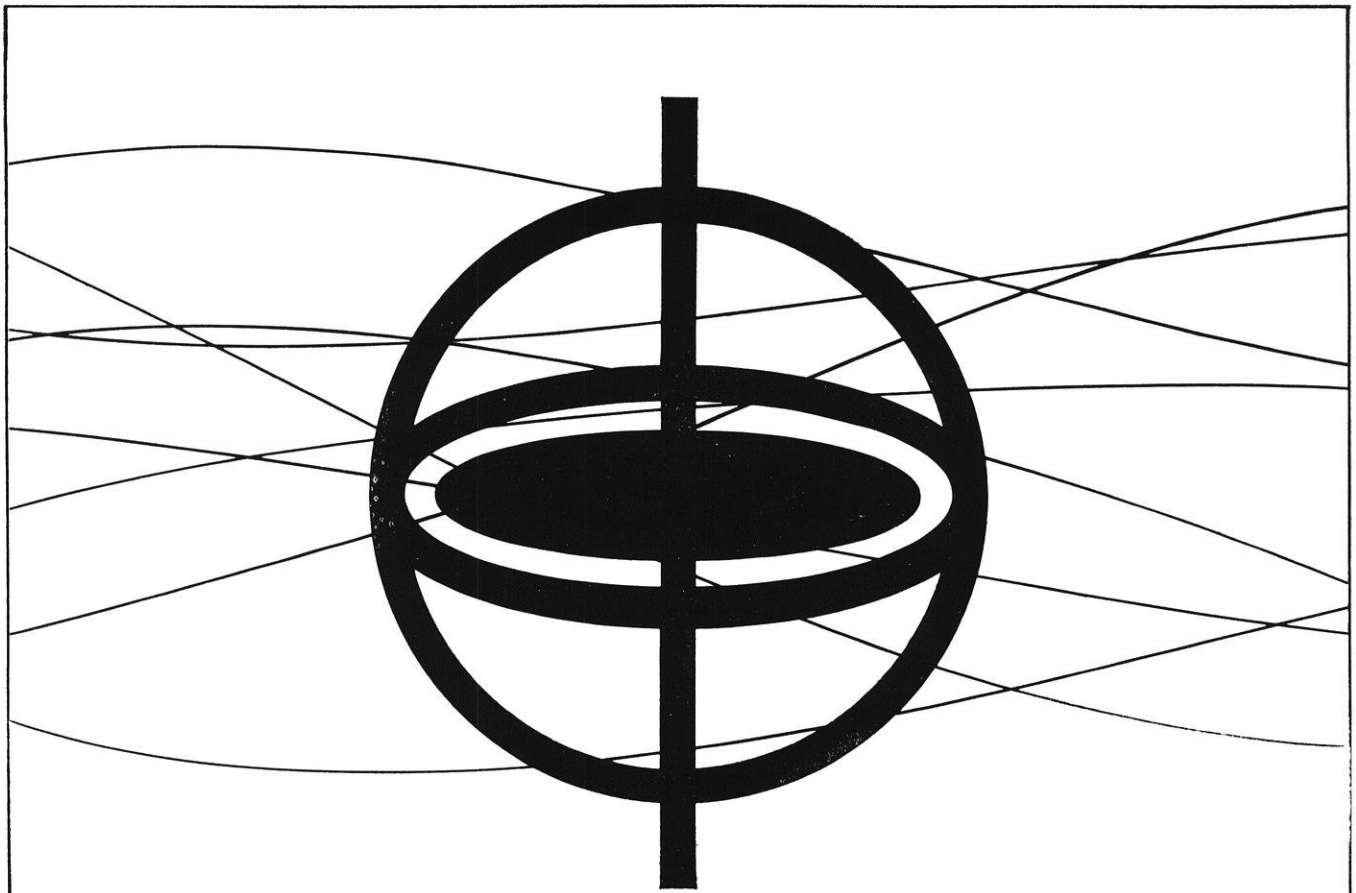

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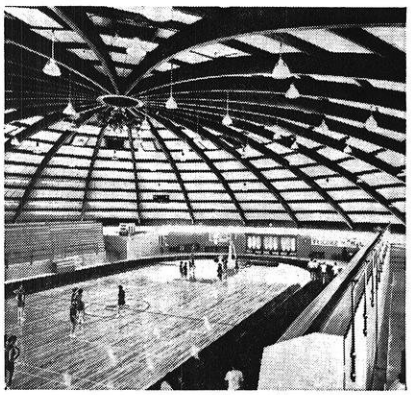
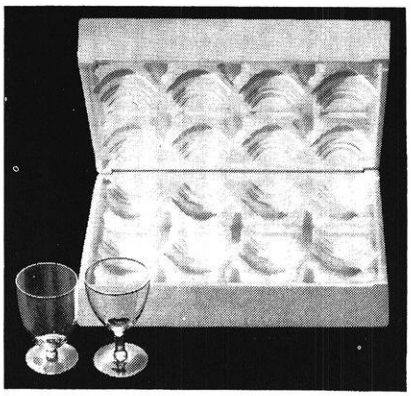
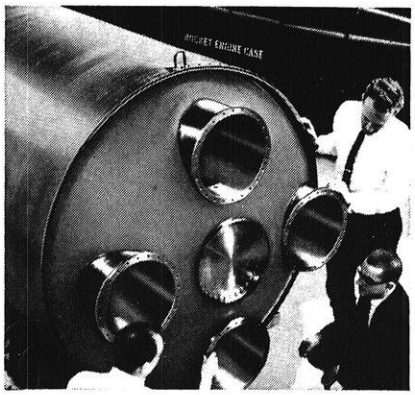


Laminated wood arches



Foam plastic packaging



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Across the Editors Desk

MEMO TO THE SECRETARY OF THE FACULTY

It's getting to be that time of the year when timetables for the coming semester will be distributed. To engineers, it means one thing: A walk up the hill, to find that they will have to come back again the following day. When "tomorrow" comes, another unnecessary hike up the hill to stand in line (if that mob in lower Bascom can honestly be called a line) is the plan.

The campus of the University of Wisconsin does extend beyond that cluster of buildings perched atop Bascom Hill, Mr. Secretary. Five blocks west of your office are nearly 5,000 Engineering and Agriculture students who are connected to the same University you are. Our point is that these students seldom have many classes on the Hill and therefore visit it very seldom.

We respectfully ask you to realize this and consider the possibilities of distributing time tables on our campus too. Sure, "it's no big thing," but it would be much more convenient for us in addition to solving some of your traffic problems.

STATE: WISCONSIN, CAPITAL: MADISON

Recent editorials in a Madison newspaper and a Madison TV station have attempted to dupe the public into thinking that the Republicans are (again) trying to relocate the state capital to Milwaukee. To use, these are illogical and uninformed accusations.

The statements were on the heels of an announcement that Governor-Elect Knowles' Inaugural Ball would be held in Milwaukee, rather than the traditional Madison. In rebuttal to this, we recall that the citizens of Madison have for over 10 years refused to authorize the bond issue for the construction of a municipal auditorium-arena; as a result, no facility is available in Madison to accomodate the thousands of people desiring to attend.

In an attempt to substantiate their claims, the public media concerned noted that the recent establishment of numerous state office facilities in Milwaukee was a first step in moving the State Capital to the state's largest city. Efficient government—the basis for many a lament by the same media—is obviously the state's motive for this action. Isn't it sensible to bring branch state offices close to the most populous areas of the state, rather than unnecessarily route a large volume of routine state business through Madison.

Another argument was based on an expansion which we have been following closely, the growth of The University of Wisconsin–Milwaukee. In addition to a newly-established four-year engineering program (which was desperately needed), a medical school and other specialized units are planned. Again, does not this metropolis need and deserve such facilities?

We commend past legislators and governors of both parties for giving Milwaukee a fair shake.

—R. J. Smith

An Introduction to Stereophonic Sound Recording

By WILLIAM G. BOEHM

EVER since the first sounds were recorded on a wax cylinder, man has been trying to achieve greater realism from his recordings. Great strides have been made since the first phonograph was introduced to the public.

Monaural or single track recording has developed into the present day hi-fidelity systems. Beyond monaural has come stereophonic (stereo), or double track recording of sound. Stereophonic sound recording has many problems and improvements are still being made in this field but at present it offers the closest thing to realism in the field of recorded sound.

A complete stereo has five components: the recordplayer, the amplifiers and preamplifiers, the speakers, the AM and FM tuners, and the tape recorder.

The converting from hi-fi to stereo would ideally be accomplished by adding an entirely separate stereo system to the existing hi-fi system, but cost rules this out in most cases. Practically, a gradual change over would have to be used.

If stereo continues to develop, it will become the major method of sound reproduction, either in the form of disc records or tape.

A glossary has been placed at the end of this article to provide the reader with a better understanding of the technical terms used.

History

In the early days of the phonograph people were more than satisfied to hear a human voice coming from a wax cylinder. At times it was hard to understand what was being said, but the phonograph was an interesting new device and everyone enjoyed it. People were even more amazed when they could put on the earphones of a radio and hear someone speaking miles away. However, amazement soon passed to annoyance as the static and interference of the early radios wore on the listener's nerves. As time passed, however, this annoying interference was reduced so that a program could be enjoyed.

As the phonograph and radio were improved, the first noticeable change was the replacement of the acoustic horns with electric speakers. These new speakers broadcast all the audible frequencies from 20 cycles per second to 16,000 cycles per second uniformly. Later, distortion was eliminated in the amplifiers. This means that all the various frequencies are amplified the same amount. The high frequencies and low frequencies are amplified the same as the middle frequencies. These two improvements were the beginning of hi-fidelity (or "hi-fi"). Since that time hi-fidelity has progressed through improvements in speakers and amplifiers. Hi-fi, although it gives a true reproduction of the frequencies recorded, does not give a true feeling of the sounds recorded. Stereo goes beyond hi-fi in this respect and gives depth and direction to the sound.

There are two important characteristics of the human ear which must be pointed out. First, directions can be sensed by the ear. Because people have two ears and because a given sound enters each ear with a slightly different intensity (unless the sound is straight ahead or behind) people soon learn to turn their heads to whoever is talking to them; to spot a bird singing in a tree; to spot an oncoming car that is sounding its horn. Second, the human ear is an analytical sensing device. Of the many sounds that come to the ear at one time, the ear can select one to concentrate on. This is called selective hearing. A person can listen to one person in a crowded room, can pick out sections of an orchestra to listen to one by one, and can discover the flat singer in a quartet. All this is done with selective hearing.

Both stereo and hi-fi utilize this last characteristic, but only stereo makes use of the directionality of hearing to give an illusion of depth of sound to the listener. It should be pointed out, however, that this depth of sound illusion is only possible in the middle range of audible frequencies. Since, as was stated earlier, the directionality of the ears arises because a given sound affects each ear with a different intensity, it is obvious that if there is no difference between what each ear hears there can be no directionality. This happens in the low frequencies where the sound waves are very long and the distance between the ears is negligible; and in the high frequencies where the waves are so short that

the distance between the ears is much more than a single wave length. This leaves only the middle frequencies.

Binaural recording was one of the first attempts to obtain a more realistic sound than was possible with monaural. Two microphones were placed in a dummy head where the ears would be located. Each microphone then picked up for recording the sound that one ear would ordinarily hear. Each microphone recorded on a separate track or channel. When the recording was listened to through a set of earphones a good sense of realism was obtained. However, there are two main shortcomings. First, the listener had the impression that the sound was "piped" into each ear instead of the ear being free to pick up the sounds from space. Secondly, the dummy head was in a fixed position during recording. If the listener turned his head while listening to the recording, the sound source seemed to turn with his head.

Two-channel stereo is a refinement of the binaural system, the main difference being that loud speakers rather than earphones are used for listening. Also, the recording microphones are placed about 2 feet apart. Thus, there is a greater phase and intensity shift between the two channels than when the microphones are placed only a head width apart.

To use these systems two complete recordings are needed along with two separate pickups, preamplifiers, amplifiers, and loud speaker systems. This is costly, but yields the best realism for the low- to middle-range frequencies. At high frequencies an echo is heard. For instance, when stringed instruments are played pizzicato there will be an illusion that there are twice as many instruments.

The best loudspeaker arrangement for the average living room is to have the speakers placed back to back.

Three-Channel Stereophonic

The three channel stereo system adds a third middle channel to the two channel system. The addition of this third channel gives a little more body to the sound; the sound has a more definite direction to it. The sections of an orchestra could be singled out more easily than on a two-channel set up. The two- and three-channel systems are otherwise alike in all respects except cost, the three channel being more expensive.

The best location of speakers for the three-channel system is along the shorter wall of the listening room.

Stereosonic

The stereosonic system uses a completely different principle than the previously mentioned systems. Instead of using normal microphones placed some distance apart, directional microphones are used. These microphones are placed next to each other with their directions of maximum pickup at 90 degrees to each other. The intensity of a given sound is different on each channel, but there is no phase difference. This eliminates the echoes present in other systems. Such a system also gives the upper frequencies a more directional effect.

Even without the actual phase difference, the intensity differences in the sounds coming from each speaker will enable the listener to hear an "effective" phase difference.

Recording

The quality of a disc recording depends on two factors:

1. How much care and attention is given to the development of the system and materials.
2. How much quantity and money are willingly used to achieve a greater dynamic range.

On the disc itself the quality is improved by making the wiggles in the groove longer.

A binaural and two channel disc uses two separate single tracks side by side on one disc. Two separate single styli or needles are therefore needed for pick-up. These styli are set at a standard spacing which is used for all discs.

With modern micro-groove recordings, it is quite easy to place a stylus in the wrong groove, thus leaving the channel-one needle in the channel-two groove and vice versa. The playing time of this type of disc will be one half the playing time for an equal sized monaural disc.

The three-channel stereo is even more involved since it requires three styli and three grooves on the disc.

The stereosonic disc records two channels on only one groove. Vertical movement of the stylus is translated into the sound of one channel while horizontal movement of the stylus, just as on monaural recording, is translated into the sound of the other.

While this is a clever method of recording two channels, there are two major difficulties present. First, very accurate and intricate pickups are needed. They are far more complicated than the pickups in the previously mentioned systems because two dimensional rather than one dimensional movement must be picked up. Secondly, it is hard to prevent the movement in one direction from affecting the movement in the other. This is called "cross talk".

Cross talk can be prevented by taking the pure horizontal and vertical lines of motion and tilting them 45 degrees. Thus, what used to be upward vertical motion becomes motion at 45 degrees upward to the right; and what was horizontal motion to the left becomes motion upward at 45 degrees to the left. See Figure 1.

As the intensity of sound on one track becomes greater the stylus moves farther down into that wall of the groove.

One problem that still remains is to find a method of duplicating or pressing out these high quality recordings quickly and economically.

Stereophonic Systems

Sound that is stereophonically recorded is best replayed in a stereophonic sound system. A complete stereo system is composed of five parts:

1. Record player
2. Preamplifier and Amplifier
3. Loud speakers
4. AM and FM tuners
5. Tape recorder

The four main components of a record player are:

1. Turntable
2. Motor
3. Spindle
4. Cartridge

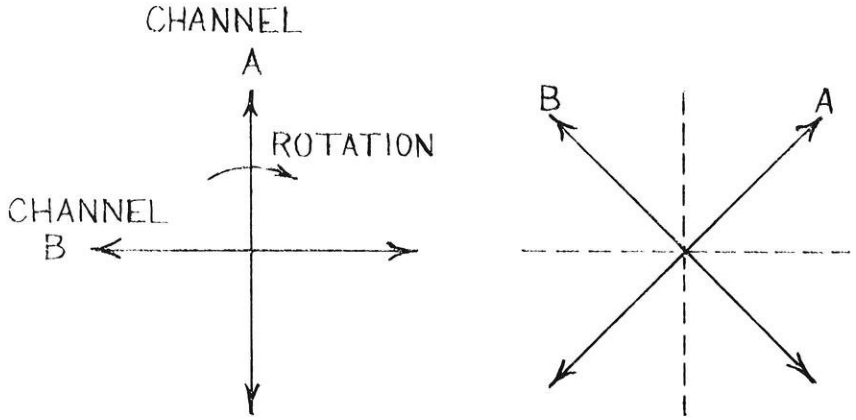

Figure 1.—Rotation of motion.

The turntable is a critical part of every record player. It must be well balanced for free movement with a minimum of friction, and heavy enough to ensure smooth rotation. Some turntables weight up to 45 pounds. It must remain perfectly level or vibrations will be created that are picked up by the stylus and finally broadcast as a "rumble". Standard turntables revolve at speeds of 16⅔ rpm, 33⅓ rpm, 45 rpm and 73.26 rpm.

The motor which provides this rotation must maintain constant and accurate speeds. If the motor runs too fast, the pitch of the recording is raised; and if it runs too slowly, the pitch is lowered. The motor may be located under the center of the turntable or to one side of it: the further the motor is from the turntable, however, the less chance there is of motor noise and vibrations being picked up by the stylus.

The spindle is used to center the record on the turntable. The standard disc record has a 5/16 centering hole while the 45 uses 1½ inch holes. The spindle also manipulates the records on self-changing record players. Two types of adapters are available to allow 45's to be played on 5/16 inch spindles. First, an adapter can be put over the spindle on the turntable to make it 1½ inches in diameter, or a plug can be put in the record to make the hole 5/16 inches in diameter.

The cartridge which contains the stylus or styli is carried in the arm and transforms the wiggles in the record groove first into mechanical motion and then into electrical impulses, called audio frequency current. These impulses then go to the amplifiers. The most widely used cartridge is the ceramic stereo cartridge which can be used on stereo or monaural records. There are also capacitive, dynamic and magnetic cartridges.

The stylus is the initial sensing device and rides in the record groove following the variations in the walls of the groove. The tip of the stylus is spherical and touches the groove at only two points. If the correct stylus is not used the delicate groove can be ruined.

The amplifier magnifies the audio frequency signal coming from the cartridge before sending it to speakers. Proper speaker selection is important. The power of the amplifier will depend on the size of the listening room and size of the speakers. The quality of the amplifier will depend on the quality of the other equipment. For an average sized room, a 20 watt amplifier would be sufficient.

The preamplifier does just what the name implies. It amplifies the audio signals before they go into the amplifier. In some setups the preamplifier and amplifier are in one unit. Both the preamplifier and the amplifier have two identical sections, one for each channel.

The loudspeaker is the voice of the system. It changes the audio frequency current coming from the amplifiers into sound. The speakers for a stereo system should not be used on as high a frequency range as in a monaural system. The high and low frequencies should be put through tweeters and woofers, respectively.

The speakers in a stereo system should be in phase for smoothest reproduction of sound. Phase can be checked by setting the volume adjustment of each speaker at a given point and then checking to see if the volumes of the two speakers are actually equal. If they are not, the wires of the voice coil of one speaker should be reversed.

AM and FM tuners will provide another area of use for a stereo system besides the reproduction of recorded sound. Many radio stations, FM especially, broadcast music. FM is used for broadcasting music because there is far less interference than AM. FM has a limited broadcast range, however.

Stereo tape recorders enable anyone to record personal stereo programs. When tapes are played back through quality stereo systems, they will sound as good as any commercial record. Most recorders use ¼ inch width tape for recording two channels. More channels can be added by widening the tape and using larger pickup heads.

Conversion to Stereophonic Sound

A monaural hi-fi system can generally be converted to stereo quite easily.

The first step is to replace the monaural cartridge with a new stereo cartridge. This requires rewiring the tone arm; it may, therefore, be easier to install an entirely new tone arm.

Next, a new amplifier and preamplifier must be added to the system since stereo requires dual units. If the old amplifier and preamplifier are to be used, the second channel should use duplicate equipment. Many manufacturers offer adapters for converting to stereo.

The final step is to install a stereo speaker system. A stereo speaker system will give a much better sound than two hi-fi speakers, but if the old hi-fi speaker is to be used, the best type of addition will be a speaker that is identical to the old one.

Immediate conversion to stereo can be very expensive. Thus, a gradual plan for change over would be advisable, starting first with speakers and amplifiers and then cartridges and records.

(Continued on page 29)

The Geometry and Uses of Aerial Photographs

By GERALD KURTZ

PHOTOGRAMMETRY is the science of taking measurements from aerial photographs. These aerial photographs can be used to make mosaics, and planimetric and topographic maps. These photographs are taken with a special camera which has features setting it apart from an ordinary ground camera.

From the geometry of these aerial photographs, determination of scale, flying height, relief displacement and ground co-ordinates can be computed.

It is also possible to use these photographs for determining boundaries of properties for compilation of tax rates. Special features of these photographs are used in the study of geology, in rural rehabilitation and land planning, and housing. Perhaps the most important use of aerial photographs is in the field of highway planning and surveying as many things such as parent material, soil type, land slope, drainage conditions, and soil material can be found for a soil survey by the use of aerial photographs.

Background

Construction of planimetric maps, topographic maps and mosaics are the major uses of present-day photogrammetry. Planimetric maps which do not show contour lines, are made by transfering data from an aerial photograph to a separate sheet of paper and topographic maps, which have contours, are made similarily. A mosaic is a series of overlapping vertical photographs placed in sequence on a mounting board to form a composite picture of the land. In a sense, a mosaic is like a planimetric map as it is an overhead view of the land showing the relative horizontal position of land features, and as it has a scale equal to that of a planimetric map. The advantages of mosaics over maps are that mosaics are cheaper to make, that they show more detail, and that they are better used by the layman because he can more easily understand an actual overhead view of the land than a map of the territory. Because of this understandability, highway commissions use mosaics to explain and show why a proposed location for a highway would be best.

These photographs from which mosaics and maps are made are of three types: vertical, oblique and convergent photographs. Most pictures taken in photogrammetry are of the vertical type, taken with the axis of the aerial camera vertical or nearly vertical. If the axis of the camera is unintentionally tilted at an angle to the vertical the photograph is called a tilted photograph. Oblique photographs, taken with the camera axis intentionally inclined from the vertical, are of two types: a low oblique in which the horizon doesn't appear and a high oblique in which the horizon is visible. Convergent photographs are those taken in sequence so that they cover essentially the same area.

The camera is, of course, the most important element in photogrammetry. The six main parts of the precision aerial camera are the lens assembly, the focal plane, the camera cone, the camera body, the drive mechanism, and the magazine. The lens assembly contains the camera lens, diaphragm, shutter and filter. The lens gathers light rays and brings them to focus on a focal plane. The opening of lens system is the diaphragm which has a set of leaves that can adjust the opening to any size. The shutter is as close to the lens as possible and has a speed of 1/100 to 1/1000 of a sec. Designed to protect the camera from stray light rays that may affect the photograph, the filter also shields the lens from flying dust particles and wind blown objects. The camera cone holds the lens assembly at the proper distance from the focal plane. The camera drive mechanism provides the motion to wind and unwind the film, trip the shutter and to hold the film against the focal plane. The magazine holds the exposed and unexposed film and advances the proper amount of film at the right time.

Geometry of an Aerial Photograph

The scale of a photograph, the determination of ground co-ordinates, flying height from a vertical photograph and relief displacement are measurements taken from vertical photos. But before the mathematics and applications of the measurements can be discussed, some basic definitions and assumptions must be presented.

The collimation marks define the x and y axes on a photograph. The x-axis is the line on the photograph connecting opposite collimation

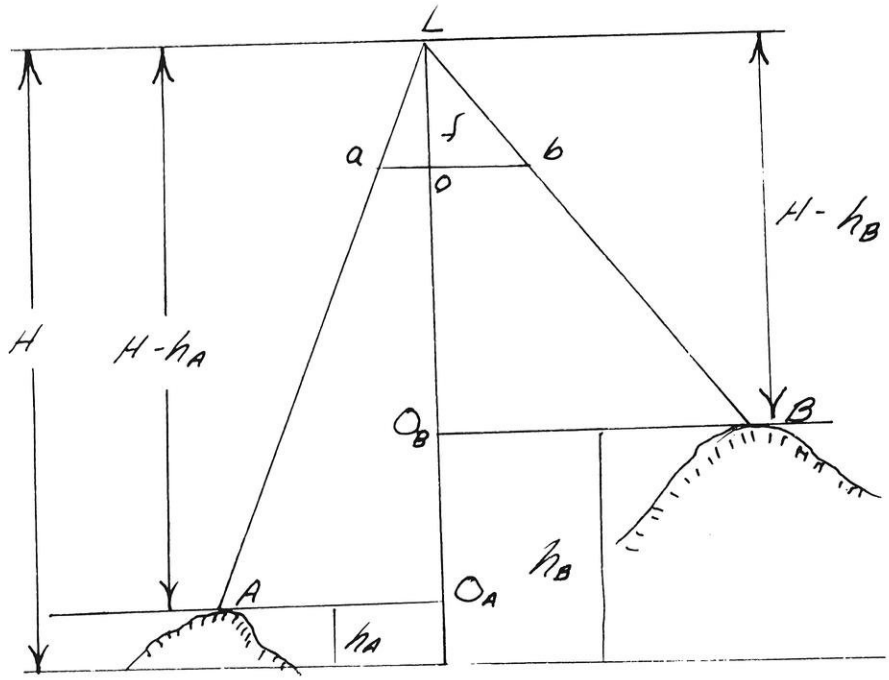

Figure 1.—Determination of scale.

marks which most nearly parallel the line of flight. The y-axis is perpendicular to the x-axis and the x-axis and y-axis intersection is the principal point. The elevation of the plane above sea level or some stated datum is the flying height. The focal length of a camera is the distance from the front of the lens to the focal plane of the camera. There are also three assumptions which make the geometry of an aerial photograph much simplier. They are. 1) the intersection of lines joining opposite collimation marks defines the principal point, 2) lens distortion either does not exist or has been allowed for, 3) film shrinkage either does not exist or has been allowed for.

The scale on a map is understood to be the ratio of distance on the map to distance on the ground. The three common ways by which scale is represented are the engineers scale, a representative fraction and a ratio. If one inch on the map corresponds to one hundred feet on the ground, the engineers scale would be 1 in. = 100 ft. The representative fraction 1/100 and the ratio 1:100 both mean that 1 unit on the map equals 100 units on the ground (note that the units must agree).

Because a vertical photograph is a perspective projection, areas closer to the camera will have a larger scale than those lying farther away. Therefore the scale of a photograph will vary greatly if there are large differences in elevation of the area.

The scale of any point on a photograph can be found by the analysis of Fig. 1. H is the flying height of the plane above sea level, f is the focal length of the camera, o is the principal point of the photograph and h_a is the elevation of point A on the ground, point A also appears on the photograph as point a. At an elevation of h_a the scale of the photograph is ao/AO_a. By similar triangles, $ao/AO_a = f/(H-h_a)$. We can use the formula $S_h = f/H - h_a$ to find the scale of a photograph, where H is the flying height above the datum, h_a is the elevation of the point above the datum, f is the focal length of the camera and S_h is the scale at elevation h. The formula $S_{avg.} = f/H - h_{avg.}$, $S_{avg.}$ being the average scale over an area and $h_{avg.}$ the average elevation of the area, is the best single scale to use for any photograph.

When the flying height or one of the other values of the above formula is not known, the scale of a photograph can be found by comparing the length of a line on a photograph or the distance between two points on the photograph to the length of the same line or distance between the two points on a map of known scale. The scale is then determined by the following relationship:

$$\frac{\text{photo scale}}{\text{map scale}} = \frac{\text{photo distance}}{\text{map distance}}$$

Both photo distance and map distance are measured in the same units and the two scales are in the same units.

The ground distance between any two points can be measured directly on a photograph if the scale of the photograph is known and if the two points are at the same elevation. If these points are not at the same elevation, the distance can be determined from the ground coordinates of the points. The formulas used to find the ground coordinates are X = H-h/f (x); Y = H-h/f(y), where X and Y are ground coordinates with respent to a set of axes which coincide with the axes on the photograph, H is the flying height, h is the elevation of the point, x and y are the photographic coordinates of the point and f is the focal length of the camera. The distance between two points can then be found by using the Pythagorean Theorem, $D^2 = (X_b - X_a)^2 + (Y_b - Y_a)^2$. D being the distance between the two points with coordinates (X_b, Y_b) and (X_a, Y_a). being the distance between the two points.

The flying height of a plane can be found by successive approximations. The formula f/ ApproxH—h_{ab} = ab/AB is used. F is the focal length, ab is a distance measured directly on a photograph, H is the approximate flying height, h_{ab} is the average elevation of points A and B, and AB is the ground distance corresponding to ab. The approximate value of H is used to solve for the coordinates of points A and B. A computed distance AB is compared with the correct distance AB to obtain a better value of H with the formula: $H-h_{ab}$/ Approx $H - h_{ab}$ = correct AB/ computed AB. This process is repeated until good precision is obtained.

Since the points on a photograph do not lie at the same elevation above the datum line, there is a displacement of them, called relief displacement, shown in Fig. 2. The line oa is a line on a photograph, A

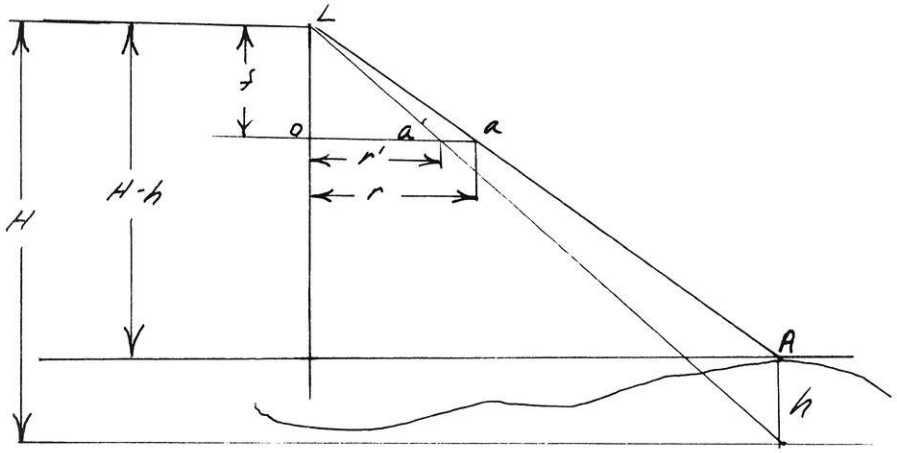

Figure 2.—Determination of relief.

is a general ground point h feet above the datum, the distance from the principal point to its image is r, the distance from the principal point to its datum photograph position is r′. By similar triangles $r - r' = rh/H$ or $r - r' = r'h/H - h$. $R - r'$ is the relief displacement of a point. It can be seen that as the distance from the principal point increases, the relief displacement increases and as the flying height increases, the relief displacement decreases. Therefore little or no relief displacement exists at or near the principal point.

Uses of Aerial Photographs

The value of aerial photographs or photo interpretation is, primarily, the recognition of details on a photograph. The uses of aerial photographs include mosaics, property ownership maps, photogrammetry in general engineering, rural rehabilitation, land planning and housing and highway studies, topographic maps, and soil survey maps.

In many cities and townships property lines and records have become confused and inaccurate. Because of increased property values and taxes, many people and even the government are getting cheated out of just taxes. Some of these inaccuracies can be adjusted by the use of aerial tax maps, because every parcel and building can be measured and a more accurate rate can be arrived at. Aerial tax maps can be delivered in a few days, whereas a ground survey map might take months or years to complete, but exhaustive search and platting must be done on the photographs, readjustments to the correct boundaries must be made, and problems that cannot be solved from the photographs must still be done by field engineers.

Photogrammetry helps the geologist by making pictures of the area available so that he can become familiar with the terrain before he goes looking for faults, anticlines, synclines or outcroppings. He can plot these very precisely on a map and confirm their location later in the field. Just as aerial exploration is used in geology, it can also be used for the study of the location of rights-of-way for railroads, highways, pipelines and transmission lines. In forestry studies, photogrammetry is used to study and classify the types of wood. Measurement of trees can be done by the principle of relief displacement as explained earlier.

The government has used photogrammetry to varying extents in the last 30 years to help in rural rehabilitation and soil conservation. The Tennessee Valley Authority, for examples, needed maps to define boundaries, range and township lines. Planimetric maps made from aerial photograph mosaics suited the purpose. The soils of the area were also surveyed with aerial photographs from which the type of soil, slope of the ground, erosion patterns and land uses of the fields were determined. Woodlands and forests were studied using aerial photographs. If photogrammetry had not been perfected the surveying needed for TVA might have taken a considerable amount of time.

Cities, counties and planning commissions can use aerial photographs to aid them. Maps can show the density of houses (and give an estimation of population), railroads, general relief of the land, parks, roads, bridges, swimming pools, etc. Maps of the area can be made to show places of interest to vacationers, fishermen or hunters.

Photogrammetry has its most important use in the highway planning and surveying. The first step in planning and designing a highway is to acquire or contract for pictures of the area where a highway is proposed. After these photographs are obtained, the possible locations of the highway are decided on. Alternate routes for the location of the highway can readily be examined from these photographs. Because elevations of ground points can be found, estimates of the cost of cut and fills, the number of culverts and bridges can be made and a fairly reliable cost for the highway can be arrived at. Survey crews are then sent out to put in a center line and boundaries for rights-of-way for the highway. After right-of-way land is determined, pictures of the land can be used to explain to land owners why the highway must go across their property. After the highway is completed the aerial photographs in the form of a mosaic can be used as control in making a highway map for the general use of the public.

The photo-topographic, where contour lines are placed on transparent overlays of the photographs, may is becoming of more use in the development of map making. These maps are more meaningful to the layman who is not accustomed to looking at regular contour maps. Large cities can use this type of map for the planning of subdivisions.

Another of the vastly increasing uses of aerial photographs is for soil surveying. For the geologist or highway engineer, this is one of the most inexpensive ways to take a soil survey as land forms, soil color, drainage system, gully systems and shapes, vegetation and land use can be determined by aerial photograph examination. The identification of land forms and the topography of the land can show

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Meteorological Balloons

By NORMAN JAHN

METEOROLOGICAL balloons are the mainstay of modern weather forecasting. Without the use of balloons, the field of meteorology would be many decades or even centuries behind what it actually is. Fortunately, though, in 1782, two Frenchmen, Joseph and Jacques Montgolfier, observed that clouds floated in the sky without support and reasoned that if they could fill a large enough bag with some kind of dust or smoke, it would float also. They were not surprised when their smoke-filled balloon rose in the air, even though their reasoning was invalid.

The first balloons ever sent up were very crude paper bags, varnished for added strength. Natural rubber followed and has served the longest as a material for constructing balloons. With the cut in natural rubber during World War II, it was necessary to find a new material as a substitute. Polyethelene, a synthetic rubber, was developed and has proven superior to natural rubber. Just recently plastic balloons have been used with excellent results.

Rubber Balloons

Effective weather forecasting demands a great deal of information about the atmosphere. The use of balloons has solved the problem of supplementing the surface information with data from intermediate, high and very high altitudes. A variety of rubber balloons have been designed, each type having a special purpose.

The ceiling balloon, smallest of all meteorological balloons, is used to determine cloud height. The balloon is released and an observer times the ascent. When the balloon disappears through the cloud ceiling, the time is recorded and the height can be calculated.

The pilot balloon — "pibal" for short—is used to determine wind velocity and wind direction at various altitudes. The pilot balloon is inflated to a specified volume of gas for which the rate of ascension is known. It is tracked with a theodolite and the elevation and azimuth angles can be read directly from the scales. Calculation of the position by this method is subject to error due to thermal and terrain currents. However, from a series of known positions of the balloons at known times, the direction and speed of the wind at all elevations can be calculated.

For more accurate results, two theodolites can be used. If the distance between the instruments is known, triangulation can be used to determine the exact position of the balloon at a given time. By using this method, the lift of the balloon is not critical because the ascension rate is determined from the position of the balloon.

The sounding balloon is the most widely used balloon in meteorology. Although simple as it may seem, the sounding balloon requires accurate designing and engineering, and elaborate care in manufacturing. It is much larger than either the ceiling balloon or the pibal because it has to carry a payload to a predetermined altitude and at a predetermined rate of ascent. The weight of the balloon should be as small as possible, since each unnecessary gram of weight sacrifices precious altitude. Also if the weight of the balloon is not evenly distributed, it will not travel evenly as it rises.

The payload of the sounding balloon may be the radiosonde, the rawinsonde or some other instrument group, and a radar target and parachute. Flights of this type are called soundings. A radiosonde sounding records humidity and temperature while a rawinsonde sounding records humidity, temperature, and wind velocity and direction. This data is automatically and continuously transmitted to the ground by radio. At the maximum altitude, the balloon bursts and the parachute assures an orderly descent.

Advertising, surveying and artillery aiming points are the main uses of captive balloons which, as their name implies, are flown while still secured by a strong flying line. They are manufactured from specially compounded latices which enable them to fly aloft for many days under adverse conditions. They are more resistant to the destructive effect of sunlight and to diffusion of gas than free-flight balloons.

A specific type of captive balloon which is used for meteorological purposes is the Kytoon. It has been developed for vertical stability in winds of up to 30 miles per hour. The Kytoon is an air-foil balloon, shaped like a zeppelin, which combines free lift with air-foil shape, thus providing stable flight despite wind. The outer casing of the scientific Kytoon is made of special nylon cloth with light-weight cotton balloon cloth for tail fins. Replaceable neoprene bladders hold the lifting gas. Struts hold the fins of the Kytoon taut and erect, at the same time keeping the entire structure under tension, thus assuring that the Kytoon will maintain it streamline shape, even with a slight diffusion of gas.

Over the years, many balloons have been developed for special jobs that sounding and captive balloons could not do. There are two-necked balloons for extra heavy payloads, heavy walled balloons for extra strength in high winds, balloons designed for fast rates of rise, balloons which will fly at a constant level, radar reflecting balloons and others.

Production and Inflation of the Balloons

Meteorological balloons are specifically engineered to give the most efficient balloon possible in keeping with low production costs. A film of neoprene latex is deposited on the outside of a mold, or form, smaller than the finished balloon. It is stripped from the form while still wet and immediately inflated with air to the desired finished size. The balloon is dried while inflated and once dry, it holds that shape.

Balloons made by this process are made entirely of one piece. There are no seams to dry out, weaken, or inhibit expansion. Balloons of this type have long, small diameter necks which make tying easy. The great strength and elasticity of the Neoprene latex used in meteorological balloons make it possible to build balloons with extremely thin walls, thus assuring balloons of minimum weight and greatest advantage in lifting force.

Meteorological balloons are inflated with either hydrogen or helium. Hydrogen has a slightly greater lifting force than helium, is much cheaper and can be found in all parts of the world. Hydrogen, however, is highly combustible and burns explosively when mixed with air.

When inflating the balloon, the neck of the balloon is fitted over the nozzle of the gas line and inflated slowly until the gas just lifts the balloon, nozzle and weights. To determine the amount of weight to attach when filling or to determine the ascention rate, the following formula is used:

$$\text{Ascension Rate} = 133 \frac{\sqrt[2]{\text{Free Lift (Grams)}}}{\sqrt[3]{\text{Gross Lift (Grams)}}}$$

where free lift is the weight of the nozzel, the uninflated balloon and the weights which just counterbalance the lift of the gas. The gross lift is the weight of the uninflated balloon and the payload. Correct inflation is achieved when all three components are taken into consideration.

Plastic Balloons

The modern plastic balloon, in its short history, has become a recognized vehicle for upper atmosphere research operations. The original plastic stratosphere balloon was designed to carry a load of 70 pounds to an altitude of 100,000 feet, or above approximately 90% of the atmosphere. Now plastic balloons are carrying loads of up to 7,500 pounds.

Until the advent of the plastic balloon, small rubber balloons were the means of conducting atmospheric research, to a limited degree. The expensive rubberized-fabric balloons were reserved for manned flights; however, because of the expense, manned flights were abandoned after the 1930's. With the coming of the new, inexpensive and more easily launched plastic balloon, manned flights became practical again.

The non-extensible plastic balloons fall into two main categories, superpressure balloons and zero pressure balloons.

A superpressure balloon is a closed cell in which the internal gas pressure is greater than that of the surrounding air pressure. At a constant density altitude, the volume remains constant while changes in internal gas temperature are reflected by changes in internal pressure according to the perfect gas laws. Since these changes can result in high envelope stress, the superpressure balloons must be built with materials having high tensile strength. Their biggest disadvantage, therefore, is that they burst at or before ceiling altitude.

The zero pressure balloon is one in which the internal pressure is approximately equal to the surrounding air pressure. The zero pressure balloon is used mainly for constant level flights in which the balloon is released and rises in the air. As the pressure decreases with height, the gas in the balloon expands and some of it is forced out to maintain equal pressure inside and outside the balloon wall. Since the amount of lifting gas decreases with height, the ascension rate also decreases until a point is reached where the gas in the balloon is just enough to hold the balloon in the air. By flying at a constant level, a horizontal wind profile can be made instead of a vertical profile.

Heat balance affects the ascent, float, stability and descent of the balloon vehicle. In addition to the surrounding air temperature, balloons are affected by radiation temperature. The volume of the balloon is a function of the density of the gas, which determines the height, while the density is a function of the temperature.

Construction

Most plastic balloons are presently made using polyethelene film. The thickness of the sections of film to be used depends on the type of construction, type of launch and amount of handling. In general, the balloon design should employ the thinnest film which will satisfy the above requirements and still perform reliably. The sections are sealed together by one of two processes — thermal pressure or thermal no-pressure. With the thermal pressure process, the sections are pressed together and heated, melting them together. With the thermal no-pressure process, sections are held together with just enough air pressure as they pass through the hot jets. The latter process has been found much more satisfactory because there is no extrusion of the film to weaken the seal.

Mylar, another plastic, is theoretically better than polyethelene; its strength is about ten times that of polyethelene. It is also thinner, withstands colder temperatures and can be fabricated using special thermoplastic adhesives. Even with this, Mylar balloons have had a very poor record of reliability. Since the film has an extremely high tensile strength, the tolerances in manufacturing become more critical. The sections are smaller, requiring more handling when manufacturing. The greatest deterrent to the use of Mylar is its low tear resistance. Folding it sharply

will develop small pinholes which in turn, develop into tears.

Research and Developments

Military requirements exist for the development of meteorological sounding balloons capable of ascending more rapidly than conventional balloons. Faster rising balloons are needed to obtain data more rapidly, to obtain data more directly over a station, and to reduce errors in tracking equipment.

The problem of increasing the ascension rate was first studied from the spherical point of view and it was found that theoretically, spherical balloons should rise much faster than they did. Failure to attain this rate was attributed to deformation of the tops of balloons due to insufficient internal pressure. To remedy this, thicker walled balloons were investigated. As a result, much higher rates of ascent were attained but the amount of gas necessary to do this made it impractical.

Plastic balloons have been built to a "spherecone" shape where the top portion is a sphere and the bottom portion is a cone. Balloons of this design seem to incur a large number of failures due to bursts at or near ceiling altitude.

Neoprene expansible-type balloons have been experimented with and a process which has given good results is known as the gel-adhered process. In this process, the tops of two spherical balloons are cemeted together while inflated. The air is then let out of one of the balloons and it is used as a tail section.

The University of Michigan has developed a balloon design called Natural Shape with Fabric Weight in which there is essentially zero circumferential stress in the envelope material. By developing a balloon with a natural shape, the characteristics would be the same as a free-flying balloon without a payload.

A smooth, spherical balloon is not suitable for measuring detailed wind profiles. For a sphere moving vertically in a horizontal wind, the forces which act on it are bouyancy, gravity, drag and lift. The forces of bouyancy and gravity remain constant throughout the flight while the drag and lift forces may be highly erratic and may affect the motion of the balloon. It was found that the induced motions due to the aerodynamics of the sphere can be reduced by stabilizing the drag force and reducing the lift force. The drag force was reduced by placing surface roughness elements (paper cups) on a superpressure plastic balloon. On August 15, 1963, a series of balloon flights were made at Cape Kennedy and tracked by radar. Included in these flights were roughened balloons, commonly called Jimspheres, with a varying number of cups, and smooth balloons varying in size. The roughened balloons give a more constant value for wind speed than the same size smooth balloon.

On March 31, 1964, Warren Johnson, a graduate student at the University of Wisconsin, began a small scale study of the effect of paper cups on the stability of pilot balloons. The complete results have not been determined yet, but it could be seen from observation that, even in a strong wind, the

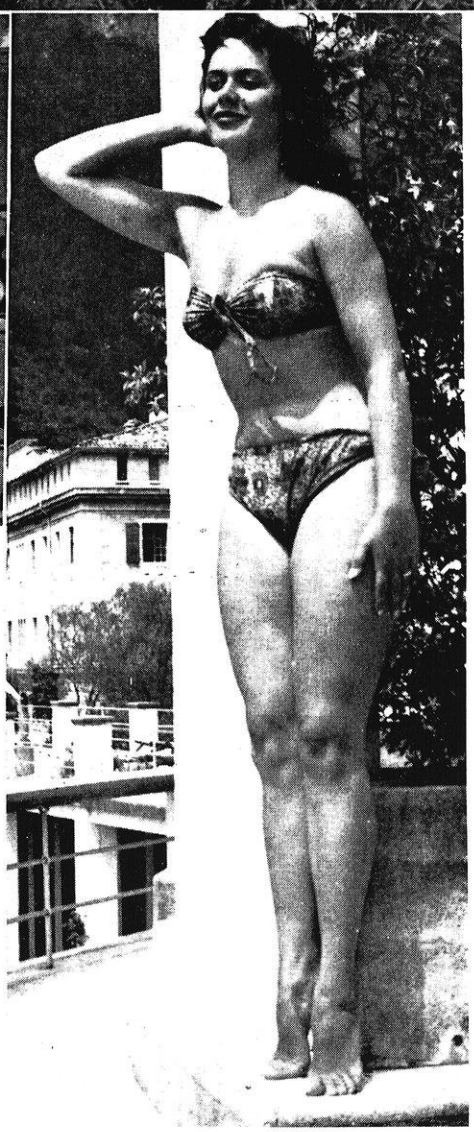
(Continued on page 33)

"Company capability is measured by the genius of its people . . . and the tools at their disposal"

Engineers can go nuts without the bolts

Blue-sky theorizing is essential to engineering. In fact, it is the ignition point for all technological achievement. But the best ideas in and out of this world can fail if the proving ground, the testing lab, or the constructive cynicism of mature co-professionals aren't available to question an idea or a product's ultimate function. ☐ Engineers working without these facilities wind up talking only to themselves — and there's a word for that condition. Hamilton Standard management long ago recognized that in the marketplaces of the aerospace industry, a company's ability to produce a workable article is largely measured by two basic criteria: the genius of its people . . . and the physical resources at their immediate disposal. Hamilton Standard is the "compleat" engineering organization. The company is a unique blend of many advanced projects, specialized engineering skills . . . plus exceptional research, laboratory and manufacturing facilities. ☐ Present projects involve *environmental control systems, engine controls, starters and turbomachinery, air induction controls, propellers, electron beam technology, ground support equipment, electronics, thrust vector controls, bioscience research and spacecraft life support systems.* This broad product range requires, obviously, an engineering team with a wide variety of engineering skills. ☐ The group of over one thousand graduate engineers and technicians are skilled in such disciplines as Aerodynamics, Cryogenics, Control Dynamics, Electronics (including Microelectronics), Electron Optics, Engineering Physics, Fluid Dynamics, Heat Transfer, Hydraulics, Instrumentation, Mechanics, Metallurgy, Physical Chemistry, Servomechanisms, Structures, Stress Analysis, Thermodynamics. Working in Project Task Forces, the men involved multiply their knowledge by mixing intelligence and constantly communicating problems . . . and solutions. ☐ Available as tools to our engineers are Divisional facilities of over 1.5 million square feet. These facilities have established Hamilton Standard as a world leader in contributing to state-of-the-art advances in vibrations, aerodynamics, hydraulics, and control dynamics, among others. A recently completed space simulator for manned missions will further advance the state-of-the-art in life support systems, when Division engineers outfitted in our space suits conduct tests at a simulated altitude of approximately 1,500,000 feet. ☐ If you would like to know more about our equal opportunity company, including graduate study programs . . . and the kind of countryside Connecticut living enjoyed by Hamilton families . . . write to Mr. Timothy K. Bye, Supervisor of College Relations, Windsor Locks, Connecticut, or see your Placement Office for an appointment with our representative when he visits your campus. ☐

Hamilton Standard DIVISION OF **United Aircraft**



Wisconsin's B. B.

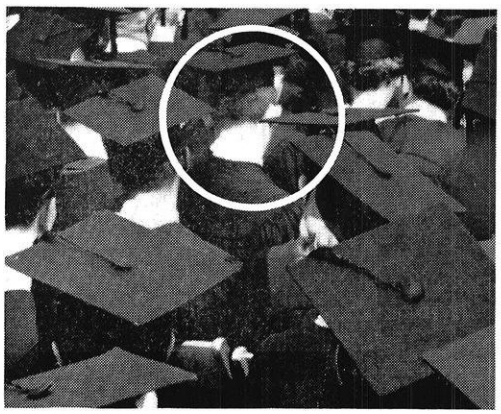
Miss Barbel Brandlmeier is a native of Dortmund, Germany and the daughter of a braumeister.

Barbel is 20 years old, 5′–7″ tall and weighs 125. Other vital statistics include: (37–23–37).

She likes swimming, water skiing and, needless to say, cheese cake and men.

Barbel won the "Miss Cinema" contest in Italy last summer.

One picture is worth a thousand words and we have three. Need we say more.



Graduation was only the beginning of Jim Brown's education

Because he joined Western Electric

Jim Brown, Northwestern University, '62, came with Western Electric because he had heard about the Company's concern for the continued development of its engineers after college graduation.

Jim has his degree in industrial engineering and is continuing to learn and grow in professional stature through Western Electric's Graduate Engineering Training Program. The objectives and educational philosophy of this Program are in the best of academic traditions, designed for both experienced and new engineers.

Like other Western Electric engineers, Jim started out in this Program with a six-week course to help in the transition from the classroom to industry. Since then, Jim Brown has continued to take courses that will help him keep up with the newest engineering techniques in communications.

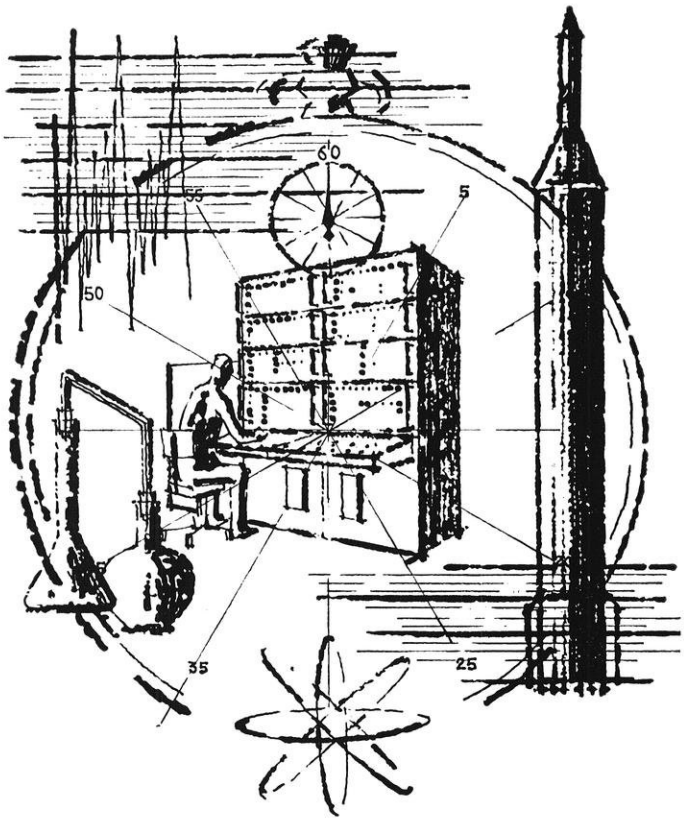
This training, together with formal college engineering studies, has given Jim the ability to develop his talents to the fullest extent. His present responsibilities include the solution of engineering problems in the manufacture of moly-permalloy core rings, a component used to improve the quality of voice transmission.

If you set the highest standards for yourself, enjoy a challenge, and have the qualifications we're looking for — we want to talk to you! Opportunities exist now for electrical, mechanical and industrial engineers, and for physical science, liberal arts and business majors. For more information, get your copy of the Western Electric Career Opportunities booklet from your Placement Officer. And be sure to arrange for an interview when the Bell System recruiting team visits your campus.

Western Electric MANUFACTURING AND SUPPLY UNIT OF THE BELL SYSTEM

AN EQUAL OPPORTUNITY EMPLOYER

Principal manufacturing locations in 13 cities ☐ Operating centers in many of these same cities plus 36 others throughout the U.S. Engineering Research Center, Princeton, N. J. ☐ Teletype Corp., Skokie, Ill., Little Rock, Ark. ☐ General Headquarters, New York City



SCIENCE HIGHLIGHTS

By HAROLD WEBER, me'66

WORLD ADOPTS NEW STANDARD OF TIME

Atomic Definition of Second Replaces Astronomical

An atomic definition of the second, the international unit of time, was authorized at 1725 Paris time, October 8, by the Twelfth General Conference of Weights and Measures, meeting in Paris. The International Committee on Weights and Measures, acting for the Conference, temporarily based the definition on an invariant transition of the cesium atom in expectation of a more exact definition in the future. The new definition replaces the definition of a second based on the annual orbit of the earth around the sun.

The action taken increases the accuracy of time measurements to a part in one hundred billion, an accuracy two hundred times greater than that formerly achieved by astronomical means. Moreover, these measurements can be accurately determined in a few minutes, as compared to the many years required to achieve an accuracy only one-hundredth as good by astronomical means.

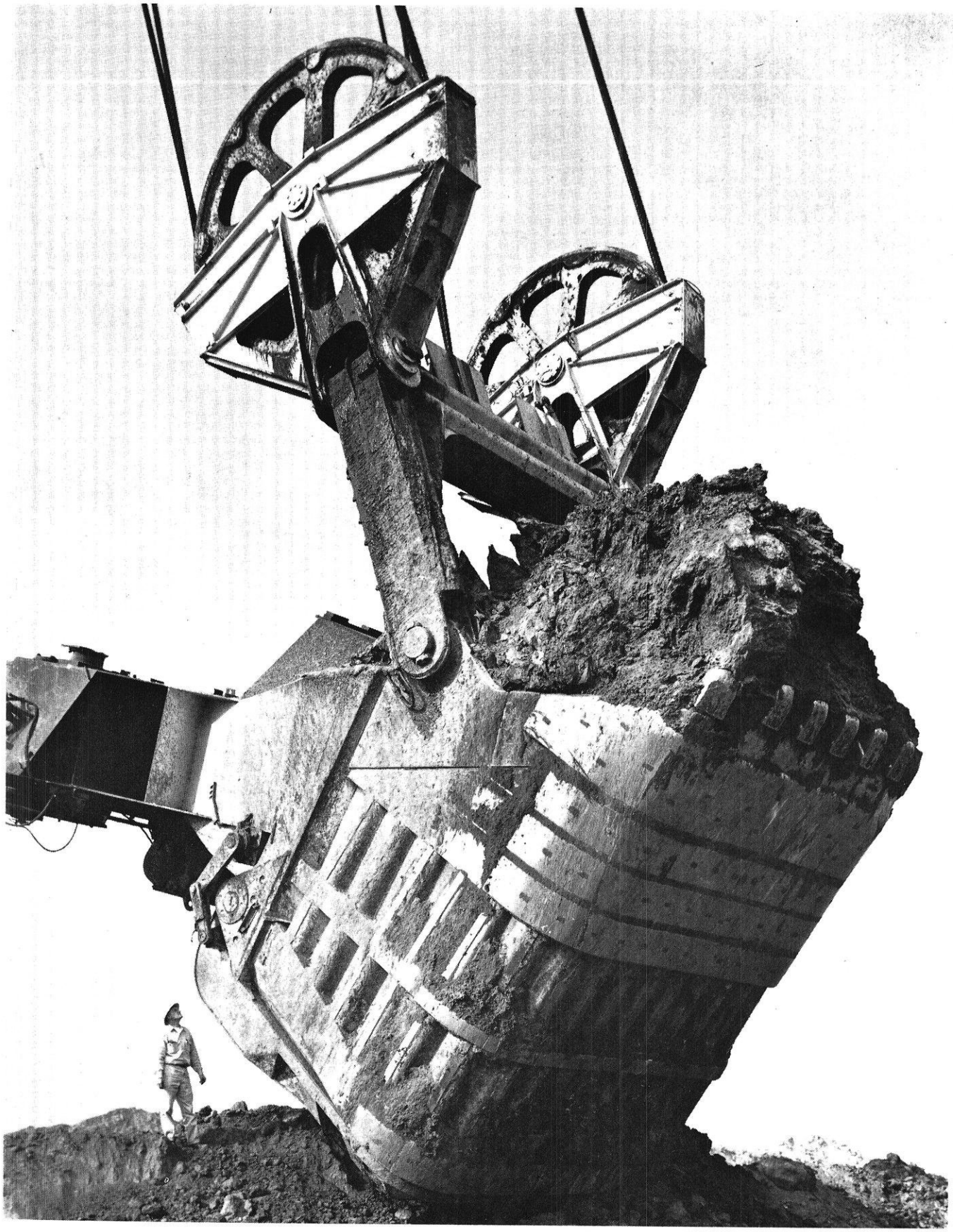
In the past, the unit of time had been established by astronomers observing the movement of stars across the sky as the earth rotates on its axis. A clock was used to relate the instant of meridian crossing for each individual star to the instant of crossing for other stars. By means of a long series of observations, the rate of the clock could be related to the earth's rotation. The earth itself thus became the timekeeper and the clock was used to interpolate the intervals of time between meridan crossings of different stars.

Pendulum clocks, some of which exhibit a stability of performance to within a few thousandths of a second per day, were employed for this purpose until quartz crystal oscillators, having even greater stability, were developed for time-interval measurements. Neither of these devices, however, maintains a rate which is as constant as that of the earth.

Prior to 1956 the second was defined as one 86,400th part of the time required for an average rotation of the earth on its axis with respect to the sun. Nevertheless, long before this date astronomers became acutely aware of irregularities in the earth's rotation as compared with the orbital motion of the moon about the earth, the earth about the sun, and various other planetary motions.

Thus in 1956 an improved arrangement was internationally agreed upon to define the second—called the ephemeris second — as 1/31, 556, 925, 9747 of the time taken by the earth to orbit the sun during the tropical year 1900. Although very exactly stated, this definition could not be realized by astronomical observations with anything like the precision implied by so many digits.

In the 1950's, research on certain atomic transitions indicated that the oscillations associated with them could be realized with great repeatability. One of them, a hyperfine transition in the cesium atom, was related to the ephemeris second with an estimated accuracy of about two parts in a billion. Measurements made with two different instruments, perfected by R. C. Mockler and R. E. Beechler working under J. M. Richardson at the NBS Boulder laboratories, agreed with each other much more precisely than the measurements made with either instrument could be related to the ephermeris second. This agreement—found to be to six parts in 10^{12}, that is, six parts in a million million—means that if two clocks are controlled separately by these two instruments, and if there are no other sources of error, the clocks will differ by only one second after running five thousand years.



NO TRICK PHOTOGRAPHY! That six foot two inch man with the safety helmet is standing next to the world's largest dipper —at the business end of the world's largest mobile land machine, a strip mining shovel manufactured by the Bucyrus-Erie Company, Milwaukee, *Wisconsin.*

The dipper devours over 140 cubic yards, or 250 tons, of earth with one bite and releases its load as far as 400 feet away. This earth, called overburden in mining parlance, is set aside and the veins of coal are exposed for other shovels—about 1/10th the size—to remove.

Campus News Briefs

AIAA BEING ORGANIZED

A Student Branch of the American Institute of Aeronautics and Astronautics is being organized at the present. Anyone interested in these fields is invited to call the Acting Chairman, Joe Movizzo, 255–7347, for details.

AIM PROGRAM TO BEGIN

A state-wide program aimed at keeping young engineers on the job in Wisconsin is being sponsored by the University of Wisconsin.

Wisconsin engineers will be able to update their professional education and earn a master's degree while on the job under the plan of the University's Articulated Instructional Media (AIM) program.

"Under this new program Wisconsin firms will be in a better position to offer the young engineer the opportunity for continuing his education as well as a job," said Prof. Edward Obert, chairman of the University's mechanical engineering department and author of the AIM engineering program.

"The lack of educational facilities for continual upgrading of engineers in Wisconsin has serious implications for our state's industrial and research program," Prof. Obert said. "The young man who wants to begin work and continue his education is in many cases forced to take a job with an out-of-state company since he cannot take college courses while he is on the job."

The AIM mechanical engineering program is an expansion of a project already underway in La Crosse. The state-wide program will be in operation in February.

AIM students will come to the Wisconsin campus in Madison to enroll in courses, plan a program, and meet a faculty advisor. Each student will receive regular course texts and study materials.

During the semester the student will maintain close contact with his professor through a regular weekly telephone hookup. The professor also will make several trips to the student's home during the semester to check his program in the course and provide individual counseling.

Students in the program will take mid-semester and final examinations with students on the Madison campus who are enrolled in the same course and attending regular classes. University professors will teach the courses and grade each student's progress.

Courses offered the second semester include automatic controls, taught by Prof. John G. Bollinger, and nuclear power engineering, by Prof. M. M. El-Wakil.

Students have the option of taking 18 credits of course work in mechanical engineering and doing a thesis, or 30 credits of course work without a thesis to fulfill requirements for the advanced degree.

The engineering program is one of several sponsored by AIM, a four-year experiment designed to provide university courses and credits to persons unable to spend lengthy periods on the Wisconsin campus. An AIM student who is a Wisconsin resident can earn from 13 to 16 credits for $150, the regular University resident fee for a semester.

For more information on the program, write or call AIM, 228 Wisconsin Center, the University of Wisconsin, Madison 53706 (262–2354), or Prof. Edward Obert, Mechanical Engineering Bldg., the University of Wisconsin, Madison, 53706 (262–3543).

Eight outstanding civil engineering students have been awarded industrial scholarships ranging from $100 to $500 for the current school year. Presenting the awards was Prof. Eldon C. Wagner (right) of the Department of Civil Engineering. The student engineers are (from left) Louis Jung of Randolph, Robert Gottsacker of Hartland, and John Gurtz of Elmhurst, Ill., all Bates and Rogers Foundation Scholarship winners; Frederick Teitgen of Mercer, Ray and Theo Owen Award; Arthur R. Roethe, Monroe, Bates and Rogers Scholarship; Mark Martinelli, Kenosha, Aring Equipment Co. Scholarship; Dennis Turke of Watertown and Robert Effa of Kaukauna, both Bates and Rogers scholarship winners.

Alumni Notes

Colonel *Lloyd L. Rall* (CE '40), formerly Deputy Director of Photography, in the Office of the Chief of Army Engineers, recently assumed the duties of Director of an Army Engineer Research and Development Authority at Fort Belvoir, Virginia.

Ensign *Ronald W. Elonen* (CE '61) was recently promoted to Lieutenant (j.g.) in the U.S. Coast and Geodetic Survey. He has been serving aboard the ship "Surveyor", which is homeported at Seattle, Washington.

SCHOLARSHIPS

All applications for engineering scholarships must be completed and submitted by February 1, 1965. It might be wise to find out if you qualify, NOW!

PREPARE FOR APRIL 2ND

We remind you that you may be able to earn some extra cash if you can put on a good show for the Engineering Exposition. Check the bulletin boards or call Dean Taylor, 257–4901, for details.

In Memoriam

We were saddened by the loss of an educator, friend and engineer, Charles A. Gilpin, Professor of Mechanical Engineering. Our deepest sympathy is extended to his loved ones.

TAKE A LOOK AT TOMORROW!

FORD MOTOR COMPANY'S EXPERIMENTAL GAS TURBINE SUPERHIGHWAY TRUCK ANTICIPATES THE NATIONAL HIGHWAY NETWORK OF THE 1970's.

A new era in trucking is almost here. When the 41,000-mile national highway network is completed it will be possible for the first time to schedule coast to coast, big payload hauling. Ford Motor Company's answer to the challenge is this experimental tractor-trailer combination. A tandem axle drive tractor, powered by a 600 hp gas turbine engine permits a cruising speed of 70 miles per hour, a non-stop range of 600 miles. Designed for long-distance, non-stop operation, the two-man cab includes sleeping facilities, fold-away table, lavatory, toilet, oven, refrigerator and TV for the co-driver—with over 6'3" of headroom. Because of its cruising speed, the truck will be compatible with the normal passenger car flowrate of traffic. Other unique features are its odorless exhaust and extremely quiet operation.

Anticipating the opportunities and needs of the future is standard practice at Ford Motor Company. That's why it's such an exciting place to work. Look to Ford Motor Company for a career with growth potential and satisfaction—from pure science to manufacturing . . . marketing to labor relations.

THERE'S A FUTURE FOR YOU WITH . . . Ford MOTOR COMPANY

The American Road, Dearborn, Michigan

An equal opportunity employer

Stereo Sound Recording

(Continued from page 14)

Conclusion

The cost of stereo systems and recordings is still relatively high, but it is dropping as more improvements are being made and as public acceptance builds. Because stereo is the closest approximation to actual sound available, people will turn to stereo in increasing numbers. Stereo has already taken over the position that hi-fi held a few years ago.

Beyond present stereo, the next advances will be made with 3-channel stereo and then with tape-recorded stereo.

GLOSSARY

AM—Abbreviation for amplitude modulation. This type of transmission is used by regular broadcast stations.

Distortion—the unequal amplification of signals of different frequencies. There is generally a band of frequencies that are uniformly amplified and frequencies above and below this band are amplified less.

FM—Abbreviation for frequency modulation. This type of transmission can provide hi-fidelity with almost no static or background noise.

Intensity—The volume of a sound wave.

Phase—The difference between the crest of one wave and the crest of another.

Stylus—The technical name for the needle in a cartridge.

Tweeter—A loudspeaker intended to reproduce very high frequencies.

Woofer—A loudspeaker intended to reproduce very low frequencies.

Directional Microphone—A microphone that records sounds directly ahead of it with more intensity than sounds to the side.

Air Photographs

(Continued from page 17)

the type of parent material, such as sedimentary deposits, glacial deposits and land forms like drumlins and kames in glacial areas, wind-blown sand dunes and sinkholes in limestone and clay shale hills. Organic and fine material appears dark in the photos and coarse material appears light. Drainage patterns, which are visible on aerial views, show the type of rock and bedding. A dendritic pattern indicates flat lying beds; a trellis pattern shows a golded or tilted bed; an irregular pattern shows a plastic soil; and a lack of a drainage pattern shows a porous material. The shape of gully systems also shows soil material. Sand and gravels are characterized by short V-shaped gullies while silts and clays have rounded V-shaped gullies. Little can be said about the interpretation of vegetation on an aerial photograph except that changes in vegetation show changes in soil. Land use can be utilized mainly in farm country if the agricultural practices of the area are known.

Soil maps of the area can usually be made up after all the information is obtained from the photographs.

Conclusion

As we have seen, the use of aerial photographs has become increasingly important. Photographs can be used for soil surveys, highway studies, land planning, ownership maps, and engineering in general. The determination of scale, the ground co-ordinates of a point, the flying height and the relief displacement on a photograph can also be determined.

Discontent can lead to big things

If you are afflicted with the divine discontent which is always seeking better ways to do things, you'll be in the mainstream at Douglas. We're working on some of the most exciting programs of tomorrow: new commercial jets...the biggest jet transport in the world...the S-IV and S-IVB stages of the moon-bound *Saturn*...more powerful *Delta's*, the world's most reliable space booster...manned orbiting space laboratories...many new defense systems. We've a lot to offer: advancement as fast as you qualify for it; nearby universities and a fine scholarship program; outstanding facilities and fine associates. You won't be jumping over the moon, like the Mother Goose bovine pictured, but we might have you figuring out ways to get there and beyond. Contact us. We are an equal opportunity employer.

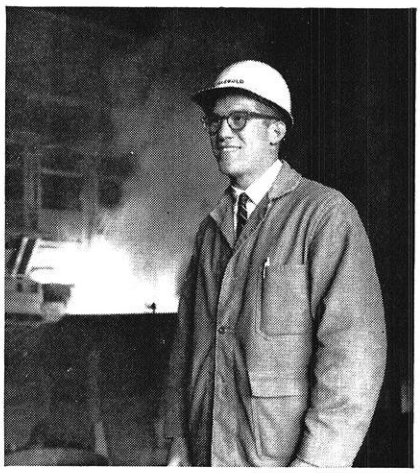
Douglas

Send your resume to
S. A. Amestoy, Box 693-X
Corporate Offices
Douglas Aircraft Co., Inc.
Santa Monica, California

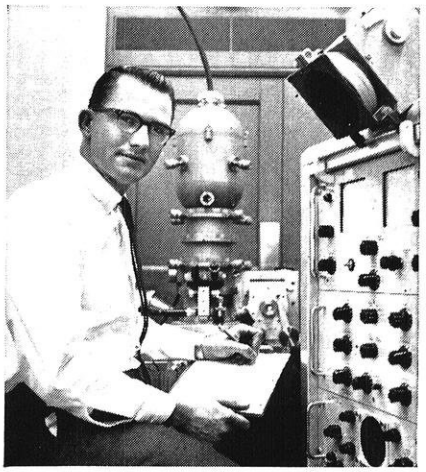
Men on the move at Bethlehem Steel

BETHLEHEM STEEL

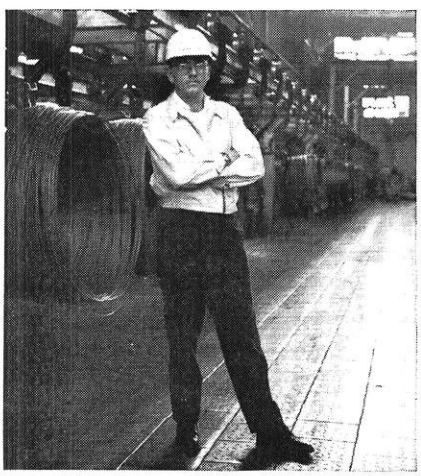
JIM DAVIS, CH.E., GEORGIA TECH '59
—Jim is a salesman in our Chicago District. His technical training has been a valuable asset in selling steel products.



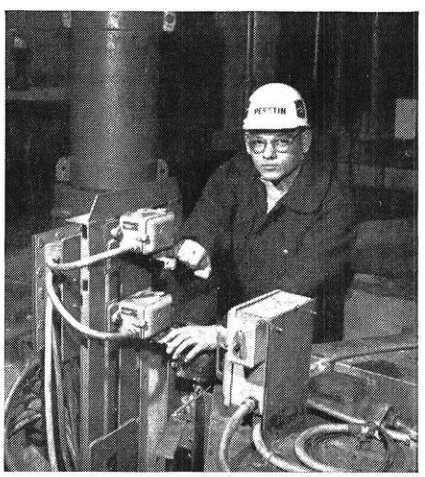
LEON HARBOLD, MET.E., LEHIGH '59
—Leon's many assignments around the open hearths at our Sparrows Point, Md., Plant led to his latest promotion as Assistant to the Superintendent of #3 Open Hearth.



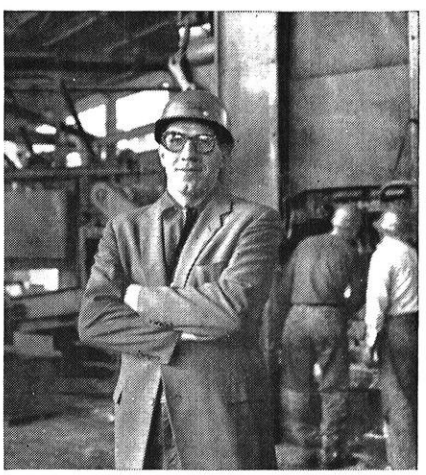
DENNIS WITMER, CH.E., MARYLAND '61
—An engineer at our research laboratories in Bethlehem, Pa., Dennis is shown using a microprobe to study corrosion-resistant coatings on sheet steel.



FRED EWING, C.E., CARNEGIE TECH '60
—Fred is a turn foreman, supervising a force of 130 men in the rod and wire mills at our Sparrows Point, Md., Plant, the nation's largest steel plant.



FRANK PERETIN, E.E., PITT '60
—As an engineer in the Johnstown, Pa., Plant Electrical Department, Frank's duties involve power generation and distribution, drive systems, and electronic controls.



BILL BALLEK, M.E., LAFAYETTE '62
—As turn foreman in the Bethlehem Plant forge shop, Bill supervises hammer forge and mechanical press operations. He also coordinates quality control for the entire shop.

These alert young men are a few of the many recent graduates who joined the Bethlehem Loop Course, one of industry's best-known management development programs. Want more information? We suggest you read our booklet, "Careers with Bethlehem Steel and the Loop Course." Pick up a copy at your Placement Office, or write to our Manager of Personnel, Bethlehem, Pa.

An equal opportunity employer

"PRINTABLES"

EE: "I hear the administration is trying to stop drinking."

ME: "That so? First thing you know they'll be trying to make the students stop too."

* * *

A college student arrived at the Pearly Gates where St. Peter asked him who he was. When told he was a pre-med, St. Peter said, "Go to the Devil."

Some time later a pre-law student arrived and upon being asked who he was, replied that he was a pre-law student. He was told to go to Hades.

The third student arrived at the Pearly Gates with his slide rule, when asked who he was, he replied, "I'm an engineer." Whereupon St. Peter said, "Come in, son, you've been through Hell already."

* * *

Ivan Papalosky liked to know all about the employees who toiled in his business. One day he came upon a new young man who was dexterously counting out a wad of the firm's cash.

"Where did you get your financial training, young man?" he asked.

"Yale," answered the young man.

"Fine," he said. "And what's your name?"

"Yackson."

Professor (pointing to a cigarette on the floor): "Jones, is this yours?"

Jones (pleasantly): "Not at all, sir. You saw it first."

* * *

Tourist Guide: "We are now passing the largest brewery in the United States."

EE: "Why?"

* * *

The M.E. instructor held the chisel against the rusted bolt. He looked at the M.E. student and said, "When I nod my head you hit it."

They're burying him at noon today.

* * *

The eager relatives gathered for the reading of the will. It contained one sentence. "Being of sound mind, I spent every damn cent I had."

* * *

Professor: A fool can ask more questions than a wise man can answer."

Student: "No wonder so many students fail your exams."

* * *

NROTC Student: "I haven't a pencil or paper for the exam."

Lieutenant: "What would you think of a soldier who went into a battle without a gun or ammunition?"

Student: "I'd think he was an officer."

Lecturer: If I talk too long, it's because I forgot my watch and there's no clock in this hall.

Voice from the audience: There's a calendar behind you.

* * *

Little Sheldon seemed to be enjoying himself thoroughly at the zoo with his father. As they were looking at the lions, however, a troubled look came over the boy's face and his father asked him what was the matter.

"I was just wondering, Daddy. In case a lion breaks loose and eats you, what number bus do I take home?"

* * *

The weird scientist looked over reports on his life-preserving tonic.

"Hmmmmm," he mused, "I see where my elixir has had its first failure—a ninety-eight-year-old woman. Ahhhh, but what's this? They saved the baby."

* * *

A student in our night-school class protested to the instructor that, although he hadn't missed a class, a notice had been mailed to him stating that he had been absent for three nights. After checking his records, the instructor agreed that an error had been made and assured the student he would straighten it out with the dean.

"It's not the dean I'm worried about," said the student. "Who's going to explain it to my wife?"

Meteorological Balloons

(Continued from page 20)

roughened balloons were much more stable than the smooth ones. The smooth balloons bobbed up and down next to the roughened ones which seemed to be virtually suspended in the sky.

Better weather forecasting is imperative. Shipping, aviation, industry and commerce as well as mechanized farming are all increasingly dependent on reliable weather forecasts. Better performance balloons are necessary to meet these demands. The newest versions of streamline balloons are capable of providing flight performance equivalent to that of the older versions and are considerably easier to inflate, launch and handle. Roughened balloons will find their place in Meteorology when they can be produced easily and cheaply and are proven superior to spherical balloons. New inflation shelters are being constructed so that balloons can be inflated and released in the strongest winds, thereby significantly improving balloon reliability.

Little progress has been made in the last 50 years for predicting weather more than three or four days in advance. Rockets and satellites are being used for upper atmosphere research but their use is still very limited. Balloons remain the Meteorologist's main tool for probing the atmosphere.

THE ENGINEER'S PSALM

Dr. ——— is my instructor;
I shall not pass.
He maketh me to exhibit mine ignorance before the whole class.
He telleth me more than I can write,
He lowereth my grade.
Yea, though I walk through the corridors of knowledge, I do not learn.
He tries to teach me;
He writeth the equations before me in hopes that I will understand them.
He bombardeth my head with integrations,
My sliderule freezeth up,
Surely enthalpies and entropies shall follow me all the day of my life,
And I shall dwell in the College of Engineering forever.

YOU CAN SHARE IN A GROWTH LIKE THIS

Whose growth? Fisher Governor Company, manufacturer of automatic controls for any and all fluids, gases or air that flow through pipe. We are the leader in our growing industry. Our sales have shown a relatively steady rise during the past decade (from 18-million to 41.5-million—a 130% increase in just ten years). See chart above. Our products—control valves, pressure regulators, liquid level controls and instruments—are key elements in industrial automation.

Location: Fisher is basically an "Engineering" company with 1,500 employees located in a pleasant Iowa community of 22,000. It's less than 10 minutes to the modern Fisher plant and engineering facilities from any home in Marshalltown. The community has an outstanding cultural and educational environment.

Type of work: Fisher offers a rewarding challenge to the graduate engineer (BS and MS) who is interested in design and development, research and test, sales or manufacturing.

Advancement: Coupled with Fisher's policy to promote from within, advancement opportunities reflect a growing company within a growing industry.

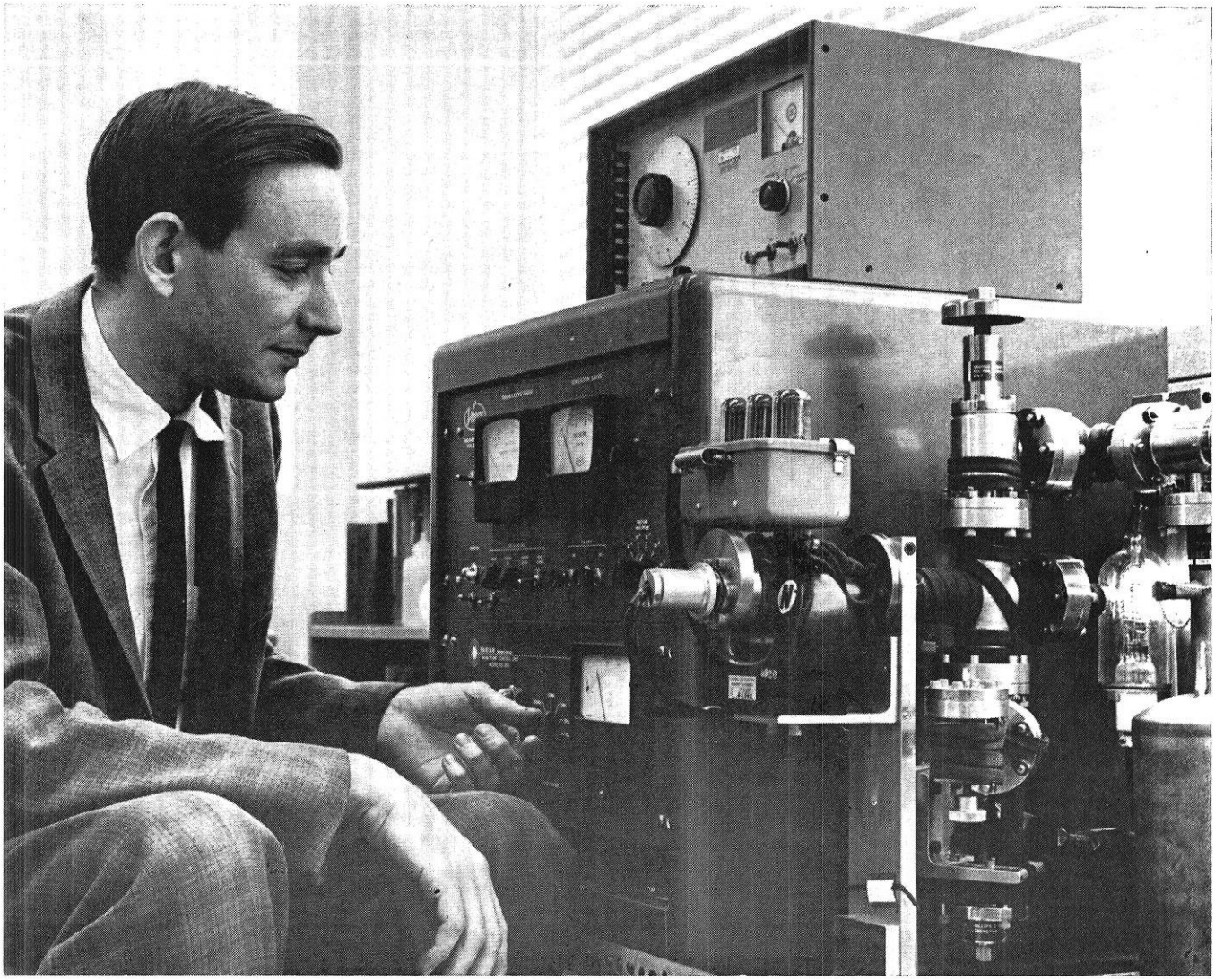
If a growing company like ours appeals to you, consult your placement office or write directly to Mr. John Mullen, Employee Relations Manager, FISHER GOVERNOR COMPANY, Marshalltown, Iowa.

An Equal Opportunity Employer

If it flows through pipe, chances are it's controlled by

FISHER® Controls SINCE 1880

#2 OF A SERIES



FROM CAMPUS TO CAREER WITH DELCO RADIO

Just 10 years ago, Max Stanton received his BA in Physics from Indiana University.

Today, Max is a senior project engineer at Delco Radio Division of General Motors Corporation in Kokomo, Indiana.

Max is shown above analyzing gas ambients found in sealed transistor enclosures. The system—a residual gas analyzer—is pumped down to a low vacuum with an absorption tank and vacion pump. Then a transistor is punctured and the gas introduced into the analyzer. Using mass spectrographic techniques, an analysis of the constituents through mass number 80 can be made. Such analyses are helpful in the study of surface effects in solid state devices.

Max Stanton has established a challenging and satisfying career with Delco—the electronics division of General Motors. As a young graduate engineer, you, too, could soon be on your way to a long-time, rewarding career at Delco.

Opportunities exist now in silicon and germanium device development, ferrites, solid state diffusion, creative packaging of semiconductor products, development of laboratory equipment, reliability techniques, and applications and manufacturing engineering.

Our brochure detailing the opportunities to share in forging the future of electronics with this outstanding Delco-GM team is yours for the asking. Watch for Delco Radio interview dates on your campus, or write to Mr. C. D. Longshore, Dept. CR, Delco Radio Division, General Motors Corporation, Kokomo, Indiana.

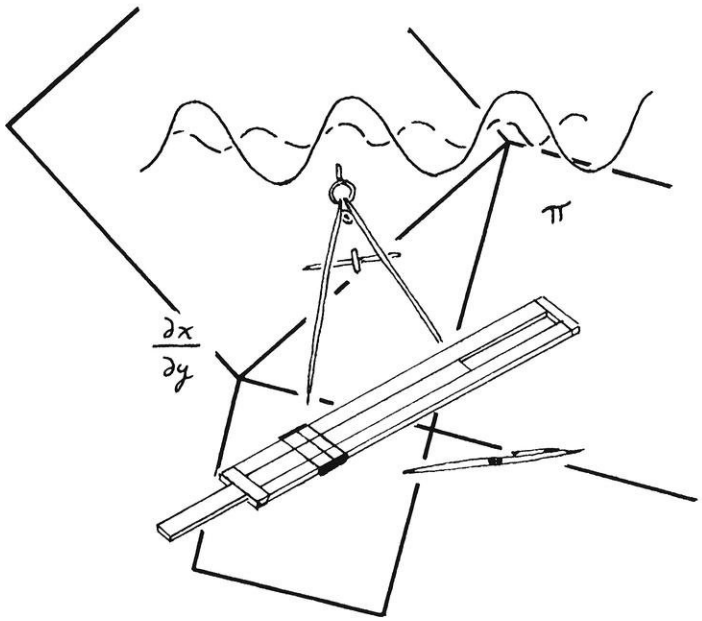
An equal opportunity employer

solid state electronics

DELCO RADIO DIVISION
OF GENERAL MOTORS
Kokomo, Indiana

THE

MENTAL MAZE



By CLIFTON FONSTAD, JR. ee4

THAT chubby little man with the shiny red cheeks and long white beard, and we don't mean the bartender at the local pub, brought the Mental Maze a Christmas present early this year. Yes, we've finally gotten a hairline for our slide rule. Not that that will help you work your way through the Maze and to the five dollars but it does tidy things up a bit. If you never noticed before that something was missing in the Mental Maze design you really can't be expected to get too excited over this great news but give it a try—look up an old issue and have a laugh.

And now, let's get started on the first puzzle—the first turn in this month's Mental Maze.

1. Three CE's were in a bookstore the other day looking at some maps. Being typical students they didn't have much money to spend —just a nickel apiece, in fact—but then some maps are cheap. The store offered maps of Southern Mongolia at 3 for a cent, maps of the Canary Islands at 4 for a cent, and maps of Devil's Tower National Monument campground at 5 for a cent. Each CE made a different selection, spent all his money, and got 20 maps. What maps did each buy?

2. Now, let's try a short thinking puzzle. Try to get the answer first without drawing a picture or doing any doodling. A wooden cube is painted black on all faces. It is then cut into 27 equal smaller cubes. How many of the smaller cubes will have three faces painted, two faces, one, none?

3. Here's another quicky; but be careful. If a brick balances evenly with three-quarters of a pound and three-quarters of a brick what is the weight of a whole brick?

4. If you're still with us try this number puzzle. Using the numbers from 1 to 9 once only once write them in such a way that by addition they give a value of 99,999.

5. The Maze thus far has been easy to get through but it looks like we'll have to slow down some. This problem could take some time.

A group of ten engineers, five EE's and five ME's, were cornered last week-end by a policeman who claimed that the boys were being a bit too noisy. He decided to take five of the group down to the station to cool off and in order to pick which five he had the ten arrange themselves in a circle and count off clock-wise around the circle. Every N-th guy would then be chosen and removed from the circle. The counting was to continue until five had been selected. To start, the officer selected one boy to pick the N to be used in the count-off and also to pick the person on whom to start the count-off. The ten engineers were arranged as shown below.

E N
E E
N N
E N
N E

If an EE got to pick the counting terms what N and what starting point could he have picked so that all ME's were chosen? Similarly, is there an N and a starting point so that all EE's will be picked?

6. Before we break out of this month's Mental Maze there is one more problem to solve. You have two coins whose sum is 55 cents. One of them is not a 50-cent piece. What coins are they?

ANSWERS: Last month's answers are:

1.
2. 100
3. 21
4. 2,499
5. a. 36, b. 27, c. 36, 25, d. 54, e. 29, 38, 47, 56

This year's first Maze Master and the winner of October's Mental Maze is David Olsen, a freshman EE at the University of Wisconsin. Competition is very keen this year so get your answers in early to the Mental Maze, 333 Mechanical Engineering, Madison, Wisconsin. Remember, you don't have to have all the answers right to win.

This is industrial engineering?

Yes.

And if that's all there were to it, our industrial engineering ranks couldn't possibly hope to deserve alert recruits from engineering colleges that lead rather than follow.

Watching an operator react to the explanation of a new assembly procedure is just one of the more easily photographed of a long series of subtle operations in the mathematics that link psychological, physical, and economic factors into a sense-making structure.

We admire fine intuitions in an engineer. We seek chaps who have involved themselves with nuts and bolts since childhood. Yet the task is to improve on the familiar fruits of intuition. The job consists of upgrading others' work and one's own to higher, more productive levels of abstraction than simple-minded busyness with nuts and bolts.

Kodak is of a size and diversity to afford room for more than one pattern in industrial engineering. A man's successive assignments here are as varied as his college courses. Confidence grows. He finds he has built a solid reputation by carrying a project from design to the stage, years later, where the aim is to squeeze another tenth of a percent into the production efficiency.

We also welcome another type. When a project reaches 80% of completion, this industrial engineering personality won't resent an invitation to form a new team with new counterparts in design and manufacturing engineering to start a new and more stimulating project. Gladly will he retain responsibility for the old one and six or seven that preceded it.

Drop us a line. Industrial engineers aren't all. We need to hear from mechanical engineers, chemical engineers, electronic engineers, chemists, and physicists as well.

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Advancement in a Big Company: How it Works

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

C. K. Rieger

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

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

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

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

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

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

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

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

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

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

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

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

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